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ACTIVE CHILDREN THROUGH INDIVIDUAL VOUCHERS – EVALUATION (ACTIVE): A MIXED METHOD RANDOMISED CONTROL TRIAL TO IMPROVE THE CARDIOVASCULAR FITNESS AND HEALTH OF TEENAGERS

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ABSTRACT

To experience the health benefits of physical activity, it is recommended that children and young people take part in at least 60 minutes of moderate to vigorous activity on average per day across the week. In Wales, only 11% of girls and 20% of boys are reported to meet these government recommendations with accessibility (e.g., cost and lack of local facilities) cited as the main barrier to participation. To date, interventions have experienced short-term success. These interventions often place emphasis on policymakers as the leaders, or experts on the matter in question. However, this can result in a disconnect between what is provided and what the group receiving the intervention value and need. The Active Children through Individual Vouchers – Evaluation Project (ACTIVE), funded by the British Heart Foundation (BHF), aimed to empower teenagers and tackle accessibility barriers to improve the physical activity, cardiovascular fitness, motivation and heart health of those aged 13 – 14 in south Wales. This study was co-produced by teenagers from its inception to delivery of the ACTIVE intervention and included a multi-component intervention encompassing a voucher scheme, peer mentoring and support worker engagement. The ACTIVE RCT had a positive impact on cardiovascular fitness and blood pressure as well as perceptions of activity. The findings from observational data provide some key predictors of teenage health which can be used to be proactive in promoting healthy behaviours in young people and identifies some protective factors which can be promoted to families and first-time parents. The key message from ACTIVE is that young people want to have their say in activity provision so that they can increase their opportunities to participate in unstructured, fun and social activity in their local communities. To improve physical activity, more should be done to listen to teenagers as to what they want and need.

DECLARATIONS AND STATEMENTS

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

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Date 23/02/2021

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly marked in a footnote(s).

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LIST OF ABBREVIATIONS

WHO – The World Health Organisation

MVPA – Moderate to Vigorous Physical Activity

MET – Metabolic Equivalent; Muscle Energy Technique

PE – Physical Education

UK – United Kingdom

NCD – Non-communicable Disease

UNCRC - United Nations Convention on the Rights of the Child

WFGA - Wellbeing of Future Generations Act

BME - Black and Minority Ethnic

AYPP - Active Young People Programmes

SDT - Self-Determination Theory

ACTIVE - Active Children through Individual Vouchers – Evaluation

BHF – British Heart Foundation

RCT – Randomised Control Trial

FSM - Free School Meals

BMI – Body Mass Index

GIS – Geographic Information Systems

MPAM-R - Motivation for Physical Activity Measure - Revised

BOKS – Build Our Kids Success Programme

WISH - Walking In Schools Intervention

PLAN-A - Peer-Led physical Activity iNtervention for Adolescent girls

GLAMA - Girls! Lead! Achieve! Mentor! Activate! Project

ASSIST - A Stop Smoking In Schools Trial

BGDP - Bristol Girls Dance Project

WIMD - Welsh Index of Multiple Deprivation

AYP - Active Young People

CRT – Cooper Run Test

BREQ-2 – Behavioural Regulation in Exercise Questionnaire

NHANES - National Health and Nutrition Examination Survey

RAI – Relative Autonomy Index

PWA – Pulse Wave Analysis

AP – Augmentation Pressure

AIx – Augmentation Index

SAIL - Secure Anonymised Information Linkage

CVD – Cardiovascular Disease

MICE - Multiple Imputation by Chained Equations

SEM - Structural Equation Modelling

ALF - Anonymous Linking Field

NCCHD - National Community Child Health Database

TECC – Tagged Electronic Cohort Cymru

CI – Confidence Interval

TA – Thematic Analysis

GP – General Practitioner

CHAPTER 1

INTRODUCTION

1.1 Adolescence: A key period of change

The teenage years involve many physical, emotional and cognitive changes. It marks the period of adolescence; defined as the period of development between childhood and adulthood (1). The beginning of adolescence is loosely attached to the onset of puberty (2) and ends at the point an individual attains a stable, independent role in society (3). During this time, teenagers begin to make decisions independently and therefore they become advocates of their own health and behaviours. Adolescence and the onset of puberty is associated with changes in motivations, psychology and social life/influence of peers (2). Along with the psychological changes associated with puberty comes the potential to make decisions with elevated risk such as experimenting with alcohol, tobacco and drugs (4). Risky behaviours coupled with an increasing trend in physical inactivity is a public health issue for the future health and wellbeing of young people.

Participation in sport and physical activity has been identified as one way of encouraging positive youth development (5). The United Kingdom's Department for Education states that sport is one of the five foundations for building character, developing resilience, determination and self-belief and instilling values of friendship and fair play (6). Being physically active in school and in the community is thought to promote better health behaviours and less risky behaviour in young people.

1.2 Defining physical activity

The World Health Organisation (WHO) defines physical activity as "any bodily movement produced by skeletal muscles that requires energy expenditure" (7, p.14). Original guidelines from the WHO stated that children and young people aged 5 - 17 years old should accumulate at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily (8). In 2020 these guidelines were updated from 'at least' to 'an average of 60 minutes of physical activity per day per week' reflecting evidence gathered by the WHO's Guideline Development Group (9,10). This should be of moderate to vigorous intensity and mostly aerobic activity across the week with the belief that some physical activity is better than none (9).

The WHO defines moderate-intensity physical activity as any activity with a MET value between 3 and 5.9 and vigorous-intensity physical activity as ≥6 MET (11). A MET refers to 'metabolic equivalents' and are used to explain the intensity of activities. A single MET would be the cost of 'sitting quietly' and is the equivalent to a caloric consumption of 1kcal per kilogram of bodyweight per hour (12). This includes aerobic activities such as play, games, sports, transportation, recreation, physical education (PE), or planned exercise in the context of family, school and community activities (8).

These guidelines were recently updated by the four nations in the United Kingdom (UK) (England, Scotland, Wales and Northern Ireland) drawing on the new evidence presented by the WHO. They echo that children and young people should engage in MVPA for an average of at least 60 minutes on average per day across the week (13). The new guidelines allow for the accumulation of activity throughout the week rather than a specific total per day, allowing a more flexible approach to achieving physical activity recommendations. The guidelines include all forms of activity such as PE, active travel, after-school clubs, play and sports. The rationale behind these guidelines is that this 60-minute threshold is required for health benefits. The benefits include improvements in body composition and the reduced risk of being overweight/obese, improved cardiorespiratory, cardiovascular and muscular fitness, improved cardiometabolic health (blood pressure and insulin resistance), the reduced risk of non-communicable disease (NCD) and improved bone health (9,14,15). Being active also has an impact on mental health by increasing wellbeing, self-esteem and socialization opportunities (16,17).

Fitness in reference to the cardiorespiratory system (the heart and lungs), cardiovascular system (the heart and blood vessels) and musculoskeletal system (bones, muscles, ligaments, tendons and connective tissue) is important in early life.

It has a protective value preventing the risk of NCDs in later life (18,19). One such NCD, cardiovascular disease (CVD), is the leading cause of mortality and morbidity worldwide (19). CVD risk factors should be low in young people but the rise in childhood inactivity and poor cardiovascular fitness in particular has led to an increase in prevalence and potential impact on lifetime CVD risk (20,21). Therefore, improving activity levels and cardiovascular fitness is important to benefit the cardiovascular health of the general population.

The UK has the tenth-highest rates of obesity globally with 26% of the population reported as obese (22) and 14% of children reported as overweight (23). The WHO regards obesity as one of the most serious public health challenges of the 21st century (24). The consequences of inactivity are not just a health issue, they are a social one too. It brings people together to enjoy shared activities and contributes to building strong communities. The Chief Medical Officers for the four nations describe physical activity in a compelling way; “If physical activity were a drug, we would refer to it as a miracle cure, due to the great many illnesses it can prevent and help treat” (13, p.3).

In early years and childhood there is a focus on ‘play’ as a form of physical activity but also as a way of learning. Wales adopted a play-based curriculum for pupils between the ages of 3 – 7 in 2008 following a global trend that saw school subjects clustered into more holistic areas of learning (25). Play is defined as “…freely chosen, personally directed and intrinsically motivated” (26, p.14) and is performed for no reward but is fundamental for health development (27). Wales has become the first country to legislate for play publishing its play policy in 2002 and subsequent relevant guidance (26,27). Welsh Government policy states that play can reduce inequalities due to its accessibility and is critically important to all children in the development of physical, social, mental, emotional and creative skills (27). There is also importance placed on the role of play in physical literacy, defined as “the motivation, confidence, and physical competence, knowledge to value and take responsibility for engagement in physical activities for life.” (25, p.432). Thus allowing activity to be confidently sustained into adulthood (28).

This has been underpinned by the child's right to play enshrined in the United Nations Convention on the Rights of the Child (UNCRC) (29). Article 31 of the UNCRC calls for young people to be able to participate fully and equally in recreation and leisure activity. It also calls for them to have a right to be heard and taken seriously on all matters affecting them (Article 12) and to gather and use public space (Article 15). The UNCRC defines being a child as being under the age of 18 (29,30) therefore teenagers have a right to be offered this opportunity too.

Rather than the concept of play, physical activity and 'sport' in its traditional form is upheld for older children in the UK's secondary schools in the national curriculum as PE. Promoting the widely believed spiritual, moral, cultural, mental and physical development of pupils (31) attributed to participation in the form of football, netball, rugby and hockey. The Education Act (2002) prohibits prescribing the amount of time to be spent on any curriculum subject, and as a result the UK government does not set a target for how much curriculum time schools must dedicate to PE (31). However Department for Education guidelines recommend schools provide a minimum of two hours per week (32) but with increasing pressure for schools to perform in formative assessments time dedicated to PE is reduced as pupils progress through secondary school.

On average pupils in Key Stage 4 (aged 14 – 16) receive 98 minutes of dedicated PE time each week (31). The minimum content changes as a pupil transitions through key stages. The PE curriculum is much more prescriptive in early key stages (e.g. athletics, football, netball), ending at Key Stage 4 where individuals are given the opportunity to plan and participate in a regular and balanced programme of PE (33).

In 2011 the Welsh Government committed to make physical literacy as important as reading or writing to develop a physically literate nation as a key part of improving engagement with lifelong physical activity (34). The Welsh national curriculum is at an important juncture with the proposal of a new curriculum to be rolled out nationally by 2022 (35). Since 2016 the Welsh Government has worked with a network of pioneer schools and experts to co-produce a curriculum that better reflects wider national and societal needs. Within this proposed new format health and wellbeing features as one of the six areas of learning and experience, thus assuming a much more prominent position on the school agenda. Moreover developing physical health and wellbeing and participating in regular physical activity is explicitly mentioned (36) with a focus on developing and promoting confidence, enthusiasm, commitment and the self-motivation to do so.

1.3 Physical (in)activity

Globally, it is estimated that 80% of teenagers are not sufficiently active (37). In Wales only 11% of girls and 20% of boys are reported to meet recommendations (38). The Active Healthy Kids Report, a global alliance of 52 countries worldwide, ranked Wales a 'D+' for physical activity and an 'F' for sedentary behaviour with 80% of children reporting sitting for two or more hours in their free time (39). There is an increasing trend for teenagers to be sedentary due to the increased availability of electronic forms of entertainment (the internet, television, mobile phones and video games) (40). Evidence shows that physical activity continues to decline throughout adolescence (14) and that there are differences in boys and girls, with girls likely to be less active (17,41–44).

Although physical activity and MVPA decreases in both boys and girls, this decline is much steeper in girls (17). According to the Active Healthy Kids – Wales 2018 Report (45), a significant effort needs to be made to address the very high levels of sedentary behaviour among young people in Wales. This has been echoed in a joint statement from Public Health Wales and Sport Wales who together state that the passive attitude towards activity, where movement and exercise is viewed as a personal choice, is not sustainable and is an issue that needs to be addressed (46).

Wales has world-leading legislation which puts the country in a unique position to make progress with physical activity in young people. Developments in the new curriculum and legislation such as the Wellbeing of Future Generations Act (WFGA) (47), the Active Travel Act (48) and the previously mentioned Play legislation (27) requires public bodies to make provision and to implement change in the pursuit of economic, social, environmental and cultural wellbeing of Wales. The WFGA features seven wellbeing goals and includes 'A healthier Wales', 'A resilient Wales' and ‘A Wales of cohesive communities’ as notable objectives (47). However, reports such as ‘Getting Wales Moving’ (46) note that despite this legislation little progress has been made.

Sport Wales is the national organisation responsible for increasing participation and performance in sport. Their vision is to create an active nation where everyone can have a lifelong enjoyment of sport where the benefits of sport can be experienced by all (49). This is underpinned by the WFGA. The body recognise the importance of participation during childhood and how this can develop essential physical skills that build confidence and enjoyment (49). Their intent is to be person-centred, to give every young person a great start, to ensure there are opportunities for all, to bring people together, to showcase the benefits of sport and to be a highly valued organisation (49). There is a clear focus on sports participation outlined in Sport Wales reports and guiding documents. While physical literacy is woven through this, there is little reference to activity and play particularly for teenagers and in the secondary school setting.

Sport Wales conducts one of the largest national surveys of physical activity in Wales under their School Sports Survey. Since 2011, this survey has captured a detailed picture of frequency of participation in young people (50). In 2018 it estimated that less than half of those in school years 3 – 11 (aged 7 to 16) are participating in organised sport in extracurricular terms more than three times per week. With Black and minority ethnic (BME) groups, more deprived young people and females are the least likely to participate. Participation levels in Wales remain stagnant and inequalities are increasing (50).

In the school setting Sport Wales have invested £5 million per annum in Active Young People Programmes (AYPP). These are led by local authority staff and are designed to promote and sustain sports participation. They target those less likely to get involved in school sport via PE (51). Recently AYPPs have transformed to include; i) the insight of young people, ii) flexible approaches between local authorities, iii) to widen the focus into the community as well as school setting and, iv) to connect to education contributing to curriculum needs, teacher skills and promotion of physical literacy (51). The journey to this current form of AYPPs stemmed from Dragon Sport in primary schools in the early 2000's. The success of this project left an extracurricular gap in provision when pupils transitioned to secondary school, hence the 5x60 Programme was piloted in 2004/05 and launched nationally in 2009 (51). The idea behind this offers secondary pupils the opportunity to engage in at least five sessions of 60 minutes of physical activity a week. There is a strong ethos of consultation in the 5x60 Programme with activities tailored to young people's preferences (51).

1.4 Facilitators of activity

Sport Wales acknowledge the multitude of factors that affects physical activity and sport participation. Their strategy reflects this by promoting activity in schools, homes, communities, individually, in groups and inclusively. Socio-environmental settings (homes, communities, schools) are important actors in the promotion of physical activity. Like any type of health promotion, acknowledging how a setting is conducive to health is important. Research suggests that the local communities that children and young people occupy have an effect on their sense of belonging, levels of self–esteem and their social and emotional wellbeing (52). This includes their homes, schools, residential streets, city or town centres and cyberspace.

In more specific terms for physical activity, previous research using objective measures of accelerometry has shown the number of park spaces, multi-use pathways (e.g. pavements for walking and cycling) and gyms in local neighbourhoods positively influences activity levels (53–55). Being within walking distance of these spaces is beneficial for young people's health and fitness (54,56). Independent mobility is decreasing in teenagers (57). Therefore supportive environments that facilitate local activity should be valued when planning activity promoting interventions for this age group (58,59).

As explained by Naidoo and Wills (60), the settings approach to promoting health behaviour is designed to introduce interventions to create healthy environments, develop policies and integrate quality, audit and evaluation procedures to allow an environment to perform better (60). The most well-known example of this kind of settings-based health promotion is the Healthy Cities project by the WHO (61). In terms of physical activity, a healthy city will provide and sustain opportunities to be active through legislation such as the likes implemented in Wales (play, active travel and WFGA). This approach is complex and also conceptualises health as determined by a range of socio-economic, organisational, environmental and personal factors (60).

Bronfenbrenner's socioecological model (62) is a framework that shows how various factors and levels affect health. These are shown in the model as layers (Appendix 1). This model has been used to understand physical activity and how the relationships between individuals and the social, physical and policy environment influence decisions to participate (63,64). The most successful programmes are based on an understanding of this (63), bringing into context how an individual's characteristics, parents, friends, colleagues, schools, homes, communities, local governments, resources, mass media and culture can all facilitate physical activity.

1.5 Barriers to being physically active

Accessibility (in terms of ease of access) has been reported as the main barrier to being active for teenagers (16,65–67). This is affected by cost, lack of local facilities and, motivation to be active among teenagers (65,68,69), especially those from more deprived backgrounds (70). In terms of cost, young people report that activities they want to do are often too expensive or the equipment to take part is costly. In particular they note having to ask their parents and the burden this places on their guardians to provide finances (70). This also means teenagers do not have the freedom to go and be active at their own autonomy. For more deprived children, this cost is inflated due to activities being located in more affluent areas and so a form of transport is also required (68). Value for money has also been identified under the cost barrier with young people highlighting how the quality of activity/facility is also important to them (71).

Due to the extra cost of travelling, activities are typically limited to locations that teenagers can access by walking or cycling (54). Therefore, the location of provision is important to improving activity levels. Distances from homes to activity enabling spaces has suggested that being within walking distance of these amenities is beneficial for teenage health and fitness, with girls needing to live closer to experience benefits (54,56). With independent mobility on the decline, it is important that environments foster the characteristics that make them accessible to young people. In particular, walkability, connectivity and a close proximity to activity provision.

Many physical activity interventions have chosen to focus on these barriers (i.e. cost or location) to underpin their approaches to activity promotion in the school setting (17,65,72,73). The school has been noted as an important setting for physical activity promotion as it reaches a large amount of young people (74,75). Interventions in the school have been prescriptive whereby teenagers are given access to specific activities or teaching strategies (17,73). These interventions have observed mixed success, often only increasing activity in the short-term (73,76). Once the intervention is over, they fail to provide on-going opportunities.

This style of intervention design and implementation is 'top down' with the emphasis on policymakers as the leaders, or experts on the matter in question. However, this results in a disconnect, or 'policy gap', between what is provided and what the group receiving the intervention value (16,65,67,77). Article 12 of the UNCRC calls for young people to have the right to express their views in all matters affecting them (29) and therefore, they should be involved in the intervention design process.

Involving target populations in policy-making processes is said to increase their legitimacy, justifiability and feasibility over those made through more traditional, top-down methods (67,78). Co-producing interventions in this way are more responsive to individual's needs (79,80). When discussing activity with teenagers, research has shown that there is a difference between current activity provision and what young people want and recommend (16,65,81). Therefore, involving teenagers in the design and implementation of physical activity initiatives may be key in influencing the uptake, sustainability and enjoyment of activity among this age group (82,83).

1.6 Motivation to be active; Self-Determination Theory

In terms of motivation to be active, Self-Determination Theory (SDT) (84) has emerged as a popular theoretical framework for examining motivation and physical activity (85). It helps provide insight into why an individual may adopt and maintain health behaviours (86). Although motivation is often treated as a singular construct, SDT suggests that people choose to act by different types of factors (84). The theory differentiates between controlled and autonomous forms of motivation; with 5 motivation regulations existing across these two categories (85).

Autonomous forms of motivation include integrated, intrinsic and identified regulation. Integrated regulation is the most self-determined type of motivation and occurs when an individual is active because it aligns with their personal values and their 'sense of self' (85). Intrinsic regulation is when an individual will participate in an activity for an activity's sake (86) or simply, because they deem it enjoyable and interesting (85). Finally, identified regulation exists when an individual sees activity as beneficial or important, even when the activity itself might not be deemed enjoyable (86). Autonomous motivation overall is regulated by feelings of enjoyment, personal importance and personal values (87). Therefore, physical activity is adopted and maintained based of these motivation characteristics.

Conversely, controlled forms of motivation include external regulation, introjection and amotivation. External regulation is when being physically active is as a result of satisfying an external requirement (86), for example to gain a reward or avoid a punishment (85). Introjection occurs when feelings of guilt or negative feelings drive being active (85,86). Amotivation refers to the absence of motivation altogether (85).

SDT helps provide a rationale for why individuals choose or do not choose to be active. For example, some individuals may value activity for fun and be inclined to be active if the enjoyment of taking part is a priority. Some may only be active as a result of pressure from external sources for example, from teachers or parents. Or perhaps, inactivity is result of negative feelings towards activity. The theory suggests that autonomous forms of motivation will result in sustained participation whereas controlled forms will promote behaviours only in the short-term (85).

1.7 The ACTIVE Project

The Active Children through Individual Vouchers – Evaluation Project (ACTIVE), funded by the British Heart Foundation (BHF), aimed to tackle accessibility barriers and increase physical activity in teenagers (aged 13 – 14) by giving teenagers vouchers to spend on activities of their choice. This study was co-produced from its inception and preliminary feasibility study all the way through to the creation of the randomised control trial (RCT) and delivery of the ACTIVE intervention. The co-production element meant that the motivation of teenagers could be better understood and utilised in line with SDT, improving the likelihood of delivering a successful trial.

Initially the concept of the study began with interviews with teenagers (aged 16 – 18) in participating schools in South Wales, UK (16). This took a child-focused approach to explore how interventions should be designed. Findings concluded that interventions need to improve access to facilities but also counteract the rhetoric that teenagers need to be studying all the time; that 'hanging about' with friends is also an essential part of youth development (16). This value of activity needed to be promoted widely to the community, to teachers and the media, essentially to all the levels within Bronfenbrenner's socioecological model (88).

1.8 The feasibility study

The ACTIVE feasibility study (65) was a mixed method cohort and process evaluation study of a single secondary school in a deprived area of Swansea, South Wales. The school was classed as deprived based on: i) the number of pupils eligible for free school meals (FSM) (54% at time of study) (89), ii) the area's eligibility for community-based initiatives and funding (e.g. Communities First) (65) and iii) the location in one of Wales' most deprived areas for children (90).

The study measured outcomes (physical activity via accelerometer wear over seven days, cardiovascular fitness, self-reported activity and focus groups) at three different time points (baseline, five months (during intervention) and 12 months. All Year 9 pupils in the school were given activity vouchers (n = 115; 51 % boys). In this study, vouchers were used to empower teenagers to be consumers and influence activity provision in their area (65). In this instance, ACTIVE encouraged friends to socialize through activity, and enabled students to access activities they normally could not afford (65). The feasibility study found increases in MVPA and decreases in sedentary behaviour, suggesting a positive impact from voucher usage (65). Process evaluation based on the RE-AIM Framework (91) demonstrated that ACTIVE was well received by pupils and teachers and was a feasible approach to increasing activity in this age group (65). Furthermore, the approach was highly supported by teachers and pupils who encouraged the development of a larger trial (65).

Adjustments were made to the ACTIVE RCT protocol following these outcomes and recommendations from funding partners. These adjustments were made to further improve the project and increase its sustainability, prior to conducting an RCT in order to assess effectiveness rather than its feasibility (92).

1.9 The ACTIVE Randomised Control Trial

The ACTIVE Randomised Control Trial (RCT) explored in this thesis was developed as a result of the feasibility study and follow-up conversations with teenagers recommending what they felt was needed to improve PA opportunities and subsequently, cardiovascular fitness, physical activity and cardiovascular health (16,69). The findings from the initial studies showed that teenagers wanted more choice over the activities they participate in rather than the traditional, structured exercise. They also wanted more information as to what is available in their local communities.

This mixed-method RCT aimed to assess whether a voucher-based multi-component intervention can improve the health of participating teenagers in seven secondary schools. To overcome accessibility barriers, voucher-based interventions to increase PA in the United Kingdom have been previously tested among adults (93,94). Financial incentives have been effective in increasing PA in adults (72,76,95), but it remains uncertain whether a similar approach could work with teenagers (92).

ACTIVE encouraged teenagers to access existing provisions or generate their own to tackle accessibility issues and create the opportunity to participate in desired activities (65,92). Evidence has shown that empowering teenagers to make their own choices over which activity they engage in, the location where they engage, and the people they participate with, can improve activity levels (80). ACTIVE also encouraged teenagers to express the importance of choice and empowerment in advocacy meetings with stakeholders. As a result, the project aimed to enhance socialisation and peer support, in order to facilitate PA uptake. This has been positively associated with teenage activity levels (96). In response to this, the ACTIVE RCT aimed to empower teenagers to make their own activity choices via a voucher scheme, peer mentoring and support worker engagement.

This thesis explores whether ACTIVE's intervention encompassing a voucher-scheme, peer mentoring and support worker engagement improved the cardiovascular fitness and cardiovascular health of participating teenagers in four intervention (compared with three control) secondary schools in South Wales. Moreover, novel data linkage and accessibility modelling are used to explore predictors of heart health and activity in young people from baseline data collection, providing further context to the current landscape of activity provision in the UK.

It explores teenage physical activity through a co-produced narrative, working with teens to inform how we can meet the wants and needs of teenage activity. It allows young people to tell their story by empowering them to have a voice on matters which not only benefit them, but also the wider community. Not only will this study present the findings of an RCT but will also discuss next steps, future developments and the implications of ACTIVE.

CHAPTER 2

AUTHORS CONTRIBUTION AND THESIS SIGNIFICANCE

The ACTIVE RCT was a novel approach to promoting physical activity to teenagers with the aim of improving cardiovascular fitness, physical activity levels, cardiovascular health and motivation to be active amongst young people. The authors role within the RCT was to manage the project and a respective team of individuals who helped collect data and provided critical input when necessary.

2.1 Conception of the work

ACTIVE was conceptualised through initial conversations with teenagers regarding barriers to being active and possible recommendations. This work was led by Professor Sinead Brophy, who supervised this thesis. From this start point, a feasibility study was developed and led by Professor Sinead's team. The work of this supported the development of a bigger trial. The development and implementation of this RCT was managed by the author. The author designed, wrote and implemented the protocol (92).

This work was funded by the British Heart Foundation who peer reviewed the protocol at the time of grant application but had no further involvement other than providing funding. The grant application was developed alongside co-applicants. Co-applicants were involved due to their expertise in their areas.

2.2. Data collection

Data collection took place between September 2016 and December 2017. This process was planned, managed and carried out by the author alongside a small team of six individuals who assisted with various measures. Members of this team feature as co-authors on published articles where applicable.

Where feasible, the author took a lead in the data collection from baseline to 12-month follow-up while assigning suitable roles and responsibilities for the team. In particular, the author led the fitness data collection in terms of the Cooper Run Test as well as assisting in measures of motivation, blood pressure and pulse wave analysis. For the latter, colleagues at Swansea University's Medical School helped produce a protocol alongside the author that could be followed by the team.

Focus groups were led by the author with support from members of the team. The author acted as the lead moderator with support from team members who took notes. Topic guides for the focus groups were constructed by the author.

2.3 Data analysis and interpretation

Data was managed, analysed and interpreted by the author. Critical input was applied from the supervisory team; Professor Damon Berridge, Professor Sinead Brophy and Dr Richard Fry. The author worked with the supervisors to develop an analysis plan which was then led and carried out by the author.

The author sought assistance from a second analyst to ensure the validity and reliability of analysis. In this instance, the second analyst was asked to reproduce findings using the same methods. This was to remove any researcher bias that may occur.

Findings were interpreted by the author alongside the supervisors. Where applicable the author wrote the first draft of the research outputs from this study with critical input from co-authors who were either co-applicants of the initial RCT grant or those involved in the data collection processes.

This thesis has been written by the author with the supervisory team providing input and revisions where necessary. The final draft of this thesis is the authors own work.

2.4 Thesis contribution to knowledge and significance

The ACTIVE RCT was developed following initial work with teenagers and a feasibility study. It was co-produced by teenagers following subsequent conversations recommending what they felt was needed to improve physical activity opportunities and fitness. This made it a novel study with a flexible approach to tackling teenage inactivity underpinned by the wants and needs of the participants. The multi-component nature of the intervention aimed to empower teenagers in a multitude of ways, encompassing both the school and community setting. This meant it was not prescriptive in nature, but allowed young people to explore activities they enjoyed with their friends and at their own leisure. This is an aspect of physical activity interventions that is often neglected. Thus, ACTIVE contributes to existing knowledge surrounding physical activity by taking a novel approach.

Moreover, ACTIVE uses novel data linkage methods to provide insight into the health of teenagers. This method has not been widely used in previous literature and therefore, this is a significant contribution to existing knowledge.

The work of ACTIVE is embedded in the theoretical framework of Self-Determination Theory, understanding that motivation is not singular but encompasses a range of regulations which will impact uptake and sustainability; therefore, understanding that teenagers may want and need different things dependent on the individual. This work's evidence combined with existing evidence highlights the significance of co-producing interventions alongside young people. By doing so, interventions are tailored to the wants and needs of participants, thus improving the likelihood of their success.

The significance of this work is underpinned by the learning from what teenagers choose to do when given the opportunity to choose their own activities. Particularly for teenagers, it is important to encourage enjoyment and socialisation in activities. Providing more local opportunities for teenagers to take part in activities that are fun, unstructured and social improves fitness, cardiovascular health and, changes attitudes towards activity.

CHAPTER 3

LITERATURE REVIEW

To assess the current landscape of physical activity, cardiovascular health and motivation in teenagers, searches of three databases; MedLine, PubMed and Scopus were conducted in February 2020. Hand searching was also used to identify literature ensuring relevant studies were not overlooked. The search process used combinations of the words: *"physical activity", activity, fitness, teenage*, adolescen*, intervention, "cardiovascular fitness", exercise, barriers, motivation, "cardiovascular health"* and "*environment"*. Boolean operators were used to form more focussed searches. Date parameters were set to narrow the search to more recent publications which would reflect contemporary research on teenage physical activity. Publications meeting the following criteria were retained for review (Table 1).

Table 1 - Inclusion criteria for literature review

Date of publication	2010 - 2020
Participants	Identified as healthy children, adolescents/teenagers, adults in the literature
Setting	School (extra-curricular) or community
Outcome measure	Physical activity (self-report or objective), cardiovascular fitness (objective), motivation, heart health (objective), focus groups/interviews
Research design	Cross-sectional, qualitative, randomised control trial, mixed methods

After scanning titles in this search process, 78 remained. On closer review a further 49 were removed as they did not meet inclusion criteria. For example, they were not written in English (n=4), included participants outside healthy children, teenagers and adults (n=20), were protocol papers or systematic reviews (n=5), used technology/apps in their interventions (n=4), were carried out in other settings (e.g. care homes) (n=9) or used measures not relevant to this study (n=7). After these exclusions, a total of 29 publications remained from the original search and further

13 publications were included as a result of citations, hand searching, and the authors own collection (Figure 1).

3.1 Publication descriptives

A total of 42 publications (Appendix 2) were included in this review from both intervention (n=20) (counting 5 pilot studies) and cross-sectional (n=22) research. Studies were from Europe (n=24 [17 from the UK]), South Africa (n=1), Australia (n=3), South America (n=2), North America (n=10) and Asia (n=2). The majority of studies were carried out in the school setting (n=28) with 20 of those taking place in secondary schools (aged 11 – 16).

The most commonly used measure in these studies was a self-report questionnaire investigating the amount of physical activity and, wellbeing and motivation (n=18). Focus groups (n=16), anthropometry (n=13), physical fitness (n=12), accelerometery (n=11), geographic information systems (GIS) (n=5), step counts (n=2) and data linkage to routine data (n=1) was also used. It is worth noting that seven of the studies included were mixed methods and therefore several measures feature in a single study.

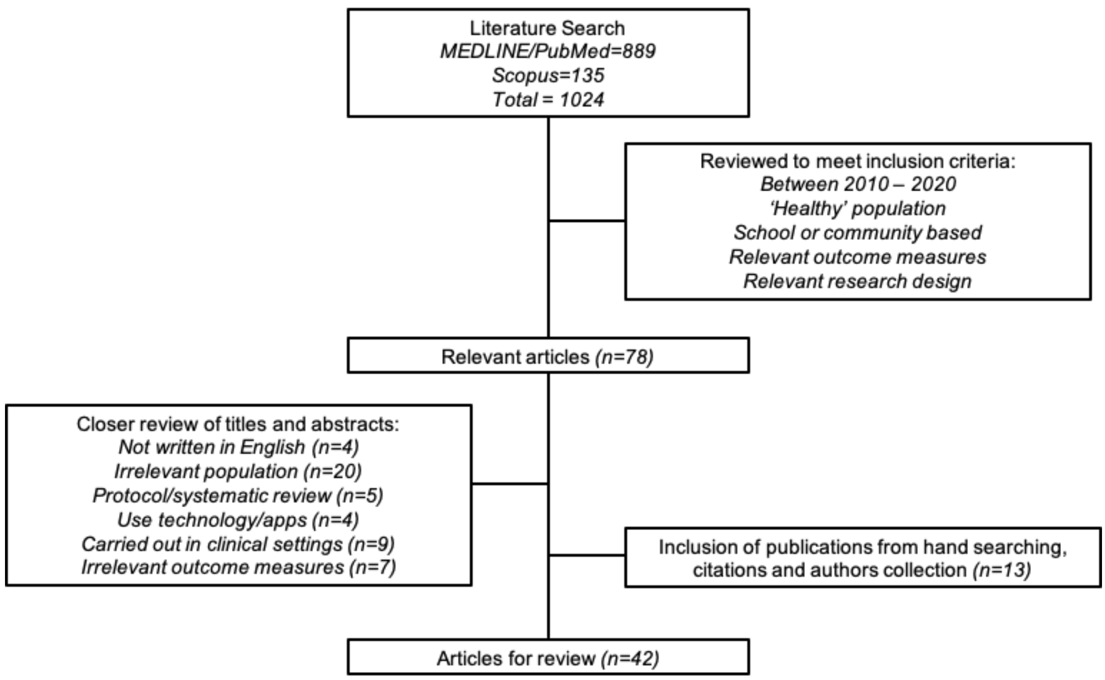

Figure 1 - Flow diagram of literature search

3.2 How important is physical activity and what facilitates it?

The health benefits of participating in regular physical activity is widely acknowledged in public health. Young people, especially those from more deprived backgrounds, are less likely to engage in activity in the form of structured activities and competitive sports. Subsequently they are at an increased risk of more sedentary lifestyles. These traits may also cluster with other health behaviours (e.g., diet) which can contribute to cardiovascular disease risk when a child is older. Consequently, prevention strategies that decrease sedentary behaviour have been designed to combat this issue.

Rangul et al. (19) examined the effect of sustained physical activity in general on cardiovascular risk and health status in adulthood in a 10-year longitudinal study. Using Norweigan health surveys, 1869 participants (n=838 male) gave information regarding activity levels, mental health and perceived health along with objective measures of body mass index (BMI), waist circumference, cholesterol, blood work, heart rate and blood pressure at 13 – 19 years old and again at 23 - 31. Maintainers of activity had lower heart rate and active boys had lower waist circumference than inactive participants. In conclusion, those who maintained physical activity levels had lower disease risk and better mental health (19).

Sedentary behaviour is also a risk factor in low cardiovascular fitness. Denton et al.'s (97) work assessed how sedentary behaviour and different physical activity components are associated with fitness in 10–14 year-old schoolchildren. This was done using accelerometry (RT3 devices) and using activity thresholds developed by Rowlands et al. (98) to determine the time spend in sedentary, light, moderate or vigorous physical activity. Participants also undertook a fitness test; a cycle-based ergometer test. This study found vigorous activity holds greater potential for cardiorespiratory fitness compared to activity at lower intensities. There was no relationship between sedentary behaviour and cardiorespiratory fitness. This suggests activity promotion should focus on higher intensity physical activity and not simply removing sedentary behaviour as a means to maintain or improve cardiorespiratory fitness (97). This is echoed by the work of Taber et al. (99), who performed a similar lab-based fitness assessment with 1,029 13 – 14 year old girls compared with self-report data on participation in sport. They concluded that the number of vigorous sports is positively associated with fitness ($p = 0.04$). Thus, promoting vigorous activity at an early age can prevent age-related declines in fitness among adolescent girls in particular.

However Young et al. (100) highlight how complex moderate to vigorous physical activity (MVPA) is due to how predictors differ between ages in girls. Lower body fat, more social support and interestingly, lower maths scores were associated with higher MVPA in 11 – 14-year-old girls but self-efficacy/motivation was associated with higher levels in older girls. Accelerometery was used again to assess activity using ActiGraphs. Cut points were derived from the researchers of this study and therefore may not be as valid as other more widely used methods.

Interestingly Young et al. (100) examined neighbourhood level influences using geographic information systems (GIS) which modelled the distance from participant's homes to their schools and park provision. This piece of work noted that individual, social, school and neighbourhood levels are all associated with MVPA, but the level of their influence differs across ages. The authors note that to achieve behaviour change towards more active lives, intervention planners need to consider not just the barriers and motivations to being active but also the school/neighbourhood environments in which young people live (100). Perceived and objective access of supportive infrastructure (e.g. parks or schools) correlated with MVPA, which according to previous studies would also contribute to greater fitness levels (97,99).

Boone-Heinonen et al. (101) investigated which areas of neighbourhoods are specifically related to physical activity in those aged 11 – 22. The study used data from the National Longitudinal Study of Adolescent Health featuring measures of self-reported MVPA from over 20,000 respondents. Associations were then explored between activity and physical activity facilities counts and street connectivity within 1, 3, 5 and 8.05km (Euclidean distance) of each respondents home (101). Similar to Young et al. (100), supportive environments were concluded to be conducive to MVPA. In particular, resources for activity within 1 – 5km helped with improving activity levels alongside better connectivity.

Although a significantly smaller sample (n=293), a study by Rodriguez et al. (102) explored the built environment's impact on female activity (aged 15 – 18). In a similar methodological approach, the built environment was mapped in a GIS alongside participant homes. The odds of higher physical activity were higher in places with parks, schools and larger population (102). Activity was lower in places with more roads and food outlets. This is interesting as increased roads would suggest better connectivity, yet Boone-Heinonen et al.'s (101) work notes that it is street connectivity and walkability that is necessary to improve activity.

Villa-Gonzalez et al. (103) and Wheeler et al. (104) have examined the environment in relation to active travel infrastructure and greenspace respectively. Villa-Gonzalez et al.'s (103) study used 494 children (229 girls) from five primary schools in Granada and Jaén (Spain), aged between 8 and 11 years. Participants completed a fitness test battery and answered a self-reported questionnaire regarding the weekly travel mode to school. Active commuting to school was significantly associated with higher levels of speed-agility in boys ($p = 0.048$) and muscle strength of the lower body muscular fitness in girls ($p = 0.016$) (103). However, there was no relationship with cardiovascular fitness. The authors acknowledge more work needs to be done examining these relationships and its location makes it difficult to generalise. Yet it does highlight the importance of good active travel infrastructure.

In Wheeler et al.'s (104) study, most activity occurring outdoors performed by 10 – 11 year olds in the United Kingdom was not in greenspace. However, when boys were in greenspace activity is likely to be higher intensity. The odds of being in MVPA in greenspace relative to outdoor non-greenspace was 1.37 (95% CI 1.22–1.53) for boys and 1.08 (95% CI 0.95–1.22) for girls. This provides evidence that young people can and will be active anywhere. Participants wore an ActiGraph accelerometer and GPS tracker over 7 days.

GIS has emerged as a novel method for exploring how an environment can impact physical activity and provides important insight into how activity provision, greenspace and transport infrastructure can support or hinder participation. However, it is not without its limitations. It omits variables such as individual (e.g. personality), inter-personal (e.g. family characteristics and social support), and community-wide factors (e.g. weather) (102). Furthermore, while it may map the amount of activity provision and resource, it cannot ascertain whether it is ‘fit for purpose’. For example, a teenager may have access to a number of leisure centres or sports clubs, but the facilities may be poor and unattractive. GIS research does, however, emphasise that MVPA has emerged as an important attribute to improving health outcomes and fitness levels in young people which will transpire into better health in later life according to previous studies. However, despite the health benefits, many teenagers do not achieve recommended amounts of MVPA.

3.3 What stops teenagers from being active?

Ten studies selected for review explicitly explored barriers to teenage activity. Three used focus groups (16,105,106) as a method for investigating barriers. Three of these studies were mixed methods; two used either focus groups or interviews to provide context to quantitative survey results (107,108) and one combined anthropometric measures linked to routinely collected data (68). Four of the studies used questionnaire data exclusively (109–111).

Focus groups were split into either gender or mixed in the studies which used focus groups exclusively (16,105). The latter also used prompts in the form of a figure with words used to initiate discussion. Participants in these focus groups were sampled from and carried out in the school setting (aging from 11 – 18 years old), in schools with above average levels of minority students. With the exception of two focus groups in Brophy et al.’s (16) study which were held in a leisure centre to overcome accessibility barriers (16). The studies also differed in location with Brophy et al.’s taking place in the United Kingdom (n=74) and Jonsson et al.’s (105) taking place in Sweden (n=53). Both studies identified themes as part of their analysis process.

The studies agreed that lack of motivation (e.g., time) and lack of support (social and parental) were barriers to being active. Brophy et al. (16) also identified cost (too expensive), accessibility (lack of local facilities/need for adult supervision) and confidence (ability, body image) as further barriers. This study also noted gender differences. For example, boys discussed the positive aspects of being active in their focus groups. Being active gave them confidence but they saw adult supervision and access to facilities as their main barriers (16). Girls discussed motivation, or the lack of it in more detail than boys. The Jonsson et al. (105) study also spoke about gender differences. They identified that girls were concerned about their 'looks' in relation to activity and they were aware of their appearance when being active.

Ashton et al. (106) conducted their study exclusively with males (n=61) between 18 – 25 years of age from Australia. According to this study the research group is classed as a 'hard to reach' group due to males of this age lack of engagement in preventative health interventions (106). This makes this study of particular interest due to assessing barriers in a group that perhaps do not engage as regularly as their female counterparts in this type of health intervention. Males identified in focus groups that lack of time, cost, feelings of inferiority (lack of confidence) and social factors were key barriers. Interestingly, they noted that these responses varied little by BMI. This study draws parallels to Brophy et al. (16) and Jonsson et al. (105) suggesting that an exclusive group of male's barriers do not differ widely to the population. However, the authors note that the sample lacked diversity and may represent the opinions of young, white, less deprived males.

Charlton et al. (68), a study from the UK (n=1147 [n=20 for focus groups]), complimented findings of cost, accessibility and, lack of motivation and support as barriers for teenagers similar to Brophy et al. (16) and Jonsson et al (105). This was a mixed method study carried out in ten schools where half were considered deprived and half non-deprived. It used focus groups and also assessed fitness, blood samples and anthropometric measures linked to routinely collected data to examine education outcomes, deprivation and health service use (68). This helped to provide some further context to the barriers. Using logistic regression and conditional trees, Charlton et al. (68) found that unfit children are more likely to be deprived, female, have obesity in their family and not achieve in education (68). Thus, revealing a specific group of teenagers who may have been overlooked by previous studies. Charlton et al. (68) did not explore gender differences but rather, presented findings as the voice of all deprived teenagers. This was a similar approach to that of Jonsson et al.'s research (105).

A similar study by Brockman et al. (112) from the United Kingdom (n=77) with 10 – 11 year olds from four primary schools found that parents constraints over rules inspired by social fears (e.g. strangers and older children), safety of their areas and concerns about the weather stopped them from being active. This study chose to frame activity under 'active play' which may change the connotations children attached to it. Findings were exclusively from focus groups analysed thematically.

Although focus groups allow in-depth exploration of responses and the opportunity to build rapport with participants, this method does not lend itself to gathering data from a large number of teenagers. Therefore, as a quantitative element, two studies adopted questionnaires as well. Withall et al.'s study (108), based in the United Kingdom, used the 'Motivation for Physical Activity Measure – Revised' (MPAM-R) questionnaire to assess the barriers and enablers to physical activity in low income groups (n=152) as well as focus groups (n=33). Again, they identified cost and accessibility as key barriers and highlighted the need for support, confidence building and competence in order to take up activity, particularly in girls. Interestingly, Withall et al. (108) highlight that they found males difficult to recruit for the qualitative arm of the study. Therefore, they are underrepresented in the sample making it difficult to generalise findings to the whole population.

Wetton et al. (107) adopted a similar approach, however they used interviews to enhance questionnaire data. This study was a relatively small sample of girls from two high schools in the UK (n=60 [n=6 recruited for interviews]). The rationale for selecting these two schools is unclear. The survey itself was specifically designed for this study and therefore its validity and reliability can be questioned. The focus was around extracurricular team sport, and four barriers became prominent; internal factors (e.g., perceived lack of ability), existing stereotypes (boys are better than girl's rhetoric), other hobbies (time constraints) and teachers (bias over those who are good at PE). Apart from internal factors, these barriers differ from the previous studies. This could be due to the small, all female sample which may have limited the number of different perspectives on certain themes such as teachers and available sports clubs. However, it does indicate that teachers and the school setting have an important part to play in creating either good or bad perceptions of activity for teenagers.

Four studies used questionnaire data only to investigate barriers. In Jodkowska et al.'s study (113), 3346 Polish teenagers (n=1759 girls) took part in a 21-item questionnaire about perceived barriers with a self-report question measuring the amount of MVPA (113). The most common barriers found were lack of energy, lack of time and lack of support. Older adolescents reported more barriers. Again, responses were broken down into gender with boys reporting more about lack of time, skills and support for low activity levels with girls reporting lack of skills (confidence), energy and support; similar to the previous studies (16,107,108). The other methodologically similar study from Dias et al. (n=1409) reported lack of friends company for both boys and girls as the top barrier (109). For both genders, there was also a strong association between number of perceived barriers and physical inactivity. The lack of a qualitative element in both these studies means there is a lack of depth to them and obtaining results through a questionnaire could present response bias.

In the context of Wales, Morgan et al. (110) looked at predictors, as opposed to the barriers, of activity via questionnaire data. This is the largest of these ten studies, recruiting 7,376 adolescents aged between 11 and 16 across 67 schools. Recruitment of this scale was helped by a partnership with the WHO. Sampling for this study was done via local authority and free-school meal eligibility before asking schools to randomly select one class in each year group for participation. After collating responses analysis was done via multilevel modelling to examine predictors of total activity, MVPA and sedentary behaviour.

The study found that active travel to school in girls predicted high levels of activity. School level factors did not predict activity, but a lower socio-economic school status was associated with higher MVPA. Shorter lunch breaks and interestingly, greater access to facilities were predictors of sedentary behaviour. Extending lunch breaks in schools could have a positive impact on sedentary behaviour and active travel could offer a mechanism for increasing activity in girls (110). This comprehensive study, including a wide sample of Welsh school-aged children highlights how important the school setting can be for provision and how the impact of school policies could influence behaviour in and out of school.

Complimenting this is the work of Baceviciene et al. (111) who explores how self-perception of physical activity and fitness impacts psychosomatic health symptoms in adolescents. The study, based in Lithuania, used self-report data on lifestyle, participation, activity, perceptions and psychosomatic health complaints in 3,284 11 – 19-year-olds. Again, recruitment took place via the school setting. Positive physical activity and physical fitness perception show lower complaints, despite the presence of unhealthy habits. This study underpins how important positive associations with activity can be for mental health and wellbeing in young people. Therefore, it is important that opportunities lend themselves to facilitating good experiences. In line with the barriers suggested by previous literature (16,68,105,107–109,113), these good experiences will need to come as a result of affordable, easily accessible, supportive, confidence-building provision.

The above studies highlight the popularity of the school setting as a method of recruiting adolescents to a physical activity study. While it is evident that focus groups can gather rich explorations of narratives around barriers to physical activity, it is difficult to carry out this style of research in large numbers due to resources and time constraints. Furthermore, they can be difficult to facilitate with power relations coming into play and more dominant characters featuring in conversations about activity barriers (16,105). Equally, questionnaires are not without their biases too. There can be participant bias based on those who consent to/take the time to participant in the survey process (68,111).

What is clear is from these studies is that cost, accessibility and confidence are key barriers to being active for teenagers (16,68,105,107–109,113). The work of Brophy et al. (16) is the only study in this review to provide recommendations underpinned by overcoming these barriers; citing the improving attitudes towards activity (treating boys and girls equally), giving freedom to need supervision or not, lowering the cost of provision and involving parents and community to improve their mind sets. The teenagers in Brophy et al.'s (16) study stressed the need to recognise, and support, girls in being active, and to give more freedom to boys rather than focusing on the formal supervision of activity. It is this novel insight, giving teenagers a voice to say how they would facilitate activity rather than simply discuss what makes them inactive or predicts their activity that can provide the foundations to build future interventions on.

3.4 The importance of considering motivation

Two studies looked at the pivotal role motivation takes in teenage physical activity (114,115). Gillison et al. (114) examined this in the context of body-related factors. A cohort of 310 adolescents (age 14.08 years at baseline; n=51% male) were classified into four groups based on reported change in leisure-time exercise over 10-months: i) those who maintain, ii) drop out from exercise, iii) take up exercise, and iv) those who were continually inactive. Analysis was conducted to predict which group adolescents were assigned to based off profiles of motivational and weight-related perceptions at baseline. For boys, maintainers reported higher identified regulation, introjected regulation, competence, relatedness, and body satisfaction than all other groups. In girls, maintainers reported higher intrinsic motivation, identified regulation, autonomy, competence, relatedness, and lower external regulation than all other groups. In the context of SDT, which is the theory of motivation used by Gillison et al. (114), identified regulation refers to motivation to act a personally meaningful goal while introjected regulation refers to acting to avoid guilt, shame and for ego enhancement (114). Intrinsic motivation occurs for the enjoyment of an activity (114).

Fostering autonomous (self-determined) motivation regulated by personal goals and enjoyment seems a key determinant to maintaining leisure-time exercise for both boys and girls. Additionally, positive interactions with others during exercise may be particularly useful to prevent dropout in girls. Gillison et al. (114) shows that allowing teenagers to feel more self-determined to be active and giving positive opportunities to be active with friends would promote and sustain activity intake.

This is reflected in the work of Duncan et al. (115) who’s quantitative questionnaire work with 544 teenagers (age 14.2 +/- .94 years) shows that intrinsic goals for activity positively influence behaviour in British adolescents but only through autonomous motivation. The study which used self-reported measures of physical activity goal content, behavioural regulations, and physical activity behaviour, again highlights the importance of giving teenagers autonomy.

3.5 Using young people's voices to underpin activity promotion

Five of the studies selected for review highlighted how using young people's voices can underpin the development of successful interventions. All of these studies were qualitative; four used focus groups (81,116–118) and one used interviews (119). The work of Corder et al. (117) and Kinsman et al. (118) looked to provide a model for promoting activity to adolescent girls that could be used by future studies. Corder et al.'s work looked to gain insight into how 13 – 14-year-old girls would promote activity to their age group and to improve participant engagement in the development of a physical activity intervention. While this was a small study, the authors used both focus groups (n=26 participants) and also identified a number of individuals who were more introverted and less active to conduct interviews with (n=5). This method helped overcome power relations and dominant individual's voices being heard most as mentioned previously in other studies.

This work identified six themes from its qualitative work which would encourage teenagers to do more activity; choice, novelty, mentorship, competition, rewards and flexibility (117). Thus suggesting that interventions should look to provide options for activity that are new, fun and flexible in their delivery based on timings and access. The use of role models, rewards and competitions were identified as important ways of improving motivation. This would be much more engaging for young people. Furthermore, Corder at el. (117) identified that there were significant gaps in promotion for older adolescents and a lack of effective interventions, lack of a whole population approach (as opposed to sub-groups, i.e. deprived teenagers, girls), lack of a whole day approach (both community and school-based activity) and the lack of involvement in the design and development of interventions.

The work of Kinsman et al. (118) compliments this. Their work with South African girls (aged 13 – 19 years) (n=51) promoted a model of 'supply and demand' (118). Notably, supplying more female role models and increasing/acquiring more facilities and equipment for a wider range of activity. In terms of demand, empowering teenagers, making it fun and providing incentives were suggested by the young girls. The authors promote the use of the 'supply and demand' model in future interventions which could provide a tool for ongoing efforts to promote activity to this age group.

Corder et al. (117) and Kinsman et al. (118) provide useful insight into promoting activity to adolescents. Most noteworthy is how narrow and non-inclusive interventions have previously been in that they focus on sub-groups of teenagers and have lacked a co-production element. The work of Mitchell et al. (119) helps solidify the importance of co-production or giving young people a choice. Their work with five girls (aged 15 – 16 years) over three phases of interviews (resulting in 15 interviews) showed that an activity intervention, which included consultation and a choice of activity, resulted in increased participation and more positive perceptions of activity, for most of the selected girls. Albeit a small sample, Mitchell et al.'s work is heavily embedded in the work of SDT (84) and the notion that being more autonomously motivated contributes to healthy psychological development which can positively impact engagement and participation in activity. This is a useful theory which can be used by activity research to underpin why young people are engaged/disengaged.

These studies focus primarily on girls. Carlin et al.'s (81) study (n=62) examines the gender differences on teenage recommendations. Interestingly, both genders suggested promoting new activities for them to try, with most happy to attend activities that were mixed gender. They also wanted more opportunities to be active with their friends and suggested rewards/incentives and the use of technology as ways of improving motivation to be active. Thus, it could be suggested that both boys and girls have similar recommendations in relation to the above studies.

The work of van den Berg et al. (116) refers to the use of young people's voices as an untapped resource for intervention design and implementation. Their work with 10 – 13-year-olds aimed to gain insight into how to increase activity in the school setting. The results show that young people are enthusiastic about additional activity; they wanted more time to do it, better facilities, better content in PE, better opportunities and, emphasised variation and being given a voice in activity as key to being engaged in the long-term. This study again uses focus groups (n=52 [n=20 boys]) and recruited from two primary schools in the Netherlands.

It is interesting that these studies, although they differ in location and sample, offer similar recommendations for activity promotion in young people; more opportunities, more choice, more fun and provide incentives. To gain insight into these perceptions, focus groups appear to the most popular choice but limit the number of participants that can be engaged with. This form of data collection is not without its limitations; there is a lack of generalisability, a risk of participation bias, the presence of power relations/dynamics and the lack of objective data to provide quantitative evidence (81,116–119). It is evident there has been a lack of consultation and inclusion of young people in physical activity interventions, an aspect future research needs to address.

3.6 What type of interventions have been used to improve teenage fitness and activity?

Of the studies selected for review, 16 were intervention studies aiming to promote, change and improve activity. Of these, 10 (120–129) have utilised the school setting; one of which was not-randomised. Young people spend a majority of their time at school and as such, most of their activity can occur in this setting (120). There is also the added benefit of continuous contact and broad reach of the school (121). Many interventions have based themselves upon PE lessons (124) but differ vastly in approach, style, sample and duration.

Whooten et al.'s (120) investigation employed a 12-week intervention before school in 24 schools in North America (n=707, aged 5 – 14) using non-participants as controls (n=396). The 'Build Our Kids Success' (BOKS) programme had children participate in either a 2 (n=442) or 3 (n=217) day a week programme. This involved before school physical activity sessions lasting 60 minutes with a trained volunteer who delivered a core curriculum. The sessions started with a warm-up game into running, relays or obstacle courses including a 'skill of the week' (e.g., plank, running, jumping) (120). This curriculum was developed by the BOKS education team.

The main outcomes were 12-week change in BMI z-score, odds of a lower BMI category at follow-up, and child report (with those >8 years of age) of social−emotional wellness. The 3-day a week programme proved more successful with improvements in BMIz-score (− 0.22, 95% CI¼−0.31,−0.14) in comparison with the control group (−0.17 difference, 95% CI¼−0.27,− 0.07). Children in the 2-days/week program had no significant changes in BMI (120). Children in the 3-days/week group demonstrated improvement in their student engagement scores.

While it would appear that a greater amount of physical activity before school improves BMI and wellness, there are some limitations to consider before drawing conclusions. The non-randomised design meant that there were some differences in groups prior to the intervention starting. As well as this fewer schools opted for the 3-day a week programme due to limited resources (120). Thus, meaning a smaller sample. Randomisation in interventions such as this would result in less differences in groups prior to implementation.

The additional nine studies in schools did use a randomisation process. Four of these were feasibility studies. Corder et al. (129) evaluated the feasibility of the 'GoActive' trial in one school (n=460; 46.6% female; aged 13 – 14); this was an 8-week intervention involving classes weekly activities encouraged by mentors and in-class peer leaders. Teenagers gained points for trying activities which were used as an incentive for participation. Accelerometer based MVPA (primary outcome), adolescent reported activity and wellbeing were used as measures of success. Accelerometers were worn for 7-days set to record at a rate of 5s epochs, however it is unclear where participants wore the device. Moreover, capacity of the study meant devices were given out on a first-come-first-served basis (129) which may incur participant bias of more active pupils wanting to engage with this element of data collection. Corder et al. (129) used Evenson et al.'s (130) cut-points to distinguish the varying intensities of physical activity in the teenagers in their study. It is worth noting that these cut-points are based on children (aged 5 – 8 years) wearing accelerometers on the hip (130) and establish MVPA at >2000 counts/min at 15s epochs (130). Interestingly Corder et al. (129) used 5s epochs putting the reliability and validity of their methods into question.

Pilot results indicated effectiveness in improving MVPA (5.1 minutes (1.1 to 9.2) p=0.014)) and justified the development of a bigger trial. Qualitative feedback was also positive suggesting the intervention was fun, increased confidence and improved likelihood to participate in activities once the trial had finished.

Studies by Sebire et al., Carlin et al. and Jenkinson et al. (121,125,127) were also feasibility studies conducted on a small scale. All three of these studies chose to promote activity in adolescent girls, further adding to the literature gap identified in the qualitative work of Corder et al. (117) who noticed a trend amongst approaches to target sub-groups rather than the whole population. The rationale for this being that girls are noted in the literature to be less active and their activity levels decline faster than boys (127). Carlin et al.'s (125) approach chose to promote walking as a method of getting girls more active due to its lack of skill and expense.

The intervention, 'Walking In Schools Intervention' (WISH), was the second study to adopt a 12-week duration, provided girls (n=199; aged 11 – 13) the opportunity to do structured 10-15-minute walks spread across the school week, before school, mid-morning and at lunch time. These walks were led by older peers (15 – 16 years old) or 'walk-leaders'. Measures included school-time activity post intervention (week 12), assessed objectively using an Actigraph accelerometer (using Evenson et al. (130) cut offs), anthropometry, cardiorespiratory fitness and psychosocial measures. A significant effect was observed for changes in light activity across the school day ($p = 0.003$), with those in the intervention increasing their light activity by 8.27 minutes compared with a decrease of 2.14 minutes in the control group. However, these changes were not sustained post-intervention and no significant changes were observed in anthropometry (e.g. waist circumference) or fitness. The authors acknowledge that the use of accelerometers in adolescents encounters some limitations; the accelerometers cannot monitor all types of activity (e.g. water-based) and wear adherence can be problematic (125).

Sebire et al. (127) and Jenkinson et al. (121) interventions were underpinned by peer support and mentoring. This a method that has been suggested by teenagers and mentioned as a facilitator to being active. Sebire et al. (127) conducted a randomised control trial; 'Peer-Led physical Activity iNtervention for Adolescent girls' (PLAN-A) in six secondary schools in England (4 intervention and 2 control) with 427 girls (aged 12 – 13). The intervention involved training girls (n=53) who were identified by their peers as influential, to provide support to their friends to increase activity. Accelerometery and questionnaires were used at the beginning and end of the academic year to monitor the success of the intervention. Accelerometers were worn on the waist and Evenson cut points (130) to estimate daily minutes of MVPA. In comparison, Jenkinson et al.'s (121) 'Girls! Lead! Achieve! Mentor! Activate!' (GLAMA) project trained girls (aged 12 – 16) in a state secondary schools in Australia to lead and focussed on gaining knowledge of activities and games structures. Data were collected using a mixed-methods approach including questionnaires and observations.

While Sebire et al. (127) showed evidence of a 6.09 minute (95% CI = 1.43, 10.76) between-arms difference in weekday MVPA in the intervention arm and showed promise to be rolled-out wider, the work of Jenkinson et al. (121) showed that there are other factors that need to be considered when implementing an intervention. Interestingly, factors that have the greatest impact on intervention success are those that come from within the school setting including the structure of the curriculum, pressure to meet curriculum targets, lack of support, multiple programs already running within the school, time allowances for teachers, appropriate training for teachers, and support for students to participate. This is valuable information for school-based interventions as these are factors that need to be considered for success.

Peer-led behaviour change has been adopted in other aspects of teenage health. Hollingworth et al. (128) has used this approach in smoking cessation in adolescents. 'A Stop Smoking in Schools Trial' (ASSIST), was a much larger randomised control trial than the previous studies reviewed. ASSIST was conducted in 59 secondary schools in England Wales (n=30 intervention schools) involving 10,730 12 – 13-year-olds (n=5,358 intervention participants). The intervention involved the identification of influential students (known as peer supporters) who were trained to have informal conversations with their peers about the effects of smoking. This process was developed by Audrey et al. (131). Smoking behaviour was collected at baseline, 1-year and 2-year follow-up using a question with six possible responses from "I have never smoked" to "I usually smoke more than six cigarettes a week". Saliva samples were also collected from participants to minimise misreporting; a way of improving validity and reliability of self-report data. In conclusion, students in the intervention were less likely to believe that they would be a smoker at age 16 years (0.80; 95% CI: 0.66 to 0.96) (128). This study highlights how peer support can translate across the promotion of other health behaviours aside from physical activity.

Ho et al. (122) also looked at mentorship within a specific sporting context. Conducted in China with 12 secondary schools, the intervention arm received an after-school, youth development sport mentorship for 18 weeks lasting 90 minutes per week. Participants (n=664; 58.1% girls; aged 12 – 13-year-old) could choose which sport they wanted to learn e.g., basketball, volleyball and kickboxing. The mentors acted like facilitators rather than adopting a teacher-led approach. Wellbeing was the primary outcome using a 12-item, self-report questionnaire. Wellbeing was shown to improve (0.25; 95% CI: 0.10 to 0.40) alongside self-efficacy and resilience (122). Fitness and physical activity (self-reported) also improved highlighting how less structured sessions, facilitated by mentors not teachers can improve teenage health and wellbeing.

Like Ho et al. (122), the promotion of specific sports or activities has been a common feature of many physical activity based interventions for teenagers; for example the WISH Project chose to promote only walking (125). Jago et al. (126) looked at the effect of providing after-school dance classes to improve physical activity in girls in the 'Bristol Girls Dance Project' (BGDP). Dance has been noted to be a favourite form of activity in girls and was therefore chosen due to its appeal. The project focussed on building the autonomous motivation of the girls in line with SDT (84).

The primary aim was to determine if a 20-week dance intervention after school (lasting 75 minutes) could improve the MVPA (measured via accelerometers) among 11–12-year-old girls across nine intervention schools out of the 18 schools involved (n=284/571 girls) at baseline and 1-year post intervention. An average of 31 girls signed up for the dance sessions per school. Girls were asked to wear Actigraph accelerometers for seven days, although it is unclear where these were worn on the body. Evenson et al.'s (130) cut-points were again used to establish mean MVPA minutes. Analysis based on intention-to-treat principles showed no differences in MVPA and attendance in the sessions decreased throughout time. It could be that the structured nature of this intervention deterred girls from sustaining engagement.

Andrade et al. (123) took a much more individualised approach to implementing a physical activity intervention. The 'ACTIVITAL' study was a randomised control conducted in South America, 28 schools met inclusion criteria and ten were allocated to the intervention (n=700), ten to the control arm (n=740) and eight were not allocated. The intervention program used the results of a needs assessment through qualitative (focus groups) and quantitative (physical fitness assessments) work. Results from this preliminary work showed there was a need to improve knowledge about activity, reduce laziness, overcome time constraints and provide role models, parent and peer support (123). At individual level the intervention delivered education packages in the classroom, workshops with parents, the organisation of social events and environmental modifications such as a walking trial drawn on the school playground.

The ACTIVITAL intervention ran for 28 months. Measures of fitness (EUROFIT test battery (132)), screen time (self-reported), physical activity (accelerometry of a sub-sample due to cost of the Actigraphs worn over 5 days) and BMI were taken before and after the trial. The proportion of schools meeting the recommendations for physical activity improved by 37% in interventions schools and increases were seen in vertical jump (2.5cm; 95% CI: 0.8 to 4.2) and the time taken to complete the speed shuttle run (-0.8s; 95% CI: -1.58 to -.07) (123). However, there was no follow-up to show if the intervention effects were sustained. Short-term, Andrade et al. (123) shows that a more individualised approach to promoting activity, assessing the needs of the population can be effective. Young people have different interests, likes and dislikes and therefore it would be difficult to promote a single type of activity to a whole population. In line with SDT, being active for enjoyment is pivotal to being motivated to participate and therefore, this individualisation should be considered by studies.

Follow-up is essential if studies want to explore the sustainability implications of their intervention. In physical activity research, follow-up post-intervention often shows little long-term impact or there is no follow-up planned. Jurak et al. (124) looked at the long-term effects of an enhanced PE curriculum in Slovenia. This curriculum featured extra lessons, a wider selection of activities and additional outdoor education for 324 children in 9 primary schools over 4 years and then 7 years post intervention. This was compared to 164 in the control group. Over the 11 years of the study, the intervention differed in motor skills measured by the SLOFIT test battery, but not in anthropometric measures or BMI (124). This study highlights how important a broad and wide-ranging curriculum can be on developing important motor skills in young people even 7 years post-intervention.

The school setting is a popular place to recruit and deliver activity provision. In terms of school-based interventions for young people, cut-points established by Evenson et al. (130) have been used as popular cut-points for distinguishing between varying levels of intensity in physical activity. However, there is ambiguity on where the accelerometer should be placed on the individual as this may be pivotal to wear compliance and the validity and reliability of recordings. Evenson et al.'s cut-points were distinguished in hip worn accelerometers (130).

These interventions are often prescriptive in nature, with young people required to access adult-determined activities e.g. walking (125) or dance (126). In line with SDT (84) and the findings from this research, it appears a better approach is to assess the wants and needs of young people prior to the start of the intervention and implement activities based off this initial consultation.

Jong et al. (133) used over 1542 participants (age 13.2 +/- 0.4 years) responses to questionnaires at baseline (shyness, activity level) and post-intervention (intervention acceptability) to provide evidence of adolescent's perspectives of using the school as a setting. Boys preferred class-based sessions (0.2, 95% CI: 0.1 to 0.3). Shy/inactive students did not enjoy the competition. Boys also enjoyed trying new activities more. These results highlight the importance of considering gender differences (133).

A further six intervention studies looked at promoting physical activity using the community setting (76,134–138). The 'Healthy for Life' pilot (134) combined community and school to implement a multi-component activity intervention for 8 – 13 year olds. Activity was assessed at an intervention and nearby control school in Australia using accelerometers and self-report at 3-time points: baseline, post-intervention and 10-week follow-up. The intervention itself provided 10-hour long school-based activity sessions, a 'passport to fun' activity booklet to complete at home and four parent workshops to support activity lasting an hour. The study showed 73% of the children at the intervention school (n= 27) did not increase MVPA after-school, or over the whole day or during school break time immediately following the intervention or at follow-up. The researchers acknowledge that this lack of change may be to do with barriers of parental, teacher and student engagement. Therefore, highlighting the importance of buy-in from all partners when implementing interventions, particularly in the school setting. Especially in deprived settings where joined up working could be vital to success.

Borawski et al. (135) used running as a vehicle to promote physical activity in youths. The community-supported but school-based programme assessed changes in obesity, health, and fitness, before and post-intervention, among 1,419 11 – 14-year olds students with a primary objective of exploring the intervention's effect on overweight or obese teens. Participants took part in a 12 – 14 weeks training programme to run or walk sections of the Cleveland Marathon in America (1.2, 6.2 or 13.1 miles). This was led by coaches. The intervention saw significant improvements in a sit-to-stand test (-0.72 seconds faster, $p=0.02$) and in the Progressive Aerobic Cardiovascular Endurance Run (PACER) test (+ 8 laps, $p < 0.01$). There was no difference in BMI but blood pressure was reduced (135). This study provides evidence that a structured approach like this can work to get teenagers fitter and healthier. The authors attribute its success to the partnership working between school and community. As a result, the 'We Run This City' intervention appeared to offer a unique opportunity to be active with friends (as previously noted as important to motivation in previous studies) outside of their formal PE classes and allowed the freedom to travel and explore parts of their city on foot (135). The lack of comparison group does limit the study and it would have benefited from a control.

The other four studies identified for review as using the community combined this approach with incentivising physical activity (76,136–138). All approaches used financial incentives. Short et al. (136), Finkelstein et al. (76) and Fennel et al. (138) used financial incentives solely. These incentives were awarded after completion of certain activity-related tasks; 8,000 steps per day measured by a pedometer on half the days in a month equated to $30 Toys-R-Us vouchers for 6 – 12 year olds in Finkelstein et al.'s 9 month trial (76), 450 miles measured by an accelerometer worn on the wrist for 12 weeks equated to $25 for adults and completion of exercise on 3 days/week for 11 – 20 year olds over 48 weeks equated to $4 per session in one group and $4, $7 and $16 respectively in the enhanced incentive group (136). Thus, highlighting the different ways activity could be incentivised in interventions such as these.

Fennell et al.'s (138) study used adults of working age (age = 48.7 +/- 1; n = 13 females) exclusively. Although this is outside of the age range being explore by this review, it is worth noting how a voucher model has been previously tested within other populations. Voucher-based incentives to increase activity in the UK have been tested in adults, but it remains uncertain whether a similar approach would work with teenagers (93,139). In the case of Fennell et al., the study took previously sedentary staff at a University in America and asked them to take part initially in a 12-week non-incentivised programme of exercise and then 12-weeks incentivised. At each exercise session, participants could choose from four stations; a bootcamp, weight training, circuit training or cardio-dance class, giving them some autonomy over the activity they did. Participants wore a 'Movband' (138) as much as possible throughout the study and also had body fat percentage, blood pressure, heart rate, maximum push-ups/sit-ups and flexibility measured. When comparing an exercise intervention with no incentives to a programme with incentives, there was no difference in the change of health variables, physical activity, or attendance; indicating that the current extrinsic reward system had no effect on improving health-related behaviour (138). However, with no control comparison and including a small sample of an older population it is difficult to conclude the feasibility of this approach in a younger group.

The work of Short et al. (136) (n=77 participants) provides a contrasting conclusion of incentivised activity. Sessions were flexible with no time constraints and a range of facilities used to host. Anthropometry measures, fitness, physical activity (measured by waist-worn accelerometers), blood work and questionnaire data showed that the enhanced financial incentives increased the duration of exercise sessions but had minimal effects on exercise participation. These results indicate that financial incentives can motivate previously sedentary, overweight/obese adolescents to exercise longer, but motivating them to sustain an exercise programme remains a challenge (136). Thus, providing evidence that a voucher-scheme alone is not enough to change activity behaviour and may need to be used in conjunction with another component. For example, previous studies in this review have shown how peer support can also be influential to activity uptake.

A physical activity programme explicitly outdoors with 138 children aged 6 – 12 showed incentives for increased step activity were effective in producing greater steps and showed a trend toward improvements in other health outcomes (6 minute walk test, BMI and parent-reported quality of life) (76). However, it is noted that the step target may have been modest and greater step targets and longer follow-up periods to provide evidence of the long-term effect of these incentives.

While the previous studies have looked at financial incentivisation alone and provided evidence that a multi-component element might be needed, Patel et al. (137) explored the use of social comparison feedback alongside incentives. Twenty-six weeks of weekly feedback on 'team' performance was then followed by 13 weeks of weekly lottery-based financial incentive plus feedback on team performance followed by 13 weeks of only performance feedback related to physical activity. Teams were comprised of eligible participants who were either employees or family members of employees from the University of Pennsylvania Health System, aged above 18 or with access to a smartphone (137). Participants were asked by the research team to form a team of four members and select a captain with the primary goal of reaching an average step count per day per team member of 7000 steps.

Feedback was given via text, e-mail or both depending on participant preference. The primary outcome of achieving 7000 steps (measured by a pedometer) was significantly greater for the incentive group with team feedback (137). This highlights how financial incentives and combining elements can improve motivation to be active.

There has been mixed success with financial incentives. There is also some evidence to suggest that financial incentives may undermine the enjoyment of an intervention. Moller et al. (139) suggests that financial incentives were reliant upon meeting behaviour goals for three weeks and became dependent upon merely providing data during the 4.5-month maintenance period. Furthermore, financial motivation and gender interacted significantly in predicting maintenance of healthy diet and activity changes (2.42; p=0.016), and financial motivation had a more harmful influence among men. However, this study was carried out with older adults.

Research regarding barriers to being active suggest more needs to be done to overcome accessibility issues faced by teens, including the cost and locality of provision whilst also giving teenagers a choice and the autonomy to choose activity that they can do with their friends (16,68,113,105–112). A financial incentive could help underpin this, providing a catalyst to overcome initial barriers and go and do activity. It would not act as a reward for being active. Interestingly, previous studies use incentives as rewards after achieving a prescribed amount of exercise/activity (76,136–138) rather than using them as an initial access tool. There is also evidence that incentives should be used in conjunction with another method for further success. With this in mind, for teenagers this could include combining an incentive for initial access with external support from peers or another source. Peers have been identified as important source of motivation (121,127).

3.7 Summary of the literature

The existing literature regarding physical activity barriers, motivations and interventions is broad. It encompasses a variety of different approaches from quantitative, qualitative to mixed methods and occurs across the school and community settings. The research designs are highly variable and change from study-to-study dependent on the location, research population and aims. The school setting is most popular due to the ease of access to a large group of young people. Self-report questionnaires and accelerometry appear to be the most popular tool for data collection within physical activity research. However, there is no universal agreement on the accelerometry protocol, in particular where the device is worn or how cut-points are derived.

Studies which report on the barriers existing for young people adopt a more qualitative approach using focus groups or interviews to encourage conversation. Within these studies, accessibility arises as the top barrier encompassing the cost and location of activities as well as the various motivations to being active. The intervention studies acknowledge this using the barriers of cost and location to underpin their deliveries. Notably, many of these interventions are prescriptive. They offer a single type of activity to a group at a specific time/day. This does not account for the ways in which motivation is regulated in teenagers.

With four of the intervention studies that were selected for review being feasibility studies, it is important to note the implications when discussing the effectiveness of these studies. Feasibility studies are undertaken to prepare for a bigger trial study and to assess any uncertainties within the research question, design, methods or analysis (140). As such, they are often smaller in scale and provide an objective evaluation of study's potential success. Without a larger, trial-based methodology for exploring the question at hand, it is difficult to ascertain the validity and reliability of findings and the effectiveness of the feasibility study.

3.8 The ACTIVE feasibility study and the ACTIVE RCT – building on the literature

Prior to the development of the ACTIVE RCT discussed in this thesis, the ACTIVE feasibility study (65) was carried out in one school in a deprived area of Swansea, South Wales. It took a mixed-method approach collecting data on activity levels (objective and self-reported), fitness, motivation and focus groups. The intervention saw £25 worth of activity-enabling vouchers given to teenagers each month for 6 months to help them overcome the barriers of accessibility identified in the literature above (*n*=115; 13.3 ± 0.48 years; 51 % boys) (65). The study found that MVPA increased, sedentary behaviour decreased, and the vouchers encouraged socialisation.

A process evaluation (91) demonstrated that ACTIVE was a feasible approach to increasing physical activity amongst adolescents from low socio-economic backgrounds. Adjustments were made to the ACTIVE protocol following outcomes, process evaluation and recommendations from funding partners. These adjustments were made to further improve the project and increase its sustainability, prior to conducting an RCT in order to assess effectiveness rather than its feasibility.

The ACTIVE RCT was developed following the feasibility study and builds upon what is already known about physical activity and teenagers. Most notably, it is evident not enough is being done to empower teenagers and target autonomous motivation in line with SDT. SDT has emerged as a popular framework for examining motivation and activity as it differentiates between controlled motivation (e.g., regulated by external pressure or guilt) and autonomous motivation (e.g., regulated by enjoyment). SDT helps explain why people engage with, adopt, and maintain physical activity which is why it underpins the work of the ACTIVE RCT.

This literature review highlights that previous interventions have been prescriptive, with specific activities or teaching strategies given to teenagers. These interventions have had mixed success to date, often only increasing activity short-term as they fail to provide ongoing opportunities. This style of intervention design and implementation is 'top down' with the emphasis on policymakers as the experts and sole designers. This results in a disconnect between what is provided and what teenagers need and want to do. Research shows that involving participants and those expected to deliver the intervention at an early stage aids the development of a strong intervention and increases the likelihood of success, effectiveness and sustainability.

Secondary school has been identified as a key period of change in teenage activity behaviours and is an important setting for promoting activity due to its broad reach. As well as this, behaviours adopted during this time are likely to be continued in adulthood which has been highlighted as important for lifelong health and protection against cardiovascular disease and other chronic health conditions. However, there has been evidence supplied by research that suggests a joined-up approach with the community can help promote activity. Thus, ACTIVE has chosen to situate itself in both the community and in schools, using previous work to underpin its development, aims and objectives.

CHAPTER 4

METHODS

4.1 Trial Design

The ACTIVE RCT was co-produced by teenagers from its inception to its implementation which allowed some flexibility in the way in which the intervention was delivered from school to school. It allowed teenagers to access activities that they wanted and needed individually, rather than being given access to prescriptive activities as a group. The intervention recognized that not all communities are the same, they have different levels of accessibility and different provisions located within them. Despite a flexible delivery, there were no changes to the data collection procedures from the protocol after the trial commenced. ACTIVE was developed within the context of strong patient and public involvement.

Data collection took place at baseline, 6 months and at 12 months for both intervention and control schools (Figure 2). Randomisation into either arm occurred prior to baseline data collection. This was done by an external statistician who had no involvement in ACTIVE.

Due to the nature of the study, participants were aware of which arm they had been allocated to. The College of Human and Health Science Ethics Committee at the College of Medicine, Swansea University granted ACTIVE ethical approval on 12/05/2016.

The protocol for ACTIVE has been peer reviewed and published (92) (Appendix 3).

4.2 Participants

All 13 schools from one local authority in South Wales were assessed for eligibility; four did not meet inclusion criteria of being deprived or located in one of Wales' most deprived areas (92).

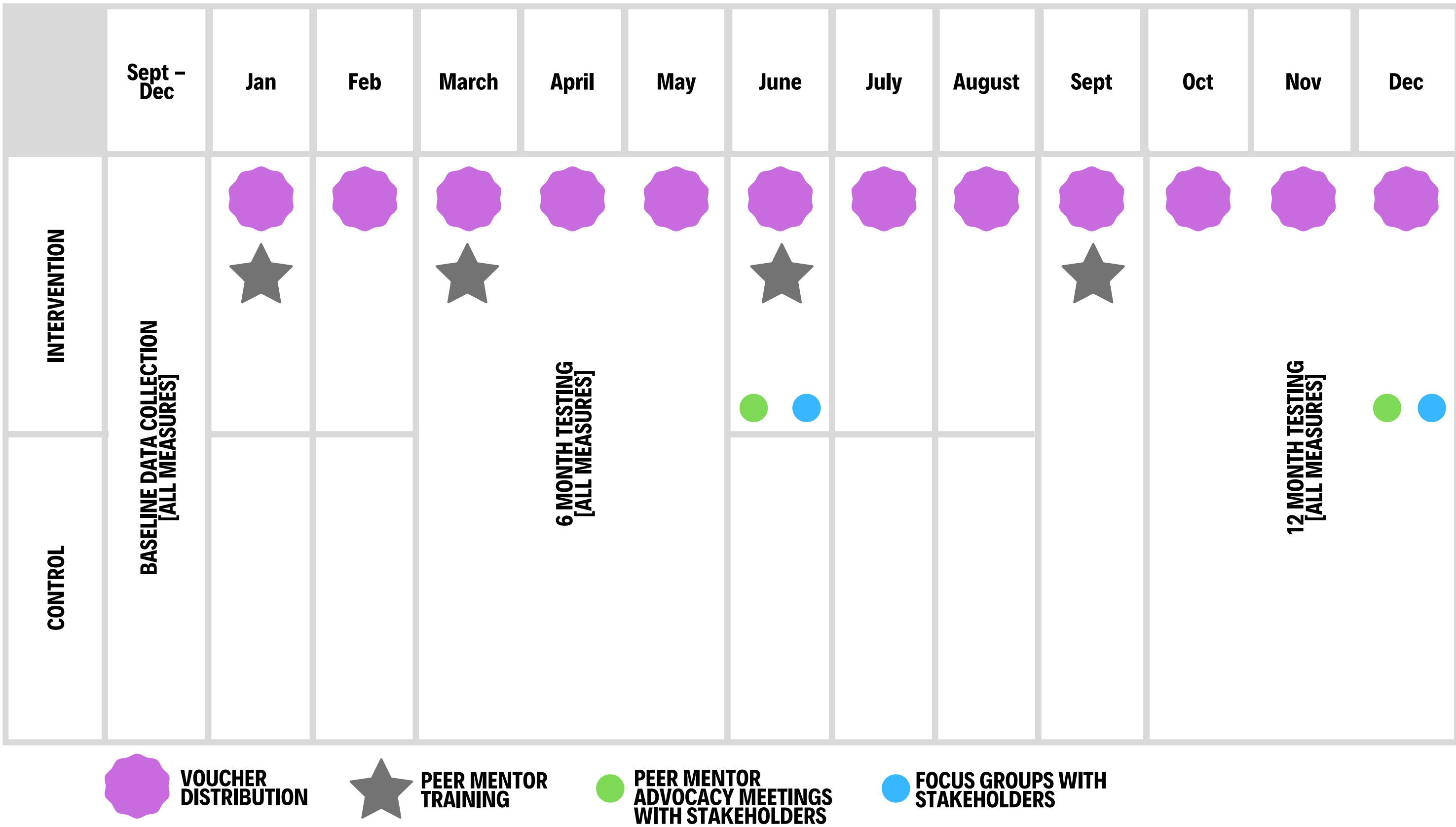

Figure 2 - ACTIVE data collection and timeline

This was a purposive sampling technique based on specific characteristics of the schools location (141). Thus, allowing the RCT to target a dense population of pupils who are most exposed to accessibility barriers to physical activity. School level deprivation was derived from the Welsh Index of Multiple Deprivation (WIMD) which is used to identify areas of deprivation based on income, employment, health, education, access to services, community safety, environment and housing (142). Schools were constituted as being 'deprived' if they were in the highest two quintiles (1 and 2) according to WIMD based on their location. These quintiles were developed by Welsh Government. Two schools declined to participate, one prior to randomisation and the other after being assigned to the control arm. This meant the total number of secondary schools taking part in ACTIVE was 7; four intervention and three control schools.

Following initial school recruitment, participants were recruited for primary and secondary outcome measures via Year 9 (aged 13 – 14) assemblies. All year 9 pupils were eligible to participate creating a census, rather than sample. The advantages of this approach included reducing sampling bias and facilitating a collection of data on all members of the target population (92). Therefore, creating a representative sample of the target population (dependent on the amount of nonresponse/lack of consent) (143). During school assemblies, information was provided to the teenagers about the project and time was allowed to answer any immediate questions or queries from both the young people and staff members. Post-assembly information, parental consent and pupil assent forms were distributed (Appendix 4). All schools received the same assembly and same amount of initial contact time.

Consent was voluntary and involved both written parental consent and pupil assent forms. Consent was via parental and participant opt-in, a popular approach which has been used by previous interventions (65,76,121,126,144). For consent to be valid both parental and child consent was needed for the pupil. After the distribution of the project's literature, parents and participants were given 2-3 weeks to consider the study to allow baseline data collection to commence in the September. Once consent and assent had been obtained, participants were eligible to take part in the study. ACTIVE recruited 908 pupils from 1,026 across all year 9 classes: a consent rate of 88%.

As well as this members of the local council's Active Young People (AYP) team (n=15) were recruited voluntarily at twelve months to take part in a one-off focus group. Recruitment of AYP team members was initially done through their team meetings. During which information was provided and members were given the opportunity to opt-in to the one-off focus group.

4.3 The intervention

The ACTIVE intervention had three components: a) physical activity vouchers, b) peer mentor scheme and advocacy, and c) support worker engagement. The intervention ran from January to December 2017.

Physical activity vouchers

Physical activity enabling vouchers equating to a monetary value of £20 (four vouchers in increments of £5) per pupil were given out each month for 12 months (92). They were distributed in schools with the purpose of being used by the teenagers to; i) access existing activities, ii) fund new activities in the schools or local communities, and iii) purchase sporting equipment. The vouchers were treated similar to a cash transaction, but change was not given to prevent the purchase of non-activity-based items.

At the end of each month, the support worker collected vouchers from each provider with an accompanying invoice for reimbursement of fees. This transaction process was informed by the ACTIVE feasibility study (145). The activity providers were recruited during the development stages of ACTIVE and continued to be recruited throughout the intervention based on pupil suggestions.

Peer mentoring scheme and advocacy

After randomisation teenagers form each of the intervention schools were asked to identify key influencers to be peer mentors (10 from each school). A peer nomination questionnaire was given to all pupils in the year and those who received the most nominations were invited to be mentors (146). Participants were asked; "Who do you respect in your year group at school?", "Who are good leaders in sports?", "Who do you look up to in your year group?" and "Who have you had a conversation with today?" as part of the questionnaire. The rationale being that individuals who were identified as the most respected and as good leaders would make the best influences for ACTIVE. This approach was underpinned by the ASSIST stop smoking trial; an intervention that involved training Year 8 students to promote the benefits of not smoking amongst their peers (128).

The role of peer mentor was to encourage the uptake and sustainability of physical activity. The mentors received training from the AYP team at Swansea Council. This training happened as baseline, 6 months and 12 months via workshops that took place at each intervention school. A student from the PR and Marketing Taught Masters course at Swansea University also assisted with training on social media use.

The purpose of these workshops was to encourage the mentors to voice their passion for activity and help others in their year group access provision. They were asked to produce videos throughout the intervention to explain why activity is important to them, how to overcome barriers to being active and any recommendations to improve activity for teenagers (92). These would help provide an innovative way to display the work of the ACTIVE at advocacy meetings and conferences. The use of popular social networking apps such as 'Snapchat' was encouraged. Studies showed that 'Snapchat' is used to facilitate relationships and 'bonding' amongst social circles (147,148) and combined with its use of filters and text would create a novel way of displaying physical activity perceptions of this age group.

ACTIVE held advocacy meetings with key stakeholders at 12 months. These meetings involved the discussion of needs, barriers to activity and changes that could improve teenager's access and uptake from the peer mentors' point of view.

Support worker engagement

ACTIVE recruited a support worker to act as link between the research team and the teenagers. They regularly attended the intervention schools to increase pupil awareness of what provision was available, give advice on how to access activities and encourage pupils to design new activities or attract new coaches to the area (92). Regular contact with the schools aided communication and maintained a presence to help pupils and teachers feel supported by the project. Assemblies were held to update the teenagers with important information regarding their vouchers and activity providers, also providing a general summary. The support worker also communicated with local activity providers to create new activity options and ensure vouchers remained redeemable throughout the 12-month intervention.

The support worker audited activities available and monitored voucher usage monthly. Each month the support worker hosted drop-in style sessions in school lunchtimes so that pupils could discuss their ideas, their current engagement with the vouchers and raise any questions/clarify any issues they may have had. Feedback from these sessions was used to target new activity providers that pupils have specifically expressed interest in.

Control schools

Control schools were encouraged to continue with their usual practice throughout the duration of the study. They received a mindfulness course for staff or pupils because of their participation in the study.

4.4 Aims

The ACTIVE RCT built upon the feasibility study by examining the effect of a multi-component voucher-based intervention on the cardiovascular fitness, health and motivation of teenagers aged 13 – 14 years in 7 schools in Swansea (4 intervention and 3 control schools). The specific aims of the ACTIVE Project were as follows:

Primary aim

1. To examine evidence of the effect of a multi-component intervention in improving cardiovascular fitness based on Cooper Run Test (CRT) score.

2. To examine evidence of the effect of a multi-component intervention in improving MVPA based on 7-day accelerometry wear.

Secondary aims

3. To explore how ACTIVE impacts the exercise motivation (BREQ-2) of teenagers.
4. To provide predictors of cardiovascular health (blood pressure and pulse wave analysis as an indicator of arterial stiffness) in teenagers from observational data using data linkage.
5. To examine the impact of a teenager's (aged 13 – 14) built environment (using Geographic Information Systems [GIS]) on the physical activity levels (using accelerometers) and the fitness levels of teenagers (using the CRT).

This study also aims to explore the qualitative experiences of the intervention from teenagers and stakeholder's perspective. This helped to provide some further insight into the intervention's effectiveness.

Cardiovascular fitness and MVPA were chosen as the primary outcomes for the ACTIVE RCT in line with the ACTIVE feasibility study (65) which used fitness and accelerometery as its primary aims. As a continuation of this work, the ACTIVE RCT wanted to remain consistent with previous aims. There is also evidence from previous interventions (123,125–127,129,135) that the increased access to activity provision combined with peer mentoring can increase these outcomes.

4.5 Data collection

Data collection periods took place at three time points: baseline (September to December 2016), 6 months (March to May 2017) and 12 months (September to December 2017) for both intervention and control schools. Quantitative measures of cardiovascular fitness, physical activity, motivation and cardiovascular health were assessed at all three time points using the measures described below. In addition focus groups were used to assess qualitative aspects of the project (92). Mapping of teenager's areas occurred after baseline to provide an exploration of influences on teenage activity and fitness prior to the intervention.

Cardiovascular fitness (Cooper Run Test [CRT])

The CRT is a 12-minute walk/run test that was performed at all three time points in both intervention and control schools to assess cardiovascular fitness. The CRT was selected as a method of assessing fitness due to its simple design and ability to be performed in the school setting under similar parameters. Researchers from the University led the testing but was supported by PE staff from the schools. The validity of the CRT as a predictor of aerobic fitness has been tested by numerous studies in both young males and females (149–151).

Researchers set up and explained the protocol of the CRT to all pupils in year 9 as part of normal PE lessons in the schools to avoid disruption to school timetables. The CRT was conducted inside the school's sports halls at all time points to improve reproducibility of the conditions (e.g. to avoid weather disruption). This involved setting up an area to walk/run around as 'laps' and asking pupils to record each other's scores. To allow this to happen, two 12-minute sessions were running during a single 1-hour PE lesson. This meant pupils could warm up, take turns to perform the test, recover and cool down in the lessons. They were instructed to complete as many laps as possible of the sports hall, perform the test to the best of their ability and to keep moving as much as possible for the 12-minute time frame. The team of researchers were present to provide further encouragement by means of clapping and cheering and, to ensure pupils were recording accurately. This meant continuously circulating the room to confirm counting was taking place. All year 9 pupils in the study were encouraged to take part but were reminded by researchers that participation was voluntary.

Pupils were categorised as 'fit' or 'unfit' based on whether their total metres ran and normative data (152). 'Fit' was considered average and above according to normative data and 'unfit' as below average and poor.

Physical activity (actigraph accelerometers)

Physical activity was measured using Actigraph GT3X+ accelerometers (Actigraph, Pensacola, Florida, United States). This is a tri-axial accelerometer which has previously been used in adolescents with both hip and wrist placement (153,154). The accelerometers were worn on the participant's non-dominant wrist. Previous studies used the hip as a site for the accelerometers but the wrist has shown improved wear compliance (92,155). This is a methodology which has also adopted by the National Health and Nutrition Examination Survey (NHANES) between 2011 - 2012.

The Actigraphs were worn for 7 full days at all times, apart from bathing or swimming, and were set to record at a frequency of 30Hz with a 5s epoch duration. Participants needed to wear the accelerometers for over 500 minutes on >3 days to be included in the analysis with non-wear time defined as >60 minutes with a measure of 0 counts based on a 24-hour protocol. This is in line with previous studies with similar aims (17,37). Research regarding wear-time in children and young people have stated that using data from children with more than two days lasting 10 hours/day should provide reliable estimates of physical activity (r=0.86) (156). However, to remain in line with studies similar in design (17,37), the >500 minutes on >3 days protocol was selected for this inclusion criteria.

The cut points for physical activity were taken from Chandler et al. (157) incorporating the vector magnitude (VM) output. VM was incorporated as it is more suitable for wrist-worn placement as there is no dominant plane of movement, particularly in children (157). Sedentary behaviour was defined as periods with counts (the unit of measurement for activity used by Actigraph) below 161 per 5 seconds and MVPA defined as periods with counts >1462.

Motivation (exercise motivation questionnaire (BREQ-2))

The modified Behavioural Regulation in Exercise Questionnaire (BREQ-2) (Appendix 5) is a 19-item questionnaire that provides a total motivation score. This was used to define pupils as 'autonomous' or 'controlled' via 5 subscales; amotivation, external regulation, introjected regulation, identified regulation and intrinsic motivation (158). The mean of the five subscales forms an idea of whether teenagers are motivated more autonomously or controlled (158).

For this study, the Relative Autonomy Index (RAI) was used. This provided insight into the degree of autonomy the teenagers had. The RAI was calculated by weighing each of the subscales and summing the weighted scores; the minimum score of RAI is -24 and the maximum is +20 (158). According to SDT (84) scoring higher equates to being more autonomously motivated. This is associated with participating in activity for the enjoyment of it and for personal values as opposed to controlled motivation and being made to feel guilty and external pressure to be active (87).

The BREQ-2 was selected due to its accessibility. It is clearly written to aid pupils understanding of the questions. The BREQ-2 has been noted by previous studies to obtain good psychometric information (159) and has been previously used to provide information regarding teenager's motivation to exercise (86,160,161). The teenagers completed the questionnaire at all time points.

Cardiovascular health (blood pressure and pulse wave analysis [PWA])

Blood pressure was measured using a standardised upper arm cuff methodology using a sphygmomanometer (Omron M2 monitor, OMRON Healthcare UK Ltd, United Kingdom). ACTIVE's protocol asked participants to be seated for a minimum of five minutes to ensure they were rested prior to any measures being taken (92). The Omron cuff was positioned on the upper left arm, with the midline of the cuff positioned over the brachial artery, and the arm out straightened, resting gently on a table so as not to influence the blood pressure reading (162). The cuff was inflated until a blood pressure recording appeared on the Omron M2 monitor screen, at which point the cuff deflated. This process was repeated twice more, allowing the average of the three measures to be taken. If any of the measures were very different (+/- 5 mmHg) an additional measure was taken (92).

To further assess the heart health of teenagers, the non-invasive measurement of pulse wave analysis (PWA) was used as an indicator of arterial stiffness (163). PWA was assessed using the Vicorder (Skidmore Medical Limited, Bristol, United Kingdom). Participants were seated and a SC10 Hokanson cuff positioned around their upper left arm. Similar to blood pressure, participants were asked to sit for 5 minutes to ensure they were rested. The cuff was then gradually inflated according to an inbuilt automated protocol, during which the brachial artery pulse-pressure waveform is recorded. Central augmentation pressure (AP) and augmentation index (AIx) were determined from the waveform using a transfer function integral to the software. This process was performed a second time, if both measures of AP were within ±5 mmHg of each other and AIx were within ±5% the two measures are accepted, if not a third reading was taken and a mean of all three taken (92).

A more in-depth exploration of cardiovascular health was completed using data linkage via the Secure Anonymised Information Linkage (SAIL) Databank (164). This part of the study used measures of arterial stiffness (augmentation index [AIx]), blood pressure and cardiovascular fitness (cooper run test) as indicators of cardiovascular health (165). Higher AIx and blood pressure readings can be used as an assessment of arterial stiffness as they indicate cardiovascular disease (CVD) risk (166–168). Poorer fitness has also been attributed to CVD risk (20,169). Participants were recruited from the baseline measures from the participating schools. Consent was voluntary and involved both written parental consent and pupil assent forms. All pupils in school year 9 (aged 13 – 14) were eligible to participate. No pupils were excluded from participation. A total of 224 (n=129 boys) out of 908 pupils across the 7 schools (25.7%) were included in this cross-sectional analysis with data linkage.

Accessibility modelling

At baseline the objective measures recorded by ACTIVE were mapped in a GIS alongside datasets relating to activity provision, active travel routes, public transport stops, main roads and natural resource. Lle (170), a geo-portal for Wales which is a partnership between Welsh Government and Natural Resources Wales, was used to access open source maps and create these datasets. Participant homes and schools were geocoded, and nearest Euclidean distance were measured from each school and home location to the nearest activity provider using QGIS 2.18. This created a database which was exported for statistical analysis.

Similar to the wider exploration of cardiovascular health, participants were recruited from baseline measures in all participating schools.

Adolescents' views (focus groups)

Digitally recorded semi-structured focus groups were conducted at all-time points (n=37 focus groups) by two researchers. A lead moderator facilitated the focus groups, and an assistant moderator was also present at each focus group and was responsible for taking notes and audio recording. The assistant moderator was also responsible for reporting back to participants on their main discussions from the focus groups to ensure correct interpretation and understanding and gain clarity over any points discussed, a method of respondent validation (171). Focus groups were selected as the preferred methodology due to their distinguishing feature of group interaction, which can encourage in-depth discussion (172).

Focus groups were carried out at the schools during the school day to ensure pupils remained in a comfortable, familiar setting. They lasted between 30 – 50 minutes each time. The groups consisted of 6 – 8 pupils with boys and girls in separate groups (equating to two focus groups per school) were carried out at all three time points. Participants were asked their opinions regarding what physical activity is, its barriers and what could be done to improve activity in their areas. Intervention schools discussed the ACTIVE project specifically (see topic guides: Appendix 6).

Baseline focus groups consisted of randomly selected consented pupils. After this, participants were purposively selected to explore the views of those engaging well with the intervention and those not. This included some peer mentors, although a focus group exclusively with the peer mentors was not considered. The focus groups provided ACTIVE with a greater understanding of the mediating factors that influence teenage physical activity. They also helped provide context to the quantitative measures.

In addition to focus groups with teenagers, focus groups and interviews were held with stakeholders (e.g. AYP Officers from the local council). These were held at 12 months.

Data linkage

The SAIL databank allowed for data linkage to take place for this these (164). For this to take place, measures of arterial stiffness (AIx), blood pressure and cardiovascular fitness were linked with routinely collected health data e.g. deprivation at school and at home, birth weight and hospital admissions. The process of this in SAIL assigns a unique Anonymous Linking Field (ALF) to person-based records before it is joined to clinical data via a system linking field (173). This ensures anonymity and ensures participants cannot be identified once their data has been linked.

The linked routine data came from two sources; the National Community Child Health Database (NCCHD) and the Tagged Electronic Cohort Cymru (TECC). The full list of variables and how they were cleaned can be seen as Appendix 7. Variables were removed from analysis if they had missing data on over 100 participants. Deprivation at school and individual level was the only variable to be measured at different time points (at birth, at 1 years old, at 13 years old and at secondary school). The purpose of this was to explore whether moving in and out of deprived areas during life affects heart health and whether deprivation impacts heart health at specific ages (165). This is in line with the study's secondary aim of providing predictors of cardiovascular health in teenagers. In this instance, exploring how deprivation across the life course at a young age impacts heart health outcomes.

4.6 Analysis

For primary outcomes, regression analysis was used as this would provide an indicator of the magnitude of effect between variables and not just whether there is a simple correlation (141). For the primary outcome of cardiovascular fitness, linear mixed effects multilevel regression with intention-to-treat principles was used to analyse the effects of the intervention on the primary outcome in terms of distance. Multiple regression involves one dependant variable and two or more predictor (independent) variables; the use of more than one predictor variables increases the accuracy of prediction (174). Gender and deprivation were used as predictor variables in the primary and secondary outcome analysis. This was clustered by school and at an individual level in STATA, version 15. Logistic regression was also used to assess whether the intervention had an effect on whether pupils were fit or not fit. A similar analysis approach was used for accelerometry (MVPA and sedentary time).

Poisson regression was used to analyse vouchers due to usage being a count variable rather than continuous. For secondary outcomes (cardiovascular health), comparisons were made between baseline and 12 months with differences and confidence intervals (CIs) presented for a measure of estimation. Two independent statisticians carried out parallel data analysis on all outcomes to avoid researcher bias. The level of significance for the results of statistical analysis was set to $p < 0.05$.

Multiple imputation of missing data due to absence during some testing was conducted using the chained equations command in STATA. Data was assumed to be missing at random (e.g. children did not have follow up data because they were not in school on the day of the measurement rather than a factor due to heart health). This included 102 participants at baseline (12%) and 170 at follow-up (19%) using measures of fitness, activity and blood pressure at other timepoints (baseline/follow-up), gender, and deprivation. This generated a complete data set, which was used for analysis.

This RCT will examine change in the intervention group compared to controls. Findings from the feasibility study showed that sedentary behaviour reduced by 65 minutes (95% CI: 12.0 to 117.6) from baseline (n=75) (65). Fitness improved in the feasibility study in the intervention group by 98 metres (95% CI: 19 to 177, children ran 1730 meters in 12 minutes at baseline and 1823.3 meters at post intervention). Therefore, estimating improvement in cooper run of 98 metres (intervention) and 22 meters (control) with average cluster size of 150 children per school and ICC of 0.16

(as above) would require 300 children or two schools per cluster (3 schools if consent rate is assumed to be 60%).

Secondary outcomes; heart health and accessibility modelling

Linear multilevel regression was used to explore the relationships between variables collected via routine data (e.g hospital admissions, birth data, GP visits) and a) AIx, b) blood pressure and, c) cardiovascular fitness. Gender was included in the models to assess any differences by gender. The level of significance for the results of statistical analysis was set to $p < 0.05$. Clustering by school was also taken into account due to school level deprivation assuming a role in predicting heart health. Structural equation modelling (SEM) in STATA was also used to show relationships between routinely collected data and the cardiovascular phenotypes collected in this study. Data linkage in SAIL allowed for observational data from ACTIVE's baseline data collection to be linked with routinely collected data from NCCHD and TECC (Appendix 7). The role of data linkage allowed access to variable that were not collected by ACTIVE and were not feasible to collect under ACTIVE's protocol.

For accessibility modelling, multivariate linear regression models were estimated in STATA (Version 15). Three models were created to answer how the environment influences a) MVPA, b) fitness and c) motivation. Regression models used to assess the associations of variables in the GIS dataset on MVPA, as well as fitness and motivation. Gender was included in the models as physical activity and fitness levels in particular differ by gender. Models were clustered by school as their locations differed and access changing from school to school. SEM in STATA was also used to show relationships between the environment and physical activity as the primary aim and also fitness and motivation as secondary aims.

The focus groups were transcribed in verbatim and names were removed to ensure anonymity. NVivo 10 was used to manage and analyse the data (175). Two researchers separately analysed the data and compared coding/themes in order to guarantee no new codes/themes emerged and there were instances of the same theme to ensure data saturation (176). The researchers used thematic analysis (TA) to identify and report patterns in the focus groups. Braun and Clarke's Phases of TA (2006) (177) underpinned the coding process. This version of thematic analysis provides a robust, systematic framework for coding qualitative data, and for then using that coding to identify patterns across the dataset in relation to the research question (178) . There are six phases of analysis; i) familiarising yourself with the data, ii) generating initial codes, iii) searching for themes, iv) reviewing themes, v) defining and naming themes and, vi) producing the report (177). A checklist for Braun and Clarke's analysis can be seen as Table 2.

Table 2 - Braun and Clarke's thematic analysis (177)

Process	No	Criteria
Transcription	1	The data have been transcribed to an appropriate level of detail, and the transcripts have been checked against the tapes for 'accuracy'.
Coding	2	Each data item has been given equal attention in the coding process.
	3	Themes have not been generated from a few vivid examples (an anecdotal approach), but instead the coding process has been thorough, inclusive and comprehensive.
	4	All relevant extracts for all each theme have been collated.
	5	Themes have been checked against each other and back to the original data set.
	6	Themes are internally coherent, consistent, and distinctive.
Analysis	7	Data have been analysed – interpreted, made sense of - rather than just paraphrased or described.
	8	Analysis and data match each other – the extracts illustrate the analytic claims.
	9	Analysis tells a convincing and well-organised story about the data and topic.
	10	A good balance between analytic narrative and illustrative extracts is provided.

Overall	11	Enough time has been allocated to complete all phases of the analysis adequately, without rushing a phase or giving it a once-over-lightly.
Written	12	The assumptions about, and specific approach to, thematic analysis are clearly explicated.
	13	There is a good fit between what you claim you do, and what you show you have done – i.e., described method and reported analysis are consistent.
	14	The language and concepts used in the report are consistent with the epistemological position of the analysis.
	15	The researcher is positioned as active in the research process; themes do not just 'emerge'.

4.7 ACTIVE's initial work

ACTIVE was a novel intervention aimed at examining the effect of a multi-component intervention in improving the cardiovascular fitness, arterial physiology and general health, whilst reducing time spent sedentary, in adolescents. The RCT takes a mixed methods approach to explore how to improve the cardiovascular fitness and health of teenagers. This includes cardiovascular fitness testing (CRT), heart health (blood pressure/PWA), physical activity (accelerometery), motivation (BREQ-2) and qualitative interviews.

Prior to the start of the ACTIVE intervention, a gap was identified regarding recommendations made by teenagers to improve activity for their age group. In order to co-produce the intervention and ensure it would meet the wants and needs of young people, 13 focus groups were carried out in the 7 secondary schools. Participants (n=78) were recruited randomly but a mix of genders was ensured. Focus groups were carried out at the schools during the school day to ensure pupils remained in a comfortable, familiar setting and lasted 30 – 50 minutes. Boys and girls were mainly in separate groups to establish any gender differences in discussions and recommendations. As a result, two focus groups were conducted in each school, except for one school where, due to time constraints, boys and girls were combined to make one focus group.

A lead moderator facilitated the focus groups to allow detailed discussion of the teenager's recommendations and gain a better understanding of their needs; improving the quality of ACTIVE's aims. An assistant moderator was also present at each focus group and was responsible for taking notes and audio recording. To ensure consistency across all focus groups, a semi-structured topic-guide was used, which reflected the study's aims. This was to provide triggers for discussion rather than a prescriptive structure. As with all other qualitative work in ACTIVE, thematic analysis was used to identify key issues from the perspective of the teenage participants.

This work provided the start point for ACTIVE and provided reference for the direction of the RCT's intervention. It was pivotal in recruiting preliminary activity providers and generating awareness and initial buy-in from schools and the community.

CHAPTER 5

EXPERIMENTAL RESULTS

This chapter discusses the experimental results of the ACTIVE RCT which formulate much of this thesis' primary and secondary outcomes. These are the findings exploring how effective the ACTIVE intervention had been in improving fitness, physical activity, motivation, heart health and, perceptions of activity in teenagers. Baseline focus groups formed the start point for the ACTIVE RCT as this allowed the trial to be co-produced and proactive in addressing the wants and needs of teenagers. As a result, these findings are presented first to provide context.

5.1 Teenage recommendations to improve physical activity for their age group – setting the scene for the ACTIVE intervention

The findings from this work have been published in BMC Public Health (67) (Appendix 8). This initial work involved 74 teenagers (aged 13 – 14) from across all 7 secondary schools involved in ACTIVE. This work identified 6 recommendations made by the teenagers; i) Lower or remove the cost of activities without sacrificing the quality, ii) make physical activity opportunities more accessible, iii) Improve the standards of existing facilities, iv) Make activities more specific to teenagers v) Give teenagers a choice of activities/increase variety of activity and vi) Provide activities that teenage girls enjoy (e.g. fun, sociable activity instead of competitive sports). Key quotes from the focus groups are in Table 3.

This section has been taken from the "Teenage recommendations to improve physical activity for their age group: a qualitative study" publication (67).

Lower/remove of the cost of activities without sacrificing the quality

Teenagers identified reducing the cost of being active as a key recommendation. They suggested that there could be a reduction made to the existing price of activities in order to increase accessibility and sustainability. One girl explained how she would have to ask for money from her parents in order to access activities and this would make her feel bad, as she knew her parents were reluctant to pay. This would deter her from being active.

Free activities were recommended as an alternative approach; however, teenagers were aware that there is sometimes a trade-off in quality in exchange for lower priced activities. If the facilities are without heat, are dirty or unsafe due to low investment this will not encourage activity. Hence, purely lowering cost, without maintaining the quality of provision would not have the desired effect in enhancing teenage activity levels. One way to tackle this is to offer informal activities in a good quality venue, as these incur less cost to run and attend (179). This would include offering self-directed gym sessions, unstructured football sessions where teenagers can attend and play without coaching, or provision of any venue where a qualified coach is not required to teach technical movements or referee. This focus on quality of facilities is also re-iterated in a following theme pertaining to improving the standards of existing facilities.

Improve local access to physical activity opportunities

Throughout the focus groups, it was evident activities should be made more local to where teenagers lived. Similar to the theme of cost, improving access to activity has repeatedly been expressed as a barrier (16,17,65,81). Teenagers advocated for closer proximity of facilities, commenting that they would be more inclined to access activities that are closer to their homes. This was particularly relevant to outdoor spaces like pitches and parks. Teenagers suggested that they need to travel to be able to play outdoors, and this would incur an additional cost. Removing the need for travel to venues, would go some way to making physical activity more accessible to these teenagers.

Both boys and girls provided examples of specific equipment and/or facilities to increase physical activity such as more local *"football pitches, basketball hoops"* and *"little gyms in the park"*. It was apparent in the focus groups that both teenage boys and girls were happy to organise their own activity if provided with the facilities, as they did not mention the need for formal coaching in these activities.

This suggests teenagers would like the increased opportunity and space to participate in unstructured, non-competitive forms of their favourite sports.

Improving the standards of existing facilities

When teenagers discussed their local facilities, they noted their current standards are in need of improvement. This was due to facilities, such as parks, falling into states of neglect and equipment being broken. This conversation focussed on local parks but also extended to discuss gym equipment and the aesthetic features of facilities (e.g., lighting).

There were small differences in the ways in which boys and girls felt this maintenance could be done. Boys recommended buying new equipment to replace the old, while girls discussed improving what is already there. However, it was apparent among focus groups with both genders that local facilities are lacking. The council's control of local provision was frustrating for teenagers because they felt more should be invested to maintain the environment and improve local facilities. It was evident that what is already in the community is not appealing to teenagers due to a lack of general maintenance.

By improving and updating local activity provision, teenagers say they are more likely to access them. Their recommendations propose that the local council need to be more proactive in their monitoring and upkeep of facilities. There was a mutual feeling among boys and girls that the local council is avoiding investing in teenagers and have chosen to invest in other developments, such as road maintenance, which teenagers do not value.

This point also draws out the need for activities and facilities invested in to be useable and appealing to teenagers and relates strongly to the next theme of ensuring activities provided are specific to teenagers.

Table 3 – Key quotes from recommendations focus groups
Lower/remove of the cost of activities without sacrificing the quality
"And probably if like the leisure centres dropped their prices, you know, maybe people will think, oh that's cheaper, okay I'll go back." (Girl, Focus Group 6) "What they could do is like get like something in a park… if they say it's like a free thing they would all just like come in and do it, instead of… if they say it's like £3 to come in they'd be like oh okay, bye." (Boy, Focus Group 13) "...if it was like free and all that you'd see loads of other older kids going to try it out because they know it's free and it's something to do with their friends, and they don't have to spend their own money." (Boy, Focus Group 13) "…they've got like one indoor pitch which costs a lot to play in, or they've just got outdoor pitches which are, like, really cheap to play but it's, like, really cold. They don't put, like, any lights on." (Boy, Focus Group 9) "…I feel bad when I have to go up to my parents and ask them for money, because their face is just like, right, and then you can see them as they pass the money over and they don't like it." (Girl, Focus Group 4)
Improving the locality of physical activity opportunities
"Well I would say bring more facilities, bring more stuff so then like more football pitches, basketball pitches, like more stuff so they're going to want to go outside." (Boy, Focus Group 5) "Just like a little gym, in the park or something, 'cos I would go then 'cos it's like really close." (Girl, Focus Group 6) "So there's the travel, but if it was, like, in your community, then it wouldn't be so bad." (Girl, Focus Group 10) "They could spend more money and invest in putting buildings in that area where they could put, for example, badminton, tennis, football, rugby" (Girl, Focus Group 8)

“Well I would say bring more facilities, bring more stuff so then like more football pitches, basketball pitches, like more stuff so they’re wanting to go outside” (Boy, Focus Group 5)
Improving the standards of existing facilities
"Like we said, like, fix the parks and stuff like that." (Girl, Focus Group 10) "I think they could like, well not even like every year, like every other year they could go round to each park and renew all the apparatus." (Boy, Focus Group 5) "And in the gym there’s umm a few of the machines are broke, you could pay to get them fixed or like help get new ones and stuff like that." (Boy, Focus Group 7) "They need to make the environment better." (Girl, Focus Group 10) "But why don’t they invest in building more things down there for our age because I, you walk through there and you mostly see glass bottles on the floor, on benches and…" (Boy, Focus Group 9) “Yeah, council investing in, like, one-way systems and everything and they’re wasting money on build, on making these one-way systems and everything when they could be looking at our age and start investing in buildings that we can go to and enjoy ourselves after school.” (Boy, Focus Group 9)
Make activties more specific to teenagers
"And they always do adult things, like they never really aim at anything for teenagers, like people our age." (Girl, Focus Group 6) "Yeah, the government is complaining saying that we’re getting like, there’s like less people being fit but there’s not really more facilities and stuff for like teenagers." (Girl, Focus Group 6) "No, and like I just think they should put more activities out for younger people, like…" (Girl, Focus Group 6)

“For our age group and under 16’s, not so much adults…” (Boy, Focus Group 7)
Give teenagers a choice and variety of activities
“There’s like clubs on, it’s the exact same every single time you go.” (Girl, Focus Group 2) “…they should give you a sheet at the beginning of the year and then choose which ones you want to do and then they go with the majority…” (Girl, Focus Group 12) “Rather than doing the same thing, like football, hockey, you know…” (Girl, Focus Group 4) “Yeah, but they could take us out of our PSE when we have it and then maybe at dinner times?”(Boy, Focus Group 1) "Yeah I think it’s as much quantity as it is quality." (Boy, Focus Group 13)
Provide activities that teenage girls can enjoy
“If I don’t like it, I won’t do it.”(Girl, Focus Group 10) “You could hold like a football game but then for the people who like football and then for the people who like cheerleading they could let them cheerlead, or people who like dancing and things you could just hold a massive event of sports and have people performing.” (Girl, Focus Group 12) "Make sure, like get their friends to do it as well, so then their friends can encourage them, like oh I'm going to go there, oh come with me, be like oh okay. Ask them." (Girl, Focus Group 12) "Yeah, just ask them if they want to go swimming, like say it's a normal thing, 'cos nobody would think of swimming as like an active thing isn’t it, just for fun" (Girl, Focus Group 6)

Make activities more specific to teenagers

Both girls and boys commented on making activities more age relevant. Girls in one focus group discussed the ways in which activity provision does not target their age group and wanted more *"encouragement"* or to clearly be included and invited. There is very little that specifically invites teenagers or promotes and provides where they feel it is for them.

The provisions suggested by these teenagers included whole gyms designed for their age group and the ability to be able to attend existing classes for example, currently, there are age restrictions on classes like Zumba and Yoga. Boys also acknowledged the lack of provision for their age group, noting that that most provision is aimed at adults. The teenagers believed the local council has neglected their age group.

Give teenagers a choice and variety of activities

Teenagers in most of the focus groups recommended that they have a choice over which activities are available for their age group. In terms of local community provision, they wanted *"quantity as well as quality",* allowing them to access a broad variety of activities. The focus groups made it evident that local activity provision is lacking in variety and teenagers do not get a choice as to what activities they would like to do. Like the "improving locality of physical activity" theme, the activities suggested to provide variety were unstructured. For example, one participant suggested they would like more choice to be able to play non-conventional sports like dodgeball in an unstructured format, where they could organise teams and rules themselves.

This lack of choice and variety was evident in the school setting too. The girls discussed this lack of choice in detail, suggesting they were more disengaged with school sport than the boys were. Girls discussed how inflexible PE lessons were to providing variety and suggested giving each pupil a sheet at the beginning of the year with which they could suggest/pick activities they would like to do. They noted that schools provide traditional, structured forms of sport, whereas they would prefer more unstructured activities. The boys discussed being able to have the ability to choose when they could be active, for example, being able to come out of other lessons to do so. For the boys, it was more of a case of being able to choose to do more activity rather than being discontent with the activity already on offer.

Provide activities that teenage girls can enjoy

It was apparent when discussing types of activity that teenage girls are more likely to be active if they can access activities they enjoy. It was evident that if they do not like what is on offer they will not participate in it and would prefer to be inactive. The idea of being able to enjoy activity was prominent amongst the girls in the focus groups and a greater emphasis was placed on the enjoyment aspect of activity among girls throughout discussions. It was important for girls that the purpose of the activity was not to 'be active' per se, rather they preferred the emphasis to be on the opportunity for them to have fun. The examples of activities that fit these criteria were the local waterpark (with slides and wave machines) and a trampoline park because *"it's fun,"* yet still gets teens active. One focus group also suggested the idea of a girls only gym in which girls could be the only ones allowed to access it which would make the experience more enjoyable, as being red and sweaty in front of boys was described as a barrier.

Inclusivity was a big part of this theme as girls suggested that everyone has a role to play in activities. These different roles included unstructured forms of activity such as cheerleading for school sports teams, which could be led and organised by teenagers. Inclusive activities would also mean peers could be active together allowing more time to spend with friends and facilitate social networks, which was appealing for teenagers (68).

How did the recommendations feed into ACTIVE?

Using the above themes, the initial provision that teenagers could access as part of the intervention was selected based on these requirements and informed of the teenagers wants and needs. As the project developed, ongoing consultation and feedback from the peer mentors and support worked allowed this provision to adapt and change which is echoed in the findings from the later focus groups. Appendix 9 shows more information regarding initial activity providers recruited and those added to the project throughout.

5.2 Results from the ACTIVE RCT

Findings from the quantitative results have been peer reviewed and published in the American Journal of Preventative Medicine (69) (Appendix 10). Figure 3 shows the participant flow of the study; a total of 118 participants were lost from baseline to 12 months (n=73 in the intervention) due to moving schools or being absent during testing. The total number of participants in ACTIVE was 908 (n=524 in the intervention). The demographics of the schools are reported in Table 4.

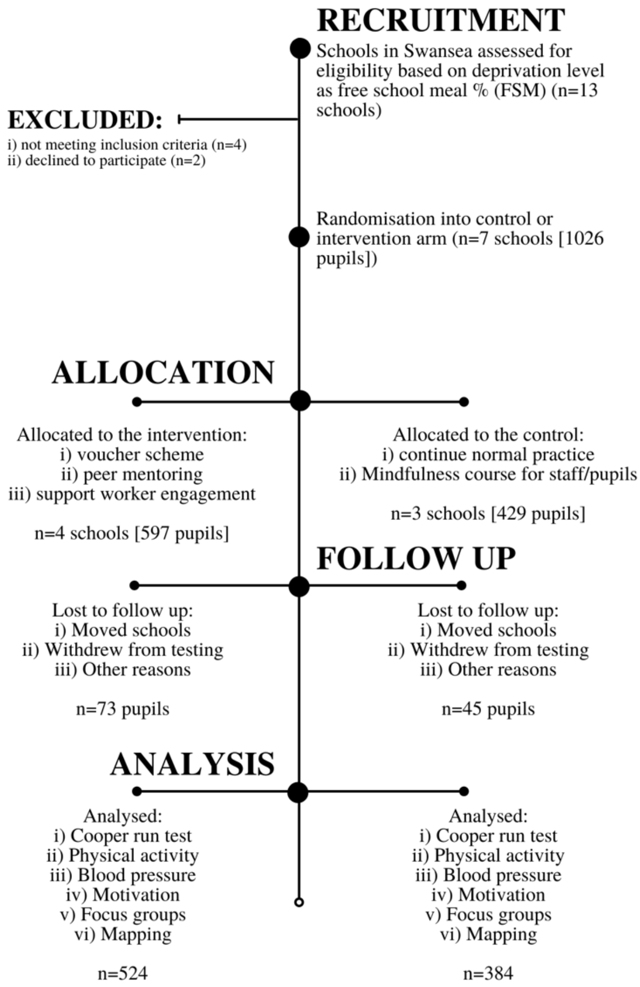

Figure 3 - Participant flow

Table 4 - Demographics of schools for experimental outcomes

#	Number of pupils in year 9 (n=boys)	Free school meal % in the school*
School 1	113 (n=56)	26.4%
School 2	231 (n=107)	19.2%
School 3	125 (n=59)	10%
School 4	128 (n=62)	38.1%
School 5	97 (n=50)	50.5%
School 6	142 (n=77)	21.7%
School 7	190 (n=105)	27.5%
*Free school meal eligibility is a marker that the family income is below the poverty threshold		

Voucher use

Teenagers in the intervention arm had the opportunity to use 48 vouchers each over the 12 months (a total of 25152 vouchers). Frequency of voucher use is displayed in Figure 4. Over the course of ACTIVE, 6327 of these vouchers were used equating to 25.1% of the total number of vouchers available to spend. The frequency of voucher use can be seen as Figure 4. Boys used 3353 vouchers (52.9%), compared to the 2974 that girls used (47.1%). Some participants used no vouchers at all (n=125 [n=55 boys; 21.6%]). The mean number of vouchers used was 15 (median = 12). Interestingly, 5 participants recorded using more than the 48 vouchers available to them suggested vouchers were given by friends or shared.

Figure 5 shows voucher use broken down by month. Highest voucher use occurred in December which would have been the last month of the intervention. Spikes in voucher use coincided with school holidays (e.g. February half term, August summer holidays). Figure 6 presents a breakdown of voucher use by school. On the whole schools A, B and D had similar usage however, school C's was lower.

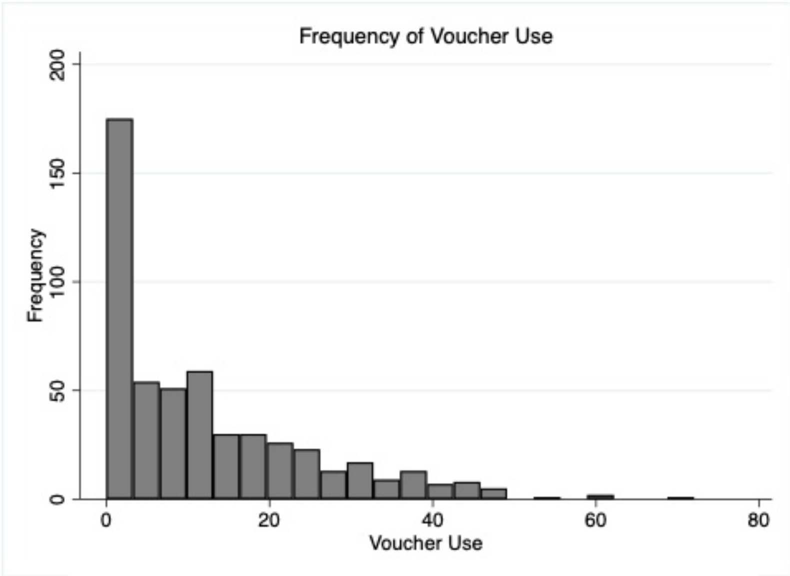

Figure 4 - Frequency of voucher use

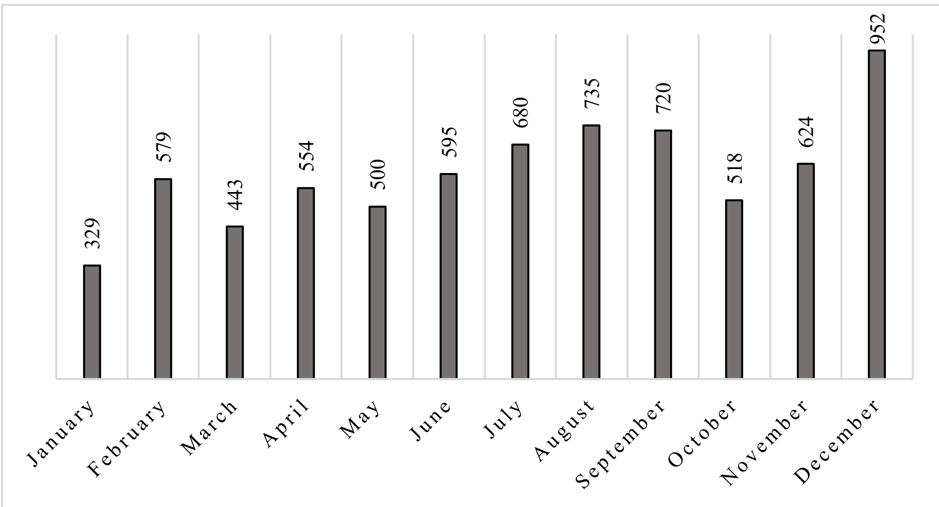

Figure 5 - Voucher use by month

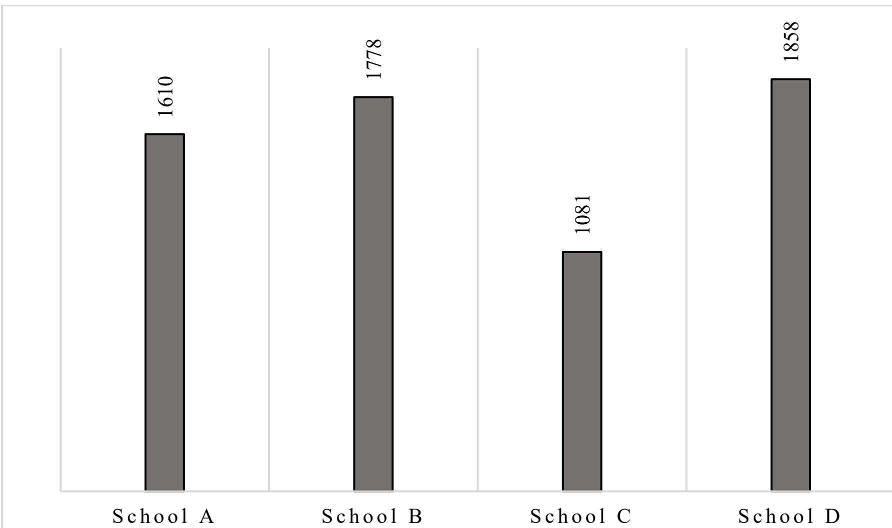

Figure 6 - Voucher use by school

Trampolining accounted for almost half of the voucher usage (49.1%), followed by laser tag (11.5%) and the waterpark (slides and surfing, 7.3%). A more detailed breakdown of the activities accessed stratified by gender can be seen as Table 5. ACTIVE helped set up three lunchtime clubs in two different schools at the request of teenagers: an unstructured football session, dance, and parkour. Notably, all choices were unstructured and informal activities

Table 5 - Frequency of voucher use by gender

Activity	Total	Girls	Boys
Aqua Aerobics	3	0	3
Aqua Zumba	2	2	0
Badminton	13	5	8
Boxing Equipment	13	0	13
Cycling Equipment	361	76	285
Miscellaneous Equipment	37	36	1
Equipment for School	19	0	19
Equipment from Nash Sport	34	7	27
Fitness Equipment	368	187	154
Foot Golf	69	19	50
Football	407	7	400
Football Equipment	122	10	112
Gym Membership	357	182	175
Gym Pay & Play	211	134	77
Gymnastics	4	3	1
Court Hire	4	0	4
Kickboxing	3	0	3
Laser Tag	862	514	348
Martial Arts	6	6	0
Martial Arts Equipment	55	28	27
Paintballing	4	4	0
Parkour	48	0	48
Play Area	3	2	1
Rock Climbing	10	10	0

Skateboard Equipment	94	62	32
Skateboarding	23	0	23
Swimming	48	20	28
Swimming Equipment	77	71	6
Tennis	8	0	8
Tennis Equipment	13	0	13
Trampolining	3692	1914	1778
Water Park	547	288	253
Zumba	3	3	0

Figures 7 and 8 show voucher use by fitness (unfit/fit) at baseline, gender and school deprivation (more deprived/less deprived). Fit/unfit boys tended to use slightly more vouchers (median = 14; for both groups) compared to fit girls (median = 12) and unfit girls (median = 11) (Figure 7). Unfit, less deprived pupils used more vouchers (median = 18) (Figure 8). This was followed by fit, more deprived pupils (median = 13). Unfit, more deprived and unfit, less deprived pupils had similar usage (median = 11).

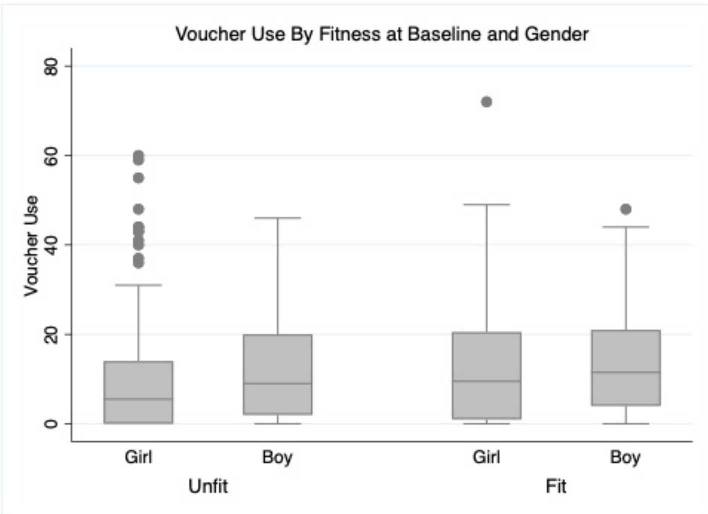

Figure 7 - Vouchers use by fitness and gender

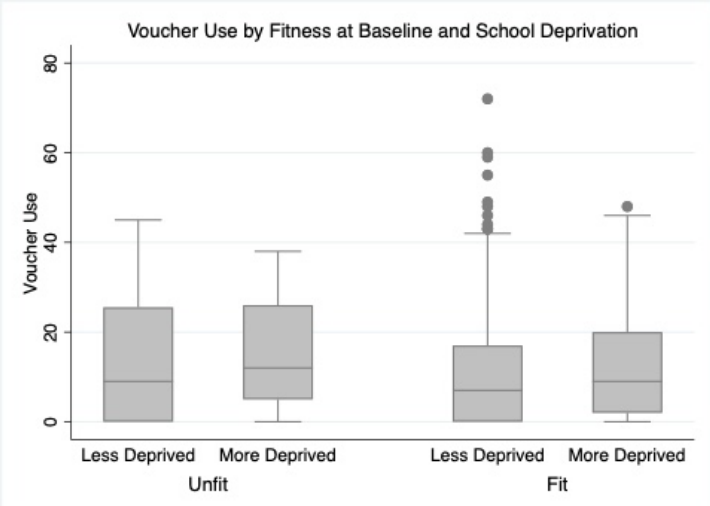

Figure 8 - Vouchers use by fitness and school deprivation

Poisson regression was used to analyse associations with voucher use and baseline measures due to the voucher use variable being count data. It demonstrated that voucher use was associated with being less deprived, being fitter, having lower blood pressure, being more motivated, having a higher sedentary time and lower MVPA at baseline (Table 6). Interestingly, gender was not significant. Common themes for not using the vouchers included the lack of local provision and motivation to exercise (Table 7).

Table 6 –Regression outcomes for voucher use

Poisson Regression (Voucher Use)			
Covariate	Coef.	p-value	95% Confidence Interval
School Deprivation	**.001**	**0.000**	**.000 to 0.002**
Gender	.796	0.143	-.269 to 1.861
Fitness (Distance Ran)	**.001**	**0.042**	**.000 to .002**
Blood Pressure	**-.045**	**0.011**	**-.080 to -.010**
Motivation	**.193**	**0.000**	**.108 to .278**
Sedentary Time	.005	0.084	-.000 to .011
MVPA	**-.057**	**0.000**	**-.080 to -.033**

*Bold denotes significance

Table 7 – Reasons for lack of voucher use

Theme	Quote
There was nothing to do in the area	"*I can't really think of many places you could use them, we haven't got that many places in the area*" (Girl)
It required travel to get to activity places	*"Sometimes it's hard to get to, you know like the paintballing place, people find it hard to get to places like that, like buses and stuff*" (Girl)
Participants were too busy	"*School work and that you don't get time to do anything*" (Boy) and *"it just very busy now, especially with the GCSE period"* (Girl)
Participants were not interested in being active	"*Like, they don't see the point"* (Boy) and *"because of Xboxes that people are using, they're too busy focussed on social media*". (Girl)

5.3 Primary aims of ACTIVE

Comparison between outcomes for the intervention and control group are reported in Table 8. The results in this table are descriptive, presenting the mean score, standard deviation and differences between baseline and 12 months including confidence intervals of the differences. Where percentages are present indicates the number of participants measuring as fit, with high blood pressure or as autonomously motivated. This demonstrates differences at baseline and twelve months for primary and secondary outcome measures by mean. This was used to test the hypothesis that a multi-component intervention would positively influence primary and secondary outcomes for teenagers. This is different to regression modelling as the regression models highlight the size of effect.

The 6-month data the same observed trends for fitness, cardiovascular health and motivation but for clarity, this thesis presents comparisons between baseline and 12 months. Data for outcomes of cardiovascular fitness, accelerometery and cardiovascular health was imputed using the MICE command in Stata version 12. This included 102 participants at baseline and 170 at follow-up using measures of fitness, activity and blood pressure at other timepoints (baseline/follow-up), gender, and deprivation. This generated a complete data set, which was used for analysis.

Cardiovascular fitness

The control group initially ran further and were fitter than the intervention (Table 8), however this was not statistically significant. Across both the intervention and control, there was a trend to fitness to decrease in teenagers. The number of teenagers categorised as fit in the control group declined by 5.4% but there was only a reduction of 0.5% in the intervention group at 12 months. This decline was greatest for girls in the control group (-7.5% compared to an increase of 2.9% in the intervention).

Girls in the intervention showed a trend to become fitter (3% more children were fit). There was a significant difference between the girls at baseline (control schools were more fit) but this was reduced at 12 months due to the intervention girls getting fitter. As well as this, the biggest increase in fitness was seen in the non-deprived participants in the intervention group (8.6%). In terms of distance run, Table 8 shows similar trends. The most notable observation being that there was a significant drop in the metres run for non-deprived pupils in the control group (-68.1 metres).

Linear mixed effects multilevel regression (Table 9) shows that, overall, the intervention (group covariate) ran fewer metres compared to the control group. The interaction between group and time (being in the intervention at 12 months), showed a positive coefficient direction in favour of the intervention but this is not statistically significant. Logistic regression showed significantly higher odds of being fit at 12 months in the intervention group compared to the control (odds ratio 1.21 (95% CI: 1.07 to 1.38) p=0.002) (Table 9).

Table 8 - Intervention compared to control in terms of outcomes

Cooper Run (% Fit)	*Control (n=384)*	*Intervention (n=524)*	Difference
Baseline (Total)	35.9% (n=138)	33.5% (n=176)	2.4% (95% CI: -3.9% to 8.6%)
12 Months (Total)	30.4% (n=117)	33.0% (n=173)	-2.6% (95% CI: -8.6% to 3.6%)
Difference (Total)	5.4% (95% CI: -.6% to 1.6%)	0.5% (95% CI: -4.5% to 5.7%)	**4.9% (95% CI: 2.7% to 7.6%)**
	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys)	22.1% (n=47)	24.4% (n=62)	-2.3% (95% CI: -9.9% to 5.5%)
12 Months (Boys)	18.3% (n=39)	20.0% (n=51)	-1.7% (95% CI: -8.9% to 5.5%)
Difference (Boys)	3.8% (95% CI: -3.5% to 11.1%)	4.4% (95% CI: -2.1% to 10.8%)	-.6% (95% CI: -.2% to 4.6%)
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference
Baseline (Girls)	52.9% (n=91)	42.2% (n=114)	**10.7% (95% CI: 11.5% to 20.2%)**
12 Months (Girls)	45.3% (n=78)	45.1% (n=122)	.2% (95% CI: -9.4% to 9.7%)
Difference (Girls)	7.5% (95% CI: -2.8% to 17.9%)	-2.9% (95% CI: -10.8% to 4.8%)	**10.4% (95% CI: .4% to 9.7%)**
	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline	36.3% (n=53)	35.0% (n=151)	1.3% (95% CI: -7.7% to 10.2%)

(Deprived) 12 Months (Deprived) Difference (Deprived)	 30.8% (n=45) 5.5% (95% CI: -4.4% to 15.4%)	 32.4% (n=140) 2.6% (95% CI: -3.1% 8.2%)	 -1.6% (95% CI: -10.4% to 7.1%) 2.9% (95% CI: -.4% to 7.9%)
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference
Baseline (Not Deprived) 12 Months (Not Deprived) Difference (Not Deprived)	35.7% (n=85) 30.2% (n=72) 5.5% (95% CI: -2.4% to 13.3%)	26.8% (n=25) 35.4% (n=33) -8.6% (95% CI: -20.6% to 3.4%)	8.9% (95% CI: -2.4% to 20.1%) -5.2% (95% CI: -16.4% to 5.9%) **14.1% (95% CI: 4.1% to 19.2%)**
Cooper Run (Distance, m)	*Control (n=384)*	*Intervention (n=524)*	Difference
Baseline (Total) 12 Months (Total) Difference (Total)	1811.8 (±365.5) 1756.0(±384.4) 55.7 (95% CI: 11.1 to 100.3)	1781.9(±373.5) 1762.3(±421.1) 19.6 (95% CI: -16.7 to 55.9)	29.9 (95% CI: -18.9 to 78.6) -6.3 (95% CI: -59.8 to 47.2) 36.1 (95% CI: -93.1 to 20.9)
	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys)	1989.9 (±346.0)	2010.9 (±335.7)	-21 (95% CI: -83.1 to 41.2)
12 Months (Boys)	1897.1 (±390.7)	1953.2 (±400.3)	-56.1 (95% CI: -128.4 to 16.3)

Difference (Boys)	92.8 (95% CI: 26.4 to 159.1)	57.7 (95% CI: .2 to 115.2)	35.1 (95% CI: -122.2 to 52.0)
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference
Baseline (Girls) 12 Months (Girls) Difference (Girls)	1592.2 (±252.1) 1582.1 (±295.8) 10.1 (95% CI: -46.6 to 66.9)	1566.5 (±263.1) 1582.7 (±356.8) -16.1 (95% CI: -61.4 to 29.0)	25.7 (95% CI: -23.9 to 75.3) -.6 (95% CI: -64.7 to 63.5) 26.2 (95% CI: -98.5 to 46.1)
	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline (Deprived) 12 Months (Deprived) Difference (Deprived)	1806.2 (±295.4) 1770.5 (±359.3) 35.7 (95% CI: -27.9 to 99.4)	1783.1 (±371.6) 1763.5 (±412.5) 19.6 (95% CI: -19.2 to 58.4)	23.1 (95% CI: -43.4 to 89.6) 7 (95% CI: -68.2 to 82.1) 16.1 (95% CI: -92.2 to 60.0)
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference
Baseline (Not Deprived) 12 Months (Not Deprived) Difference (Not Deprived)	1815.2 (± 403.0) 1747.1 (±363.2) **68.1 (95% CI: 7.3 to 128.7)**	1776.3 (±384.1) 1756.5 (±461.1) 19.8 (95% CI: -79.9 to 119.5)	38.9 (95% CI: -56.7 to 134.6) -9.4 (95% CI: -109.8 to 91.1) 48.3 (95% CI: -163.2 to 66.6)
MVPA (Minutes)	*Control (n=384)*	*Intervention (n=524)*	Difference

Baseline (Total)	77.06 (±15.75)	73.18 (±15.75)	**3.88 (95% CI: 1.80 to 5.95)**
12 Months (Total)	58.06 (±14.20)	57.80 (±14.20)	.26 (95% CI: -1.56 to 2.07)
Difference (Total)	**19.00 (95% CI: 17.20 to 20.80)**	**15.38 (95% CI: 13.73 to 17.02)**	**3.62 (95% CI: 1.16 to 6.07)**
	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys)	74.43 (±15.05)	69.67 (±13.44)	**4.76 (95% CI: 2.16 to 7.36)**
12 Months (Boys)	52.92 (±12.82)	52.69 (±11.92)	.23 (95% CI: -2.48 to 2.02)
Difference (Boys)	**21.51 (95% CI: 19.13 to 23.88)**	**16.98 (95% CI: 14.89 to 19.06)**	**4.53 (95% CI: 1.38 to 7.67)**
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference
Baseline (Girls)	80.31 (±16.04)	76.47 (±17.03)	**3.84 (95% CI: .63 to 7.02)**
12 Months (Girls)	64.41 (±13.25)	62.60 (±13.2)	1.81 (95% CI: -.72 to 4.32)
Difference (Girls)	**15.90 (95% CI: 13.18 to 18.60)**	**13.87 (95% CI: 11.36 to 16.38)**	2.03 (95% CI: -1.78 to 5.84)
	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline (Deprived)	77.05 (±17.73)	73.79 (±15.58)	**3.26 (95% CI: .22 to 6.29)**
12 Months (Deprived)	58.91 (±13.64)	57.89 (±13.64)	1.02 (95% CI: -1.54 to 3.57)

Difference (Deprived)	18.14 (95% CI: 15.09 to 21.17)	**15.89 (95% CI: 14.09 to 17.6)**	2.25 (95% CI: -1.30 to 5.80)
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference
Baseline (Not Deprived) 12 Months (Not Deprived) Difference (Not Deprived)	77.06 (±14.43) 57.53 (±14.54) **19.53 (95% CI: 17.29 to 21.78)**	70.35 (±16.34) 57.35 (±13.05) **13.00 (95% CI: 8.96 to 17.05)**	**6.71 (95% CI: 3.10 to 10.31)** .18 (95% CI: -3.22 to 3.58) **6.53 (95% CI: 2.15 to 10.90)**
Sedentary Time (Minutes)	*Control (n=384)*	*Intervention (n=524)*	Difference
Baseline (Total) 12 Months (Total) Difference (Total)	610.40 (±53.52) 563.14 (±62.02) **47.26 (95% CI: 39.07 to 55.45)**	606.99 (±67.47) 561.63 (±64.21) **45.36 (95% CI: 37.63 to 53.08)**	3.41 (95% CI: -4.75 to 11.57) 1.51 (95% CI: -6.83 to 9.84) 1.9 (95% CI: -9.51 to 13.31)
	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys) 12 Months (Boys) Difference (Boys)	618.66 (±52.95) 551.30 (±63.16) **67.36 (95% CI: 56.43 to 78.27)**	616.60 (±68.14) 549.76 (±61.44) **66.84 (95% CI: 55.89 to 77.77)**	2.06 (95% CI: -9.19 to 13.32) 1.54 (95% CI: -9.81 to 12.90) .53 (95% CI: -15.03 to 16.09)
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference

Baseline (Girls)	600.17 (±52.60)	597.96 (±65.69)	2.21 (95% CI: -9.47 to 13.89)
12 Months (Girls)	577.79 (±57.46)	572.80 (±64.86)	4.99 (95% CI: -6.91 to 16.89)
Difference (Girls)	**22.38 (95% CI: 10.95 to 33.80)**	**25.16 (95% CI: 14.75 to 35.56)**	-2.77 (95% CI: 13.10 to 18.64)
	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline (Deprived)	605.31 (±60.13)	611.70 (±62.42)	-6.38 (95% CI: -17.99 to 5.21)
12 Months (Deprived)	568.56 (±62.26)	561.55 (±64.44)	7.01 (95% CI: -4.97 to 19.00)
Difference (Deprived)	**36.75 (95% CI: 22.78 to 50.71)**	**50.15 (95% CI: 42.00 to 58.30)**	-13.40 (95% CI: -2.76 to 29.56)
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference
Baseline (Not Deprived)	613.54 (±48.87)	585.18 (±84.16)	**28.36 (95% CI: 13.73 to 43.00)**
12 Months (Not Deprived)	559.78 (±61.77)	562.02 (±63.49)	-2.24 (95% CI: 17.21 to 12.74)
Difference (Not Deprived)	**53.76 (95% CI: 43.71 to 63.80)**	**23.16 (95% CI: 1.68 to 44.62)**	**30.60 (95% CI: 9.77 to 51.42)**
Blood Pressure (% High)	*Control (n=384)*	*Intervention (n=524)*	Difference
Baseline (Total)	1.6% (n=6)	5.3% (n=28)	-3.7% (95% CI: -5.5% to .2%)
12 Months	3.1% (n=12)	2.7% (n=14)	.4% (95% CI: -1.7% to 2.9%)

(Total) Difference (Total)	-1.4% (95% CI: -3.7% to .6%)	2.6% (95% CI: -3.0% 5.0%)	-4% (95% CI: -.9% to 3.0%)
	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys)	2.4% (n=5)	6.7% (n=17)	-4.3% (95% CI: .4% to 8.3%)
12 Months (Boys)	4.2% (n=9)	3.5% (n=9)	.7% (95% CI: -2.9% to 4.3%)
Difference (Boys)	-1.8% (95% CI: -1.7% to 5.7%)	3.2% (95% CI: -.7% to 7.2%)	(95% CI: -1.9% to 4.4%)
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference
Baseline (Girls)	**0.6% (n=1)**	**4.1% (n=11)**	**-3.5% (95% CI: .3% to 6.6%)**
12 Months (Girls)	1.7% (n=3)	1.9% (n=5)	.2% (95% CI: -3.3% to 2.7%)
Difference (Girls)	-1.1% (95% CI: -1.7% to 4.4%)	2.2% (95% CI: -.7% to 5.4%)	-3.3% (95% CI: -2.1% to 3.7%)
	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline (Deprived)	2.0% (n=3)	4.6% (n=20)	-2.6% (95% CI: -1.5% to 5.3%)
12 Months (Deprived)	3.4% (n=5)	2.3% (n=10)	1.1% (95% CI: -1.6% to 5.5%)
Difference (Deprived)	-1.4% (95% CI: -2.9% to 5.9%)	2.3% (95% CI: -.1% to 4.9%)	-3.7% (95% CI: -2.6% to 3.0%)
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference

Baseline (Not Deprived) 12 Months (Not Deprived) Difference (Not Deprived)	**1.3% (n=3)** 2.9% (n=7) -1.6% (95% CI: -1.1% to 4.8%)	8.6% (n=8) 4.3% (n=4) 4.3% (95% CI: -3.2% to 12.2%)	**7.3% (95% CI: 2.5% to 14.8%)** -1.4% (95% CI: -2.6% to 7.7%) -5.9% (95% CI: -1.0% to 8.9%)
Augmentation Pressure (mmHg)	*Control (n=384)*	*Intervention (n=524)*	Difference
Baseline (Total) 12 Months (Total) Difference (Total)	4.9 (±2.5) 4.1 (±2.2) .8 (95% CI: .4 to 1.1)	5.0 (±2.6) 4.0 (±2.4) 1 (95% CI: .7 to 1.3)	-.1 (95% CI: -.5 to .1) .1 (95% CI: -.2 to .3) .2 (95% CI: -.1 to .7)
	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys) 12 Months (Boys) Difference (Boys)	4.6 (±2.7) 4.1 (±2.2) .5 (95% CI: -.0 to .9)	4.6 (±2.6) 4.2 (±2.5) .4 (95% CI: -.0 to .8)	.0 (95% CI: -.4 to .5) .1 (95% CI: -.4 to .4) .1 (95% CI: -.7 to .5)
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference
Baseline (Girls) 12 Months	5.2 (±2.3) 4.0 (±2.2)	5.5 (±2.4) 3.9 (±2.2)	-.3 (95% CI: -.7 to .1) .1 (95% CI: -.3 to .5)

(Girls) Difference (Girls)	1.2 (95% CI: .7 to 1.7)	1.6 (95% CI: 1.2 to 2.0)	.1 (95% CI: -.1 to .9)
	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline (Deprived)	4.5 (±3.2)	5.2 (±2.4)	**-.7 (95% CI: -1.2 to -.1)**
12 Months (Deprived)	4.0 (±2.0)	4.1 (±2.3)	-1 (95% CI: -.5 to .3)
Difference (Deprived)	.5 (95% CI: -.1 to 1.1)	**1.3 (95% CI: .8 to 1.4)**	**.8 (95% CI: .1 to 1.4)**
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference
Baseline (Not Deprived)	5.1 (±2.0)	4.2 (±2.9)	**.9 (95% CI: .3 to 1.4)**
12 Months (Not Deprived)	4.1 (±2.3)	3.6 (±2.6)	.5 (95% CI: -.0 to 1.0)
Difference (Not Deprived)	1.0 (95% CI: .5 to 1.3)	.6 (95% CI: -.2 to 1.3)	.4 (95% CI: -1.2 to .4)
Augmentation Index (%)	*Control (n=384)*	*Intervention (n=524)*	Difference
Baseline (Total)	9.5 (±4.0)	10.0 (±4.6)	**-.5 (95% CI: -1.1 to .0)**
12 Months (Total)	7.4 (±3.2)	7.6 (±4.3)	-.2 (95% CI: -.6 to .3)
Difference (Total)	2.1 (95% CI: 1.5 to 2.5)	2.4 (95% CI: 1.8 to 2.9)	-.3 (95% CI: -.4 to 1.0)

	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys)	8.8 (±3.9)	9.1 (±4.8)	-.3 (95% CI: -1.1 to .5)
12 Months (Boys)	7.9 (±3.1)	8.1 (±4.5)	-.2 (95% CI: -.9 to .5)
Difference (Boys)	.9 (95% CI: .1 to 1.5)	1.0 (95% CI: .2 to 1.7)	-.1 (95% CI: -.9 to 1.1)
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference
Baseline (Girls)	10.3 (±3.9)	10.9 (±4.1)	-.6 (95% CI: -1.3 to .2)
12 Months (Girls)	6.9 (±3.2)	7.2 (±4.0)	-.3 (95% CI: -1.0 to .4)
Difference (Girls)	3.4 (95% CI: 2.6 to 4.2)	3.7 (95% CI: 3.0 to 4.4)	-.3 (95% CI: -.7 to 1.3)
	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline (Deprived)	8.8 (±4.5)	10.4 (±4.3)	**-1.6 (95% CI: -2.4 to -.8)**
12 Months (Deprived)	7.6 (±3.0)	7.8 (±3.9)	-.2 (95% CI: -.8 to .5)
Difference (Deprived)	1.2 (95% CI: .2 to 2.1)	2.6 (95% CI: 2.0 to 3.1)	**-1.4 (95% CI: -2.5 to -.4)**
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference
Baseline (Not Deprived)	9.9 (±3.6)	8.3 (±5.2)	**1.6 (95% CI: .6 to 2.6)**
12 Months	7.4 (±3.3)	7.0 (±5.5)	.4 (95% CI: -.5 to 1.3)

(Not Deprived) Difference (Not Deprived)	2.5 (95% CI: 1.9 to 3.2)	1.3 (95% CI: -.2 to 2.8)	1.2 (95% CI: -.1 to 2.5)
Motivation (% Autonomous)	*Control (n=384)*	*Intervention (n=524)*	Difference
Baseline (Total) 12 Months (Total) Difference (Total)	98.1% (n=378) 97.9% (n=377) .2% (95% CI: -1.5% to 2.1%)	97.1% (n=509) 97.9% (n=513) -.8% (95% CI: -2.4% to .9%)	1% (95% CI: -.9% to 3%) 0% (95% CI: -1.8% to 1.9%) .9% (95% CI: -.7% to 1.7%)
	Control Boys (n=212)	*Intervention Boys (n=254)*	Difference
Baseline (Boys) 12 Months (Boys) Difference (Boys)	98.1% (n=209) 98.5% (n=210) -.4% (95% CI: -2.9% to 1.9%)	97.6% (n=248) 97.6% (n=248) 0% (95% CI: -2.1% to 2.1%)	.5% (95% CI: -2.1% to 3.1%) .9% (95% CI: -1.5% to 3.4%) -.4% (95% CI: -1.0% 2.6%)
	Control Girls (n=172)	*Intervention Girls (n=270)*	Difference
Baseline (Girls) 12 Months (Girls) Difference (Girls)	98.2% (n=169) 97.0% (n=167) 1.2% (95% CI: -1.6% to 3.9%)	96.6% (n=261) 98.1% (n=265) -1.5% (95% CI: -4.0% to 1.0%)	.6% (95% CI: -1.5% to 4.7%) -1.1% (95% CI: -3.9% to 1.8%) 2.7% (95% CI: -3.2% to 3.0%)

	Control Deprived Pupils (n=146)	*Intervention Deprived Pupils (n=431)*	Difference
Baseline (Deprived)	97.2% (n=143)	98.1% (n=423)	-0.9% (95% CI: -3.5% to 1.8%)
12 Months (Deprived)	99.3% (n=146)	98.1% (n=423)	1.2% (95% CI: -1.1% to 3.5%)
Difference (Deprived)	-2.1% (95% CI: -5.0% to .9%)	0% (95% CI: -1.5% to 1.5%)	**2.1% (95% CI: .4% to 5.8%)**
	Control Not Deprived Pupils (n=238)	*Intervention Not Deprived Pupils (n=93)*	Difference
Baseline (Not Deprived)	98.7% (n=235)	92.4% (n=86)	**6.3% (95% CI: 2.1% to 10.3%)**
12 Months (Not Deprived)	97.0% (n=231)	96.7% (n=90)	3% (95% CI: -3.8% to 4.4%)
Difference (Not Deprived)	1.7% (95% CI: -.6% to 4.0%)	-4.3% (95% CI: -10.3% to 17.0%)	6% (95% CI: -1.0% to 8.9%)
*Bold denotes significance			

Table 9 – Regression outcomes for fitness

Mixed Effects Multi-Level Regression (Distance Ran)		
Covariate	Coef.	95% CI
Group (Intervention)	-32.3	-89.0 to 24.4
Time (12 Month Follow Up)	-55.3	-98.3 to -12.1
Interaction *Intervention with time (Slope difference of intervention v control at 12 months)*	35.6	-21.2 to 92.4
Logistic Regression (1 = Fit/0 = Not Fit)		
Covariate	Estimate	95% CI
Group (Intervention)	**1.21**	**1.07 to 1.38**
*Bold denotes significance		

In terms of how voucher use impacted fitness, linear regression controlling for fitness at baseline, gender and deprivation shows that the number of vouchers used did not have a statistically significant impact on total distance ran at 12 months. However, it did have a significant relationship with whether a teenager was categorised as fit (odds ratio 1.01 (95% CI: 1.007 to 1.025) p=0.000) (Table 10).

Table 10 – Regression outcomes for fitness and voucher use

Linear Regression (Distance Ran)			
Covariate	Coef.	p-value	95% CI
Voucher Use	1.754	0.243	-1.19 to 4.70
Logistic Regression (1 = Fit/0 = Not Fit)			
Covariate	Coef.	p-value	95% CI
Voucher Use	**1.016**	**0.000**	**1.007 to 1.025**
*Bold denotes significance			

Interestingly, there was no significant relationship between fitness (distance ran or fit/not fit) and the number of minutes spent sedentary or doing MVPA at 12 months.

Physical activity (MVPA)

Average daily wear time across participants was 886.01 minutes at baseline and 799.69 minutes at 12 months suggesting some drop off in daily wear compliance across the intervention. At baseline 82% of participants returned valid data to be included in analysis and 76% at 12 months, again suggesting some drop off in wear compliance across the study duration.

The control group started with higher amounts of MVPA which was a significant difference. Following a similar trend to that of cardiovascular fitness, there was evidence that the amount of time spent being active decreases as teenagers age. This was significant in both the control and intervention groups, between genders and deprivation. For example, control schools MVPA dropped by 19 minutes while intervention schools did 15 minutes less from baseline to 12 months (-3.62 minutes (95% CI: 11.6 to 6.07)) (Table 8).

In a regression model the intervention did not have a significant relationship with the amount of time spent doing MVPA (Table 11). However, when controlling for MVPA time at baseline, gender and deprivation there was a significant relationship between the voucher usage and MVPA at 12 months. Suggesting an increased use of vouchers could improve MVPA (Table 11). Interestingly, Table 6 shows the opposite where MVPA decreases with increased voucher use. This is because Table 6 presents baseline MVPA where Table 11 presents 12-month MVPA measures. Highlighting that at the start of the intervention, those with lower levels of MVPA were using more vouchers and by the end those with higher MVPA were using more vouchers.

Table 11 – Regression outcomes for MVPA

Linear Regression (MVPA)			
Covariate	Coef.	p-value	95% CI
Group (Intervention)	-.259	0.780	-2.075 to 1.556
Linear Regression (MVPA)			
Covariate	Coef.	p-value	95% CI
Voucher Use	**.140**	**0.007**	**.038 to 2.42**

Sedentary time also dropped in both arms (Table 8). The most notable decline being observed in deprived pupils in the intervention whose sedentary time reduced by 50.15 minutes, compared to 36.75 in the control. However, the opposite was observed in non-deprived pupils. There was no significant relationship between time spent sedentary and the intervention or voucher usage.

5.4 Secondary aims of ACTIVE

Exercise motivation (BREQ-2)

Table 8 demonstrates that the BREQ-2 questionnaire showed that participants were autonomously motivated. Between 92%-98% of teenagers in each group autonomously motivated. In line with Self Determination Theory (SDT) (84) this means that teenage participation in activity is attributed to enjoyment and personal values as opposed to being made to feel guilty and pressured to be active (87).

Cardiovascular health (blood pressure and pulse wave analysis)

The proportion of pupils categorised as having high blood pressure (systolic blood pressure>130mmHg) in the intervention group fell (baseline 5.3% [28/524] and 12 months 2.7% [14/524]) (Table 8). A rise in the proportion of those with high blood pressure was seen in the control group (baseline 1.6% [6/385] 12 months 3.1% [12/385]) but this was not significant. Thus, providing evidence that the intervention helped improve blood pressure, particularly for those with high blood pressure measures at baseline.

AP and AIx improved in both arms (Table 8). Deprived children in the intervention saw a significant decrease in AP compared to the control. This compliments the finding of a reduction in those with high blood pressure in the intervention.

Impact of the intervention

ACTIVE’s impact on teenage activity was said to be positive by the participants and local council focus group conversations flowed around two themes: i) the breaking down of cost barriers and, ii) changes in perception of activity. Teenagers reported they no longer had to ask their parents for money, which had often been a barrier. One boy said he was able to *“go places and do different things”* (Boy) because of knowing more about what was available. The local council in their focus group echoed this and one individual felt *“…they [the vouchers] are making people more aware of what is in the local area so that they can be active…”.*

Teenagers reported changes in their local area thanks to the vouchers. A leisure centre doubled the value of the vouchers to £10; *“…they’ve doubled up, so like one is now worth £10 because it costs more than £5 for some of the sessions”* (Girl). As well as this, the local trampoline park added free food to the voucher which made activity feel more social and welcoming, one girl stated *“…because then like you go there, you have food as well, it’s like more of a thing”* (Girl).

Some participants noted that the study had changed their view of physical activity as something fun to do with friends that did not feel like sport or exercise. For example, one girl noted, *"you don't realise its exercise…"* (Girl). For girls, this change of definition seemed to be very helpful in improving access to activity as *"you don’t have to wear sports clothes, and it doesn’t matter, but you can make a day of it, so like you can go to town, and then maybe go to Laser Zone."* (Girl). Again, this highlights the changing perception of activity to a social-fun event. Changes in the perception was also present in the local council focus group. They spoke about using the data collected from ACTIVE to change their delivery and approach to activity provision. One individual said they would *“use the results to shape and inform our planning for our areas*” as well as tackling the issues associated with teenage inactivity. They noted that the data could underpin *“how we can address them [barriers identified in ACTIVE] within our [school and community] programmes”.*

However, there were some aspects of the study that teenagers said were less positive. There was a lack of clarity about who the peer mentors actually were and one boy stated *"…like I haven’t felt the need to like go to one”* (Boy). The participants suggested that the mentors should be chosen by school teachers; *"get a gym teacher to* *look at who does most sports in the school and like who enjoys it most"* (Boy). This was due to *"I feel like some of the people that have been chosen don't really want to be involved..."* (Girl) and a different selection process may have protected against this.

The teenagers thought that presence of the support worker was beneficial as they created awareness of what was new or *"if anything had changed, which was really informative and nice"* (boy, focus group 1). However, some pupils noted that the timings of the support worker were not ideal; in particular, they said morning assemblies are a time when they do not pay attention. As well as this, the local council noted that one school selected was a welsh-medium school where pupils were likely to have travelled to attend and therefore, the participants would not have benefitted in any change to their community provision around the school.

5.5 What works best when implementing a physical activity intervention for teenagers? Reflections from the ACTIVE Project

At the 12-month time point of ACTIVE, semi-structured focus groups were carried out in the four intervention schools to assess the strengths and weaknesses of ACTIVE. Namely, to explore any recommendations that teenagers had to the interventions delivery and the impact it had on the physical activity of young people. Members of the local council's AYP team also participated in an additional focus group to get an insight from stakeholders. These qualitative findings have been published in BMJ Open (180) (Appendix 11).

Three themes emerged from the discussions; i) Ability to choose own activities ii) Using external influences (e.g., peer mentors and a support worker) and iii) The intervention's settings. The following findings have been taken from ACTIVE's "What works best when implementing a physical activity intervention for teenagers? Reflections from the ACTIVE Project: a qualitative study" publication (180).

Ability to choose own activities

Teenagers discussed the ability to choose their own activities with the vouchers as a notable strength of ACTIVE. Both boys and girls used the trampoline parks frequently, one boy explained *"... I think the most popular would be [trampoline park] and that's quite a multi-sex sport then, isn't it?"* (boy, focus group 7). The choice allowed boys and girls to participate in the same activities which one boy (focus group 3) believed had made girls more active. Girls acknowledged there were *"loads of things"* (girl, focus group 4) they could do with the vouchers that were more chilled than typical activity provision on offer. Boys also agreed that activity had become fun. There were a lot of places young people did not realise would count as activity which they saw as a strength of the project as it had changed perceptions of activity for the teenagers.

As well as this, there was no longer a concern about money. One boy noted that young people would find paying for activities as a barrier but *"now you've got the vouchers to pay for it"* (boy, focus group 5). There was an agreement amongst teenagers that the vouchers had helped improve socialisation for this reason. The vouchers gave them the choice of doing *"something in the nights"* (girl, focus group 8), on *"Saturday afternoons and Sunday afternoons"* (boy, focus group 3) or when you're *"on holiday"* (girl, focus group 6). One girl (focus group 8) stated that by being able to use the vouchers in a social capacity had made her more confident to be active.

The local council agreed that giving teenagers a choice was a strength of ACTIVE. They liked that teenagers could decide where and how and considered the vouchers as more of a leisure pass where teenagers could go and enjoy activities with their friends. They also believed that the choice aspect improved the sustainability of ACTIVE's impact on physical activity as some teenagers found an activity they really enjoyed or bought equipment that could have a long-term effect.

Using external influences (e.g., peer mentors and a support worker)

Using external influences to promote physical activity was a contested issue on ACTIVE. When asked about the peer mentoring scheme, most teenagers were unaware of it. The peer mentors themselves said they did not have anything to do, that they needed more *"recognition of who they were"* (girl, focus group 8) or that the scheme would have benefit from "a meeting, once a month, or something" (boy, focus group 7). Some pupils also said they did not feel the need to go to them. There were issues raised with the selection of peer mentors. They suggested that a teacher should select the peer mentors *"to look at who does most sports in the school"* as a good role model (boy, focus group 3). One member of the local council suggested that pupils should put themselves forward and then there be a vote, but another felt that *"perhaps the people that put themselves forward might not be the people that you actually want."* (council focus group).

The teenagers thought that presence of the support worker was beneficial as they created awareness of what was new or *"if anything had changed, which was really informative and nice"* (boy, focus group 1). However, some pupils noted that the timings of the support worker were not ideal; in particular, they said morning assemblies are a time when they do not pay attention. The council focus group noted that the support worker was a difficult role as it had a variety of responsibilities from voucher distribution to activity promotion and drop-in sessions in schools. They perceived the support worker role to be a hard position and that the personality of the individual was the most important factor when considering who should fill it.

The intervention's settings

Most teenagers stated that there was very little within walking distance and that more activities should be put in the local community. However, the local council felt teenagers did not know all that was available and felt there could be a greater awareness created of community provision. One council member suggested that ACTIVE could have promoted the providers better in the schools. The project could have showed a video for example as this might capture the kids or activity providers should promote more of *"showing what they [the teenagers] would get if they went to see these providers"* (council focus group). They believed the promotion was a weak aspect of ACTIVE.

There was a lot of discussion centred on physical activity lessons in school. Teenagers wanted more opportunities to be active through *"sports clubs at (lunch) dinner break and break"* (boy, focus group 5) in school, for timings of activities to be lengthened, school PE kit to be more lenient and more choice offered. The local council discussed teacher's involvement in ACTIVE, as they believed they had a pivotal role in the project's success. Some teachers were really proactive and *"really pushed the project"* (council focus group) therefore, the intervention ran well. However, in other schools *"there wasn't that many links between the PE department"* (council focus group) which hindered delivery.

5.6 Discussion of experimental results

Voucher use

Throughout ACTIVE, the voice of young people was listened to, aiming to share suggestions made by teenagers to improve activity provision, uptake and sustainability for both themselves and their peers. Conversations confirm that cost, accessibility and lack of local facilities are perceived as barriers to being active (16,65,68,81,119,179,181). When addressing these barriers explicitly, previous studies have found short-term improvement to activity levels (72), particularly in the school setting (17,65,73). The repetition of these barriers in ACTIVE suggests that despite a plethora of interventions and policy, the issue of accessibility has not been addressed long-term.

ACTIVE argues that this is perhaps because of a lack of involving teenagers in the decision-making processes of activity provision. This study highlights that they have six key recommendations to make:

1. Lower/remove the cost of activities without sacrificing the quality
2. Make physical activity opportunities more locally accessible
3. Improve the standards of existing facilities
4. Make activities more specific to teenagers
5. Give teenagers a choice of activities/increase variety of activity

6. Provide activities that teenage girls enjoy (e.g. fun, sociable and not competitive sport) (67)

These recommendations provided a pivotal start point for ACTIVE helping to recruit initial activity providers and understand the wants and needs of young people. The recommendations were reflected in the voucher usage with unstructured, fun and social activities favoured. Vouchers were predominantly used by teenagers who were less deprived, fitter, more motivated, more sedentary and less active at baseline. The intervention was successful in targeting those who were less active and there was some evidence to suggest that the more vouchers used improved MVPA; which is a positive of ACTIVE. Teenagers who were less active were becoming more active and evidence suggested that spending more vouchers was associated with higher activity. Thus, it could be said that ACTIVE overcame the accessibility barrier of cost. However, it appears that those who were already more motivated, and fitter chose to use the vouchers. This could be due to having an increased level of confidence and feeling more capable to access the activities on offer.

Cardiovascular fitness and physical activity

ACTIVE demonstrates improvements in the primary aims of fitness and physical activity relating to voucher use, girls and non-deprived teenagers. It also highlights some other important findings regarding teenage activity. Approximately 65% of children are unfit and this may increase by 5% per year arbitrating from changes in the control arm of ACTIVE (69). This is in line with previous findings (38,182). MVPA also follows a similar trend with number of minutes decreasing through the school year. Without successful intervention, this trend could continue.

It is evident through examining voucher use that unstructured, fun and social activities were favoured. These activities were often low skill with low barriers to entry where young people could make up their own rules. This supports previous findings that some teenagers see structured activity and sport as a barrier to being active (65) and that more of these types of activities should be made available (16,65,67). The casual nature of such activities allowed for more time to socialise, meaning teenagers could be active with their friends which could be influential in promoting confidence and providing peer support to be more active (16). This also goes someway to changing perceptions of activity. Moving away from traditional notions of sport being a competitive, structured, adult-led time. The local council agreed that provision of sport was not appealing to young people and there needs to be more unstructured, informal opportunities (67).

Previous interventions have opted for structured activity as a tool to promote activity levels (17,73) and this may contribute to the lack of long-term success of such interventions (180). The implications of this suggest that we need to reframe what we mean when we promote physical activity. Interestingly, there was no evidence to suggest that improvements in MVPA aligned with improvements in fitness. Thus, it cannot be assumed that improving activity and improving fitness are intrinsically linked. Moreover, accessibility modelling via GIS showed sedentary time increased as MVPA increased. This argues that being more sedentary cannot be a single determinant of poor activity, health and fitness (11). Activities that are likely to influence MVPA, such as structured, competitive sports may have high sedentary time outside this formal training period due to increased rest/recovery time between sessions. This finding suggests that we should promote different intensities of activity (e.g. light, moderate and vigorous). All of which have shown benefits to cardiovascular health and fitness, despite variances in intensity (11).

Motivation

ACTIVE's secondary aim of improving motivation found interesting insight into teenager's attitudes to activity. With a high percentage of young people being autonomously motivated according to BREQ-2, it would suggest that they know they need to be active but do not respond to external pressures to make them more active (69). For example, this would mean trying to use guilt as a tool would not be effective. Rather, participation in activity is linked to enjoyment and personal values (87).

In line with SDT (84), teenagers value activity for fun and would be inclined to be active if the enjoyment of taking part is a priority. Evidence of this is seen in the voucher usage. They do not need pressure from external sources such as teachers or parents rather, as ACTIVE suggests, they need the freedom to make their own choices. Giving this freedom has positive implications for teenage health and should be valued. Fun and enjoyment should be a priority in activity promotion.

Cardiovascular health

ACTIVE saw a reduction in the number of participants categorised as having high blood pressure over the duration of the intervention. As well as this, more deprived pupils saw a reduction in their AP. Therefore, providing evidence that empowering teenagers to do a range of activities at a range of intensities can improve their heart health (65,67,69,183). This helps provide protection against poor health in later life, instilling healthy behaviours that they enjoy. Given that seven million people fight cardiovascular disease daily (184) this is noteworthy. Improving the accessibility of activities young people enjoy (as seen with the voucher usage) could help underpin lifelong participation.

What works when implementing a physical activity intervention for young people?

The implications of the voucher scheme were ACTIVE's biggest success. While overcoming accessibility barriers, the activities also often required no intervention from adults. For example, hiring football pitches. This lack of intervention from adults is important as it empowers young people. They felt the vouchers allowed them to pay for activities themselves, overcoming cost barriers and giving them ownership. This is a significant strength of the project as it addressed the accessibility barrier (65,67,68). Not only this, being able to access provision on their own terms helped changed perceptions of activity for young people. From something teenagers felt they were pressured to do by adults that was high-intensity and difficult to a social-fun event (69).

There were wider community benefits seen alongside the delivery of ACTIVE. Teenagers observed that there had been changes made to local activity. For example, some providers changed the cost of their provision allowing discounted entry or 'two for one' deals as a way to promote teenagers bringing their friends. As well as this, the local council used the feedback and initial findings from ACTIVE to underpin their future planning (69,180). This provides evidence of the sustainability of ACTIVE as it helped influence the delivery of community and school-based activity for teenagers from the local council's perspective (69).

Some barriers still existed that the intervention did not overcome (69). Teenagers only used 25.1% of the vouchers. Some stated they could not use their vouchers in their local area as there was often little available for them to do. More research is needed to develop ways of overcoming this issue whether addressing public transport shortages or bringing more activities to young people's local communities (69). Teenagers stated they would like more opportunities to be active with their friends (1) but their needs are largely overlooked. They say they find themselves at the bottom of the hierarchy in claims on use of public space and feel there are deliberate attempts to keep them away from the spaces they'd like to be active. For example, in leisure centres many of the activities had either a maximum age limit of aged 10 (e.g. for children) or a minimum age limit of 16 (e.g. for adults) and there was little specifically available and advertised for those aged 11 to 16.

Some elements of ACTIVE were less successful compared to the voucher scheme. The peer support element was not received positively by teenagers and deemed unsuccessful despite the evidence of this approach working in other health behaviour intervention studies (128,146). Most of the young people in ACTIVE appeared to have little to no awareness of the peer mentors, who they were or what the scheme aimed to do. When they were aware, they believed there were issues with their selection (180). The teenagers noted that those selected to be peer mentors (10 in each intervention school) were, generally speaking, individuals who others found unapproachable, often intimidating. They noted that often 'influential' can be mistaken for asking who the 'most popular' is. It was important for teenagers that the mentors act as role models for being active but suggested more rigorous selection methods be used, e.g., having a teacher involved or someone who knows the young people.

With this in mind, it is essential that the correct characteristics be sought after when selecting mentors and that a suitable selection process be put in place. ACTIVE used a very similar process as the smoking cessation project, ASSIST (146). However, both have different aims. One sees the promotion of a behaviour and one looks at deterring. This could explain the difference in success. There is not a one size fits all approach to peer mentoring. However, given that teenagers were autonomously motivated and wanted to be active with their friends in an unstructured environment (69), it is possible that the peer mentor approach of a mentor was too structured, and an 'expert' peer is not motivating for teenagers (180). They stated that they would not really ask a peer for advice in relation to physical activity or exercise.

The support worker was seen as beneficial to ACTIVE's delivery and as an important link between pupils, schools and collaborative partners. However, more could be done to strengthen the impact this role had in terms of the timings of school visits and drop-in sessions (180). Teenagers explained that school assembly time is not a good time to deliver messages as they are often bombarded with other key messages for their school day. In future, it would be useful to consult with schools and involve teenagers in discussions as to how external support could most benefit them (180). The local council suggested that the support worker's role could improve awareness of existing provision. This does highlight a tension in the support workers role when working with stakeholders. ACTIVE's aim was to empower teenagers to be able to access activities they wanted yet the local council felt they should promote activities that are available but were perhaps ignored by the teenagers.

CHAPTER 6

OBSERVATIONAL RESULTS – OUTCOMES FROM LINKED DATA AND GIS

This chapter explores the observational results of baseline data collection as a single cohort rather than split participants as the control or intervention arm. This formulates much of the secondary aims of this thesis and paints a picture of the health and key influencers of the health of teenagers. In particular it looks at cardiovascular health and the influence of the built environment on teenage health and behaviour. As previously mentioned, 224 (n=129 boys) consented to take part in the observational analysis across the 7 schools (25.7%) were included in this cross-sectional analysis with data linkage. All 234 were successfully linked to routine data which were matched via their ALF. Appendix 7 shows how the variables were cleaned based on completion of data.

6.1 Predictors of cardiovascular health in teenagers: a cross-sectional study linked with routine data.

Findings from this observational aspect of the ACTIVE RCT have been previously published in Open Heart (165) (Appendix 12). Table 12 shows the demographics of participants who participated in the exploration of predictors of cardiovascular health in teenagers. Boys had higher measures across most variables including deprivation levels, hospital and GP visits and sedentary time. However, these differences were marginal except for differences in cardiovascular fitness which showed boys are fitter than girls at this age. Figure 9 shows relationships via SEM.

Table 12 – Demographics of participants for cardiovascular health

Variable	Male (n = 129) (SD)	Female (n = 105) (SD)
Arterial Stiffness (%)	9.54 (5.58)	10.17 (4.67)
Blood Pressure (mmHg)	114.47 (13.86)	110.42 (11.62)
Cardiovascular Fitness (metres ran)	2004.98 (412.92)	1604.98 (266.19)
School Deprivation	674.60 (677.01)	642.76 (688.17)

Deprivation at Birth	744.27 (559.9)	573.93 (468.94)
Deprivation at 1	665.25 (557.14)	595.45 (470.16)
Deprivation at 13	734.07 (534.4)	663.6 (482.38)
Birth Weight (g)	3368.23 (576.38)	3257.35 (597.67)
Gestational Age (weeks)	38.99 (1.82)	38.81 (2.48)
Birth Number	1.02 (.15)	1.01 (.13)
Maternal Age (years)	26.9 (5.78)	26.57 (5.88)
Breastfed (%)	48.44 (n = 62)	40.20 (n = 41)
C Section (%)	19.38 (n = 25)	23.81 (n = 25)
Hospital Admission (total number)	1.63 (2.01)	1.33 (2.85)
GP Visits (total number)	74.17 (43.24)	63.67 (34.00)
Sedentary Time (Week) (minutes)	627.21 (82.53)	601.96 (79.08)
Sedentary Time (Weekend) (minutes)	621.55 (115.31)	563.62 (120.11)
MVPA (Week) (minutes)	81.39 (22.10)	78.47 (24.25)
MVPA (Weekend) (minutes)	56.57 (20.67)	61.86 (26.06)

Augmentation Index (AIx)

Analysis showed higher AIx measures was associated with a lower school WIMD score (indicating higher levels of deprivation) (-.003 [95% CI: -.005 to -.0007]; Table 13). Lower hospital admissions (-.363 [95% CI: -.627 to -.099]) but higher number of GP visits (.030 [95% CI: .008 to .052]) also had significant relationships with higher AIx. School deprivation was also significant in the SEM (Figure 9).

Table 13 – Regression outcomes for AIx

Variable	Coef.	P	95% CI
School Deprivation	**-.003**	**0.010**	**-.005 to -.0007**
Deprivation at Birth	.0008	0.506	-.001 to .003
Deprivation at 1	.001	0.488	-.002 to .005
Deprivation at 13	-.0002	0.886	-.003 to .002
Gender	1.26	0.383	-1.57 to 4.10

Birth Weight	-.002	0.088	-.005 to .0003
Gestational Age	.314	0.403	-.423 to 1.05
Birth Number	-8.10	0.019	-14.85 to -1.34
Maternal Age	-.072	0.536	-.300 to .156
Breastfed	1.22	0.513	-.181 to .050
C-Section	.472	0.780	-2.83 to 3.78
Hospital Admissions	**-.363**	**0.007**	**-.627 to -.099**
GP Visits	**.030**	**0.006**	**.008 to .052**
Sedentary Time Week	-.011	0.054	-.046 to .024
Sedentary Time Weekend	.011	0.196	-.005 to .028
MVPA Time Week	-.054	0.065	-.113 to .003
MVPA Time Weekend	-.003	0.907	-.066 to .059
Blood Pressure	-.065	0.268	-.181 to .050
Fitness	-.001	0.581	-.005 to .002
*Bold denotes significance			

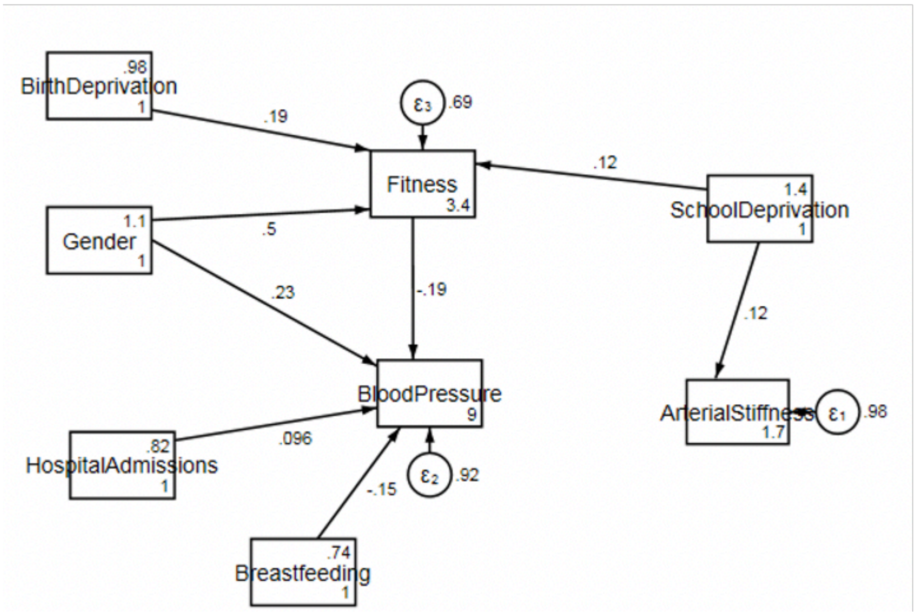

Figure 9 - Path analysis of predictors of cardiovascular health in teenagers

Blood pressure

Lower blood pressure was observed in teenagers who were first born (-29.96 mmHg [95% CI: -46.04 to -13.88]; Table 14) and were breast fed as infants (-6.09 mmHg [95% CI: -11.96 to -.22]. Being born as a result of caesarean meant blood pressure was higher as a teenager (5.15 mmHg [95% CI: 1.13 to 9.16]). As well as this, being more sedentary in the week was associated with higher blood pressure (.068 mmHg [95% CI: .28 to .11]). SEM included gender as a predictor of having higher blood pressure too (Figure 9).

Table 14 – Regression outcomes for blood pressure

Variable	Coef.	P	95% CI
School Deprivation	-.001	0.530	-.008 to .004
Deprivation at Birth	**.003**	**0.000**	**.001 to .007**
Deprivation at 1	-.007	0.276	-.019 to .005
Deprivation at 13	.004	0.348	-.005 to .014
Gender	5.32	0.111	-1.22 to 11.87
Birth Weight	-.0008	0.802	-.007 to .005
Gestational Age	.333	0.795	-2.18 to 2.84
Birth Number	**-29.96**	**0.000**	**-46.04 to -13.88**
Maternal Age	.205	0.630	-.631 to 1.042
Breastfed	**-6.09**	**0.042**	**-11.96 to -.22**
C-Section	**5.15**	**0.012**	**1.13 to 9.16**
Hospital Admissions	.096	0.769	-.544 to .736
GP Visits	-.011	0.677	-.064 to .041
Sedentary Time Week	**.069**	**0.010**	**0.28 to 0.11**
Sedentary Time Weekend	-.032	0.037	-.06 to -.001
MVPA Time Week	-.07	0.972	-.22 to -.085

MVPA Time Weekend	-.01	0.839	-.189 to -.154
AIx	-.44	0.310	-1.29 to .40
Fitness	-.007	0.079	-.015 to .0008
*Bold denotes significance			

Cardiovascular fitness

Teenagers who were more deprived at birth ran further in the fitness testing (.163 [95% CI: .045 to .281]; Table 15). Boys were more likely to run further than girls (389.50 metres [95% CI: 233.69 to 545.30]; Table 15). Interestingly, teenagers were less fit if they were not first born (-1216.63 [95% CI: -1500.44 to -932.81]) but were fitter if their mothers were older (16.33 [95% CI: .45 to 32.2]). SEM showed that school deprivation also had a relationship with fitness that was not present in the multilevel regression.

Table 15 – Regression outcomes for cardiovascular fitness

Variable	Coef.	P	95% CI
School Deprivation	.020	0.673	-.070 to .116
Deprivation at Birth	**.163**	**0.007**	**.045 to .281**
Deprivation at 1	-.002	0.983	-.233 to .228
Deprivation at 13	-.112	0.371	-.358 to .133
Gender	**389.50**	**0.000**	**233.693 to 545.307**
Birth Weight	-.001	0.987	-.202 to .198
Gestational Age	-9.30	0.729	-61.98 to 43.37
Birth Number	**-1216.631**	**0.000**	**-1500.44 to -932.81**
Maternal Age	**16.33**	**0.044**	**.454 to 32.21**
Breastfed	195.72	0.063	-10.69 to 402.13
C-Section	93.22	0.372	-111.61 to 298.06
Hospital Admissions	-3.74	0.800	-32.77 to 25.27

GP Visits	1.23	0.341	-1.30 to 3.76
Sedentary Time Week	-1.24	0.374	-4.42 to 1.92
Sedentary Time Weekend	1.48	0.099	-.375 to 3.35
MVPA Time Week	-2.85	0.052	-5.73 to .026
MVPA Time Weekend	-2.08	0.448	-8.38 to 4.20
AIx	-5.42	0.606	-26.05 to 15.20
Blood Pressure	-5.16	0.013	-9.23 to -1.08
*Bold denotes significance			

6.2 The impact of a teenager's environment on physical activity levels and fitness

Demographic data is seen as Table 16. Boys were more active and fitter than girls. Distances to active travel, public transport, main roads, natural recourses and activity providers were similar for the participant's homes and schools on average showing that these built environments have similar provisions.

Table 16 – Participant demographics for built environment

Characteristic	**Total**		
Gender	n=224		
Boy	*n=129 (58%)*		
Girl	*n=95 (42%)*		
	Mean (SD)	Min	Max
MVPA (Minutes)	69.3 (18.4)	26.1	140.5
Boy	*70.1 (18.7)*	*26.1*	*140.5*
Girl	*67.9 (18.1)*	*33.1*	*126.7*
Amount Meeting 60 Mins MVPA	n=170 (69%)		
Boy	*n=109 (64%)*		
Girl	*n=60 (36%)*		

Fitness (Metres Ran)	1840.3 (393.8)	476	2883
Boy	*1967.5 (407.2)*	*476*	*2883*
Girl	*1636.7 (267.1)*	*984*	*2430*
Motivation (Total)	10.0 (4.7)	-7.9	18
Boy	*9.9 (4.4)*	*-6.7*	*18*
Girl	*10.1 (5.2)*	*-7.9*	*18*
Home Deprivation (WIMD)	664.9 (559.6)	3	1878
Boy	*680.7 (573.9)*	*3*	*1878*
Girl	*639.5 (538.0)*	*3*	*1799*
Home Distance to Active Travel (Metres)	1438.2 (999.9)	85.1	5217.6
Boy	*1425.8 (967.7)*	*141.5*	*4933.6*
Girl	*1458.1 (1054.3)*	*85.1*	*5217.6*
Home Distance to Public Transport (Metres)	143.2 (562.8)	16.4	8879.9
Boy	*110.9 (79.3)*	*16.4*	*487.9*
Girl	*195.0 (902.5)*	*17.9*	*8879.9*
Home Distance to Main Road (Metres)	644.5 (454.6)	11.2	3617.3
Boy	*662.2 (489.6)*	*35.5*	*3617.3*
Girl	*616.1 (393.0)*	*11.2*	*1969.4*
Home Distance to Natural Resource (Metres)	1336.6 (752.1)	48.1	4271.4
Boy	*1392.2 (797.2)*	*110.5*	*4271.4*
Girl	*1247.7 (668.2)*	*48.1*	*3123.3*
Home Distance to Activity Provider (Metres)	1108.2 (1324.5)	0	14702.7
Boy	*1137.0 (1159.6)*	*0*	*13301.7*
Girl	*1062.1 (1558.1)*	*0*	*14702.1*
Home Distance to School (Metres)	2321.8 (2349.5)	95.1	20899.2

Boy	*2563.0 (2623.4)*	*95.1*	*20899.2*
Girl	*1936.1 (1773.9)*	*228.5*	*13587.2*
School Deprivation (WIMD)	673.3 (674.6)	56	1660
Boy	*681.4 (679.7)*	*56*	*1660*
Girl	*660.2 (669.6)*	*56*	*1660*
School Distance to Active Travel (Metres)	1361.9 (662.1)	596.9	2729.6
Boy	*1420.4 (641.4)*	*596.9*	*2729.6*
Girl	*1268.3 (686.9)*	*596.9*	*2729.6*
School Distance to Public Transport (Metres)	105.2 (66.1)	42.7	276.4
Boy	*102.8 (57.7)*	*42.7*	*276.4*
Girl	*108.9 (77.8)*	*42.7*	*276.4*
School Distance to Main Road	800.8 (382.3)	273.5	1654.1
Boy	*885.0 (396.5)*	*273.5*	*1654.1*
Girl	*666.1 (316.5)*	*273.5*	*1654.1*
School Distance to Natural Resource	1712.9 (569.4)	398.8	2315.1
Boy	*1723.4 (591.9)*	*398.8*	*2315.1*
Girl	*1696.1 (533.9)*	*398.8*	*2315.1*
School Distance to Activity Provider	901.4 (891.4)	0	2494.2
Boy	*889.9 (905.2)*	*0*	*2494.2*
Girl	*919.7 (873.3)*	*0*	*2494.2*

Moderate to vigorous physical activity

Table 17 shows that teenagers had higher MVPA levels if their homes were closer to public transport. Conversely, they were also more active if their schools were further away from public transport and natural resources. Interestingly, teenagers who had higher levels of activity also had higher levels of sedentary time, which shows a contrasting relationship between MVPA and sedentary behaviour. In this study, over 60% of teenagers met government's recommendations of 60 minutes of MVPA per day on average across the week.

Table 17 – Regression outcomes for MVPA and built environment

Variable	Coef.	95% CI	P
Boy	1.157	-5.570 to 7.884	0.735
Home Deprivation	-.0020	-.006 to .002	0.384
Home Distance to Active Travel Route	-.0008	-.003 to .001	0.525
Home Distance to Public Transport	**-.004**	**-.009 to -.003**	**0.036**
Home Distance to Main Road	.002	-.003 to .007	0.449
Home Distance to Natural Resource	-.002	-.006 to .001	0.165
Home Distance to Activity Provider	-.0003	-.002 to .001	0.685
Home Distance to School	.0001	-.000 to .001	0.785
School Deprivation	.022	-.005 to .050	0.119
School Distance to Active Travel Route	-.014	-.036 to .007	0.186
School Distance to Public Transport	**.189**	**.047 to .331**	**0.009**
School Distance to Main Road	.004	-.010 to .019	0.555
School Distance to Natural Resource	**.014**	**.0003 to .029**	**0.044**
School Distance to Activity Provider	-.010	-.024 to .002	0.120
Fitness (Distance Ran in Cooper Run)	.0004	-.008 to .009	0.927
Sedentary Time	**.050**	**.024 to .076**	**0.000**
Motivation	-.133	-.619 to .353	0.590

Fitness

Table 18 shows boys had higher levels of fitness. Teenagers were fitter if schools were closer to natural resources which is in contrast to findings regarding activity levels. Teenagers were fitter if they had higher motivation.

Table 18 – Regression outcomes for fitness and built environment

Variable	Coef.	95% CI	P
Boy	**474.997**	**403.550 to 546.444**	**0.000**
Home Deprivation	.046	-.017 to .111	0.157
Home Distance to Active Travel Route	-.002	-.037 to .032	0.868
Home Distance to Public Transport	.003	-.058 to .066	0.902
Home Distance to Main Road	-.022	-.098 to .053	0.565
Home Distance to Natural Resource	-.008	-.060 to .043	0.761
Home Distance to Activity Provider	-.0007	-.024 to .022	0.950
Home Distance to School	-.008	-.024 to .008	0.326
School Deprivation	-.272	-.670 to .124	0.177
School Distance to Active Travel Route	.110	-.194 to .416	0.475
School Distance to Public Transport	-1.481	-3.494 to .532	0.149
School Distance to Main Road	.160	-.044 to .366	0.124
School Distance to Natural Resource	**-.217**	**-.419 to -.016**	**0.034**
School Distance to Activity Provider	.149	-.038 to .337	0.119
MVPA	.085	-1.748 to 1.919	0.927
Sedentary Time	-.361	-.764 to .010	0.057
Motivation	**7.196**	**.414 to 13.977**	**0.038**

Path analysis

Combining all variables using a path analysis model (Figure 10) showed that there was no relationship between levels of MVPA and fitness. The school environment appears integral to fitness. An increasing distance from schools to natural resource and public transport shows a negative effect on fitness, whereas being further away from active travel and the nearest activity provision shows higher fitness levels. Being more active was influenced by distance to public transport. Teenagers who had higher levels of MVPA also showed higher sedentary time, but sedentary time did not affect fitness.

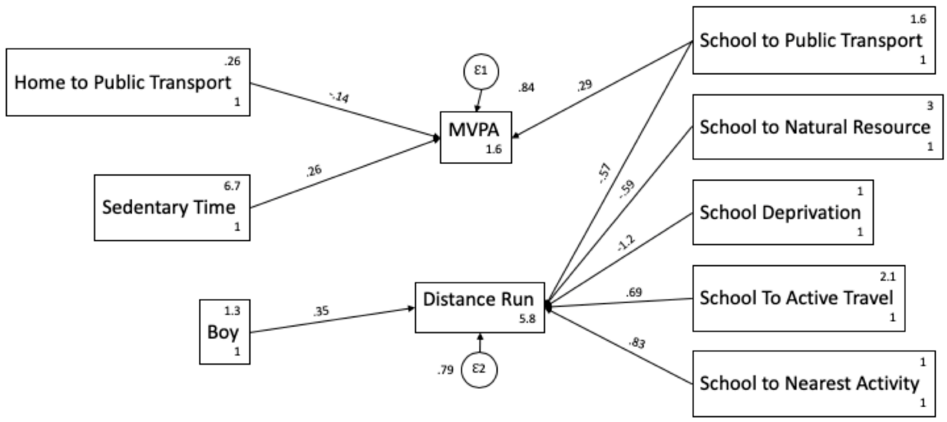

Figure 10 - Path analysis of built environment

6.3 Discussion of observational results

ACTIVE found interesting relationships between school deprivation and heart health in teenagers. AIx (as a proxy of arterial stiffness) was greater in pupils attending more deprived schools. This suggests they already had stiffer arteries by their early teens. Other influences could explain this such as poor nutrition and potential tobacco exposure but this would require further investigation in a future study (165).

However, teenagers in more deprived schools appeared fitter. Previous research has noted that schools in deprived areas typically offer less PE time (110) and provide fewer opportunities for sports and physical activities in and after school (110,185). Yet this finding suggests that despite this it may be that young people from more deprived areas engage in more accessible activities such as active travel, due to the cost of running a car or the cost of using public transport (68). This could account for higher fitness levels, particularly as despite being an exposure, MVPA was not significant in influencing fitness.

There are other factors which could predict fitness which should also be considered in this context. Energy intake, body composition and heredity can also contribute to higher/lower fitness levels (68). However, given the previous research regarding deprivation, this group are more likely to present the risk factors for poor fitness (e.g. obesity) (186). Therefore, it is interesting that more deprived schools are appearing fitter in this study suggesting that this group have overcome predisposed barriers/predictors. This could be because of the environments they are surrounded by, perhaps allowing easier access to aspects such as active travel.

Interestingly, ACTIVE also found breastfeeding was associated with lower blood pressure. This is consistent with findings in previous literature (187). Although, this relationship has been described as modest. Longer duration breastfeeding has been shown to have a beneficial effect on fitness also (188). ACTIVE did not have access to data on the duration of breastfeeding in this cohort and was unable to explore this further. However, this warrants future study. Nonetheless, these findings add to the evidence base supporting a beneficial impact of breastfeeding which may translate into longer-term cardiovascular benefits.

Being a first-born child was also better for blood pressure outcomes as a teenager as well as better performance in the fitness testing. There is some evidence that first born children/single child families have greater access to resources and attention (189). However, it is an interesting finding as it would be thought that having other siblings at birth would increase opportunities for play and social interaction which are important to physical activity (96). This is worthy of further investigation and coupled with the finding that older mothers have fitter children provides evidence that support for larger, younger families is needed to facilitate equality of activity opportunities and resources (165). This would be particularly beneficial to those in more deprived communities.

Boys were found to be significantly fitter than girls (based on metres ran). This is unsurprising as most literature suggests boys are more active and therefore, potentially fitter (37,43,44,161). Boys generally have a higher amount of lean body mass at this age, which could contribute to better fitness levels (190). Interventions and programmes that target girls activity and fitness have been implemented (17,42,183), but this observational data at baseline provides evidence there are still differences between boys and girls and more needs to be done.

Mapping showed the environments that teenagers live and go to school in have roles to play in fitness and activity levels. More so the school environment. However, the impacts are complex. Fitness was associated with going to school near natural resources (e.g., green space). This adds to the existing literature relating to accessibility of resources. Adding to the literature regarding associations between these resource and activity (53–55).

This highlights the cardiovascular benefits of being nearer green space. This means that some teenager's schools/homes more naturally compliment fitness levels (191). For example, less urban, greener spaces are ones where teenagers could walk, run or cycle safely away from roads or play with their friends after-school. Again, this is in line with previous work (101) as increased roads would suggest better connectivity and accessibility yet, walkability of spaces is necessary to improve activity not simply the means to get to spaces. Previous research suggests that more built up, populated, busy spaces impacts activity (66). There are often safety concerns over traffic. This is often a reason why young people are inactive in their communities (192).

Walkability can facilitate activity by means of walking as an activity itself, equating to better fitness levels. Moreover, increased exposure and access to green spaces could facilitate forms of more structured sport (e.g. football/rugby) or encompass less conventional activities such as den building (30). In findings opposite to fitness, activity levels improve when public transport and natural resource is further away from schools. The increased walking distance to access these provisions may increase recorded activity; suggesting walking can contribute to MVPA time as previously mentioned. While supportive environments and local activity, so teenager's would not need to travel, should be valued to improve fitness (58,59), activity levels can be sustained despite distance.

Previous analysis has shown that being within walking distance of provision is beneficial for teenage fitness (54,56,100) and therefore, the importance of considering the needs of teenagers when planning environments should not be overlooked. Although ACTIVE did not look into the optimal distance to improve activity fitness, the findings from the study as a whole suggests that emphasis be placed on bringing activities that young people enjoy to their local areas. It would seem that teenagers value enjoyment from activity and therefore are willing to travel further to do things they like (87) rather than the convenience of accessing whatever activity is on your doorstep. It could also be the case that there is simply nothing for them to do in their local communities. This is in line with previous research (193), which has acknowledged how important public transport infrastructure is, particularly when overcoming accessibility barriers (16,65–67). This would suggest that ACTIVE's focus on improving access via cost may have been too narrow and could explain the low usage of vouchers amongst teenagers.

The prominence of the school setting in all outcomes highlights that to improve MVPA and fitness, interventions should centre on the school as a hub for teenagers. Where most environment-based studies and interventions focus on the home (54,55,66,194–196), these findings suggest that focus is due to environments around the school. Generally school grounds are under-utilised for child-led play and activity when the teaching day ends (197). Whilst the importance of community access to schools, particularly in more deprived communities is recognised (198), the focus for teenagers is often on adult led and structured activities. ACTIVE has shown that this is not what young people want or need.

Generally speaking over half of the teenagers involved in the observational arm of ACTIVE met the recommendation of 60 minutes of MVPA across the week which is high compared to previous data (43). This could be due to the smaller sample size of the observational data and consent rates to participate being higher in those more interested in being active. Interestingly, this modelling showed sedentary time increased as MVPA increased. This argues that being more sedentary cannot be a single determinant of poor activity, health and fitness (11). Activities that are likely to influence MVPA, such as structured, competitive sports may have high sedentary time outside this formal training period due to increased rest/recovery time between sessions. This finding suggests that we should promote different types of activity (e.g., light, moderate and vigorous), all of which have shown benefits to cardiovascular health and fitness, despite variances in intensity (11).

CHAPTER 7

DISCUSSION

The teenage years mark the transition from childhood to adulthood (2). It is during this time that young people begin to make decisions more independently, becoming advocates for their own health and lifestyle choices. Currently, many young people do not meet the recommended 60 minutes of MVPA in Wales, with 11% of girls and 20% of boys active enough (38,39). This lack of activity is leading to detrimental impacts on short and long-term physical and mental health (14–17). Accessibility (in terms of cost, lack of local facilities and motivation) has been reported as the main barrier to being active for teenagers (16,65–68), especially for those from more deprived backgrounds (70).

The ACTIVE RCT aimed to overcome these barriers by co-producing a multi-component intervention with teenagers to empower them to access the activity provision that they want. This study identified methods that may help alter the trend of declining activity, fitness and poor heart health in teenagers.

7.1 Summary of key findings

The findings from the ACTIVE RCT presented in this thesis provides evidence that removing accessibility barriers and improving opportunities to participate in a variety of activity intensities that are unstructured, fun, social and low skill activity can improve the fitness, physical activity, cardiovascular health and perceptions of being active in teenagers. In the experimental arm ACTIVE saw improvements in cardiovascular fitness for teenagers, particularly for girls. The intervention improved the likelihood of being categorised as fit by the end of the study compared with baseline measures. Even though the control arm were fitter generally, girls and non-deprived teenagers in the intervention became fitter, running further in the fitness testing.

Using the vouchers improved the likelihood of being categorised as fit. Voucher use was also positively associated with MVPA. This suggests an increased use of vouchers, or ability to overcome accessibility barriers, could improve activity levels. With evidence showing that activity continues to decline throughout adolescence (14) and girls less likely to be active (17,41–44), this is a key finding.

ACTIVE saw a reduction in pupils registering as having high blood pressure (69). Therefore, providing evidence that empowering teenagers to be active can improve their heart health (65,67,69,183). This helps provide protection against poor health in later life, instilling healthy behaviours that they enjoy and feel empowered to do. Being active is good for heart health in terms of improved cardiovascular fitness as well as body composition and the reduced risk of being overweight/obese (14,15). The UK has the tenth-highest rates of obesity globally, with 26% of the population reported as obese (22) and 14% of children reported as overweight (23). Therefore, promoting and instilling active lifestyles is a public health priority. ACTIVE goes someway to underpinning how this may be implemented.

ACTIVE also found that teenagers are autonomously motivated (84). In line with SDT, this purposes that any intervention that relies on external pressure, guilt or a top-down approach is likely to be unsuccessful in this age group (69,84). Instead there should be a focus on enjoyment and listening to what teenagers would like to improve their activity (16,67). The autonomous nature of motivation has been observed in previous studies (114,115) and has been used to underpin intervention delivery (126). In one study, autonomy has been noted to be more present in girls than boys (114) however these gender differences were not observed in ACTIVE. Moreover, observational findings present the current landscape of heart health and activity in this group showing how components of young people's environments (e.g., family factors and built environment) relate to their health and fitness prior to intervention. Within this, ACTIVE highlights aspects which can be utilised better (for example, access to resources for young families and the school setting).

ACTIVE was novel as it gave young people the choice to take part in activities that they chose to do and offered them the opportunity to establish new provision in their area. Previous interventions targeting fitness and heart health have been prescriptive, with teenagers given specific activities to participate in or coaching/teaching sessions (17,73,85). These interventions have had mixed success (180), often only seeing short-term success (73,76). The findings from ACTIVE suggest a need to move away from the traditional, top-down approach and focus on allowing teenagers to have a say in what they need and want to access (69). Listening to, empowering teenagers and encouraging them to make their own choices allowed ACTIVE to be successful in understanding how to improve engagement in activity (69).

7.2 Implications of ACTIVE for promoting fitness and physical activity

ACTIVE demonstrates improvements in fitness and physical activity in teenagers. This was a result of taking part in a variety of activities throughout the intervention, at varying intensities. A common theme throughout the activities is that they were unstructured. This type of unstructured activity seen in ACTIVE is not dissimilar to the definition of 'play' (26), highlighting that older children want to play too. Welsh Government supports play as it reduces inequalities due to its accessibility, it is low cost and can be done locally in any space which is beneficial for more deprived individuals. ACTIVE highlights the need for play in older children to be taken more seriously by policy-makers due to its accessible characteristics and alignment with the wants and needs of young people.

There is prevalent focus on 'sport' in society and in the curriculum due to its association with positive youth development in building character, developing resilience, determination and self-belief and instilling values of friendship and fair play (5,6). However, this has been turning young people off activity. Physical activity levels continue to decline throughout adolescence (14) and girls are most at risk of being less active (17,41–44). Thus, improving the accessibility of sport is not enough. Teenagers want accessibility to be improved to play and this type of physical activity needs to be better recognised for the benefits to fitness and heart health. This had a positive impact on activity, fitness levels, heart-health and perspectives of PA.

With structure and competition being cited as a barrier to being active (65), ACTIVE provides evidence that there are physical benefits in promoting more unstructured provision, namely improvements in fitness and activity levels. Currently, there is a focus on unstructured activity and play only in the early years and childhood. As children age, opportunities to play are overlooked in favour of structured sports, particularly during school and as part of the PE curriculum. ACTIVE provides further evidence that some teenagers see structured activity and sport as a barrier to being active (65). This is not to say that sport does not have its place but its barriers to entry, requirement of rules, regulations and skills are often a deterrent for young people (65).

Previous research has also opted to uphold these traditional forms of activity, with interventions often prescribing specific activities or teaching strategies over a particular duration (17,73,85). Findings from ACTIVE suggest this may be limiting their success in improving fitness and activity. Firstly, due to the prescription of activities. By prescribing activities or sports, interventions are not acknowledging how teenagers are motivated.

Motivation to be active has been cited as a barrier by previous studies (65,68). This is often interpreted as a teenager's lack of motivation or shared the rhetoric that young people are 'lazy'. This is facilitated by the increasing trend for teenagers to be more sedentary and the ease of access to electronic forms of entertainment (the internet, television, mobile phones and video games) (40). However, it could be that previous interventions and programmes have failed to acknowledge how teenagers are motivated. Instead of considering this, they offer specific types of activity which may pressure or guilt young people into being more active.

This is a 'top-down' approach to activity promotion which does not acknowledge the autonomy of young people. As demonstrated by ACTIVE, teenagers are autonomously motivated, and this needs consideration. Without considering motivation, the narrative that teenagers would rather be sedentary than active prevails due to the disconnect between what is provided and what teenagers need and want to do (16,65,67). ACTIVE has provided evidence that there are activities young people want to do, but opportunities are limited. Moving forward there needs to be greater emphasis placed on the role of motivation and how motivation underpins activity choices and behaviour.

Secondly, improvements in fitness and MVPA in interventions may be limited by using the primary aim of improving MVPA (121,126,127,129,134). Holding MVPA as the gold standard of activity may be limiting how activity is promoted to teenagers. As mentioned, there are cardiovascular benefits associated with all levels of activity (199). Active travel in particular has been associated with healthier body compositions and cardiovascular fitness (200). The importance of promoting different intensities of activity in young people cannot be overstated (11,20,179), particularly in deprived settings as highlighted by ACTIVE.

ACTIVE did not show evidence that improvements in MVPA correlated with improvements in fitness either. Moreover, being more active in this study was associated with extended periods of sedentary behaviour. As previous research has also noted being more sedentary cannot be a single determinant of poor activity, health and fitness (11). Therefore, health behaviour promotion should look to endorse different intensities of activity (e.g. light, moderate and vigorous). All of which have shown benefits to cardiovascular health and fitness (11). Rather than using MVPA as a sole measure of success.

To promote a broader definition of physical activity to include unstructured activity, it is necessary to work across the community and the school setting. For short and long term cardiovascular benefits in particular, supportive environments and local activity, so teenager's would not need to travel (58,59), should be of importance to establish, particularly for teenagers from more deprived backgrounds. The school setting is where teenagers spend most of their time. Where most environment-based studies and interventions focus on the home (54,55,66,194–196), ACTIVE's findings suggest that focus is also due on environments around the school.

7.3 What works best when promoting activity in teenagers? Give them a voice.

ACTIVE's use of a voucher scheme to empower teenagers to overcome accessibility barriers appeared to be the biggest success in terms of promoting activity. Rather than prescribe specific activities, ACTIVE allowed teenagers to design and access activities that they wanted to. The activities often required no intervention from adults. For example, hiring football pitches. This lack of intervention from adults is important as it empowers young people. They felt the vouchers allowed them to pay for activities themselves, overcoming cost barriers and giving them ownership. This is a significant strength of the project as it addressed the accessibility barrier (65,67,68). Not only this, being able to access provision on their own terms helped changed perceptions of activity for young people. From something teenagers felt they were pressured to do by adults that was high-intensity and difficult to a social and fun event (69).

This is a novel approach to activity promotion and it has received some attention in the literature. Previous research has noted the importance of listening to the wants and needs of young people in the physical activity sphere (80,81,116,118,119). It is interesting that these studies, although undertaken in different locations and samples, offer similar recommendations for activity promotion in young people namely providing more opportunities, more choice, more fun and provide incentives. These underpinned ACTIVE and was the foundation of its success. The repetition of these recommendations and the accessibility barriers in this thesis suggest that despite a number of physical activity interventions, teenagers are still not being active enough.

It was clear from this study that current activity provision is not meeting the wants and needs of young people. This is resulting in teenagers feeling frustrated, not encouraged and disengaged with local physical activity provision. These recommendations highlight reasons why teenagers are bored and disengaged with their local provision (80). Teenagers believe there is a focus on very young children and then again in adulthood. Teenage years are often neglected but bridge the gap between childhood and adulthood.

Many of their solutions and insights are applicable to all ages (1, 4, 5). For example, many of the barriers faced by teenagers are identical to those faced by young families (5). Fears standards of facilities and safety of these facilities are identical to those of older adults (1). Therefore, listening to teenagers could benefit communities. This thesis presents six key recommendations from teenagers:

7. Lower/remove the cost of activities without sacrificing the quality
8. Make physical activity opportunities more locally accessible
9. Improve the standards of existing facilities
10. Make activities more specific to teenagers
11. Give teenagers a choice of activities/increase variety of activity
12. Provide activities that teenage girls enjoy (e.g. fun, sociable and not competitive sport) (67)

Thus, involving teenagers in the design and implementation of physical activity initiatives in this way is imperative not only to empowering teenagers to positively impact their activity and health but also to generate better community cohesion. Acknowledging and gaining a better understanding of teenagers' own recommendations and needs would increase the legitimacy and feasibility of activity interventions as agreed with by previous literature involving the public in designing public health initiatives (77,78,201).

Throughout discussions with young people and voucher usage findings, the increased opportunity to participate in unstructured activity was a key recommendation echoed by both boys and girls (70). Young people did not mention formal coaching, competitions or leagues rather there was an agreement that activity should allow teenagers the opportunity to enjoy and choose what they would like to do with their friends (67). Inclusivity was essential.

During the focus group discussions there were a few subtle gender differences to emerge. For example, girls placed more emphasis on the enjoyment aspect of activity and the need to be active with friends. Girls also seemed to be more disengaged with school PE than boys, something that has been acknowledged by previous initiatives (119,183). ACTIVE’s findings agree that reviewing physical activity provision for girls in secondary schools may go some way towards addressing girls’ physical activity levels (67). While certain aspects of physical activity interventions could be tailored to suit girls or boys (e.g. greater emphasis on enjoyment and socialisation for girls), the overall core components of an intervention do not need to differ by gender (67). Acknowledging and focusing on the six recommendations made by teenagers at the start of ACTIVE is likely to enhance participation for both boys and girls in this age group.

Article 31 of the United Nations Convention of the Rights of the Child (UNCRC) (29) calls for young people to be able to participate fully and equally in recreation and leisure activity. It also calls for them to have a right to be heard and taken seriously on all matters affecting them (Article 12) and to gather and use public space (Article 15). However, the evidence from ACTIVE suggests these rights for teenagers are being overlooked. The voucher use suggests what is currently on offer is not what teenagers want to do. We should be involving young people in decisions that affect them. There is a gap between what is promoted to young people and what they want from activity provision.

Despite teenagers only using 25.1% of the vouchers available, the takeaway message from ACTIVE is that empowering teenagers, listening to them and encouraging them to make choices allowed ACTIVE to be successful in understanding how to improve engagement in activity and also improve fitness and blood pressure. Wales is in a unique position to implement the changes teenagers have requested. Wales has world-leading legislation; developments in the new curriculum and legislation such as the Wellbeing of Future Generations Act (47), the Active Travel Act (48) and Play legislation (27) requires public bodies to make these provisions accessible for all. Sport Wales' most recent strategy sets out to be person-centred and to give every young person a great start and ensure there are opportunities for all (49). These are promising steps in the right direction in line with ACTIVE's findings but trends in physical activity suggest that this legislation may not be transferring into practice.

7.4 What about external support for young people?

Previous research has implemented external support for young people in the form of mentorship programmes with some success in improving activity (121,122,127,129).

ACTIVE drew upon the methods used in ASSIST (128), a smoking cessation project. As previously mentioned, the peer mentoring scheme in ACTIVE was not positively received. In particular, the teenagers noted that in the selection process, asking about how influential an individual was not a measure of mentoring. Often 'influential' can be mistaken for asking who the 'most popular' is. It was important for teenagers that the mentors act as role models for being active but suggested more rigorous selection methods be used, e.g., having a teacher involved or someone who knows the young people.

ACTIVE used a very similar process as ASSIST (146). However, both have different aims. One sees the promotion of a behaviour and one looks at deterring. This could explain the difference in success. There is not a one size fits all approach to peer mentoring. Given that teenagers were autonomously motivated and wanted to be active with their friends in an unstructured environment (69) it is possible that the peer mentor approach of a mentor was too structured, and an 'expert' peer is not motivating for teenagers (180). They stated that they would not really ask a peer for advice in relation to physical activity or exercise. Despite evidence of peer mentoring working in other health interventions in this age group (128,146), differences in the reasons for using peer mentors meant they had little impact in ACTIVE. This is something for future interventions to consider.

Similarly, while the support worker was considered 'helpful', thought needs to be given to the timings of school visits and how messages are delivered. There is not a 'one size fits all' model when working with schools. What works for one, may not work for another. Thus, for external support for physical activity to work well, a period of consultation with schools, the local council and pupils would be beneficial. However, ACTIVE also demonstrated some tension in the support workers role when working with stakeholders. ACTIVE's aim was to empower teenagers to be able to access activities they wanted yet the local council felt they should promote activities that are available but were perhaps ignored by the teenagers. The council felt they had ample activities; teenagers just did not access them. However, evidence from ACTIVE shows that these activities were not necessarily developed alongside young people to complement their wants and needs.

Moreover, previous research notes that external influences in the form of those in a position of leadership (e.g., intervention leads and head teachers) play an important role in the success of an intervention. In the case of ACTIVE, leaders needed to value activity for activity's sake and be willing to allocate time to increase opportunities for teenagers to be active (202). In particular, school buy-in and promoting the importance of teenage activity levels and health underpins this (180). School is where teenagers spend a significant amount of time and any successful activity intervention needs engagement and buy-in from the school (17,18). Generally speaking, teenagers believed that not enough time and value is placed on physical activity in school. Yet, there is emphasis placed on sport and being critiqued on their participation. Teenagers wanted more opportunities to be active during school time that was less structured and wanted a choice in what they would like to do (67). Future physical activity promoting interventions and policy should take note of this. However, this also pivots on the PE lead in the school. The local council observed that the person taking responsibility for ACTIVE was also vital in the delivery and that buy-in from them would ensure success. This is important as the wrong lead could hinder an intervention's success (180).

Observational findings from ACTIVE have reiterated how important the school setting is. Heart health has been attributed to the school setting and mapping shows the pivotal role the school environment plays in fitness and activity (165). Fortunately, ACTIVE had good engagement with the schools it worked with. In particular two schools supported the establishment of new lunchtime clubs within the school day to facilitate activity opportunities.

7.5 Wider community benefits and learning from ACTIVE

There were wider community benefits seen alongside the delivery of ACTIVE. Teenagers observed that there had been changes made to local activity. For example, some providers changed the cost of their provision allowing discounted entry or 'two for one' deals as a way to promote teenagers bringing their friends. As well as this, the local council used the feedback and initial findings from ACTIVE to underpin their future planning (69,180). This provides evidence of the sustainability of ACTIVE as it helped influence the delivery of community and school-based activity for teenagers from the local council's perspective (69). This allowed for more supportive environments to be created for young people.

Supportive environments and local activity, so teenager's would not need to travel (58,59) should be of importance to establish. Particularly for teenagers from more deprived backgrounds. Being within walking distance of provision is beneficial for teenage fitness (54,56); with this in mind, schools and communities should focus on promoting and maintaining active travel and active travel infrastructure. The importance of considering the needs of teenagers when planning environments should not be overlooked. ACTIVE highlights that these needs centre around increased provision and opportunity for fun, unstructured and social activity that can benefit fitness, heart health, motivation and perceptions of activity.

The learning from ACTIVE can also be applied to the design and development of the built environment. ACTIVE highlights the importance of the school setting in improving MVPA and particularly, fitness for teenagers. Being able to travel independently and access to green space closer to schools could make a significant difference to teenage health. Environments that improve PA and fitness for teenagers should focus on making activities more locally accessible. This is particularly relevant in more deprived communities where the cost of transport is an expense some families do not have (68). Creating environments that are conducive to activity is not a new concept but has been gathering momentum more recently (58). ACTIVE highlights that there is a need to consider how a local environment influences the opportunity to be active and plan around this. Whether this is in terms of the walkability of an area, access to green space or the use of facilities, such as schools, in novel ways. Planning the development of communities is a long-term process that requires work from many stakeholders.

The school environment also plays a vital role in physical activity. It should not be taken for granted that school PE provision is enough. Department for Education guidelines recommend schools provide a minimum of 2 hours per week (32) but, with increasing pressure for schools to perform in exams, time dedicated to PE is reduces as pupils progress through secondary school (31). This time needs to be protected. Young people want to be active but there needs to be a change in culture and approach in schools, for example, moving away from rigid, skill-based assessments of sporting ability to more holistic activities which are more inclusive. To date, the PE curriculum remains prescriptive especially in early key stages (e.g. athletics, football, netball), ending in Key Stage 4 where individuals are given the opportunity to plan and participate in a regular and balanced programme of PE (33). More consideration should be given to pupil's wellbeing when planning the school day and when making decisions on how the school environment might be utilised to support teenagers to make better use of it, including being able to access school facilities after the school day ends. It is not simply a case of making teenagers more aware of what they can access in their communities, they need to be able to access it easily and it needs to be activities they want to do.

ACTIVE clearly demonstrates that provision, however that looks in a school or community, should include different types of activity (e.g., light, moderate and vigorous) rather than addressing sedentary behaviour. ACTIVE shows young people want the choice to access more unstructured activity and if schools want to reduce sedentary behaviour they need to engage with teenage voices and understand the needs of young people. There is conflict between improving MVPA and increasing sedentary time. Time spent sedentary cannot be a single determinant of poor activity, health and fitness (11). To address this consultation with those being targeted is essential.

The health implications of ACTIVE have wider benefits. A more active lifestyle, being fitter and having lower blood pressure as a teenager means poorer health in the future is less likely (14,15). This study also provides evidence of early life indicators which may make teenagers more vulnerable to poorer cardiovascular health and CVD risk (165). Schools in deprived areas could be targeted with interventions that improve heart health. For example, improving access to and uptake of a variety of activities that promote all types of physical activity, rather than simply aiming to reduce sedentary behaviour, for example active travel or low cost, easy to access physical activities outside the school environment. Promotion of breastfeeding and play/socialisation support for younger, larger families may have also a beneficial effect. Recognition of the important early indicators and determinants of cardiovascular health would warrant further development of the evidence base to encourage policymakers to implement preventative measures in young people.

The protective value of physical activity cannot be ignored. Benefits include improvements in body composition and the reduced risk of being overweight/obese, the reduced risk of non-communicable disease (NCD), improved cardiorespiratory and muscular fitness and, improved bone health (14,15). Moreover, being active has a positive impact on mental health, increasing wellbeing, self-esteem and socialisation opportunities (16).

During the COVID 19 (SARS-CoV-2) pandemic, physical activity was cited as vital in decreasing the negative physical and psychological impact of sedentary behaviours (203). During periods of restriction in movement to stop the spread of infection, physical activity was written in to guidance as an essential use of time in the UK (204). The value of physical activity during a global pandemic has been recognised, from its protective role in improving general health to its role in providing a channel for wellbeing (203,205–207). If it is relevant during a time of crisis, it is relevant always. It cannot be an afterthought in schools, it cannot be considered second best to other subjects. It needs to be central in the designing of communities. As shown by ACTIVE the best place to start is to ask what people want and need in terms of activity provision.

7.6 Lessons learned and future implications

ACTIVE's delivery had both strengths and weaknesses that could be used to underpin future physical activity promotion. Teenagers reported to be able to do activities they wanted with their friends and changed their perceptions of physical activity. Thus, providing young with a choice coupled with financial support in deprived areas was a strength of the ACTIVE. This is not to say that a voucher scheme is a replicable intervention but that improving the ease of access and increasing the choice teenagers have is pivotal for activity. Teenagers would like this choice translated into the school setting and into community provision.

Acknowledging how teenagers are motivated is key. They know they need to be active and would like to be but do not respond to being made to feel guilty or pressured. Therefore, care needs to be taken when employing mentors or support staff to promote activity. These individuals need to be selected for specific characteristics (e.g., they need to be approachable). Again, these processes would be strengthened if there were more collaboration between teenagers, activity provision and policymakers to ensure their wants and needs are met.

Further work is needed on how the intervention's strengths and weaknesses can underpin a larger scale project that can reach a bigger number of teenagers across Wales. The numbers of vouchers used in ACTIVE suggest there are barriers that the project did not overcome as only 25.1% of vouchers were used, and perhaps more needs to be done from the bottom-up to ensure teenagers have sufficient opportunities and access locally. Future projects should advocate for and empower teenagers to make them feel like an important part of the community. Listening to their feedback, exploring young people's neighbourhoods, schools and activity provision through their eyes and involving them in the creation and planning of activities in their local communities rather than believing adults are best placed to decide what teens want.

7.7 Limitations

Bias may have been introduced into the study as ACTIVE was only able to measure outcomes and ask opinions of teenagers who consented (ACTIVE had an 88% consent rate), although all children received vouchers and imputation used. Those responding/consenting may have been more motivated and interested in being active resulting in in-group bias. It is possible that the teenagers who did not consent were less interested or less motivated to be active (69). Therefore, the sample would have been reflective of more active teenagers perhaps not capturing the views of those less engaged with sport, physical activity and their general health. Only the local council were asked to participate in a focus group from the perspective of a collaborator and activity provider. The viewpoints of other stakeholders may have differed based on the voucher usage with their service and funding (for example, if they were a charity or privately funded). Furthermore, the focus groups were conducted with a small age-range of teenagers (aged 13 – 14 years old). This means the recommendations made by teenagers aged 15 years old and upwards have not been included and may differ. One focus group was conducted with both boys and girls together, which may also have affected the recommendations made from this particular focus group.

When implementing the intervention, importance was placed on gathering the opinions of all teenagers including those more engaged and less engaged with activity and the intervention itself, as well as peer mentors. It is possible that despite support worker engagement and the communication in place, the views of those less active or disengaged with the intervention were missed. Other sample characteristics which could have been collected to improve inclusivity include PE lesson attendance and participation which would have helped the intervention establish activity levels and engagement with physical activity further.

An important limitation in this study was that ACTIVE selected deprived schools if they were located in a deprived area. However, for one school at least, the area was not representative of the children and this was not good method of identifying deprivation status of teenagers. This is reflected in the voucher use, where school C used fewer vouchers. Future work could select schools based on free school meal percentage rather than deprivation of the geographical area in which the school is located.

In terms of analysis, the norm value used to categorise participants as either fit/unfit were based on cut-points derived in 1968. It is possible that these cut-points may not be as relevant, particularly as a decline in fitness has been observed over time since the original development of the cut-points. As well as this, wear time criteria for accelerometers was based on criteria for waist-worn protocols when this study was using wrist-worn.

Observational analysis reports the findings of a small group of teenagers in south Wales, which may not be generalisable to the whole population. Future work should include a larger sample size. The path analysis shows that even though relationships were present, these relationships only explained a small proportion of variation in AIx and blood pressure in particular and warrant further evaluation in larger prospective studies ideally with careful documentation of important covariates including anthropometric and serological measurements to add greater depth to analysis (165).

GIS accessibility measures were developed using Euclidean distances which provides an indicative measure of access. In addition, access to public transport is based on bus stop locations as opposed to more sophisticated origin-destination measures. Further work could include more sophisticated network measures of access which take into account urban morphology and whether a destination (e.g., leisure centre) is served by a public transport route from an origin (e.g. home or school). As well as this, GIS analysis can calculate the geographic availability of activity provision and resource however, it cannot ascertain the suitability of the resource without more detailed data on services provided (and restrictions) at each location. For teenagers this is an important limitation, as age restrictions could impact whether they can access a provision.

7.8 ACTIVE's take home messages

Being given a choice of activities that are unstructured, fun and social was a defining factor of ACTIVE and can be attributed to its success. Teenagers were empowered to choose activities that appealed to them and fulfilled what they want and need from provision. In turn, they saw improvement in fitness and blood pressure. Findings also suggest that an increased use of vouchers, or ability to overcome accessibility barriers, could improve activity levels too. With this in mind, it is evident we need to listen to young people and improve ways of working to align current practice with UNCRC's article 12, 15 and 31 (29). This cannot be done in isolation but needs to involve working across both local communities and school settings.

Future work in this field should focus on working with teenagers and not for teenagers in a top-down fashion. This could have countless implications on the heart health, physical activity, fitness, motivation and presence in local communities for this age group. Working with teenagers and co-producing interventions and provision can help to build community cohesion and combat the health inequalities observed in young people; making them feel valued. Being told what they cannot do by adults and only having access to prescriptive activity has led to a lack of inclusion on matters that are important to teenagers. The findings of ACTIVE highlight the need for empowerment and advocacy for teenagers. Generating greater awareness of the barriers teenagers face, the recommendations they make, and protective factors for their health in the future.

CHAPTER 8

CONCLUSION

The teenage years involve many physical, emotional and cognitive changes alongside the increased ownership of one's own health behaviours including being physically active. Guidelines recommend that young people should take part in an average of 60 minutes of physical activity per day per week (9,10) and this should be in the form of MVPA but with the belief that some physical activity is better than none (9).

The ACTIVE RCT explored in this thesis was co-produced alongside teenagers to empower them to overcome the barriers that prevent them from being active. The study had two primary aims; i) to improve cardiovascular fitness and, ii) to improve physical activity (MVPA) in teenagers. As well as a number of secondary aims, i) exploring how motivation is impacted by the intervention, ii) providing predictors of cardiovascular health in teenagers and, iii) examining the impact of a teenager's build environment on physical activity and fitness.

8.1 ACTIVE's primary aims (the experimental arm)

Voucher use suggested that unstructured, fun, social and low skill activities were favoured by teenagers. They were mostly used by teenagers who were less deprived, fitter, more motivated, more sedentary and less active at baseline. However, only a small number of vouchers were used with travel, time and motivation to be active cited as barriers for their use.

Overall, the ACTIVE RCT had a positive impact on the primary aim of cardiovascular fitness. Logistic regression showed significantly higher odds of being fit at 12 months in the intervention group compared to the control and girls in the intervention showed a trend to become fitter. Despite this, ACTIVE did not have a significant impact on the amount of time spent doing MVPA. However, there was a significant relationship between the voucher usage and MVPA at 12 months suggesting an increased use of vouchers could improve MVPA. There were also improvements seen in blood pressure in the intervention group.

Interestingly ACTIVE found all participants were autonomously motivated. Underpinned by SDT, this finding shows teenagers attribute activity to enjoyment as opposed to being pressured to be active which would help explain the physical activity choices made by young people. It was also help explain why more prescriptive interventions see mixed success. Therefore, SDT as a theoretical framework should be utilised more in physical activity research and policy. Understanding what motivates a group of individuals prior to implementation could help improve the success and longevity of work within the field of physical activity.

The use of baseline focus groups to inform the delivery of the ACTIVE intervention helped align the study with its ethos of co-production and empowering teenagers to have a say in their physical activity choices. Thus, taking a proactive, not reactive, approach to promoting activity. This was a strength of the study and teenager's recognized that having a choice was an effective element of the RCT. However, there was some discussion about the effectiveness of the use of peer mentors, support worker engagement and the location of activities. Furthermore, conversations with young people discussed physical activity lessons in school and how there were few opportunities to be active and the buy-in from PE teachers. Highlighting that there is still some work to be done in the school setting and within curriculum delivery.

8.2 ACTIVE's secondary aims (the observational arm)

The findings from the observational arm of ACTIVE provide some key predictors of teenage health which can be used to be proactive in promoting healthy behaviours in young people and identifies some protective factors which can be promoted to families and first-time parents. For example, lower blood pressure was observed in teenagers who were first born and those who were breastfed. Potentially as a result of increased access to resources and proxies of other health behaviours. Higher AIx measures, as a measure of arterial stiffness, was associated with higher levels of deprivation, lower hospital admissions but more general practitioner (GP) visits. Thus, highlighting that those more deprived are at risk of poorer heart health.

In terms of the built environment, young people did more MVPA if their homes were closer to public transport but were also more active if their schools were further away from public transport and natural resources. The school environment is a pivotal space of teenage activity and health and therefore future planning could incorporate these places as a hub for health and wellbeing in the community (e.g., remaining open after the school day ends for increased accessibility). Interestingly teenagers who had higher levels of activity also had higher levels of sedentary time, which shows a contrasting relationship between MVPA and sedentary behaviour. Thus, this highlights that we cannot assume that more physically active young people are less sedentary.

The environments which young people occupy are important facilitators of physical activity and health behaviours generally. Thinking about and encompassing the environment in a settings approach (60) helps interventions to create healthy environments and develop policies to allow an environment to perform better (60). For teenagers, ACTIVE highlights that there are two environments to consider in the school and the community setting. A more holistic approach to physical activity, underpinned by Bronfenbrenner's socioecological model (62), can bring into context how an individual's characteristics, parents, friends, colleagues, schools, homes, communities, local governments, resources, mass media and culture can all facilitate physical activity.

8.3 Concluding remarks

Providing more local opportunities for teenagers to take part in activities that fit the umbrella of 'fun, unstructured and social' promotes participation and changes attitudes towards activity. The findings of ACTIVE highlight the need to empower more young people to make a difference and give young people opportunities to shape their future. Generating greater awareness of the barrier's teenagers face, the recommendations they make, and protective factors for their health in the future could go some way to making young people more active, healthier and happier.

To conclude, the key message from ACTIVE is that young people want to have their say in activity provision so that they can increase their opportunities to participate in unstructured, fun and social activity in their local communities. Similar to the principles of play, these activities can be ‘freely chosen’ and ‘intrinsically motivated’. These are key values for teenagers when being active.

CHAPTER 9

THE FUTURE FOR ACTIVE

The value of an active lifestyle and activity enabling environments on health cannot be underestimated. ACTIVE demonstrates that the best advocates for changing environments to be healthier for young people, are young people themselves. Their six key recommendations presented in this thesis provide a pathway to improving activity for their generation. To date there are few effective, sustainable interventions to address inactivity. Major limitations have been underpinned by accessibility including cost, location and the lack of choice in unstructured, fun and social activities.

ACTIVE's work with teenagers highlights that there is a difference between current activity provision and what young people want and recommend (16,65) and they have strong opinions that communities need to change. The future of ACTIVE aims to build on a previous success using the voucher scheme to improve teenager's access to local activities. While ACTIVE improved fitness and cardiovascular health, teenagers expressed that the accessibility barrier still remained; namely there was little in their local area that they wanted to do, transport to other areas was expensive and teenagers were not welcome in community spaces.

Future direction sets out to build upon the success and address the barriers faced by young people, namely that the built environment is designed around cars, those with wealth and the activity interests of adults or what adults think teenagers want. Future work will build upon the momentum and impact of ACTIVE using novel methods such as accessibility modelling, advocacy and empowerment. This will include producing maps with teenagers of their communities as seen and experienced by young people, with a special focus on deprived areas. Then working with young people to inform how we meet the wants and needs of teenage activity. This bottom-up style of intervention, working with teenagers to map their local communities, advocacy and empowerment can improve physical activity levels for all in the community, perceptions of activity, wellbeing and subsequently, cardiovascular health.

The data collected from future work offers a unique opportunity to link with routinely collected data via the SAIL Databank helping to provide a longitudinal insight of the health of young people, those in deprived communities and women, in Wales. For example, it can help compare health outcomes for rural vs urban communities, for those with access to more green space, active travel infrastructure and for those in areas of higher pollution. This will create a powerful tool for examining and profiling the health of communities (teenagers, deprived, female) which often ignored in a more commercially driven society.

Conversations with teenagers since the end of the ACTIVE intervention further highlight the need for the advocacy and empowerment that a future project proposes. Generating greater awareness of the barriers teenagers face could go some way to making them more active, healthier and happier. ACTIVE has listened to their feedback and are proposing to look at young people's neighbourhoods, schools and activity provision through their eyes and involve them in the creation and planning of activities in their local communities rather than believing adults are best placed to decide what teens want. The voices of young people should be heard on all matters that affect them. This is happening on a global stage with climate change. While momentum is gathering in this space, there still remains gaps for their voices in health matters. Physical activity could be the area of health where the British Heart Foundation could lead conversations with teenagers to help better provision.

Physical activity protects against ill health in later life. It reduces the risk of chronic health conditions such as heart disease and reduces the risk of stroke and heart attacks. This has become even more apparent during the COVID-19 pandemic. For long-term health benefits we need to start young and engage young people in the solutions. Public Health Wales have voiced their thoughts on this in their 2017 evidence summary, by saying we should be “actively involving young people in designing, planning and delivering physical activity opportunities” (46).

8.1 ACTIVE 2.0

A new trial design has been proposed. Using a mixed method randomised control trial design, areas (local authorities) in Wales will be randomised into either the intervention or control arm. Control authorities will be encouraged to continue normal practice. Intervention authorities will have access to an empowerment and advocacy-based intervention. This will include:

- *Advocacy:* The advocacy arm of the project would be ongoing throughout the 3 years of funding. Article 12 underpins this work giving teenager’s a right to be heard and taken seriously on all matters affecting them. A large element of this will be mapping how teenagers use their local areas and sharing this with the local councils, members of parliament, local councillors, organisations (Sport Wales, Play Wales), schools, education boards and other relevant stakeholders. This component will also consist of collecting and disseminating the narratives of teenager’s experiences of being active in their communities through media such as YouTube, Instagram, TikTok and podcasting. We will deliberately bring teenager groups together with charities and advocacy groups (e.g., for activity travel -Sustains, bike ability) to try to maximise single one voice messages from teenagers.

- *Empowerment:* Teenagers will be encouraged to work together to form ideas of how they can change their areas via workshops ran by the research team and relevant stakeholders, which include lawyers, local business and architecture/planning. Thereby empowering teenagers to understand the law and systems in order to be able to create change from within. Training in accessing grants (such as the Youth Bank) It is anticipated this will help to create long term sustained ability to create change beyond the life of the projects, due to skills development and knowledge in young people.

Teenage assessment of the area will be linked with hospital admissions from that area for CVD, strokes, and to GP records of mental health and other risk facts for heart disease (cholesterol, blood pressure)), to examine how differences in built area impacts on the health of all. This will be done using the SAIL database which has all hospital admissions in Wales. This will help to give objective evidence of how changes in area may contribute to changes in cardiovascular health for all. ACTIVE wants to produce a way of communicating what young people especially those in deprived communities and especially girls, want and need that can be replicated throughout the UK to create local change.

The school curriculum is undergoing an important transition. With well-being so high on the new curriculum's agenda and complimented by the pioneering Wellbeing of Future Generations Act in Wales (47), results from a new trial will provide evidence of specific working that can be promoted or adapted to help create more active, happier teenagers who can be protected against the risk of poor health in later life. Moreover, this research can link findings with routine data on health to provide an extensive e-cohort that can be used for longitudinal analysis. This will be a valuable insight that can be used by Welsh Government, Public Health Wales and Sport Wales' future work as well as across the UK.

ACTIVE will continue to advocate for young people's voices to be heard.

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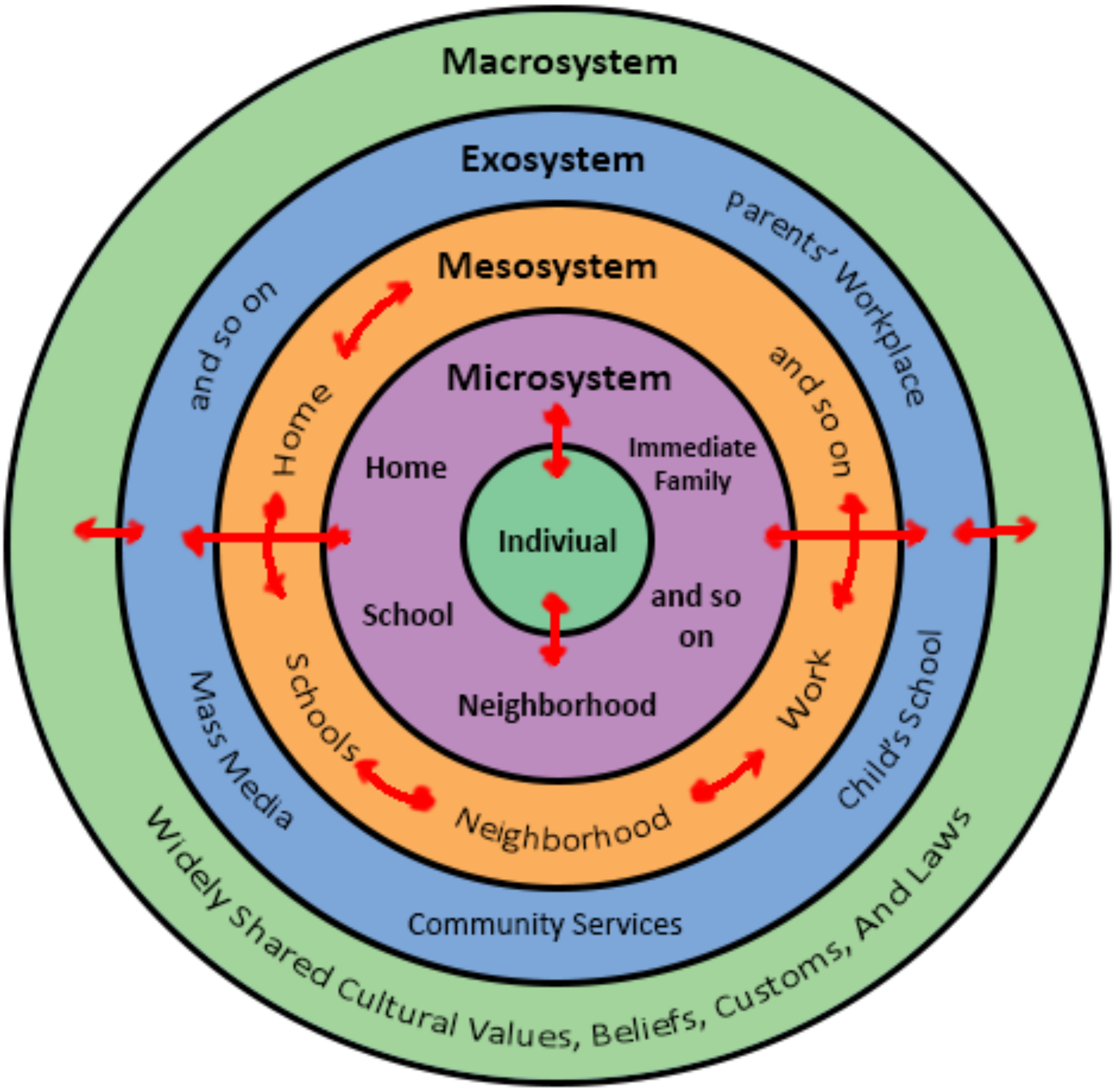
Appendix 1 Bronfenbrenner's Socioecological Model



Appendix 2 Literature for review

	Title	Location	Participants	Methods	Results	Conclusion
1. Kinsman et al. (2015)	A model for promoting physical activity among rural South African adolescent girls.	South Africa.	51 adolescent girls (aged 13 – 15 and 16 – 19). Recruited from 3 secondary schools. Schools were selected to represent geographical diversity but fell within the bottom 2 quintiles of academic performance for schools in the county.	Six focus groups were conducted, and 7 interviews were held with sports teachers and youth leaders. Data was analysed via thematic analysis.	Seven themes were identified; 1) poverty, 2) body image ideals, 3) gender, 4) parents and home life, 5) demographic factors, 6) perceived health effects of physical activity and 7) human and infrastructural resources. More barriers were reported than facilitators.	Themes were synthesized into a model of ‘supply’ (provision, training, facilities) and ‘demand’ (empowering messages about body image, more parental involvement). The development of physical activity interventions that incorporate this supply- and demand- side model would represent an additional tool for ongoing efforts aimed at tackling

						the expanding non-communicable disease.
2. Ashton et al. (2015)	Young adult males' motivators and perceived barriers towards eating healthily and being active: A qualitative study.	Australia.	Ten focus groups (32-63 minutes; 3-9 participants per group) were conducted with 61 young men.	Three groups were with healthy weight participants, 3 with overweight/obese participants and 4 with mixed-BMI participants. Sessions were audio recorded, transcribed and then analysed via NVIVO10.	Motivators for healthy eating grouped into 4 themes: physical health (e.g. to live longer), sport or performance (e.g. to support their sporting goals), physical appearance (e.g. sexual attractiveness) and social influences (e.g. societal expectations to eat healthy), while key motivators for physical activity were: physical appearance (e.g. sexual attractiveness), social	This research emphasises the importance of consulting young men when developing healthy lifestyle programs that aim to promote Physical activity in young men. Future research is needed to identify the most effective ways to address their motivators and barriers in intervention research.

					inclusion (e.g. making friends), physical and mental health (e.g. relieve stress) and improvements for sport or performance (e.g. improve fitness).	
3. Withall et al. (2011)	Why some do but most don't. Barriers and enablers to engaging low-income groups in physical activity programmes: a mixed methods study.	United Kingdom.	152 physical activity session participants in a highly deprived suburban neighbourhood.	A mixed method research approach was adopted to guide data collection and analysis. A survey, incorporating the Motivation for Physical Activity Measure - Revised (MPAM-R) was used. Semi-structured interviews were also conducted with 33 local residents who	Participants reported cost, childcare, lack of time and low awareness as barriers to joining activity classes. The need for support, confidence and competence in order to take up activity was widely expressed, particularly among women. Once people are active, high levels of social interaction,	This study suggests that some factors such as cost, the fear of 'walking in alone', accessibility of facilities, and appropriate communication strategies may be of particular importance to increasing recruitment of low income groups. Interventions

				did not participate in activity sessions and with 14 activity session leaders. All interviews were audio-taped, transcribed verbatim and analyzed using an inductive thematic approach.	interest and enjoyment are associated with improved levels of retention, with different types of physical activity scoring differently on these factors.	targeting this group should consider low cost sessions and childcare; activities popular with the target group and associated with good recruitment and retention; sessions held at accessible times; a focus on fun and socialising; well- researched and designed communications strategies; targeting of friendship groups; clearly branded beginners' sessions, and the potential of social marketing as strategies. The evidence presented

						here suggests that the current UK government approach designed to 'enable and guide people's choices' may not be sufficient if low-income groups are to be effectively supported in changing their health behaviours.
4. Jonsson et al. (2011)	What undermines healthy habits with regard to physical activity and food? Voices of adolescents in a disadvantaged community.	Sweden.	Adolescents (n = 53, 12–13 y/o) were recruited from one school situated in a multicultural community characterized by low S.E.S.	Embracing an interpretive approach, 10 focus- group interviews were conducted to produce data for the study. The focus-group interviews were audio recorded,	The analysis resulted in two major themes: (1) the availability of temptations is large, and support from the surroundings is limited; and (2) norms and demands set the agenda. The adolescents' voices	The adolescents' stories illuminated that it is difficult for them, within their environment, to establish healthy habits with regard to P.A. and food. To facilitate the adolescents' healthy habits, we suggest that support from

				transcribed verbatim, and analysed using qualitative content analysis.	illuminate a profound awareness and the magnitude of tempting screen-based activities as undermining their P.A. and healthy food habits. Moreover, several gender boundaries were highlighted as undermining girls' P.A. and healthy food habits.	family, friends, the school, and society at large is essential.
5. Wetton et al. (2013)	What Are the Barriers Which Discourage 15-16 Year-Old Girls from Participating in Team Sports and How Can We Overcome Them?	United Kingdom.	30 girls from 2 high schools.	Completed a questionnaire designed specifically for this study, based on previous research findings. This was piloted in a group of 5 girls not included in the study. Six girls	Four barriers became prominent as to why girls in this sample do not participate: Internal Factors, Existing Stereotypes, Other Hobbies and Teachers. Methods to overcome these barriers were	Following the successful summer Olympics and Paralympics in the UK, and the resulting positive focus on some of the nation's female athletes, a shift in focus may be possible. However,

				were selected for a short face-to-face semi- structured interview (with ARW), following a pilot session with a girl not included in the study. These were girls who stated they did not participate in extracurricular team sports in their questionnaires; offering the opportunity to explore why in more detail.	identified; changing teachers' attitudes and shifting the media's focus away from male sport.	this needs to be maintained to allow girls more opportunities, role models and motivation to participate in sport.
6. van der Berg et al. (2013)	Untapped Resources: 10- to 13-Year-Old Primary Schoolchildren's Views on	Netherlands.	Nine focus groups (32 girls and 20 boys) with children attending the final two grades of primary school in	The aim of our qualitative study was to gain comprehensive insight into 10–13-year-old primary	The results showed that children were enthusiastic about additional PA in school. Children suggested various	Children have concrete ideas, acknowledging the challenges that accompany integrating

	Additional Physical Activity in the School Setting: A Focus Group Study.		the Netherlands.	schoolchildren’s perspectives on how to increase activity in the school setting.	ways to increase PA, including more time for PA in the existing curriculum, e.g., physical education (PE), recess, and occasional activities, such as field trips or sports days; school playground adaptation; improving the content of PE; and implementing short PA breaks and physically active academic lessons. Children emphasized variation and being given a voice in	additional PA in school. We therefore recommend actively involving children in efforts to increase school-based PA and to make “additional PA in school” a shared project of teachers and students.

					their PA participation as a prerequisite to keep PA enjoyable and interesting in the long term. Finally, children mentioned the role of the teacher and making efforts to accommodate all children and their different preferences as important.	
7. Baceviciene et al. (2019)	Self-perception of physical activity and fitness is related to lower psychosomatic health symptoms in adolescents with unhealthy lifestyles.	Lithuania.	A total of 3284 11–19-year-old adolescents (average age 14.9 ± 2.0; 48.6% male) participated in the population-based cross-sectional study.	Self-administered questionnaires addressed lifestyle, sports participation, physical activity, physical fitness and perceptions.	Female gender, smoking, alcohol consumption, unhealthy foods, hours of internet use, and poor personal fitness perception were associated with activity in	It is important to study cognitive factors when exploring the associations between adolescent lifestyles and activity. These results are

					adolescents. Lower physical activity and self- perceived insufficient physical activity, perception of physical fitness as being poor, and not participating in sports were associated with greater somatic and psychological complaints controlling for age, gender, and BMI. Participation in sports and physical activity did not change PHC in adolescents involved in unhealthy behaviour. However, a positive perception of one's	important for health promotion and education programmes aimed at improving healthy lifestyle and psychosocial well- being in adolescents.

					own physical activity and physical fitness decreased PHC in adolescents who reported an unhealthy lifestyle.	
8. Morgan et al. (2016)	Predictors of physical activity and sedentary behaviours among 11-16 year olds: Multilevel analysis of the 2013 Health Behaviour in School-aged Children (HBSC) study in Wales.	United Kingdom.	The final sample comprised 7,376 young people aged 11-16 years across 67 schools.	Individual-level data provided by the 2013/14 cross-sectional survey 'Health Behaviour in School-aged Children (HBSC) study in Wales' were linked to school-level data within the 'HBSC School Environment Questionnaire'.	Taking more physical activity (less than 5 days vs. 5 or more days per week), engaging in higher levels of MVPA (less than 4 hours vs. 4 or more hours per week) and reporting 2 or less hours of sedentary time were predicted by several individual level variables. Active travel to school positively predicted	Shorter lunch breaks were associated with increased sedentary time. Therefore, while further research is needed to better understand the causal nature of this association, extending lunch breaks could have a positive impact on sedentary behaviour through the provision of more time for physical activity. The findings

					high levels of physical activity, however, gender stratified models revealed active travel as a predictor amongst girls only. No school- level factors were shown to predict physical activity levels, however, a lower school socio-economic status was associated with a higher level of MVPA and a lower risk of sedentary behaviour. A shorter lunch break and greater provision of facilities were associated with	also suggest that active travel could offer a mechanism for increasing physical activity levels particularly amongst girls. Particularly, the design and evaluation of interventions to promote physical activity during school hours should employ a comprehensive approach, including a focus on school policies and behaviours both in and out of school hours.

					increased sedentary activity. Gender stratified models revealed that PE lesson duration and the provision of sports facilities were predictors of boy's sedentary behaviours only.	
9. Jodkowska et al. (2015)	Perceived barriers to physical activity among Polish adolescents.	Poland.	3346 students aged 10 - 16 years (1759 girls) took part in the cross-sectional, nationally representative study.	For this paper the dataset was created from adolescents who reported perceived barriers to PA, N=2300, (1259 girls), range 13-16 years. Barriers and physical activity MVPA) were analysed for all participants, as well as by gender, age group and place of residence. Multiple	Lack of energy, lack of time and lack of support were three of the five barriers reported by more than 40% of adolescents, statistically more likely by girls than boys and older youth than younger. For boys - lack of time, lack of skills, lack of willpower, and lack of	Perceived barriers to physical activity among adolescents have strong negative impact on recommended PA level. For girls lack of skills is the strongest predictor of low PA, for boys – lack of time. Identification more precisely barriers to

				regression analysis was used to examine the relationships between perceived barriers and physical inactivity for all and then separately for boys and girls.	support were the predictors contributing to low level of PA. For girls lack of skills, lack of energy, lack of support and lack of time were positively and statistically significant associated with physical inactivity.	physical activity among adolescents will enable to developed more effective interventions in high-risk populations.
10. Dias et al. (2015)	Perceived barriers to leisure-time physical activity and associated factors in adolescents.	South America.	A representative sample of 1,409 high school students from public schools in the city of Londrina/Paraná was selected through multistage sampling.	For data collection, the adolescents completed a questionnaire.	The relationship between leisure-time physical inactivity (<300 minutes/week) and perceived barriers was analyzed by calculating the prevalence ratio (PR) in Poisson regression models. "Lack of friends company" was the most	The perception of barriers was associated with a higher prevalence of leisure-time physical inactivity in adolescents and should therefore be considered in actions for promoting physical activity in

					prevalent barrier for both girls (75.8%) and boys (58.7%). “Feel lazy” for girls (PR: 1.21; CI 95%: 1.08 to 1.36) and “prefer to do other things” for the boys (PR: 1.48; CI 95%: 1.01 to 2.15) were the barriers most strongly associated with leisure-time physical inactivity. For both genders, a strong dose-response relationship was observed between the number of perceived barriers and leisure-time	this population.

					physical inactivity.	
11. Charlton et al. (2014)	Factors associated with low fitness in adolescents--a mixed methods study.	United Kingdom.	1147 children were assessed for fitness, had blood samples, anthropometric measures and all data were linked with routine electronic data to examine educational achievement, deprivation and health service usage.	Factors associated with fitness were examined using logistic regression, conditional trees and data mining cluster analysis. Focus groups were conducted with children in a deprived school to examine barriers and facilitators to activity for children in a deprived community.	Unfit adolescents are more likely to be deprived, female, have obesity in the family and not achieve in education. There were 3 main clusters for risk of future heart disease/diabetes (high cholesterol/insulin); children at low risk (not obese, fit, achieving in education), children 'visibly at risk' (overweight, unfit, many hospital/GP visits) and 'invisibly at risk' (unfit but not	Low fitness in the non-obese child can reveal a hidden group who have high risk factors for heart disease and diabetes but may not be identified as they are normal weight. In deprived communities low fitness is associated with non-achievement in education but in non-deprived communities low fitness is associated with female gender. Interventions need to target deprived families and

					overweight, failing in academic achievement). Qualitative findings show barriers to physical activity include cost, poor access to activity, lack of core physical literacy skills and limited family support.	schools in deprived areas with community wide campaigns.
12. Corder et al. (2015)	Development of a universal approach to increase physical activity among adolescents: The GoActive intervention.	United Kingdom.	N=31 girls.	Relevant systematic reviews and longitudinal analyses of change were examined. An intervention was developed iteratively with older adolescents (17.3 ±0.5 years) and teachers, using	Limitations of the existing literature include lack of evidence on whole population approaches, limited adolescent involvement in intervention development, and poor participant engagement.	We have followed an evidence-based iterative approach to translate existing evidence into an adolescent PA promotion intervention. Qualitative work with adolescents and teachers supported

				the following process: (1) focus groups with (A) adolescents (n=26) and (B) teachers (n=4); (2) individual interviews (n=5) with inactive and shy adolescents focusing on engagement and programme acceptability. Qualitative data were analysed thematically.	Qualitative work suggested six themes which may encourage adolescents to do more PA; choice, novelty, mentorship, competition, rewards and flexibility. Teachers discussed time pressures as a barrier to encouraging adolescent PA and suggested between-class competition as a strategy. GoActive aims to increase PA through increased peer support, self-efficacy, group cohesion, self-	intervention design and addressed lack of engagement with health promotion programmes within this age group. Future work will examine the feasibility and effectiveness of GoActive to increase PA among adolescents while monitoring potential negative effects. The approach developed is applicable to other population groups and health behaviours.

					esteem and friendship quality, and is implemented in tutor groups using a student-led tiered-leadership system.	
13. Carlin et al. (2015)	Current influences and approaches to promote future physical activity in 11–13 year olds: a focus group study.	Ireland.	One hundred eighty participants, mean (SD) age 12.1 (0.5) years, completed the Physical Activity Questionnaire for Children (PAQ-C) and had height and weight measured. This information was used to select a subsample of participants (n64; mean (SD) age 12.3 (0.4) years; 39	A semi-structured discussion guide was employed to explore the key influences on current PA participation and to actively seek ideas on how best to promote future PA in this population. In total, nine focus groups (mixed-gender) were conducted within the school setting. All focus groups were audio	A number of themes emerged in relation to influences on current PA including friendship and peers, family and other people, the consequences of not taking part in PA, changing priorities, and cost and access to resources. With regards to the future provision of PA, participants	This study has highlighted a number of influences on current and future participation in PA, which differed based on gender and existing PA levels, for example, maximising the potential of the school day and including technology and incentives. These components

			females; 25 males; 25% overweight/obese) to take part in focus group discussions. Participants were grouped based on PAQ-C responses into ‘low-active’ and ‘highly-active’ groups, so that those with similar existing levels of PA were in the same focus group.	recorded, transcribed verbatim and analysed thematically.	favoured opportunities to try new activities, increased provision of school-based activities which can be undertaken with friends and activities which incorporated the use of technology and encouragement through rewards and incentives. Gender differences were apparent in relation to the types of activities participants preferred taking part in. Differences were also observed between ‘low-active’ and ‘highly-active’ groups in	can inform targeted interventions to increase PA in low active adolescents.

					relation to barriers to current participation in PA.	
14. Brockman et al. (2011)	Children's active play: Self-reported motivators, barriers and facilitators.	United Kingdom.	Eleven focus groups were conducted with 77, 10-11 year old children from 4 primary schools in Bristol, UK.	Focus groups examined: (i) factors which motivate children to take part in active play; (ii) factors which limit children's active play and (iii) factors which facilitate children's active play. All focus groups were audio-taped and transcribed verbatim. Data were analysed using a thematic approach.	Children were motivated to engage in active play because they perceived it to be enjoyable, to prevent boredom, to have physical and mental health benefits and to provide freedom from adult control, rules and structure. However, children's active play was constrained by a number of factors, including rainy weather and fear of groups of teenagers in their play spaces. Some features of	Children express a range of motivational and environmental factors that constrain and facilitate their active play. Consideration of these factors should improve effectiveness of interventions designed to increase active play.

					the physical environment facilitated children's active play, including the presence of green spaces and cul-de-sacs in the neighbourhood.	
15. Mitchell et al. (2015)	'This choice thing really works … ' Changes in experiences and engagement of adolescent girls in physical education classes, during a school-based physical activity programme.	United Kingdom.	Several visits were made to each school during the course of the evaluation for a range of purposes including: survey administration, meetings and focus groups with staff and some observational research. Three phases of semi-structured individual interviews were carried out with the	A questionnaire was used to identify five disengaged girls for three phases of semi-structured individual interviews. These were to track changes in girls' engagement and experiences in the PE environment. Interviews were carried out with the selected girls over	Key themes: understandings girls disengagement in PE (competence, social influences, choice) and the PA intervention (a positive perspective, social influences).	Pre-intervention the PE environment did not fulfil the girl's basic psychological needs of autonomy, competence and relatedness. However, the PA intervention, which included consultation and a choice of activity, resulted in increased participation and more positive perceptions of the

			selected girls over an 18-month period, resulting in 15 interviews for this case study school (n-5 girls).	an 18-month period, resulting in 15 interviews for this case study school.		subject, for most of the selected girls. These factors resulted in a more supportive PE environment overall and so were critical for the girls transition from disengagement to engagement.
16. Harrington et al. (2019)	A school-based Intervention improves physical fitness in Ecuadorian adolescents: a cluster-randomized controlled trial.	Ecuador.	Schools were eligible if: (i) they had >90 students in 8th and 9th grade, and (ii) they were located in the urban area of Cuenca, Ecuador. The eligible schools were paired ac- cording to four criteria: (i) total number of students	The intervention included an individual and environmental component tailored to the local context and resources. Primary outcomes were physical fitness (EUROFIT battery), screen time (questionnaires) and physical activity (accelerometers).	The intervention increased vertical jump (mean effect 2.5 cm; 95% CI 0.8- 4.2; P = 0.01). Marginally insignificant, adolescents from the intervention group needed less time for speed shuttle run (intervention effect	A school-based intervention with an individual and environment component can improve physical fitness and can minimize the decline in physical activity levels from childhood into adolescence in urban Ecuador.

			of the school, (ii) monthly school fee (as proxy for the socio- economic status of the school), (iii) gender (male/female only or mixed gender) and (iv) time schedule of classes (morning: 7:00 to 13:00 or afternoon: 12:00 to 18:00). In Ecuador, large schools might divide the students in two groups because of logistic constraints.	Change in BMI was a secondary outcome. A total of 1440 grade 8 and 9 adolescents (intervention: n = 700, 48.6%) and 20 schools (intervention: n = 10, 50%) participated. Data of 1083 adolescents (intervention: n = 550, 50.8%) from 20 schools were analyzed.	= −0.8 s, 95% CI −1.58- 0.07; P = 0.05). The proportion of students achieving over 60 minutes of moderate-to- vigorous physical activity/day decreased over time with the change in proportion significantly less in the intervention schools (6 vs. 18 percentage points, P < 0.01). The intervention effect on speed shuttle run was significant in larger schools while the effect on vertical	

					jump was larger in mixed gender school compared to small and female schools. The proportion of schools that met the recommendations for physical activity increased with 37% in intervention schools with half-day schedule compared to the controls in the pair. No significant effects were found on screen time and BMI. Measurement of physical activity in a subsample was a limitation. No adverse effects were reported.	
17. Ho et al.	A Sports-Based	China.	Six hundred and	Participants were	The	A PYD-based sports

(2017)	Youth Development Program, Teen Mental Health, and Physical Fitness: An RCT.		sixty-four students (mean age 12.3 years [SD 0.76]; 386 girls [58.1%]) completed baseline and post intervention assessments from 12 secondary schools.	randomly assigned in a 1:1 ratio to an intervention or a control arm after stratification for school from October 2013 to June 2014. Participants were not blinded to allocation because of the nature of the intervention. Students in the intervention arm received an after-school, PYD-based sports mentorship for 18 weeks. Each weekly session lasted 90 minutes. Students in the control arm received exclusive	intervention improved students' mental well-being, self-efficacy, resilience, physical fitness, lower limb muscle strength, and dynamic balance, and physical activity levels. The intervention did not significantly improve physical well-being, BMI z scores, body fat proportion, and social connectedness.	mentorship intervention improved healthy adolescents' mental well-being, psychological assets, physical fitness, and physical activity levels.

				access to a health education Web site.		
18. Karr et al. (2017)	Effects of Before School Physical Activity on Obesity Prevention and Wellness.	North America.	707 children, from kindergarten to eighth grade from 24 schools.	In each school, children whose parents registered them for BOKS participated in a 1-hour, before school program. Nonparticipating children served as controls. Primary outcomes included students' BMI z -score collected by study staff at baseline and at 12 weeks, and odds of being in a lower BMI category at follow-up.	Follow-up BMI was obtained from 67% of children and self-reported surveys from 72% of age-eligible children. Children in the 3 days/week group had improvements in BMI z - score and this mean change was significantly different than the comparison group. Children in the 3 days/week group also had higher odds of being in a lower BMI category at follow-up;	A 3 days/week before school physical activity program resulted in improved BMI and prevented increases in child obesity. Both Build Our Kids Success groups had improved social– emotional wellness versus controls.

				Students aged ≥8 years also completed surveys assessing social–emotional wellness.	significantly different than the comparison group ($p < 0.01$). Children in the 2 days/week program had no significant changes in BMI outcomes. Children in the 3 days/week group demonstrated improvement in their student engagement scores and had non-significant improvements in reported peer relationships, affect, and life satisfaction versus comparison. The 2 days/week group	

					had significant improvements in positive affect and vitality/ energy versus comparison.	
19. Borawski et al. (2018)	We run this city: Impact of a community-school fitness program on obesity, health, and fitness.	North America.	1,419 sixth- to eighth grade students participating in WRTC for the first time, with particular interest in the program's effect on overweight (85th– 94th body mass index percentile) or obese (≥95th percentile) students.	Collected data from 2009 through 2012, and analyzed it in 2016 and 2017. Outcomes of interest were body mass index (BMI), waist-to-hip ratio (WHR), elevated blood pressure, and fitness levels evaluated by using the Progressive Aerobic Cardiovascular Endurance Run (PACER) test and the sit-to-stand test.	We saw significant improvements overall in fitness and blood pressure. Controlling for demographics, program event, and training dosage, BMI percentile increased among normal weight parti- cipants and decreased among overweight and obese participants ($P < .001$). WHR increased among obese participants,	Even small amounts of regular physical activity can affect the health and fitness of urban youths. School–community partnerships offer a promising approach to increasing physical activity by supporting schools and making a school- based activity inclusive, fun, and connected to the broader fitness community.

					whereas reductions in blood pressure among those with elevated blood pressure were associated with higher amounts of training and lower baseline BMI.	
20. Short et al. (2018)	Using financial incentives to promote physical activity in American Indian adolescents: A randomized controlled trial.	North America.	Male and female American Indians were recruited from the Choctaw Nation Health Service Area of Southeast Oklahoma. From July 2013 through March 2015 the age criterion for the exercise intervention was 11,0 to 17.9 years old, and the	Overweight/obese AI boys and girls, 11–20 years old, were instructed to exercise on 3 days/week for 48 weeks at a tribal wellness center. The pro- gram was divided into three, 16-week-long phases to test different financial incentive strategies. Within each phase	In Phase 1, the number of exercise sessions did not differ between the group receiving a modest fixed-value payment per exercise session and the group receiving enhanced incentives to exercise more frequently (26 ± 3 versus 28 ± 2 sessions, respectively, p = 0.568). In Phase 2,	In conclusion, enhanced financial incentives increased the duration of exercise sessions, but had minimal effects on exercise participation. These results indicate that financial incentives hold promise in motivating previously

			BMI criterion was 95th percentile for age- and sex-specific norms based on growth charts from the Centers for Disease Control and Prevention, respectively.	participants were randomly assigned to one of two groups that received different payments for exercise.	the provision of an enhanced financial incentive to increase exercise duration resulted longer sessions, as the incentivized and standard payment groups exercised 38 ± 2 versus 29 ± 1 minutes per session ($p = 0.002$), respectively. In Phase 3, the effect of reducing the incentives on maintenance of exercise behaviors was inconclusive due to high participant withdrawal. Aerobic fitness increased 10% during Phase 1 but was unchanged	sedentary, overweight/obese adolescents to exercise longer, but motivating them to sustain an exercise program remains the major challenge.

					thereafter. Insulin sensitivity and body composition were unchanged during the study.	
21. Jenkinson et al. (2018)	The GLAMA (Girls! Lead! Achieve! Mentor! Activate!) physical activity and peer leadership intervention pilot project: A process evaluation using the RE-AIM framework.	Australia.	All Year 7 girls (12-13 years old) and Year 10 girls (15-16 years old) at a school were invited to participate via an assembly at which information was provided (Figure 2). Year 10 peer leaders were provided with music vouchers in appreciation of the time commitment required to lead the Year 7 students. Girls were chosen as our tar- get	Conducted in a state secondary school in Australia, the intervention was designed to provide students with opportunities to develop leadership skills, school and social connectedness in addition to a range of physical activity experiences. As it was not the specific aim of this pilot, no behavioural change data were collected	There were three main considerations evident across more than one RE-AIM dimension that need to be addressed to assist with future GLAMA dissemination. Firstly, the development of teacher, school and student participation. This needs to be through a variety of professional development opportunities for	Factors that have the greatest impact on intervention success are those that come from within the school setting including: the structure of the curriculum, pressure to meet curriculum and assessment content, lack of support for new initiatives, multiple programs already running within the school, time allowances

			demographic as they are often underserved in terms of encouragement and opportunities to partake in both physical activity and leadership development, particularly in rural communities.	from students. Data were collected using a mixed methods approach including student questionnaires, teachers and researchers reporting on their own observations and feedback from students.	teachers, integration of the program within timetabled classes within the school and promoting the program to students as an opportunity to develop a range of skills to apply to future learning and workplace environments. Secondly, the successful translation of leadership training to practice is necessary to ensure that leaders are effectively able to motivate, facilitate and activate their teams. Finally, the need for consistent	for teachers, appropriate training for teachers, and support for students to participate. These barriers need to be considered when developing all secondary school interventions.

					activity implementation requires sequential, competitive elements, purposeful team selection and clearly defined scoring and time periods for team ‘challenges’.	
22. Sebire et al. (2018)	Results of a feasibility cluster randomised controlled trial of a peer-led school-based intervention to increase the physical activity of adolescent girls (PLAN-A).	United Kingdom.	46 secondary schools in the two areas; four hundred twenty-seven girls were recruited (95% recruitment rate). 55 girls consented to be a peer-supporter and 53 peer-supporters were trained (97% of those invited).	A two-arm cluster randomised controlled feasibility study was conducted in six English secondary schools (4 intervention & 2 control). Year 8 (age 12-13) girls were eligible and randomisation was at school-level.	Accelerometer return rates exceeded 85% at each time point and wear time criteria was met by 83%, 71% and 62% participants at Time 0, 1 and 2 respectively. Questionnaire data were provided by >91% of	The PLAN-A intervention adopts a novel peer-led approach, is feasible, and shows evidence of promise to positively affect girls’ physical activity levels. A definitive trial is warranted.

				The intervention involved training Year 8 girls (out of school for two consecutive days, plus one top-up day 5 weeks later), who were identified by their peers as influential, to provide informal support to their friends to increase their physical activity.	participants at each time point. Complete-case adjusted linear regression analysis showed evidence of a 6.09 minute (95% CI = 1.43, 10.76) between-arms difference in weekday MVPA at Time 2 in favour of the intervention arm. On average PLAN-A cost £2685 per school to deliver (£37 per Year 8 girl). There were no adverse events. A trial involving 20 schools would be adequately powered to detect a between-	

					arms difference in weekday MVPA of at least six minutes.	
23. Jurak et al. (2013)	Long-term effects of 4-year longitudinal school-based physical activity intervention on the physical fitness of children and youth during 7-year follow- up assessment.	Slovenia.	In total, 324 children from nine Slovenian primary schools either received the enhanced curriculum (intervention (n=160)) or standard PE (control (n=164)), and were followed for a four-year intervention period and seven years post intervention.	A PA intervention taking place in the first four years of some Slovenian primary schools entails an enhanced physical education (PE) curriculum, including two extra lessons of PE per week, a wider selection of PE content, and additional outdoor education delivered by both a specialist PE teacher and a general teacher. The effects of the	Over an 11-year period, the PA intervention group significantly differed in all motor tasks, but not in anthropometric measures or body mass index, after controlling for year of measurement and sex. Differences between the control and intervention groups decreased with time.	PA intervention in the first four years of Slovenian primary school offers the possibility of improving physical performance in children; initiatives aiming to increase their performance (physical fitness, physical activity) and health outcomes are warranted.

				intervention on children's physical fitness (motor tasks and anthropometry) were evaluated within a quasi-experimental study. Data from the SLOFIT database were used to compare differences in the physical fitness of children each year. Linear Mixed Models were used to test the influence of the PA intervention.		
24. Dollman et al. (2019)	Healthy for Life Pilot Study: A Multicomponent School and Home Based Physical Activity	Australia.	All students aged 8 to 13 years in two socially disadvantaged primary schools in the northern	The study aimed to develop and evaluate a multicomponent school and home based physical	The study showed 73% of the children with complete data sets at the intervention school (n	In conclusion, while the multifaceted approach to improve PA was ineffective over the

	Intervention for Disadvantaged Children		suburbs of Adelaide, Australia were invited to participate. The two schools were demographically comparable due to similar location, enrollment numbers, physical environment and facilities (n=98).	activity (PA) intervention in children in grades 3– 7 (aged 8–13 years) and determine the psychological variables that influence PA; 10 × 1 h school-based training sessions, a home-based activity program and 4 × 1 h lifestyle workshops for parents. PA was assessed at an intervention and nearby control school using accelerometers and self-report at 3-time points: baseline, post intervention	= 27) did not increase device measured moderate to vigorous PA (MVPA) in the after-school period (3 p.m. to 6 p.m.) or over the whole day or during school break time immediately following the intervention or at follow-up, as compared to 70% of children with complete data sets at the control school. Overall, 59% of boys attained more than double the recommended 120 min of MVPA each	time span of the study, important predictors of PA in this sample of disadvantaged children were identified.

				and 10-week follow- up. Self-efficacy, self-management strategies, enjoyment, perceived barriers to PA, outcome-expectancy and social support were evaluated.	day compared to 42% of girls (p = 0.013). At the baseline, children’s self-reported PA in the intervention school positively correlated with: outcome expectancy, enjoyment, self-efficacy, self-management, social support at home, and social support at school. Similar relationships were observed after the intervention and at follow-up. Focus groups with the children, parents and interviews with teachers identified areas for	

					improvement of the intervention.	
25. Hollingworth et al. (2012)	Reducing smoking in adolescents: Cost-effectiveness results from the cluster randomized assist (a stop smoking in schools trial).	United Kingdom	Fifty-nine secondary schools in England and Wales were randomized to receive the ASSIST programme or usual smoking education. Ten thousand seven hundred and thirty students aged 12–13 years attended participating schools. Following training, the 835 peer supporters who consented to undertake the intervention were asked to undertake informal conversa- tions about smoking with other Year 8	The ASSIST programme trained students to act as peer supporters during informal interactions to encourage their peers not to smoke.	Previous work has demonstrated that the ASSIST programme achieved a 2.1% (95% CI = 0%– 4.2%) reduction in smoking prevalence. The ASSIST programme cost of £32 (95% CI = £29.70–£33.80) per student. The incremental cost per student not smoking at 2 years was £1,500 (95% CI = £669–£9,947). Students in intervention schools were less likely to believe that they would be a smoker at	A peer-led intervention reduced smoking among adolescents at a modest cost. The intervention is cost-effective under realistic assumptions regarding the extent to which reductions in adolescent smoking lead to lower smoking preva- lence and/or earlier smoking cessation in adulthood. The an- nual cost of extending the intervention to Year 8 students in all U.K.

			students over a 10-week period and to record details of these conversations in a diary.		age 16 years (odds ratio [OR] = 0.80; 95% CI = 0.66–0.96).	schools would be in the region of £38 million and could result in 20,400 fewer adolescent smokers.
26. Carlin et al. (2018)	Effects of a peer-led Walking In ScHools intervention (the WISH study) on physical activity levels of adolescent girls: A cluster randomised pilot study.	Ireland.	A convenience sample of schools in Northern Ireland were invited to take part in the study. Of the 17 schools initially invited to take part in the study, six schools agreed to participate; three schools declined to participate on the basis of time constraints and eight schools did not reply to the initial invitational letter. A total of 199	Participants were randomized by school (cluster) to participate in regular 10–15-min peer-led brisk walks throughout the school week (the WISH study) (n = 101, two schools) or to continue with their usual PA (n = 98, four schools). The primary outcome measure was school-time PA post intervention (week	A significant interaction effect was observed for changes in light intensity PA across the school day (p = 0.003), with those in the intervention increasing their light intensity PA by 8.27 mins/day compared with a decrease of 2.14 mins/day in the control group. No significant interactions were observed for the other PA measures	The intervention increased daily light intensity PA behaviour in these adolescent girls but did not change moderate to vigorous physical activity (MVPA). These findings suggest that a school-based brisk walking intervention may be feasible and can change PA behaviour in the short term, but it is possible that the

			parents/guardians and participants returned consent and assent forms (33% response rate).	12), assessed objectively using an Actigraph accelerometer. Secondary outcome measures included anthropometry, cardiorespiratory fitness and psychosocial measures. Changes in PA data between baseline (T0) and end of intervention (week 12) (T1) were analysed using a mixed between-within subjects analysis of variance with one between (group) and one within	across the intervention. Intervention effects on school-time PA were not sustained four months post intervention.	self-selected walking speeds determined by a peer-leader may not be sufficient to reach MVPA in this age group. Further research is needed to evaluate the potential of school-based brisk walking to contribute to MVPA in adolescent girls.

				(time) subjects factor, with two levels.		
27. Fennell et al. (2016)	Combined incentives versus no-incentive exercise programs on objectively measured physical activity and health-related variables.	North America.	15 Previously sedentary faculty and staff (n=2 males and 13 females), age 48.7±1 participated in both of the two 12-week interventions.	They wore a program accelerometer throughout the entire day during the 12weeks. During the first intervention, there were no incentives offered to participants. The second intervention consisted of an incentivized program. Positive reinforcements included various rewards for meeting achievements related to physical activity levels. A program rebate worth $25 for	A two-way repeated measures ANOVA demonstrated a main effect of time for percent body fat (p b 0.001) and push-ups (p=0.018). All other variables revealed no differences between conditions or from pre to post testing. There was no difference between conditions with physical activity or attendance.	No differences in physical activity or health-related variables were found within the incentivized and non-incentivized conditions.

				achieving 450 miles was used as the negative reinforcement “buy-in” incentive.		
28. Jago et al. (2016)	Bristol Girls Dance Project: a cluster randomised controlled trial of an after-school dance programme to increase physical activity among 11- to 12-year-old girls.	United Kingdom.	A total of 508 girls were included in the primary analysis, which found no difference in weekday MVPA between trial arms.	Nine intervention schools received an after-school dance intervention (40 × 75-minute sessions) underpinned by self-determination theory, which attempts to improve intrinsic motivation for being active, and delivered by external dance instructors. Control schools continued as normal.	Data were subjected to a per-protocol analysis and no effect was found. However, at T1, girls who attended dance classes had 4.61 minutes more of MVPA and 14.27 minutes more of light-intensity activity between 15.00 and 17.00 on the days on which they attended intervention sessions. The intervention was inexpensive at £73 per participant (£63	The intervention was enjoyed by participants. However, there was no difference in the MVPA levels (which were high at baseline) of girls allocated to receive dance compared with girls receiving the control. High baseline MVPA levels indicate that the study appealed to an already active cohort and, therefore, may not

					when excluding dance instructor travel) but was not cost-effective owing to the ineffectiveness of the intervention. The European Quality of Life-5 Dimensions Youth survey data were unresponsive to changes in the sample. The process evaluation reported that girls in attendance enjoyed the sessions, that exertion levels were low during sessions and that attendance was low and declined. Fidelity to the session-plan manual was low but theoretical fidelity	have targeted those most in need of an intervention. Dance is an enjoyable activity for adolescent girls and could be further trialled as a means by which to increase PA. Research might consider the impact of dividing the intervention period into smaller blocks.

					(to self-determination theory) was good. Qualitative information provides information for improving future interventions.	
29. Corder et al. (2013	What do adolescents want in order to become more active?	United Kingdom.	Participants (n = 457) (Mean ± SD age: 14.3 ± 0.3 years; 45.2% male).	Responded to questionnaire items: "What activities would you like to try or do more often?" (yes/no to 6 activity types e.g. team sports) and "I would like to do more PA …" followed by options regarding co-participants, timing and PA location (agree/disagree to 10 items). Anthropometry,	Most adolescents wanted to increase participation in ≥1 type of PA (94.4%). Gym use (56.7%) and team sports (50.6%) were most popular. Girls were less likely to choose racquet sports (vs. boys OR; 95% CI 0.6;0.4-0.9) but more likely to select dancing (40.3;17.8-91.1). Preference for participation was	Targeting adolescent PA promotion by subgroup and providing choice of PA type, co-participants, timing and PA location appears promising. Adolescents want to do more types of PA more often; interventions could increase opportunities and support to facilitate this.

				demographics, accelerometer- and questionnaire-derived PA were obtained. Logistic regression was used to examine differences in views by subgroup (sex, weight status, objective PA level, parental education (SES)).	positively associated with existing participation in a similar activity (all $p < 0.02$). More adolescents wanted to increase PA with friends (88.8%) than family (63.5%). A leisure centre was most popular for increased participation (81.0%), followed by home (70.0%). Participation during school time was less popular among girls (vs. boys: 0.6;0.4-0.9) and more popular among low	

					SES participants (vs. high: 1.6;1.1-2.4). Overweight/obese adolescents were less likely to choose participation with friends (vs. normal weight 0.5;0.3-0.9).	
30. Patel et al. (2016)	A Randomized Trial of Social Comparison Feedback and Financial Incentives to Increase Physical Activity.	North America.	Two hundred eighty-six adults. Interventions:	Twenty-six weeks of weekly feedback on team performance compared to the 50th percentile (n ¼ 100) or the 75th percentile (n ¼ 64) and 13 weeks of weekly lottery-based financial incentive plus feedback on team performance compared to the 50th percentile (n ¼ 80) or the 75th percentile (n ¼ 44) followed by 13	Compared to the 75th percentile without incentives during the intervention period, the mean proportion achieving the 7000-step goal was significantly greater for the 50th percentile with incentives group (0.45 vs 0.27, difference: 0.18, 95% confidence interval [CI]:	Social comparison to the 50th percentile with financial incentives was most effective.

				weeks of only performance feedback. Measures were mean proportion of participant-days achieving the 7000-step goal during the 13-week intervention.	0.04 to 0.32; P¼.012) but not for the 75th percentile with incentives group (0.38 vs 0.27, difference: 0.11, 95% CI: ?0.05 to 0.27; P ¼ .19) or the 50th percentile without incentives group (0.30 vs 0.27, difference: 0.03, 95% CI: 0.10 to 0.16; P ¼ .67).	
31. Finkelstein et al. (2013)	A Cluster Randomized Controlled Trial of an Incentive-Based Outdoor Physical Activity Program.	Singapore.	Children aged 6-12 years were randomized to control (n = 138 from 106 families) or intervention arm	The intervention included incentives for meeting step targets as measured by pedometers and structured weekend outdoor activities.	At follow-up, children in the intervention group recorded significantly more pedometer steps than controls over	Incentives for increased step activity were effective in producing greater steps and showed a (nonsignificant)

			(n=147 from 106 families)	Outcomes included trends in activity for the intervention group and between-group differences in pedometer steps, 6-minute walk test, body mass index, and parent-reported Pediatric Quality of Life Inventory.	the entire week (8660 vs 7767; P = .010), on weekdays (8646 vs 7826; P = .041), and on weekends (8779 vs 7684; P = .018). Three different trajectory classes were identified. The first group increased activity but was not sustained, the second group met the target step levels, and the third group significantly surpassed the step goals. The intervention group showed trends toward longer 6-minute walk test times and higher	trend toward improvements in other health outcomes. Thus, future incentive trials should be incorporate greater step targets and longer follow-up periods to provide evidence of the long-term effect of these incentives on children's health.

					Pediatric Quality of Life Inventory scores, but the differences were not statistically significant.	
32. Gillison et al. (2011)	Motivation and body-related factors as discriminators of change in adolescents exercise behaviour profiles.	United Kingdom.	A cohort of 310 adolescents (51% male, Mean age 14.08.32 years at baseline) was classified into four groups on the basis of reported change in leisure-time exercise over 10-months: those who maintain, drop out from exercise, take up exercise, and those who were continually inactive.	Discriminant function analyses were conducted to predict group membership from adolescents' profiles of motivational and weight-related perceptions at baseline.	For boys, the first discriminant function (DF1) revealed that exercise maintainers reported higher identified regulation, introjected regulation, competence, relatedness, and body satisfaction than all other groups (between-group R2?.45). DF2 was more indicative of current exercise	Fostering autonomous (self-determined) motivation seems a key determinant to maintaining leisure-time exercise for both boys and girls. Additionally, reducing perceptions of pressure to lose weight and promoting positive interactions with others during exercise may be particularly useful to prevent dropout in

					levels than change, indicating higher intrinsic motivation and lower amotivation for both active groups at baseline (between- group R2 ? .40). In girls, DF1 showed that exercise maintainers reported higher intrinsic motivation, identified regula- tion, autonomy, competence, relatedness, and lower external regulation than all other groups.	girls.
33. Duncan et al. (2017)	Autonomous motivation mediates the relation between	United Kingdom.	Data were collected from five schools in	Children were pro- vided with a short introduction to the	Body mass index was determined from height and	This study indicates that intrinsic goals for PA positively

	goals for physical activity and physical activity behavior in adolescents.		Warwickshire, UK, one from each quintile of deprivation based on electoral ward data. Overall, 544 children (mean age ± standard deviation = 14.2 ± .94 years) completed self-report measures of physical activity goal content, behavioral regulations, and physical activity behavior.	study and were then asked to complete the questionnaires described below. The questionnaires were admin- istered by a research assistant in small groups (n = 4–6) to ensure they were completed correctly and so that the school children could ask any questions or be prompted if required. Once the questionnaires were completed, the participants then undertook assessment of height, mass, and waist circumference with a research	mass. The indirect effect of intrinsic goal content on physical activity was statistically significant via autonomous (b = 162.27; 95% confidence interval [89.73, 244.70]), but not controlled motivation (b = 5.30; 95% confidence interval [−39.05, 45.16]). The indirect effect of extrinsic goal content on physical activity was statistically significant via autonomous (b = 106.25; 95%	impact PA behavior in British adolescents but only through autonomous motivation. Extrinsic goals for PA also positively impacts on PA behavior but were mediated by autonomous and controlled motivation. Weight status did not influence these mediation effects.

				assistant.	confidence interval [63.74, 159.13]) but not controlled motivation (b = 17.28; 95% confidence interval [−31.76, 70.21]). Weight status did not alter these findings.	
34. Rangul et al. (2012)	Is physical activity maintenance from adolescence to young adulthood associated with reduced CVD risk factors, improved mental health and satisfaction with life: The HUNT Study, Norway.	Norway.	Included 1869 individuals (838 males) participating in Young-HUNT (1995–97), aged 13–19 years and followed-up at HUNT3 (2006–08), aged 23–31.	Self-reported physical activity (PA), mental health and perceived health were recorded, along with measurements of body mass index (BMI), waist circumference (WC), total cholesterol (TC), HDL cholesterol, glucose, triglycerides, resting heart rate (HR) and	Active maintainers had significantly lower HR, compared to all other PA patterns. Active maintaining men had significantly lower WC than relapsers and inactive maintainers. When adjusted for age and gender, WC, BMI, HR, diastolic blood pressure and HDL-C showed	Those who maintained their physical activity from adolescence to young adulthood demonstrated a significantly lower CVD risk and better mental health, compared to inactive maintainers. Compared to inactivity

				blood pressure. They used separate linear regressions models to investigate associations between physical activity and each CVD risk factor, and logistic regression analysis to examine PA patterns and subsequent mental health. Physically active maintainers were compared to inactive maintainers. Adopters (inactive as adolescents and physically active as young adults) were compared to inactive	significant differences comparing active maintaining to other PA patterns. Comparing inactive maintainers against adopters, only HR was significantly lower. Male adopters did not differ significantly in CVD risk compared to inactive maintainers and relapsers. Among females adopting was associated with lower HR and TC compared to inactive maintainers. Active maintainers showed better mental health	maintainers and relapsers, adopting physical activity was not significantly associated with lowered CVD risk. Adopting physical activity between adolescence and young adulthood may not necessarily protect against mental distress.

				maintainers and to those who discontinued activity (relapsers).	than inactive maintainers. Active maintaining males had an increased likelihood of good mental health compared to adopters. Active maintaining females reported greater satisfaction with life compared to adopters.	
35. Villa-Gonzalez et al. (2015)	Associations between Active Commuting to School and Health-Related Physical Fitness in Spanish School-Aged Children: A Cross-Sectional Study.	Spain.	A total of 494 children (229 girls) from five primary schools in Granada and Jaén (Spain), aged between eight and 11 years, participated in this cross-sectional study.	Participants completed the Assessing Levels of Physical Activity (ALPHA) fitness test battery and answered a self-reported questionnaire regarding the	Active commuting to school was significantly associated with higher levels of speed-agility in boys ($p = 0.048$) and muscle strength of the lower body muscular fitness in	Our findings suggest that active commuting to school was associated with higher levels of both speed-agility and lower body muscular fitness in boys and girls, respectively.

				weekly travel mode to school.	girls (p = 0.016). However, there were no significant associations between active commuting to school and cardiorespiratory fitness and upper body muscular fitness.	Future studies should confirm whether increasing active commuting to school increases speed-agility and muscle strength of the lower body.
36. Harris et al. (2017)	Participation in Vigorous Sports, Not Moderate Sports, Is Positively Associated With Cardiorespiratory Fitness Among Adolescent Girls.	North America.	Six schools were recruited at each of the 6 field centers. Forty eighth-grade girls per school were randomly selected to participate in cardiorespiratory fitness tests in Spring 2005, following the 2-year intervention	The purpose of this study was to estimate the association between moderate and vigorous sports participation and cardiorespiratory fitness among adolescent girls. This study hypothesized that participation in vigorous sports is	The number of vigorous sports in which girls participated was positively associated with absolute fitness (β = 10.20, P = .04) and relative fitness (β = 0.17, P = .04). Associations were reduced, but not eliminated, after	Vigorous sports participation is positively associated with cardiorespiratory fitness. Future longitudinal research should analyze whether promoting vigorous sports at an early age can prevent age-related declines in

			period. Girls were recruited through required classes in their respective schools. Girls who were not able to participate in regular physical education class or were taking contraindicated medications were excluded from the fitness tests. Of the 1440 girls who were selected, 1226 (85%) provided both assent and parental/guardian consent.	associated with higher cardiorespiratory fitness levels, independent of race/ethnicity and body composition.	controlling for MET-weighted MVPA. Participation in moderate sports was not associated with either fitness measure.	cardiorespiratory fitness among adolescent girls.
37. Young et al. (2017)	Multilevel Correlates of Physical Activity for Early, Mid, and Late Adolescent Girls	North America.	All field sites of the Trial of Activity for Adolescent Girls contributed participants from	Questionnaires were used to obtain demographic and psychosocial	Variables at individual, social, school, and neighborhood levels were associated	MVPA is a complex behavior with fluid, multilevel correlates that

			6th (n = 1576) and 8th grades (n = 3085).	information (individual- and social-level variables); height, weight, and triceps skinfold to assess body composition; interviews and surveys for school-level data; and geographical information systems and self-report for neighborhood-level variables. Moderate to vigorous physical activity minutes (MVPA) were assessed from accelerometers. Mixed models (13 individual, 5 social, 15 school, 12	with MVPA, but differed across grades. Lower percent body fat, higher social support from friends, and lower school math scores were associated with higher MVPA at 6th and 8th grade. Higher physical activity self- efficacy was associated with higher MVPA at 11th grade. Only lower physical activity barriers were associated with higher MVPA at all grades.	differ among girls across middle and high school.

				neighborhood variables) were used to determine multilevel associations.		
38. Denton et al. (2013)	Cardiorespiratory Fitness Is Associated with Hard and Light Intensity Physical Activity but Not Time Spent Sedentary in 10-14 Year Old Schoolchildren: The HAPPY Study	United Kingdom	135 schoolchildren (81 girls, 12+1 year).	7-day minute-by-minute habitual physical activity monitoring using triaxial accelerometers and undertook a maximal cardiorespiratory fitness test.	After controlling for sex, age, ethnicity, socioeconomic status and total wear time, light physical activity (1.5–2.9 METs) was negatively associated (b=2.24, p,.01) and hard physical activity ($9 METs) positively associated (b=.45, p,.001) with cardiorespiratory fitness. Vigorous and hard physical	Hard physical activity ($9 METs) holds greater potential for cardiorespiratory fitness compared to physical activity of lower intensities. There was no relationship between sedentary behaviour and cardiorespiratory fitness. These findings suggest that, for children, advice should focus on higher

					activity were associated with cardiorespiratory fitness for boys (F=5.64, p,.01) whereas light, moderate and hard physical activity were associated with physical fitness for girls (F=10.23, p,.001). No association was found between sedentary time and cardiorespiratory fitness (r=2.13, p..05). Conclusions: Sedentary to active transitions revealed little variability between cardiorespiratory fitness tertiles.	intensity physical activity and not sedentary behaviour as a means to maintain or improve cardiorespiratory fitness. Future research should explore longitudinal relationships between hard physical activity, cardiorespiratory fitness and health parameters.

39. Wheeler et al. (2010)	Greenspace and children's physical activity: A GPS/GIS analysis of the PEACH project.	United Kingdom	Data were collected between 2006 and 2008 from 1,307 children aged 10–11 in Bristol, UK.	Data were collected between 2006 and 2008 from 1,307 children aged 10–11 in Bristol, UK. Accelerometers and Global Positioning System receivers measured activity and location every 10 s (epoch) after school for four days. Data were mapped in a Geographic Information System with a greenspace dataset. Activity volume (accelerometer counts per minute), time in moderate-vigorous physical	13% of monitored time was spent outdoors (2% in greenspace), during which time 30% of activity volume and 35% of MVPA was accumulated. 7% of boys' activity volume and 9% of MVPA were in greenspace with girls slightly lower (5% and 6% respectively). The odds of an epoch being MVPA in greenspace relative to outdoor non-greenspace was 1.37 (95% CI 1.22–1.53) for boys and 1.08 (95% CI 0.95–	Most activity occurring outdoors is not in greenspace and non-green urban environments are therefore very important for children's activity. However, when boys are in greenspace, activity is more likely to be of higher intensity.

				activity (MVPA), and the odds of an epoch being MVPA (using logistic regression) were compared for greenspace, non-greenspace and indoors.	1.22) for girls.	
40. Moller et al. (2012)	Financial motivation undermines potential enjoyment in an intensive diet and activity intervention.	North America	Chicago area adults of ages between 21 and 60 years were recruited through community advertisements. The final sample of 204 adults included 48 males, 46.6% minorities, 25% with no more than a high school education, and mean age 33.3	We assessed participants' context-specific financial motivation to participate in the Make Better Choices trial—a trial testing four different strategies for improving four health risk behaviors: low fruit and vegetable intake, high saturated fat	Financial incentives were contingent upon meeting behavior goals for 3 weeks and became contingent upon merely providing data during the 4.5-month maintenance period. Financial motivation for participation was assessed at baseline using a 7-itemscale (α = .97). Across	Implications for practice and future research on incentivized lifestyle and weight interventions are discussed.

			years (s.d. = 11.01).	intake, low physical activity, and high sedentary screen time. The primary outcome was overall healthy lifestyle change; weight loss was a secondary outcome.	conditions, a main effect of financial motivation predicted a steeper rate of weight regained during the maintenance period, t(165) = 2.15, P = .04. Furthermore, financial motivation and gender interacted significantly in predicting maintenance of healthy diet and activity changes, t(160) = 2.42, P = .016, such that financial motivation had a more deleterious influence	

					among men.	
41. Boone-Heinonen et al. (2010)	What neighborhood area captures built environment features related to adolescent physical activity?	North America	Using Wave I data (n=20,745; 11–22 years of age) from The National Longitudinal Study of Adolescent Health (Add Health), a prospective cohort study of adolescents representative of the U.S. school-based population in grades 7–12 in 1994–95.	Comparisons of associations between moderate-vigorous PA (MVPA) and PA facility counts and street connectivity measures (intersection density and link:node ratio) within 1, 3, 5, and 8.05 km of each respondent's residence (Euclidean neighborhood buffers).	BE-MVPA associations varied by BE characteristic, urbanicity, and sex. PA facilities within 3 km buffers and intersection density within 1 km buffers exhibited the most consistent associations with MVPA.	Policy recommendations and corresponding research should address potential differences in relevant neighborhood areas across environment feature and population subgroup.
42. Rodriguez et al. (2012)	Out and about: Association of the built environment with physical activity behaviors of	North America	A sample of 293 adolescent females aged 15 to 18 years old in Minneapolis and San Diego.	The built environment around each GPS point and its corresponding	The odds of higher physical activity intensity (3-level outcome: sedentary, light, MVPA) were	Understanding the places where physical activity and sedentary behaviors occur

	adolescent females			sedentary, light, and moderate-to-vigorous intensity physical activity was examined using random intercept multinomial logistic regression models.	higher in places with parks, schools, and high population density, during weekdays, and lower in places with more roads and food outlets.	appears to be a promising strategy to clarify relationships and inform policy aimed at increasing physical activity and reducing sedentary behaviors.

Appendix 3 ACTIVE Protocol Paper

BMC Public Health

STUDY PROTOCOL Open Access

Active children through individual vouchers – evaluation (ACTIVE): protocol for a mixed method randomised control trial to increase physical activity levels in teenagers

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Abstract

Background: Many teenagers are insufficiently active despite the health benefits of physical activity (PA). There is strong evidence to show that inactivity and low fitness levels increase the risk of non-communicable diseases such as coronary heart disease (CHD), type 2 diabetes and breast and colon cancers (Lee et al. Lancet 380:219–29, 2012). A major barrier facing adolescents is accessibility (e.g. cost and lack of local facilities). The ACTIVE project aims to tackle this barrier through a multi-faceted intervention, giving teenagers vouchers to spend on activities of their choice and empowering young people to improve their fitness and PA levels.

Design: ACTIVE is a mixed methods randomised control trial in 7 secondary schools in Swansea, South Wales. Quantitative and qualitative measures including PA (cooper run test (CRT), accelerometery over 7 days), cardiovascular (CV) measures (blood pressure, pulse wave analysis) and focus groups will be undertaken at 4 separate time points (baseline, 6 months,12 months and follow-up at 18 months). Intervention schools will receive a multi-component intervention involving 12 months of £20 vouchers to spend on physical activities of their choice, a peer mentor scheme and opportunities to attend advocacy meetings. Control schools are encouraged to continue usual practice. The primary aim is to examine the effect of the intervention in improving cardiovascular fitness.

Discussion: This paper describes the protocol for the ACTIVE randomised control trial, which aims to increase fitness, physical activity and socialisation of teenagers in Swansea, UK via a voucher scheme combined with peer mentoring. Results can contribute to the evidence base on teenage physical activity and, if effective, the intervention has the potential to inform future physical activity interventions and policy.

Trial registration: ISRCTN75594310 (Assigned 06/03/2017).

Keywords: Fitness, Physical activity, Peer mentor, Teenagers, Voucher, Mixed methods

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Background

Being active in adolescence is associated with many health benefits [1–6] and physical activity (PA) levels established during this time are likely to be taken into adulthood [2]. However, reports show that many adolescents are not sufficiently active to achieve these benefits [2, 7]. Government recommendations for PA suggest adolescents should be engaging in at least 60 min of moderate to vigorous physical activity (MVPA) every day [8]. A large proportion of young people do not meet this recommendation in Wales [9], with recent evidence showing that only 11% of girls and 20% of boys are sufficiently active [10]. This is concerning, as there is strong evidence to show the increased risk of non-communicable disease such as CHD, reduced well-being and shortened life expectancy resulting from inactivity and low aerobic fitness levels [11, 12].

Given that 7 million people in the United Kingdom are fighting CV diseases, [13] with physical inactivity a major risk factor, the development of effective interventions to promote activity in adolescence is of urgent public health concern [14]. It is reported that one of the main barriers to PA for teenagers is accessibility (e.g. cost and lack of local facilities) [8, 15], particularly for teenagers from disadvantaged backgrounds [4]. There is also a population trend towards spending more time inside, where technology can increase screen time and sedentary behaviours [3, 6].

The Active Children through Individual Vouchers – Evaluation Project (ACTIVE), funded by the British Heart Foundation (BHF) [16], aims to tackle these barriers and increase PA by giving teenagers vouchers to spend on activities of their choice. The project encourages teenagers to access existing provisions or generate their own in order to tackle accessibility issues and create the opportunity to participate in desired activities [15]. Evidence has shown that empowering teenagers to make their own choices over which activity they engage in, the location where they engage, and the people they participate with, can improve activity levels [17]. ACTIVE will also encourage teenagers to express the importance of choice and empowerment in advocacy meetings with stakeholders. As a result, the project aims to enhance socialisation and peer support, in order to facilitate PA uptake. This has been positively associated with teenage activity levels [18].

A voucher based intervention to increase PA in the UK has been previously tested amongst adults [19, 20], however, it remains uncertain whether a similar approach could work with teenagers. Financial incentives have been previously tested within a variety of populations [21–24] and have been effective in increasing physical activity levels. However, these focus on financial rewards rather than activity enabling vouchers. The ACTIVE Project aims to investigate whether a multi-component voucher based scheme can positively influence teenagers to become more physically active and improve their cardiovascular fitness.

Feasibility study

The ACTIVE feasibility study [15] was a mixed method cohort and process evaluation study of one school in a deprived area of Swansea, South Wales. The school was classed as deprived based on: i) the number of pupils eligible for free school meals (FSM) (54% at time of study) [25], ii) the area's eligibility for community-based initiatives and funding (e.g. Communities First) [15] and iii) the location in one of Wales' most deprived areas for children [26]. The study measured outcomes at three different time points (baseline, 5 months (during intervention) and 12 months (follow-up)). All Year 9 pupils in the school were given activity vouchers (n = 115; 13.3 ± 0.48 years; 51% boys).

The project found increases in MVPA and decreases in sedentary behaviour, suggesting a positive impact from voucher usage [15]. Process evaluation based on the RE-AIM Framework [27] demonstrated that ACTIVE was well received by pupils and teachers and was a feasible approach to increasing PA amongst adolescents from low socio-economic backgrounds.

Adjustments were made to the ACTIVE protocol following outcomes, process evaluation and recommendations from funding partners. These adjustments were made to further improve the project and increase its sustainability, prior to conducting a Randomised Controlled Trial (RCT) in order to assess effectiveness rather than its feasibility.

Aims

The current study builds upon the feasibility study by examining the effect of a multi-component voucher based intervention on the cardiovascular fitness and MVPA levels of teenagers aged 13–14 years in seven schools in Swansea (4 intervention and 3 control schools). The specific aims of the ACTIVE Project are as follows:

Primary aims

1. To examine evidence of the effect of a multi-component intervention in improving cardiovascular fitness based on Cooper Run Test score.

Secondary aims

2. To examine evidence of the effect of a multi-component intervention in reducing time spent sedentary, as measured by 7-day accelerometry.
3. To determine the effectiveness of the ACTIVE intervention to improve the following secondary outcomes:

- The amount of teenagers meeting the recommendation of 60 min of MVPA per day.
- Cardiovascular health (blood pressure and pulse wave analysis (PWA) an indicator of arterial stiffness).
- Exercise motivation (BREQ-2).
- The characteristics of teenagers who engage with the scheme, particularly among high risk groups to determine what works for whom, why and in what contexts.

4. To examine evidence of the effect on sustained local investment in implementing recommendations of teenagers in promoting PA and cost-effectiveness.
5. To provide evidence of whether ACTIVE can have a sustainable effect on fitness and PA (18-month follow-up)
6. To provide evidence that ACTIVE can be implemented by the local council with future rollout to other areas.
7. To undertake data linkage of quantitative measures through the Secure Anonymised Information Linkage (SAIL) databank [28] to analyse the effects of physical activity levels on educational attainment and GP visits.

Design

ACTIVE is a mixed methods randomised controlled trial based in state secondary schools in Swansea, South Wales. Schools will be approached to take part due to their: i) location in one of Wales' most deprived areas and ii) location in a Communities First catchment area [29, 30]. Randomisation will occur prior to baseline data collection with schools randomised into either the intervention arm or control arm. Due to the nature of the study, participants will be aware of which arm they have been allocated to.

The College of Human and Health Science Ethics Committee at the College of Medicine, Swansea University granted ACTIVE ethical approval on 12/05/2016.

Participant recruitment

Following initial school recruitment, participants will be recruited for primary and secondary outcome measures via Year 9 assemblies. During the assemblies, researchers on the project (DC & MJ) will provide information about the project and answer any questions before distributing project information, parental consent and pupil assent forms after the assembly. Once consent and assent has been obtained, participants will be eligible to partake in the study.

Intervention

The ACTIVE intervention consists of three different components; a) physical activity vouchers, b) peer mentor scheme, advocacy meetings and pupil-led video production, and c) support worker engagement.

Physical activity vouchers

The intervention involves provision of vouchers equating to a monetary value of £20 (four vouchers in increments of £5) per pupil each month for 12 months. They are to be distributed in schools with the purpose of being used to; i) spend on existing activities, ii) fund new activities in the schools or communities such as fitness classes, and iii) purchase sporting equipment for themselves or a club. The vouchers are to be treated similar to a cash transaction but without the delivery of change, in order to prevent the purchase of non-PA based items. At the end of each month, vouchers will be collected from each provider with an accompanying invoice for reimbursement of fees. This transaction process has been informed by the ACTIVE feasibility study [7]. Activity providers (for example, leisure centres and sports clubs) have been recruited during the development stages of the project and will continue to be recruited throughout the intervention based on pupil suggestions.

Peer mentoring scheme, advocacy meetings and pupil-led video production

Prior to baseline measures, pupils from each school will be asked to identify key influencers to be peer mentors (10 from each school). A peer nomination questionnaire was given to all pupils in the year and those who received the most nominations were invited to be peer supporters [31]. These individuals will receive training to be 'peer supporters' from the Active Young People team at Swansea Council and a student from the PR and Marketing Taught Masters course at Swansea University. The role of peer supporter is to encourage the uptake and sustainability of physical activity. This approach has been underpinned by ASSIST (A Stop Smoking in Schools Trial); an intervention which involved training Year 8 students to promote the benefits of not smoking amongst their peers. [32].

Peer mentors will be encouraged to produce videos throughout the intervention to explain why activity is important to them, the barriers to being active and any recommendations to improve activity for teenagers. These will help provide an innovative way to display the work of the ACTIVE intervention at advocacy meetings. These videos will be uploaded to YouTube and shown to local stakeholders and providers. Using an ACTIVE profile, videos will be recorded via 'Snapchat', a popular image-messaging app. Studies have shown that 'Snapchat' is used to facilitate relationships and 'bonding' amongst social circles [33, 34] and combined with its use of filters and text will create a novel way of displaying physical activity perceptions of this age group.

Throughout the ACTIVE intervention, advocacy meetings will be held with key stakeholders in order to promote sustainable investment for the provision of physical activities in the local community. These meetings will occur at 6 months and 12 months and involve discussion of needs, barriers to activity and changes that could improve teenager's access and uptake from the peer mentors' point of view.

Support worker engagement

A support worker will regularly attend the participating schools to increase pupil awareness of what is available in the area, provide advice on how to access activities and encourage pupils to design new activities or attract new coaches to the area. The support worker will audit the activities available and monitor voucher usage monthly to identify those engaging well and those not engaging with the project. Each month, the support worker will host drop-in style sessions in school lunchtimes so that pupils can liaise regarding their ideas and current engagement with the vouchers, and raise any questions or clarify any issues they may have. Feedback from these sessions will be used to target new activity providers that pupils have specifically expressed interest in.

Regular contact with the schools will aid communication, and maintain a presence to help pupils and teachers feel supported by the project. Assemblies will be held at the schools, to directly update the year group with important information regarding their vouchers and activity providers, also providing a general summary. The support worker will also communicate with local activity providers to create new activity options and ensure vouchers remain redeemable throughout the 12-month intervention.

Control schools

Control schools are encouraged to continue with their usual practice throughout the duration of the study. They will receive a mindfulness course for staff or pupils because of their participation in the study at baseline, 6 months, 12 months and 18 months.

Data collection

Data collection periods will take place at three time points: baseline, 6 months, 12 months and 18 months follow-up for both intervention and control schools (Fig. 1).

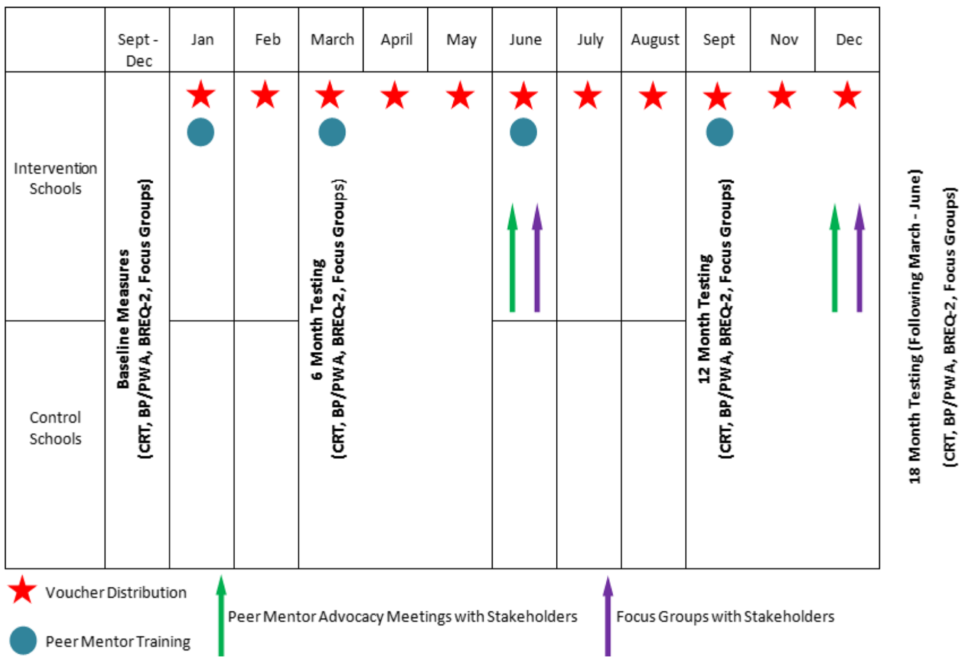

Fig. 1 Data collection and Intervention time scale

Quantitative measures of fitness, PA, motivation and cardiovascular health will be assessed at all four time points using the measures described below, in addition to focus groups and interviews to assess qualitative aspects of the project.

Cardiovascular fitness (Cooper run test)

The CRT is a 12-min walk/run test that will be performed at all four time points to assess cardiovascular fitness. The validity of the CRT as a predictor of aerobic fitness has been tested by numerous studies in both young males and females [35–37]. The test will be performed as part of normal PE lessons in the schools to avoid disruption to school timetables.

Physical activity (Actigraph accelerometers)

Physical activity will be measured via Actigraph GT3X+ accelerometers (Actigraph, Pensacola, Florida, United States), a tri-axial accelerometer which has previously been used in adolescents both for hip and wrist placement [38, 39]. The accelerometers will be worn on the non-dominant wrist of the participant, as opposed to the hip, for improved compliance [40]; a methodology adopted by the recent National Health and Nutrition Examination Survey (NHANES) between 2011 and 2012. The Actigraphs will be worn for seven full days at all times, apart from bathing or swimming, and will be set to record at a frequency of 30 Hz.

Motivation (exercise motivation questionnaire (BREQ-2))

The modified Behavioural Regulation in Exercise Questionnaire (BREQ-2) is a 19- item questionnaire that provides scores for amotivation and external, introjected, identified and intrinsic regulation. It is an accessible questionnaire, clearly written to aid pupils understanding of the questions. The BREQ-2 has been noted to obtain good psychometric information [41] and has been previously used to provide information regarding teenager's motivation to exercise [42–44]. The questionnaire will be administered at all four time points.

Cardiovascular health (blood pressure and pulse wave analysis)

Blood pressure will be measured through a standardised upper arm cuff methodology using a sphygmomanometer (Omron M2 monitor, OMRON Healthcare UK Ltd., United Kingdom). Participants will be seated for a minimum of five minutes to allow them to be sufficiently rested prior to any measures being taken. The Omron cuff will be positioned on the upper left arm, with the midline of the cuff positioned over the brachial artery, and the arm out straightened, resting gently on a table so as not to influence the blood pressure reading [45]. The cuff size will be chosen in accordance with recommendations to ensure adequate fit for all participants [45]. The cuff will be inflated until a blood pressure recording appears on the Omron M2 monitor screen, at which point the cuff will deflate. This process will be repeated twice more, allowing the average of the three measures to be taken. Should any of the measures be very different (+/− 5 mmHg) an additional measure will be taken.

To further assess vascular function, non-invasive measurement of pulse wave analysis will be undertaken as an indicator of arterial stiffness [46]. Pulse wave analysis will be assessed using the Vicorder (Skidmore Medical Limited, Bristol, United Kingdom). Participants will be seated and a SC10 Hokanson cuff positioned around their upper left arm. Once the participant has rested for five minutes, the cuff will be gradually inflated according to an inbuilt automated protocol, during which the brachial artery pulse-pressure waveform is recorded. Central augmentation pressure and augmentation index are determined from the waveform using a transfer function integral to the software. This process will be performed a second time, if both measures of augmentation pressure are within ±5 mmHg of each other and augmentation index are within ±5% the two measures are accepted, if not a third reading is taken and a mean of all 3 taken.

Adolescents' views (focus groups)

Semi-structured focus groups will consist of 6–8 pupils with boys and girls in separate groups (two focus groups per school). Participants will be asked their opinions regarding what physical activity is, its barriers and what could be done to improve activity in their areas. Intervention schools will discuss the ACTIVE project specifically (See Topic Guides: Appendix one). Baseline focus groups will consist of pupils of randomly selected consented pupils. After this, participants purposively selected from consented pupils to gain a variety of viewpoints from those engaging well with the intervention and those who are not. The focus groups will provide ACTIVE with a greater understanding of the mediating factors that influence teenage physical activity. These will also help provide context to the quantitative measures from baseline to 18 months.

In addition to focus groups with teenagers, focus groups and interviews will be held with stakeholders (e.g. Active Young People Officers from the local council and teachers from intervention schools) to inform the process evaluation of ACTIVE. These will be held at the 6 month, 12 month and 18 months data collection time points.

Analysis

CONSORT guidelines will inform the analysis and presentation of the study [47]. Multilevel regression analyses will test the effect of the intervention on our primary and secondary outcome measures in comparison with the control arm. We will adjust for baseline, 6 month, 12 month and 18 month follow-up scores and baseline characteristics (e.g. sex). Focus groups will be analysed via thematic analysis in order to identify key themes from discussions with pupils involved in the project [48]. Quantitative measures will be linked to the SAIL databank to analyse the impact of physical activity levels on educational attainment and GP visits. COREQ (Consolidated Criteria for Reporting Qualitative Research) will be followed for the qualitative aspects of the research.

This RCT will examine change in the intervention group compared to controls. Findings from the feasibility study showed that sedentary behaviour reduced by 65 min (95% CI: 12.0 to 117.6) from baseline (n = 75). A previous study [49] had an intracluster correlation of fitness scores across 10 schools of 0.16. Therefore, estimating a reduction in sedentary behaviour of 65 min (intervention) and 15 min (control) with a standard deviation of 30 min, and an average cluster size of 150 children per school ICC of 0.16, coefficient of variation of cluster sizes of 0.9, power of 80% and significance of 5% would require 450 children per arm in 3 schools in each arm (6–8 schools in total depending on consent rates).

Fitness improved in the feasibility study in the intervention group by 98 m (95% CI: 19 to 177, children ran 1730 m in 12 min at baseline and 1823.3 m at post intervention). Therefore, estimating improvement in cooper run of 98 m (intervention) and 22 m (control) with average cluster size of 150 children per school and ICC of 0.16 (as above) would require 300 children or 2 schools per cluster (3 schools if consent rate is assumed to be 60%).

Conclusion

ACTIVE is a novel intervention aimed at examining the effect of a multi-component intervention in improving the cardiovascular fitness, arterial physiology and general health, whilst reducing time spent sedentary, in adolescents. Providing insight into the results of the trial, alongside process evaluation can strongly add to the evidence base in this field and can inform future intervention and policy involving teenagers and physical activity.

Appendix 1

INTERVENTION FOCUS GROUP TOPIC GUIDE – PARTICIPANTS – PRE-INTERVENTION.

Activity 1 (5–10 min): What is physical activity? What does it mean to you?

(Ask pupils to discuss/write down what the term means to them).

How active should people your age be? (60 min recommended per day).

Question 1: How active do you think people in your year are? Do you think you are as active as you can be?

Activity 2 (5–10 min): What do you see as the current barriers to physical activity? How do you feel about your current levels?

(Give post-it notes and ask pupils to list 5–6 barriers to activity. Then rank these barriers in order of most common barriers and discuss the reasoning for this order).

Question 2: Why do you think people your age like/don't like being active? Is there much to do in your area? If so, how accessible are these activities to your age group?

Question 3: Vouchers are currently accepted by *(refer to list of participants).* What other activities or providers would you like to see included before we start?

Question 4: Having heard the way the scheme is set up; do you think there will be any problems? What do you think we could do about these problems? Do you think we should do things differently?

Question 5: What is the best way of letting everyone in the school know about this scheme? When are the best times for the support worker to be available in the school?

Question 6: Do you have anything else to add about the project?

CONTROL FOCUS GROUP TOPIC GUIDE – PARTICIPANTS – PRE-INTERVENTION.

Activity 1 (5–10 min): What is physical activity? What does it mean to you?

(Flipchart/post-its – ask pupils to discuss/write down what the term means to them).

How active should people your age be? (60 min recommended per day).

Question 1: How active do you think people in your year are? Do you think you are as active as you can be?

Activity 2 (5–10 min): What do you see as the current barriers to physical activity? How do you feel about your current levels?

(Give post-it notes and ask pupils to list 5–6 barriers to activity. Then rank these barriers in order of most common barriers and discuss the reasoning for this order).

Question 2: Why do you think people your age like/don't like being active?

Question 3: Is there much to do in your area? If so, how accessible are these activities to your age group?

Question 4: Are your friends/family active? Does this influence you?

Question 5: What is the best way to get people your age active?

Question 6: Do you have anything else to add?

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Authors' contributions
MJ – Wrote the first draft of the paper and all authors provided critical input and revisions for all further drafts. DC & SB – Designed and carried out feasibility study. DC, MJ, CT & SS - Undertook data collection and data analysis. DC – Wrote accelerometer and cardiovascular measures sections. CT, SB, GS, JH, SA, SM – Co-applicant's for funding. EE – Provided contribution to the grant methods and practical assistance with the Arterial assessment protocol. All authors read and approved the final manuscript.

Ethics approval and consent to participate
The College of Human and Health Science Ethics Committee at the College of Medicine, Swansea University granted ACTIVE ethical approval on 12/05/2016 (Reference: 090516). Participant consent for primary and secondary outcomes was voluntary and involved parental consent and pupil assent forms.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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Appendix 4 Information sheets, parent and pupil consent forms

PARTICIPANT/PARENT INFORMATION SHEET
(INTERVENTION GROUP)

Dear participant and parent/guardian,

Your school has agreed to take part in a research study involving Year 9 pupils outlined below. Please read this information sheet carefully before deciding whether to take part. If you decide to volunteer we thank you for your participation. If you decide not to take part there will be no disadvantage to you of any kind and we thank you for considering our request.

Aims of the research
To find out whether adolescents engage in more physical activity if they are given vouchers to fund activities of their choice and have peer mentors to promote and advocate for the importance of physical activity.

What will happen if you decide to volunteer?
You will be given activity vouchers (£20 every month for a period of 12 months). You can only use the vouchers to fund physical activity. For example, you might want to use them for a gym membership for 12 months, to hire an instructor to come into school to teach you and your friends Zumba classes, to buy sports equipment, to have surf lessons, or to attend the skateboard park in Swansea. You can only use these vouchers for exercise and sport; they can only be used by you (you won't be able to give them to anyone else).

We want to know if a voucher scheme like this helps you to be more active. For us to know whether it has made a difference to your exercise habits, you will be asked to complete a fitness test *before* you start using your activity vouchers, *during* the vouchers (6 months) and *after* you have finished using the vouchers. During this session you will complete the cooper run test as part of your usual P.E. lesson (with others in your class) in the school sports hall. This is a test that you are familiar with and involves running around a large circuit to see how much distance you can cover within 12 minutes. You will be encouraged to keep running as long as possible, but you can walk if you get too tired to keep running. You will also be asked to complete a questionnaire that tells us how active you usually are. This will take approximately 15 minutes to complete.

A number of you will also wear accelerometers (watches that tell us how active you are) for seven days and will have your blood pressure and heart rate measured. Some of you will be asked to wear a blood pressure cuff to measure how well your blood circulates through your body via an in-built ultrasound machine. The blood pressure reading will take around 10 minutes and will be done when trained researchers visit the school to carry out fitness measures (before, during and after you finish using the vouchers).

For those of you who want to be involved in group interviews, some of you may be selected at random by researchers to participate in a group discussion with 5 other people (these will be held in the school). This can help us design the ACTIVE study and also tell us how you think it went at the end. There will also be a chance for some pupils to be trained to produce videos for the public to explain the barriers teenagers face with physical activity.

What type of participants do we want?
We want all Year 9 pupils to participate in this study.

What are the risks of participating in the study?
The risks of participating in the study are minimal and this project has been approved by the University Research Ethics Committee (a group of people at the University who decide whether the project is okay to do). The fitness test will be familiar to you but you will feel tired if you have completed the test properly.

Benefits to the participant
You will be given activity vouchers (£20 every month for a period of 12 months). Remember, these vouchers can be used to fund physical activity only. There may also be opportunities for you to gain experience and skills which can help you in getting jobs in the future through receiving training on media production and peer mentoring and advocacy.

What will happen to the information collected?
All the information collected during the ACTIVE Study will be held safely at the University and will only be seen by relevant University staff (Dr Danielle Christian, Charlotte Todd and other members of the research team). If you agree, we will also look into other records such as your exam results and information from your doctor. All linked data can only be looked at by group (for example, whether the group of children who used more vouchers had better health compared to the group who used fewer). Your name will be changed to a number to make sure you cannot be recognised when we analyse the data and all data will be kept on password protected computers in secure offices. Results from the ACTIVE Study may be published but the information included will in no way be able to be linked to any pupil.

What next?
Questions are always welcome at any time. If you should have any questions about the ACTIVE Study then please contact us (details given at bottom of the page). If you would like to participate in the study then the attached forms need to be signed by both you (the participant) and your parent/guardian and returned to the main office.

Michaela James
[redacted]

THANK YOU

PARTICIPANT INFORMATION SHEET (CONTROL GROUP)

Dear participant and parent/guardian,

Your school has agreed to take part in a research study involving Year 9 pupils. Please read this information sheet carefully before deciding whether to take part. If you decide to volunteer we thank you for your participation. If you decide not to take part, there will be no disadvantage to you of any kind and we thank you for considering our request.

Aims of the research

The research is being done to look at ways of improving the physical activity levels, fitness and health of teenagers. In order for researchers to do this, we will need to examine current levels of activity and health at different time points.

What will happen if you decide to volunteer?

If you decide to participate, we will ask you to participate in a number of data collection measures (described below).

As part of the research, you will be asked to complete fitness tests as part of your usual PE lesson. During this session you will complete the cooper run test (with others in your class) in the school sports hall. This is a test that you are familiar with and involves running around a large circuit to see how much distance you can cover within 12 minutes. You will be encouraged to keep running as long as possible, but you can walk if you get too tired to keep running. You will also be asked to complete a questionnaire about physical activity. This will take approximately 15 minutes to complete.

A number of you will also wear accelerometers (watches that tell us how active you are) for seven days and some of you will be asked to have your blood pressure and heart rate measured. This will involve wearing a blood pressure cuff to measure how well your blood circulates through your body and using an in-built ultrasound machine. The blood pressure reading will take around 10 minutes and will be done when trained researchers visit the school to carry out the fitness measures.

Also, for those of you who want to be involved in group interviews, some of you may be selected at random by researchers to participate in a group discussion with 5 other people (held in the school). This can help us understand what physical activity and sports are available in your area and what you feel are the barriers to participating in exercise.

What type of participants do we want?

We want all Year 9 pupils to participate in this study.

What are the risks of participating in the study?

The risks of participating in the study are minimal and this project has been approved by the University Research Ethics Committee (a group of people at the University who decide whether the project is okay to do). The fitness test will be familiar to you but you will feel tired if you have completed the test properly.

Benefits to the participant

The results of this study will benefit teenagers in the area through improving community understanding of teenage needs with regards to physical activity, thus having the potential to improve physical activity and health of large numbers of teenagers.

What will happen to the information collected?
All the information collected during the study will be held safely at the University and will only be seen by relevant University staff (Dr Danielle Christian, Charlotte Todd and other members of the research team). If you agree, we will also look into other records such as your exam results and information from your doctor. All linked data can only be looked at by group (for example, whether the group of children who were more active had better school results or visited the doctor less than the less active group). Your name will be changed to a number to make sure you cannot be recognised when we analyse the data and all data will be kept on password protected computers in secure offices. Results from the ACTIVE Study may be published but the information included will in no way be able to be linked to any pupil.

What next?
Questions are always welcome at any time. If you should have any questions about the ACTIVE Study, then please contact me (details given at bottom of the page). If you would like to participate in the study then the attached forms needs to be signed by both you (the participant) and your parent/guardian and returned to the PE office.

Michaela James
[redacted]

THANK YOU

PARTICIPANT ASSENT FORM (INTERVENTION GROUP)

(To be completed by the participant with the parent/guardian present)

Full name…………………………………………….

Class………………………………………………… ***Date***………………………………

Participant to **circle** as appropriate:

1. Have you read the information sheet? **YES / NO**

2. Has somebody else explained the ACTIVE Study to you? **YES / NO**

3. Do you understand what the ACTIVE Study is about? **YES / NO**

4. Have you asked the questions you want? **YES / NO**

5. Have your questions been answered in a way that you understand? **YES / NO**

6. Do you understand that it's okay to stop taking part at any time? **YES / NO**

If you are <u>happy</u> to take part in the ACTIVE study please complete the following table:

I am happy to take part in:	**Please initial those that apply**
An exercise motivation questionnaire	
A Cooper Run Test as part of P.E. (measures fitness)	
Group interviews	
Wearing an accelerometer (a watch that records activity levels)	
Having my blood pressure measured	
Having my heart health measured via a blood pressure cuff	
Being a peer mentor (speaking to pupils, activity providers and local government about teenagers views on physical activity)	
Volunteering to be part of a group making a short video on physical activity (may appear in presentations or on Youtube)	
Researchers looking at my school exam results and information from my doctors in a way in which I can't be identified	

Please return to the main office within 7 days.

Please check that you have answered **all** questions.

THANK YOU

PARTICIPANT ASSENT FORM (CONTROL GROUP)
(To be completed by the participant with the parent/guardian present)

Full name……………………………………….

Class……………………………………………   ***Date***………………………………

Participant to **circle** as appropriate:

1. Have you read the information sheet?   **YES / NO**

2. Has somebody else explained the ACTIVE Study to you? **YES / NO**

3. Do you understand what the ACTIVE Study is about? **YES / NO**

4. Have you asked the questions you want? **YES / NO**

5. Have your questions been answered in a way that you understand? **YES / NO**

6. Do you understand that it's okay to stop taking part at any time? **YES / NO**

If you are <u>happy</u> to take part in the ACTIVE study please complete the following table:

I am happy to take part in:	**Please initial those that apply**
An exercise motivation questionnaire	
A Cooper Run Test as part of P.E. (measures fitness)	
Group interviews	
Wearing an accelerometer (a watch that records activity levels)	
Having my blood pressure measured	
Having my heart health measured via a blood pressure cuff	
Researchers looking at my school exam results and information from my doctors in a way in which I can't be identified	

Please return to the Head of your P.E. department within 7 days.

Please check that you have answered **all** questions.

THANK YOU

PARENTAL CONSENT FORM (INTERVENTION GROUP)

(To be completed by parent or guardian)

NAME OF CHILD:………………………………………………………..

Please answer the following if you agree to your child taking part in the survey.
For each question circle the appropriate answer.

- Has your child ever suffered from any illness or disease that may affect his or her ability to take part in exercise?

YES / NO

If "YES", please give details…………………………………………………………………….

- Has your child ever complained of chest pain, wheeziness, headaches or dizziness during or after exercise?

YES / NO

If "YES", please give details…………………………………………………………………….

- Are you aware of any complaint (e.g. joint soreness) which may prevent your child taking part in normal exercise?

YES / NO

If "YES", please give details……………………………………………………………………

- Is your child receiving any medication or medical treatment at present?

YES / NO

If "YES", please give details ……………………………………………

- Has your child ever been in hospital?

YES / NO

If "YES", please give details……………………………………………………………………

- Is your child recovering from a viral complaint (such as 'flu') at present?

YES / NO

If "YES", please give details………………………………………………………………………

PLEASE TURN OVER...

If you are happy for your child to take part in the ACTIVE study please complete and return this form to school within 7 days

Please INITIAL boxes below as appropriate

- I **AGREE** to my child …………………………………………..(**name**) taking part in the ACTIVE survey. ☐
- I confirm that I have read and understood the information sheet for the research and have had the opportunity to ask questions. ☐
- I understand that participation is voluntary and that my child is free to withdraw at any time, and without giving a reason. ☐
- I am happy for any data collected in this study to be used in future Health and Education related studies, where data collected will be linked to electronic health and educational records without my child being identified. ☐

If you are happy for your child to take part in the ACTIVE study please complete the following table:

I am happy for my child to take part in:	**Please INITIAL all those that apply**
An exercise motivation questionnaire	
A Cooper Run Test as part of P.E. (measures fitness)	
Group interviews	
Wearing an accelerometer (a watch that records activity levels)	
Having their blood pressure measured	
Having their heart health measured via a blood pressure cuff	
Being a peer mentor (speaking to pupils, activity providers and local government about teenagers views on physical activity)	
Volunteering to be part of a group making a short video on physical activity (may appear in presentations or on Youtube)	

Signature…………………………… (parent)   Signature…………………………..(pupil)

Please return to the main office within 7 days.

Please check that you have answered **all** questions.

THANK YOU

PARENTAL CONSENT FORM (CONTROL GROUP)

(To be completed by parent or guardian)

NAME OF CHILD:

Please answer the following if you agree to your child taking part in the survey.
For each question circle the appropriate answer.

- Has your child ever suffered from any illness or disease that may affect his or her ability to take part in exercise?

YES / NO

If "YES", please give details…………………………………………………………………….

- Has your child ever complained of chest pain, wheeziness, headaches or dizziness during or after exercise?

YES / NO

If "YES", please give details…………………………………………………………………….

- Are you aware of any complaint (e.g. joint soreness) which may prevent your child taking part in normal exercise?

YES / NO

If "YES", please give details……………………………………………………………………

- Is your child receiving any medication or medical treatment at present?

YES / NO

If "YES", please give details ……………………………………………

- Has your child ever been in hospital?

YES / NO

If "YES", please give details……………………………………………………………………

- Is your child recovering from a viral complaint (such as 'flu') at present?

YES / NO

If “YES”, please give details…………………………………………………………………

PLEASE TURN OVER...

If you are happy for your child to take part in the ACTIVE study please complete and return this form to school within 7 days

Please INITIAL boxes below as appropriate

- I **AGREE** to my child …………………………………………..(**name**) taking part in the ACTIVE survey ☐
- I confirm that I have read and understood the information sheet for the research and have had the opportunity to ask questions. ☐
- I understand that participation is voluntary and that my child is free to withdraw at any time, and without giving a reason ☐
- I am happy for any data collected in this study to be used in future Health and Education related studies, where data collected will be linked to electronic health and educational records without my child being identified ☐

If you are happy for your child to take part in the ACTIVE study please complete the following table:

I am happy for my child to take part in:	**Please INITIAL all those that apply**
An exercise motivation questionnaire	
A Cooper Run Test as part of P.E (measures fitness)	
Group interviews	
Wearing an accelerometer (a watch that records activity levels)	
Having their blood pressure measured	
Having their heart health measured via a blood pressure cuff	

Signature…………………………… (parent) **Signature…………………………..(pupil)**

Please return to the Head of your P.E. department within 7 days. Please check that you have answered **all** questions

THANK YOU

Appendix 5 Behavioural Regulation in Exercise Questionnaire (BREQ-2)

EXERCISE REGULATIONS QUESTIONNAIRE (BREQ-2)

Name:________________________________

Age: ___________ years Sex: male female (please circle)

WHY DO YOU ENGAGE IN EXERCISE?

We are interested in the reasons underlying peoples' decisions to engage, or not engage in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about exercise. Your responses will be held in confidence and only used for our research purposes.

		Not true for me		**Sometimes true for me**		**Very true for me**
1	I exercise because other people say I should	0	1	2	3	4
2	I feel guilty when I don't exercise	0	1	2	3	4
3	I value the benefits of exercise	0	1	2	3	4
4	I exercise because it's fun	0	1	2	3	4
5	I don't see why I should have to exercise	0	1	2	3	4
6	I take part in exercise because my friends/family/partner say I should	0	1	2	3	4
7	I feel ashamed when I miss an exercise session	0	1	2	3	4
8	It's important to me to exercise regularly	0	1	2	3	4

Please turn over…

		Not true for me		Sometimes true for me		Very true for me
9	I can't see why I should bother exercising	0	1	2	3	4
10	I enjoy my exercise sessions	0	1	2	3	4
11	I exercise because others will not be pleased with me if I don't	0	1	2	3	4
12	I don't see the point in exercising	0	1	2	3	4
13	I feel like a failure when I haven't exercised in a while	0	1	2	3	4
14	I think it is important to make the effort to exercise regularly	0	1	2	3	4
15	I find exercise a pleasurable activity	0	1	2	3	4
16	I feel under pressure from my friends/family to exercise	0	1	2	3	4
17	I get restless if I don't exercise regularly	0	1	2	3	4
18	I get pleasure and satisfaction from participating in exercise	0	1	2	3	4
19	I think exercising is a waste of time	0	1	2	3	4

THANKYOU

Appendix 6 Topic Guides

FOCUS GROUP TOPIC GUIDE – PARTICIPANTS – PRE-INTERVENTION (ACTIVE)

Focus group rules:

Try to speak one at a time
Listen when others are speaking
Respect each other's views
Anything discussed is confidential and should not be discussed with others not present in this focus group

Focus group equipment:

- Voice recorder (plus chargers/battery)
- Second recorder as back up
- Topic guide
- Flipchart paper/paper
- Post-it notes
- Pens

***Remember to start recorder prior to focus group starting**

Focus group questions:

Activity 1 (5 – 10 mins):	What is physical activity? What does it mean to you? *(Flipchart/post-its – ask pupils to discuss/write down what the term means to them)* How active should people your age be? (60 minutes recommended per day)
Question 1:	How active do you think people in your year are? Do you think you are as active as you can be?
Activity 2 (5 – 10 mins):	What do you see as the current barriers to physical activity? How do you feel about your current levels? *(Give post-it notes and ask pupils to list 5-6 barriers to activity. Then rank these barriers in order of most common barriers and discuss the reasoning for this order)*
Question 2:	Why do you think people your age like/don't like being active? Is there much to do in your area? If so, how accessible are these activities to your age group?
Question 3:	Vouchers are currently accepted by *(refer to list of participants).* What other activities or providers would you like to see included before we start?
Question 4:	Having heard the way the scheme is set up; do you think there will be any problems? What do you think we could do about these problems? Do you think we should do things differently?
Question 5:	What is the best way of letting everyone in the school know about this scheme? When are the best times for the support worker to be available in the school?
Question 6:	Do you have anything else to add about the project?

FOCUS GROUP SUMMARY SHEET- PRE INTERVENTION

Activity 1 - What is physical activity?
Question 1 - How active are you year?
Activity 2 - Current barriers to PA?
Question 2a - Why do people like/don't like PA?
Question 2b - Is there much to do in your area? Accessibility?
Question 3- What other activity providers would you like?
Question 4 – Any problems with the scheme?

Question 5 – What is the best way of letting people know? What time for the support worker?
Question 6 – Anything else to add?
Additional Notes

FOCUS GROUP TOPIC GUIDE – PARTICIPANTS – SIX MONTHS (ACTIVE) INTERVENTION

Focus group rules:

Try to speak one at a time
Listen when others are speaking
Respect each other's views
Anything discussed is confidential and should not be discussed with others not present in this focus group

Focus group equipment:

- Voice recorder (plus chargers/battery)
- Second recorder as back up
- Topic guide
- Flipchart paper/paper
- Post-it notes
- Pens

****Remember to start recorder prior to focus group starting***

Focus group questions:

Activity 1 (5 – 10 mins): What is physical activity? What does it mean to you?
(Flipchart/post-its – ask pupils to discuss/write down what the term means to them)

Question 1: Do you think you are/people in your year are as active as they could be? What are the barriers to physical activity?

Question 2: Is there much to do in your area? If so, how accessible are these activities to your age group?

Activity 2 (5 - 10 mins): How would you improve physical activity for your year? Are there any better ways to use the vouchers?
(Post-its *– ask pupils to discuss/write down ideas.)*

Question 3: Why do you think people your age like/don't like being active?

Question 3: Now that you've had the vouchers…

- What has worked well?
- What hasn't worked well?
- Are vouchers accepted everywhere you wanted them to be?
- How could it be improved?
- Are there any particular groups using them? Why do you think not everyone is using them?

Question 5: Have you found the peer mentors helpful?

- Is there anything else they could do to help you be active?
- Are there any other characteristics you need to be a peer mentor?

Question 6: Have you found the support worker helpful? What could be improved?

Question 7: What would you like to see happen in the next six months?

FOCUS GROUP SUMMARY SHEET- SIX MONTHS - INTERVENTION

Activity 1 - What is physical activity?
Question 1 - Do you think people in your year are active?
Question 2 – Is there much to do in your area? How accessible?
Activity 2 – How would you improve physical activity?
Question 3a – Vouchers – What has worked well/hasn't worked well?
Question 3b – Vouchers – How could it be improved/everyone use them?

Question 4 – How could we improve the scheme?
Question 5 – Have the peer mentors been helpful? What could they do?
Question 6 – What would you like to happen in the next six months?
Additional Notes

FOCUS GROUP TOPIC GUIDE – PARTICIPANTS – SIX MONTHS (ACTIVE)
CONTROL
School Name:

Focus group rules:

Try to speak one at a time
Listen when others are speaking
Respect each other's views
Anything discussed is confidential and should not be discussed with others not present in this focus group

Focus group equipment:

- Voice recorder (plus chargers/battery)
- Second recorder as back up
- Topic guide
- Flipchart paper/paper
- Post-it notes
- Pens

****Remember to start recorder prior to focus group starting***

Focus group questions:

Activity 1 (5 – 10 mins):	What is physical activity? What does it mean to you? *(Flipchart/post-its – ask pupils to discuss/write down what the term means to them)*
Question 1:	Do you think you are/people in your year are as active as they could be? What are the barriers to being active?
Question 2:	Do you think all schools have the same barriers? Are there any differences?
Question 3:	Why do you think people your age like/don't like being active?
Question 4:	Is there much to do in your area? If so, how accessible are these activities to your age group?
Activity 2 (5 - 10 mins):	If you had a pot of money, what would you do to make people more active? *(Post-*its *– ask pupils to discuss/write down ideas. Rank these ideas based on achievability)*
Question 5:	What could help you become more active?
Question 6:	Anything to add?

FOCUS GROUP SUMMARY SHEET- SIX MONTHS - CONTROL

Activity 1 - What is physical activity?
Question 1 - Do you think people in your year are active?
Question 2 – Do you think all schools have the same barriers?
Question 3 – Why do you think people your age like/don’t like being active?
Question 4 – Is there much to do in your area?
Activity 2 – If you had a pot of money, what would do to make people more active?

Question 5 – What would help you become more active?
Question 6 – Anything to add?
Additional Notes

FOCUS GROUP TOPIC GUIDE – PARTICIPANTS – TWELVE MONTHS (ACTIVE) INTERVENTION

Focus group rules:

Try to speak one at a time
Listen when others are speaking
Respect each other's views
Anything discussed is confidential and should not be discussed with others not present in this focus group

Focus group equipment:

- Voice recorder (plus chargers/battery)
- Second recorder as back up
- Topic guide
- Flipchart paper/paper
- Post-it notes
- Pens

****Remember to start recorder prior to focus group starting***

Focus group questions:

Activity 1 (5 – 10 mins):	What is physical activity? What does it mean to you? Has this meaning changed since being a part of ACTIVE? *(Flipchart/post-its – ask pupils to discuss/write down what the term means to them)*
Question 1:	Now that the vouchers have been used for nearly a year, do you think you are/people in your year are as active as they could be? What are the barriers to physical activity?
Question 2:	Is there much to do in your area? If so, how accessible are these activities to your age group?
Question 3:	Do you think your school helps you be more active?
Question 4:	How would you improve physical activity for your year? Are there any better ways to use the vouchers?
Question 5:	Why do you think people your age like/don't like being active? Why do you think people your age have not used the vouchers?
Question 6:	Are there any differences in the ways boys and girls use the vouchers? Why is this? Which group has the vouchers helped more?
Question 7:	Have you found the peer mentors and support worker helpful? • Is there anything else they could do to help you be active? • Are there any other characteristics you need to be a peer mentor?
Question 8:	Would you carry on using the vouchers if you could? What would you like to see happen in your local area to improve your activity/health?
Question 9:	For those of you who have been using the vouchers, do you think you'll continue to be as active when the vouchers are no longer available?

FOCUS GROUP SUMMARY SHEET- TWELVE MONTHS - INTERVENTION

Activity 1 - What is physical activity?
Question 1 - Now that the vouchers have been used for nearly a year, do you think you are/people in your year are as active as they could be?
Question 2 – Is there much to do in your area? How accessible?
Question 3 – Do you think your school helps you be more active?
Question 4 – How would you improve physical activity for your year?
Question 5 – Why do you think people your age like/don't like being active?

Question 6 – Are there any differences in the ways boys and girls use the vouchers?
Question 7 – Have the peer mentors been helpful? What could they do?
Question 8 – Would you carry on using the vouchers if you could?
Question 9 - For those of you who have been using the vouchers, do you think you'll continue to be as active when the vouchers are no longer available?
Additional Comments

FOCUS GROUP TOPIC GUIDE – PARTICIPANTS – TWELVE MONTHS (ACTIVE)
CONTROL
School Name:

Focus group rules:

Try to speak one at a time
Listen when others are speaking
Respect each other's views
Anything discussed is confidential and should not be discussed with others not present in this focus group

Focus group equipment:

- Voice recorder (plus chargers/battery)
- Second recorder as back up
- Topic guide
- Flipchart paper/paper
- Post-it notes
- Pens

****Remember to start recorder prior to focus group starting***

Focus group questions:

Activity 1 (5 – 10 mins):	What is physical activity? What does it mean to you? *(Flipchart/post-its – ask pupils to discuss/write down what the term means to them)*
Question 1:	Do you think you are/people in your year are as active as they could be? What are the barriers to being active? Are these still the same as when we first spoke to you? Has anything changed?
Question 2:	Do you think all schools have the same barriers? Are there any differences?
Question 3:	Do you think your school helps you be active?
Question 4:	Do you think there is any differences between boys and girls? How would you get boys/girls more active?
Question 5:	Is there much to do in your area? If so, how accessible are these activities to your age group? Has anything changed in the last year?
Question 6:	If you had a pot of money, what would you do to make people more active?
Question 7:	What could help you become more active?
Question 8:	Anything to add?

FOCUS GROUP SUMMARY SHEET- TWELVE MONTHS - CONTROL

Activity 1 - What is physical activity?
Question 1 - Do you think people in your year are active?
Question 2 – Do you think all schools have the same barriers?
Question 3 – Why do you think people your age like/don’t like being active?
Question 4 – Is there much to do in your area?
Activity 2 – If you had a pot of money, what would do to make people more active?

Question 5 – What would help you become more active?
Question 6 – Anything to add?
Additional Notes

Appendix 7 Variable List

Name	Description	Source (SAILW435V.[…..])
ALF_E	Anonymised Linking Field - Encrypted	TECC_CHILD (NCCGD + WDS)
WOB	Week of birth (defaults to the previous Monday)	TECC_CHILD (WDS)
GNDR_CD	Gender code (1 = male, 2 = female)	TECC_CHILD (WDS)
BRTH_WGT	Birth Weight (grams)	TECC_CHILD (NCCHD + ADBE)
BRTH_WGT_CAT	Birth weight category	TECC_CHILD (NCCHD)
GEST_AGE	Gestational age (weeks)	TECC_CHILD (NCCHD)
GEST_AGE_CAT	Gestational age category	TECC_CHILD (NCCHD)
HOUSE_MEMBERS_10	Number of household members at the time of tenth birthday	HOUSEHOLD_MEMBERS_CHILD
FLAG_MH_10	Flag-Any household member, age=>16 ,has mental health condition at	HOUSEHOLD_MEMBERS_CHILD

	time of tenth birthday	
FLAG_ALCOHOL_10	Flag-Any household member, age=>16 , drinks Alcohol at time of tenth birthday	HOUSEHOLD_MEMBERS_CHILD
HOUSE_MEMBERS_11	Number of household members at the time of eleventh birthday	HOUSEHOLD_MEMBERS_CHILD
FLAG_ALCOHOL_11	Flag-Any household member, age=>16 , drinks Alcohol at time of eleventh birthday	HOUSEHOLD_MEMBERS_CHILD
FLAG_MH_11	Flag-Any household member, age=>16 ,has mental health condition at time of eleventh birthday	HOUSEHOLD_MEMBERS_CHILD
KS2_EXAM_DATE	Approximate date of KS2 exam ('05-01' +	TECC_DCEL_FINAL_V2

	KS2_YEAR)	
KS2_MATHS	KS2 Maths results	TECC_DCEL_FINAL_V2
KS2_ENG	KS2 English results	TECC_DCEL_FINAL_V2
KS2_SCI	KS2 Science results	TECC_DCEL_FINAL_V2
KS2_CYM	KS2 Welsh results	TECC_DCEL_FINAL_V2
KS2_SEN_FLAG	Special Education Needs flag	TECC_DCEL_FINAL_V2
KS2_SEN_TYPE	Special Education Needs type	TECC_DCEL_FINAL_V2
FREE_SCH_MEAL	Free School Meal	TECC_DCEL_FINAL_V2
FREE_MILK	Free School Milk	TECC_DCEL_FINAL_V2
SESSIONS_POSSIBLE	Total sessions possible	TECC_DCEL_FINAL_V2
ABS_TOTAL	Total absences at KS2	TECC_DCEL_FINAL_V2
ABS_AUTHORISED	Total authorised absences at KS2	TECC_DCEL_FINAL_V2
ABD_UNAUTHORISED	Total unathorised absences at KS2	TECC_DCEL_FINAL_V2
ATTENDANCE	Total sessions	TECC_DCEL_FINAL_V2

	attended at KS2	
ADHD_DATE	Date of ADHD event	ADHD_GP ADHD_DRUGS_GP
ASTHMA_DATE	Date of Asthma event	QOF_ASTHMA_GP ASTHMAMEDICATION_GP
CD_DATE	Date of Conduct Disorder event	CONDUCT_DISORDER_GP
DIABETES_DATE	Date of Diabetes event	DIABETES_GP
EPILEPSY_DATE	Date of Epilepsy event	EPILEPSY_GP EPILEPSY_PEDW
ANXIETY_DATE	Date of Anxiety event	MENTALHEALTH_GP MENTALHEALTH_PEDW
DEPRESSION_DATE	Date of depression event	MENTALHEALTH_GP MENTALHEALTH_PEDW
ED_DATE	Date of eating disorder event	MENTALHEALTH_GP MENTALHEALTH_PEDW
SH_INTENTIONAL_DATE	Date of intentional self-harm event	MENTALHEALTH_PEDW
SH_UNDETERMINED_DATE	Date of undetermined self-harm event	MENTALHEALTH_PEDW
MH_OTHER_DATE	Date of other mental	MENTALHEALTH_GP

	health issue event	
ADHD_FLAG	ADHD flag	PREP_RG_Edu_attainment_ADHD
ASTHMA_FLAG	Asthma flag	PREP_RG_Edu_attainment_ASTHMA
CONDUCT_FLAG	Conduct disorder flag	PREP_RG_Edu_attainment_CONDUCT
DIABETES_FLAG	Diabetes flag	PREP_RG_Edu_attainment_DIABETES
EPILEPSY_FLAG	Epilepsy flag	PREP_RG_Edu_attainment_EPILEPSY
ANXIETY_FLAG	Anxiety flag	PREP_RG_Edu_attainment_MENTAL
DEPRESSION_FLAG	Depression flag	PREP_RG_Edu_attainment_MENTAL
EATING_FLAG	Eating disorder flag	PREP_RG_Edu_attainment_MENTAL
SH_INTENTIAL_FLAG	Intentional self-harm flag	PREP_RG_Edu_attainment_MENTAL
SH_UNDETERMINED_FLAG	Undetermined self-harm flag	PREP_RG_Edu_attainment_MENTAL
MH_OTHER_FLAG	Other mental health flag	PREP_RG_Edu_attainment_MENTAL

Exclusion Criteria – Cleaning

TECC_CHILD DATA

- ALF_E
- WOB
- GNDR_CD
- BRTH_WGT
    - Range: -600 – 7000

- BRTH_WGT_CAT
- GEST_AGE
    - Range: 2 – 50
    - Clean range: 16 – 43
- GEST_AGE_CAT

HOUSEHOLD_MEMBERS DATA

- HOUSE_MEMBERS_10
    - Range: 1 – 336
    - Clean range: 1 – 10
- FLAG_MH_10
- FLAG_ALCOHOL_10
- HOUSE_MEMBERS_11
    - Range: 1 – 215
    - Clean range: 1 – 10
- FLAG_ALCOHOL_11
- FLAG_MH_11

EDUCATION DATA

- KS2_EXAM_DATE
- KS2_MATHS
    - Range: 0 – 8
- KS2_ENGLISH
    - Range: 0 – 7
- KS2_SCI
    - Range: 0 – 6
- KS2_CYM
    - Range: 0 – 6
- KS2_SEN_FLAG
- KS2_SEN_TYPE

ATTENDANCE DATA

- ABS_TOTAL
    - Range: 0 –
- ABS_AUTHORISED
    - Range: 0 –
- ABS_UNAUTHORISED
    - Range: 0 –
- ATTENDANCE
    - Range: 0 –

GP/PEDW DATA

- ADHD_DATE
- ASTHMA_DATE
- CD_DATE
- DIABETES_DATE
- EPILEPSY_DATE
- ANXIETY_DATE
- DEPRESSION_DATE
- ED_DATE
- SH_INTENTIONAL_DATE
- SH_UNDETERMIND_DATE
- MH_OTHER_DATE
- ADHD_FLAG
- ASTHMA_FLAG
- CONDUCT_FLAG
- DIABETES_FLAG
- EPILEPSY_FLAG
- ANXIETY_FLAG
- DEPRESSION_FLAG
- EATING_FLAG

Appendix 8 Teenage Recommendations To Improve Physical Activity For Their Age Group

BMC Public Health

RESEARCH ARTICLE Open Access

Teenage recommendations to improve physical activity for their age group: a qualitative study

Michaela James[1*], Charlotte Todd[1], Samantha Scott[1], Gareth Stratton[2], Sarah McCoubrey[3], Danielle Christian[4], Julian Halcox[5], Suzanne Audrey[6], Elizabeth Ellins[5], Samantha Anderson[7], Isabel Copp[8] and Sinead Brophy[1]

Abstract

Background: It is recommended that young people should engage in 60 min of moderate-to-vigorous activity (MVPA) a day for health benefits, but few teenagers actually meet this recommendation. Policy-makers play a vital role in designing physical activity initiatives, but they generally do this with little or no input from the intervention recipients. This study explores the recommendations made by teenagers to improve activity provision, uptake and sustainability of physical activity engagement for both themselves and their peers.

Methods: Thirteen focus groups were carried out in seven secondary schools in South Wales, United Kingdom. Participants ($n = 78$) were recruited from a larger mixed-method randomised control trial, which involved the implementation of a voucher scheme to promote physical activity in teenagers (aged 13–14). Thematic analysis was undertaken to identify key issues from the perspective of the teenage participants.

Results: Six key recommendations were identified following analysis of the focus groups: i) Lower/remove the cost of activities without sacrificing the quality, ii) Make physical activity opportunities more locally accessible, iii) Improve the standards of existing facilities, iv) Make activities more specific to teenagers v) Give teenagers a choice of activities/increase variety of activity and vi) Provide activities that teenage girls enjoy (e.g., fun, sociable and not competitive sport). Throughout the focus groups, the increased opportunity to participate in unstructured activity was a key recommendation echoed by both boys and girls in all themes.

Conclusion: There is a disconnect between what is available and what teenagers want to do. Policy-makers and those involved in physical activity delivery (e.g., schools, local council and local activity providers) should include young people in designing interventions and facilities to ensure they are meeting the needs of this age group and providing the right opportunities for teenagers to be active. That is unstructured, local, low cost, fun, sociable opportunities and the right facilities to be active.

Keywords: Physical activity, Recommendations, Teenagers, Barriers

Background

It is recommended that young people should engage in 60 min of moderate-to-vigorous activity (MVPA) a day for health benefits [1], yet many fail to meet this recommendation [2–4]. It is estimated that 80% of teenagers worldwide are not sufficiently active [5]. Physical activity has been found to positively impact on both physical and psychological health [3, 6–10]. The main barriers to being active for teenagers are reported to be cost, accessibility and lack of local facilities [11–17]. Many physical activity interventions have chosen to focus on these to underpin their approaches to activity promotion [3, 11, 18–20]. Policy-makers play a vital role in designing physical activity initiatives but they often have little or no input and feedback from key intervention recipients. This creates a 'policy gap' between professional understandings of young people's health needs and what teenager's actually want from interventions [21].

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Involving target populations in policy-making processes is said to increase legitimacy, justifiability and feasibility over policies designed through more traditional, top-down methods [22]. Initiatives designed in this way are noted to be more responsive to user's needs and improve the quality of their aims [23, 24]. When discussing activity with teenagers, research has shown that there is a difference between current activity provision and what young people actually want and recommend [11, 14, 15]. Therefore, involving teenagers in the design and implementation of physical activity initiatives may be key in influencing the activity uptake of among this age group [25, 26].

The Active Children through Incentive Vouchers – Evaluation (ACTIVE) Project [27] centres upon user involvement, through the provision of physical activity vouchers to all pupils in year nine in four intervention schools. The project gives pupils the choice over access to existing provisions or support in designing their own [11]. The baseline data collection for the project involved focus groups with 13–14 year old pupils in seven schools (four intervention and three control schools). The focus group interviews were conducted to include teenagers in the design of the ACTIVE intervention and give them the opportunity to make their own recommendations to tackle inactivity in young people. The aim of this was to understand the current barriers to physical activity faced by teenagers and understand potential ways in which teenagers feel these barriers could be overcome. The interviews were conducted prior to the ACTIVE intervention, to establish what was missing for teenagers in their local area and what could be done to combat inactivity.

Previous research has focused on adult involvement in the policy making process in clinical settings [21–23, 28, 29]. The recommendations made by teenagers could increase the success of physical activity policies and initiatives and help improve the short and long-term health of young people. This study explores the recommendations made by teenagers to improve activity provision, uptake and sustainability of physical activity engagement for both themselves and their peers. Through doing so, further understanding can be gained of the current barriers, facilitators and motivation [30–32] to being active faced by 13–14 year olds attending secondary schools in deprived areas of Wales.

Methods

Thirteen focus groups were carried out in seven secondary schools in South Wales, United Kingdom. Participants ($n = 78$) were recruited by purposive sampling to ensure a mix of genders from a larger mixed-method randomised control trial, which involved the implementation of a voucher scheme to promote physical activity in teenagers (aged 13–14). Schools were approached to take part due to their: i) location in one of Wales' most deprived areas and ii) location in a Communities First catchment area [33]. Schools were randomly assigned into either the intervention or control arm of the trial.

Focus groups were selected as the preferred methodology due to their distinguishing feature of group interaction, which can encourage in-depth discussion. The groups consisted of 6–8 pupils selected at random. Boys and girls were mainly in separate groups to establish any gender differences in discussions and recommendations in terms of motivation to be active [30] or differences in activity preferences [34, 35]. This was also because of the trend for girls of this age to drop out of physical activity at a higher rate than boys [34] and therefore, separate focus groups could provide into why this is the case. As a result, two focus groups were conducted in each school, except for one school where, due to time constraints, boys and girls were combined to make one focus group.

Focus groups were carried out at the schools during the school day to ensure pupils remained in a comfortable, familiar setting and lasted 30–60 min (the average length was 38.42 min). A lead moderator, previously experienced in leading focus groups, facilitated the focus groups to allow detailed discussion of the teenager's recommendations and gain a better understanding of their needs; improving the quality of ACTIVE's aims [36]. An assistant moderator was also present at each focus group and was responsible for taking notes and audio recording. The assistant moderator was also responsible for reporting back to participants on their main discussions from the focus groups to ensure correct interpretation and understanding and gain clarity over any points discussed, a method of respondent validation [37] and increasing the trustworthiness of the findings. The pupils involved in the focus groups had previously met the moderator/assistant moderator during data collection at the school. To ensure consistency across all focus groups, a semi-structured topic-guide was used, which reflected the study's aims [38]. This can be found as Additional file 1. This was to provide triggers for discussion rather than a prescriptive structure. Once transcribed in verbatim, NVivo 10 was used to manage, code and analyse the data and two researchers validated the themes derived from the data via triangulation [2]. This was done after the coding process. To protect participants identities, names were removed during transcription. Participants were encouraged to review themes in order to validate findings.

Thematic analysis (TA) was undertaken in order to identify, analyse and report patterns within the discussion with the teenage participants without the rigidity and inflexibility of other qualitative analysis methods [39, 40]. This analysis approach was used due to the ability of TA to examine the different perspectives of the participants, as well as its usefulness to summarise key points of a large data set [40] helping to produce a clear conclusion, particularly in this instance where many viewpoints needed to be considered. This is due to TA forcing the researcher to take a well-structured approach to handling data [40].

Braun and Clarke's Phases of Thematic Analysis (2006) [41] was used to underpin the coding process. Once familiarised with the transcripts of the focus groups, initial codes were generated, defined and named accordingly with data collated into the relevant theme. This process was ongoing throughout the analysis phase to refine the specifics of each theme and the overall story the analysis told [41]. The analysis was carried out by two researchers independently who compared coding/themes in order to guarantee no new codes/themes have emerged and there are instances of the same theme to ensure data saturation [42]. This also helped achieve inter-rater reliability. Lincoln and Guba's (1985) criteria for trustworthiness was used to ensure trustworthiness by using an audit trail, method and analyst triangulation [2]. Consolidated criteria for reporting qualitative research (COREQ) guidelines were used to inform the analysis and presentation of this study [43].

Ethical approval

All participants provided written assent and parental consent for participation in focus groups. Participation was voluntary and participants were informed of their right to withdraw from any aspects of the study at any time. The College of Human and Health Science Ethics Committee at the College of Medicine, Swansea University granted the ACTIVE Project ethical approval on 12/05/2016 (Reference: 090516).

Findings

Themes emerged following Braun and Clarke's Phases of Thematic Analysis (2006) [41]. Initially, 17 codes were used across the entire data set with these collated into six key recommendations based on similarities in phrases/words used by participants. This was the point in which data saturation occurred and no new codes emerged when researcher's compared analysis.

The six recommendations to improve physical activity for teenagers were: i) Lower/remove the cost of activities without sacrificing the quality, ii) Make physical activity opportunities more locally accessible, iii) Improve the standards of existing facilities, iv) Make activities more specific to teenagers, v) Give teenagers a choice of activities/increase variety of activity and vi) Provide activities that teenage girls enjoy (key quotes from the focus groups are in Table 1).

Lower/remove of the cost of activities without sacrificing the quality

Teenagers identified reducing the cost of being active as a key recommendation. They suggested that there could be a reduction made to the existing price of activities in order to increase accessibility and sustainability. A boy stated that "...if it was like free and all that you'd see loads of other older kids going to try it out because they know it's free and it's something to do with their friends, and they don't have to spend their own money" (Boy, Focus Group 13). Another girl reiterated this point by saying "…and probably if like the leisure centres dropped their prices, you know, maybe people will think, oh that's cheaper, okay I'll go back" (Girl, Focus Group 6).

One girl explained how she would have to ask for money from her parents in order to access activities and this would make her feel bad, as she knew her parents were reluctant to pay. This would deter her from being active. She said "…I feel bad when I have to go up to my parents and ask them for money, because their face is just like, right, and then you can see them as they pass the money over and they don't like it" (Girl, Focus Group 4). Free activities were recommended as an alternative approach; however, teenagers were aware that there is sometimes a trade-off in quality in exchange for lower priced activities. One boy explained that "…they've got like one indoor pitch which costs a lot to play in, or they've just got outdoor pitches which are, like, really cheap to play but it's, like, really cold. They don't put, like, any lights on" (Boy, Focus Group 9).

If the facilities are without heat or are dirty or unsafe due to low investment this will not encourage activity hence, purely lowering cost, without maintaining the quality of provision would not have the desired effect in enhancing teenage activity levels. One way to tackle this is to offer informal activities in a good quality venue, as these incur less cost to run and attend [16]. This would include offering self-directed gym sessions, unstructured football sessions where teenagers can attend and play without coaching, or provision of any venue where a qualified coach is not required to teach technical movements or referee. This focus on quality of facilities is also re-iterated in the theme pertaining to improving the standards of existing facilities.

Improve local access to physical activity opportunities

Throughout the focus groups, it was evident activities should be made more local to where teenagers lived. Similar to the theme of cost, improving access to activity has repeatedly been expressed as a barrier [3, 11, 14, 15]. Teenagers advocated for closer proximity of facilities,

Table 1 Six Key Recommendations to Improve Teenage Activity

Teenage recommendations
Lower/remove of the cost of activities without sacrificing the quality
"And probably if like the leisure centres dropped their prices, you know, maybe people will think, oh that's cheaper, okay I'll go back." (Girl, Focus Group 6)
"What they could do is like get like something in a park… if they say it's like a free thing they would all just like come in and do it, instead of… if they say it's like £3 to come in they'd be like oh okay, bye." (Boy, Focus Group 13)
"...if it was like free and all that you'd see loads of other older kids going to try it out because they know it's free and it's something to do with their friends, and they don't have to spend their own money." (Boy, Focus Group 13)
"…they've got like one indoor pitch which costs a lot to play in, or they've just got outdoor pitches which are, like, really cheap to play but it's, like, really cold. They don't put, like, any lights on." (Boy, Focus Group 9)
"…I feel bad when I have to go up to my parents and ask them for money, because their face is just like, right, and then you can see them as they pass the money over and they don't like it." (Girl, Focus Group 4)
Improving the locality of physical activity opportunities
"Well I would say bring more facilities, bring more stuff so then like more football pitches, basketball pitches, like more stuff so they're going to want to go outside." (Boy, Focus Group 5)
"Just like a little gym, in the park or something, 'cos I would go then 'cos it's like really close." (Girl, Focus Group 6)
"So there's the travel, but if it was, like, in your community, then it wouldn't be so bad." (Girl, Focus Group 10)
"They could spend more money and invest in putting buildings in that area where they could put, for example, badminton, tennis, football, rugby" (Girl, Focus Group 8)
Improving the standards of existing facilities
"Like we said, like, fix the parks and stuff like that." (Girl, Focus Group 10)
"I think they could like, well not even like every year, like every other year they could go round to each park and renew all the apparatus." (Boy, Focus Group 5)
"And in the gym there's umm a few of the machines are broke, you could pay to get them fixed or like help get new ones and stuff like that." (Boy, Focus Group 7)
"They need to make the environment better." (Girl, Focus Group 10)
"But why don't they invest in building more things down there for our age because I, you walk through there and you mostly see glass bottles on the floor, on benches and…" (Boy, Focus Group 9)
"Yeah, council investing in, like, one-way systems and everything and they're wasting money on build, on making these one-way systems and everything when they could be looking at our age and start investing in buildings that we can go to and enjoy ourselves after school." (Boy, Focus Group 9)
Make activties more specific to teenagers
"And they always do adult things, like they never really aim at anything for teenagers, like people our age." (Girl, Focus Group 6)
"Yeah, the government is complaining saying that we're getting like, there's like less people being fit but there's not really more facilities and stuff for like teenagers." (Girl, Focus Group 6)
"No, and like I just think they should put more activities out for younger people, like…" (Girl, Focus Group 6)

Table 1 Six Key Recommendations to Improve Teenage Activity *(Continued)*

"For our age group and under 16's, not so much adults…" (Boy, Focus Group 7)
Give teenagers a choice and variety of activities
"There's like clubs on, it's the exact same every single time you go." (Girl, Focus Group 2)
"…they should give you a sheet at the beginning of the year and then choose which ones you want to do and then they go with the majority…" (Girl, Focus Group 12)
"Rather than doing the same thing, like football, hockey, you know…" (Girl, Focus Group 4)
"Yeah, but they could take us out of our PSE when we have it and then maybe at dinner times?"(Boy, Focus Group 1)
"Yeah I think it's as much quantity as it is quality." (Boy, Focus Group 13)
Provide activities that teenage girls can enjoy
"If I don't like it, I won't do it."(Girl, Focus Group 10)
"You could hold like a football game but then for the people who like football and then for the people who like cheerleading they could let them cheerlead, or people who like dancing and things you could just hold a massive event of sports and have people performing." (Girl, Focus Group 12)
"Make sure, like get their friends to do it as well, so then their friends can encourage them, like oh I'm going to go there, oh come with me, be like oh okay. Ask them." (Girl, Focus Group 12)
"Yeah, just ask them if they want to go swimming, like say it's a normal thing, 'cos nobody would think of swimming as like an active thing isn't it, just for fun" (Girl, Focus Group 6)

commenting that they would be more inclined to access activities that are closer to their homes. One boy said, "I would say bring more facilities, bring more stuff so then like more football pitches, basketball pitches, like more stuff so they're going to want to go outside" (Boy, Focus Group 5). A girl noted that the proximity of "…a little gym, in the park or something" would help her be active "…'cos it's like really close" (Girl, Focus Group 6). This was particularly relevant to outdoor spaces like pitches and parks. Teenagers suggested that they need to travel to be able to play outdoors, and this would incur an additional cost.

Removing the need for travel to venues, would go some way to making physical activity more accessible to these teenagers. Both boys and girls provided examples of specific equipment and/or facilities to increase physical activity such as more local *"football pitches, basketball hoops"* and *"little gyms in the park"*. It was apparent in the focus groups that both teenage boys and girls were happy to organise their own activity if provided with the facilities, as they did not mention the need for formal coaching in these activities. This suggests teenagers would like the increased opportunity and space to participate in unstructured, non-competitive forms of their favourite sports.

Improving the standards of existing facilities

When teenagers discussed their local facilities, they noted their current standards are in need of improvement. This was due to facilities, such as parks, falling into states of neglect and equipment being broken. This conversation focussed on local parks but also extended to discuss gym equipment and the aesthetic features of facilities (e.g., lighting). There were small differences in the way in which boys and girls felt this maintenance could be done. Boys recommended buying new equipment to replace the old, while girls discussed improving what is already there for example, one girl said, "Like we said, like, fix the parks and stuff like that" (Girl, Focus Group 10). One boy stated, "I think they could like, well not even like every year, like every other year they could go round to each park and renew all the apparatus" (Boy, Focus Group 5). Another boy noted the ways in which the council has been investing in other provisions that he did not feel was important, he said, "…yeah, council investing in, like, one-way systems and everything and they're wasting money on build, on making these one-way systems and everything when they could be looking at our age and start investing in buildings that we can go to and enjoy ourselves after school" (Boy, Focus Group 9). It was apparent among focus groups with both genders that local facilities are lacking. The council's control of local provision was frustrating for teenagers because they felt more should be invested to maintain the environment and improve local facilities. It was evident that what is already in the community is not appealing to teenagers due to lack of general maintenance.

By improving and updating local activity provision, teenagers say they are more likely to access them. Their recommendations propose that the local council need to be more proactive in their monitoring and upkeep of facilities. There was a mutual feeling among boys and girls that the local council is avoiding investing in teenagers and have chosen to invest in other developments, such as road maintenance, which teenagers do not value. This point also draws out the need for activities and facilities invested in to be useable and appealing to teenagers and relates strongly to the next theme of ensuring activities provided are specific to teenagers.

Make activities more specific to teenagers

Both girls and boys commented on making activities more age-relevant. Girls in one focus group discussed the ways in which activity provision does not target their age group and wanted more *"encouragement"* or to clearly be included and invited. There is very little that specifically invites teenagers or promotes and provides where they feel it is for them. One girl stated "…they always do adult things, like they never really aim at anything for teenagers, like people our age" (Girl, Focus Group 6). Another boy echoed this by saying he wanted to see more activity provision for "…our age group and under 16's, not so much adults…" (Boy, Focus Group 7).

The provisions suggested by these teenagers included whole gyms designed for their age group and the ability to be able to attend existing classes for example, currently, there are age restrictions on classes like Zumba and Yoga. The teenagers believed the local council has neglected their age group, one girl said "…yeah, the government is complaining saying that we're getting like, there's like less people being fit but there's not really more facilities and stuff for like teenagers" (Girl, Focus Group 6). Boys also acknowledged the lack of provision for their age group, noting that that most provision is aimed at adults.

Give teenagers a choice and variety of activities

Teenagers in most of the focus groups recommended that they have a choice over which activities are available for their age group. In terms of local community provision, they wanted *"quantity as well as quality"*, allowing them to access a broad variety of activities. The focus groups made it evident that local activity provision is lacking in variety and teenagers do not get a choice as to what activities they would like to do. One girl said that "there's like clubs on, it's the exact same every single time you go" (Girl, Focus Group 2). While another girl requested that activity provision should be varied "rather than doing the same thing, like football, hockey, you know…" (Girl, Focus Group 4). Like the "improving locality of physical activity" theme, the activities suggested to provide variety were unstructured. For example, one participant suggested they would like more choice to be able to play non-conventional sports like dodgeball in an unstructured format, where they could organise teams and rules themselves.

This lack of choice and variety was evident in the school setting too. The girls discussed this lack of choice in detail, suggesting they were more disengaged with school sport than the boys were. Girls discussed how inflexible Physical Education (PE) lessons were to providing variety and suggested giving each pupil a sheet at the beginning of the year with which they could suggest/pick activities they would like to do. They noted that schools provide traditional, structured forms of sport, whereas they would prefer more unstructured activities. One girl suggested that "…they should give you a sheet at the beginning of the year and then choose which ones you want to do and then they go with the majority…" (Girl, Focus Group 12).

The boys discussed being able to have the ability to choose when they could be active, for example, being able to come out of other lessons to do so. For the boys, it was more of a case of being able to choose to do more activity rather than being discontent with the activity already on offer.

Provide activities that teenage girls can enjoy

It was apparent when discussing types of activity, that teenage girls are more likely to be active if they can access activities they enjoy. It was evident that if they do not like what is on offer, they will not participate in it and would prefer to be inactive. One girl said "if I don't like it, I won't do it" (Girl, Focus Group 10). The idea of being able to enjoy activity was prominent amongst the girls in the focus groups and a greater emphasis was placed on the enjoyment aspect of activity among girls throughout discussions. It was important for girls that the purpose of the activity was not to 'be active' per se, rather they preferred the emphasis to be on the opportunity for them to have fun. The examples of activities that fit this criteria were the local waterpark (with slides and wave machines) and a trampoline park because *"it's fun,"* yet still gets teens active. One focus group also suggested the idea of a girl's only gym in which girls could be the only ones allowed to access it which would make the experience more enjoyable as being red and sweaty in front of boys was described as a barrier.

Inclusivity was a big part of this theme as girls suggested that everyone has a role to play in activities. These different roles included unstructured forms of activity such as cheerleading for school sports teams, which could be led and organised by teenagers. One example of how this could be done was suggested by a girl who said, "You could hold like a football game but then for the people who like football and then for the people who like cheerleading they could let them cheerlead, or people who like dancing and things you could just hold a massive event of sports and have people performing" (Girl, Focus Group 12). Inclusive activities would also mean peers could be active together allowing more time to spend with friends and facilitate social networks, which was appealing for teenagers [13].

Discussion

This study aimed to explore the recommendations made by teenagers to improve activity provision, uptake and sustainability of physical activity engagement for both themselves and their peers. The focus groups identified six key themes that would be important to consider in order to improve the success of physical activity policies and initiatives for young people. The study suggests that cost, accessibility and lack of local facilities are perceived by teenagers to be barriers to physical activity as confirmed in other research publications [11–17]. Previous studies have found short-term improvement to physical activity levels when purely addressing the barriers to being active, [19], particularly in the school setting [3, 11, 20]. However, the repeated acknowledgment of these barriers in this study suggests that despite a number of initiatives implemented to tackle these obstacles, the issue has not been adequately addressed long-term.

Throughout the focus groups, the increased opportunity to participate in unstructured activity was a key recommendation echoed by both boys and girls in all themes. This is noteworthy as previous interventions have offered structured activity such as coached dance lessons to combat inactivity, however these have only seen short-term improvements to physical activity and do not show evidence of sustainability [3]. There was no mention of coaches, teams or leagues but there was a universal agreement that activity should allow teenagers the opportunity to enjoy and choose what they would like to do with their friends.

It was clear from this study that current activity provision is not meeting the wants and needs of young people. Teenagers feel frustrated, not encouraged and disengaged with local physical activity provision. This lack of choice means teenagers are bored and disengaged with their local provision as there is difference between what is offered and what teenagers would like to do [24]. For example, teenagers suggested they wanted access to nice facilities for little to no cost and no oversight therefore it could be an idea to increase the accessibility to leisure centres or improve the facilities in local parks so that teenagers can go to the gym or play football with their friends in pleasant environments. This could be as simple as the local council organising an evening where teenagers can use their gyms for free or at a reduced rate. Teenagers would feel valued and allow them to have more choice in what they can do in their local areas.

Involving teenagers in the design and implementation of physical activity initiatives in this way is imperative in empowering teenagers to positively influence their activity levels. Therefore, acknowledging and gaining a better understanding of teenagers' own recommendations and needs would increase the legitimacy and feasibility of activity interventions as agreed with by previous literature involving the public in designing public health initiatives [21, 22]. The recommendations highlight the importance of relevance, choice and motivation for teenagers. Motivation, in particular, is an important correlate and determinant of physical activity [31]. The importance of acknowledging the different types of motivation to be active cannot be understated as this would help policymakers understand why teenagers choose to be active and tailor initiatives to suit motivations. Self-Determination Theory (SDT) [44] has emerged as a popular framework for examining motivation and physical activity [31] as it differentiates between controlled motivation (e.g., regulated by external control or guilt) and autonomous motivation (e.g., regulated by enjoyment and personal values) [30]. The recommendations made suggest teenagers are motivated autonomously due to their focus on enjoyment and personal values of spending money, for example. This is positively related to sustained health behaviours [31]. Therefore, by addressing autonomous motivation, policy-makers are more likely to promote physical activity behaviours that would be valued and sustained by young people. Consequently, addressing accessibility, specificity of activity, choice and enjoyment is paramount to improving teenage activity levels.

During the focus group discussions, there were a few subtle gender differences to emerge. For example, girls placed more emphasis on the enjoyment aspect of activity and the need to be active with friends. Girls also seemed to be more disengaged with school PE than boys, something that has been acknowledged by previous initiatives [10, 17]. More girls are believed to have negative experiences in PE that lower interest and involvement in physical activity in their leisure time [45]. These findings suggest that a focus on reviewing physical activity provision for girls in secondary schools may go some way towards addressing girls' physical activity levels (e.g., allowing them a choice of activities to choose from). This is particularly important as declines in physical activity levels amongst girls are greater than in boys [34]. Gender differences have been acknowledged in physical activity interventions, however they have either been unsuccessful or positive outcomes have been short-lived [3, 34, 46]. This may be due to not considering what motivates teenage girls. For example, implementing a school-based intervention with dance as the activity will not be successful if girls do not enjoy dance. Hence, while certain aspects of physical activity interventions may need to be tailored to specific genders (e.g., greater emphasis on selling the enjoyment and socialisation aspect of the intervention for girls), the overall core components need not differ. Focusing on reducing cost, improving locality and standards of physical activity facilities, lowering age limits on activities and providing choice and variety is likely to enhance participation for both boys and girls in this age group.

Limitations

Whilst the use of focus groups enabled a more in-depth exploration of teenager's barriers to physical activity, the focus groups were conducted with a limited age range and only those children consenting to take part in the study were able to be involved in the focus groups. These children could potentially be the more active and involved children, perhaps not capturing the views of those less engaged with activity and health. Furthermore, the focus groups were conducted with a limited age-range of teenagers (aged 13–14 years old), this means the recommendations made by teenagers aged 15 years old and upwards have not been included and may differ. One focus group was conducted with both boys and girls together, which may also have affected the recommendations made from this particular focus group.

Conclusion

Teenagers believe current physical activity provisions should be low cost, should be local, are in need of improvement, should be specific to their age, need more choice/variety and need to include activities that they enjoy. Based on the recommendations made by teenagers in this paper, physical activity interventions could be influenced and designed more effectively. For example, the six recommendations could be used as a guide for future activity regarding activity levels in young people. In particular, interventions need to consider the motivations of teenagers in reference to Self-Determination Theory [44] as a guiding principle in their development. They should consider whether the group they are targeting are motivated in a controlled or autonomous manner in order to be more effective. Therefore, a consultation phase, could go a long way to improving physical activity in certain groups. As previously mentioned, involving target populations in policy-making processes is said to increase legitimacy, justifiability and feasibility over policies made through more traditional, top-down methods [22].

Throughout the focus groups and spanning across all themes, the increased opportunity to participate in unstructured activity was echoed by both boys and girls in all themes. There was no mention of coaches, instructors, teams or leagues. However, there was a universal agreement that activity should allow teenagers the opportunity to enjoy and choose what they would like to do with their friends. Key examples of this were accessing the local trampoline and water park. In these environments, teenagers can organise their own activity and define their own teams and rules. Therefore, if allocated the correct facilities, resources and opportunities, teenagers believe they would be more active.

Policy-makers and those involved in physical activity delivery (e.g., schools, local council and local activity providers) should include young people in designing interventions and facilities to ensure they are meeting the needs of this age group and providing the right opportunities for teenagers to be active. By acknowledging the recommendations made in this paper, physical activity initiatives can improve uptake, sustainability and overall success of future projects. The ACTIVE Project [27] will use these recommendations to underpin its delivery of a physical activity intervention for young people in Wales focusing upon user involvement in its design and implementation.

Additional file

Additional file 1: ACTIVE Focus Group Topic Guide PUBH-D-17-02284R2. ACTIVE Focus Group Questions The topic guides for the ACTIVE focus groups for both intervention and control schools. (DOCX 14 kb)

Abbreviations
ACTIVE: Active Children Through Individual VouchersEvaluation; COREQ: Consolidated criteria for reporting qualitative research; MVPA: Moderate to vigorous physical activity; PE: Physical education; SDT: Self-determination theory; TA: Thematic analysis

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Authors' contributions
MJ – Wrote the first draft of the paper and all authors provided critical input and revisions for all further drafts. DC, MJ, CT & SS - Undertook data collection and data analysis. CT, SB, GS, JH, SAudrey, SM, EE – Designed the study, aided in interpretation of findings and supervision of study quality. SAnderson – Teacher from one of the intervention schools provided critical input and comments. IC – Pupil from one of the intervention schools provided critical input and comments. All authors read and approved the final manuscript.

Ethics approval and consent to participate
The College of Human and Health Science Ethics Committee at the College of Medicine, Swansea University granted ACTIVE ethical approval on 12/05/2016 (Reference: 090516). Participant consent for primary and secondary outcomes was voluntary and involved parental consent and pupil assent forms.

Consent for publication
Consent has been obtained to publish from the participant's legal parent or guardian to report individual patient data.

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The authors declare that they have no competing interests.

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Appendix 9 Recruitment of Activity Providers

INITIAL RECRUITMENT - A RESULT OF RESEARCHER SEARCH OF LOCAL AREA AND BASELINE FOCUS GROUPS
Provider
Watersports Centre*
Bike Hire Company
Circus Skills
Outdoor Recreation Centre*
Rock Climbing
Local Football Clubs
Skatepark
Surfing Company
Gymnastics Centre
Laser Tag
Local Rugby Clubs
Trampoline Park 1
Local Equipment Distributor*
Coasteering Group
Local Netball Clubs
Leisure Centre/Waterpark*
Martial Arts Company
Swimming Pool*

ONGOING RECRUIMENT – RECRUITED AS A RESULT OF RECOMMENDATIONS FROM PARTICPANTS AND PROVIDER ENGAGEMENT
Provider
Trampoline Park 2
FootGolf Course
Premiership Football Club Community Coaches (For Supervision of Lunchtime Clubs – Not Formal Coaching)
Boxing Club
Kickboxing Club
Dance Coach
Parkour Coaches
Sports Complex*
All Local Authority Community Leisure Centres (Including Swimming Pools)*
Football Pitch Hire Company
Tennis Centre
Various Equipment Providers (Extending To Use of Amazon)*

*Indicates provider offering more than one activity on-site.

Appendix 10 Active Children Through Individual Vouchers Evaluation: A Mixed Method RCT

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Preventive Medicine

RESEARCH ARTICLE

Active Children Through Individual Vouchers Evaluation: A Mixed-Method RCT

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Introduction: Physical activity declines in adolescence, especially among those in deprived areas. Research suggests this may result from accessibility barriers (e.g., cost and locality). The Active Children Through Individual Vouchers Evaluation RCT aimed to improve the fitness and heart health of teenagers in Wales with the help of teenagers who co-produced the study.

Study design: This study was a mixed-method RCT.

Setting/participants: Before data collection, which took place at baseline, 6 months, and 12 months for both arms, 7 schools were randomized by an external statistician (4 intervention schools, n=524; 3 control schools, n=385).

Intervention: The Active Children Through Individual Vouchers Evaluation intervention included provision of activity vouchers (£20 per month), a peer mentoring scheme, and support worker engagement for 12 months between January and December 2017. Data analysis occurred February−April 2018.

Main outcome measures: Data included measures of cardiovascular fitness, cardiovascular health (blood pressure and pulse wave analysis), motivation, and focus groups.

Results: The intervention showed a trend to improve the distance ran (primary outcome) and was significant in improving the likelihood of intervention teenagers being fit (OR=1.21, 95% CI=1.07, 1.38, p=0.002). There was a reduction in teenagers classified as having high blood pressure (secondary outcome) in the intervention group (baseline, 5.3% [28/524]; 12 months, 2.7% [14/524]). Data on where teenagers used vouchers and evidence from focus groups showed that teenagers wanted to access more unstructured, informal, and social activities in their local areas.

Conclusions: Active Children Through Individual Vouchers Evaluation identified methods that may have a positive impact on cardiovascular fitness, cardiovascular health, and perspectives of activity. Consulting with teenagers, empowering them, and providing more local opportunities for them to take part in activities that are fun, unstructured, and social could positively impact teenage physical activity.

Trial registration: ISRCTN, ISRCTN75594310.

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INTRODUCTION

Being physically active in adolescence is associated with health benefits, including a decreased risk of noncommunicable diseases, such as coronary heart disease and type 2 diabetes,[1,2] as well as increased well-being and self-esteem.[3,4] Coronary heart disease currently affects more than 7 million people in the United Kingdom.[5] Therefore, the physical activity (PA) of teenagers is of public health concern.[6] Public health guidelines recommend 60 minutes of moderate-to-vigorous PA daily.[2] However, it is reported that only 11% of girls and 20% of boys are sufficiently active in Wales.[7]

Secondary school has been identified as a key period of change in teenagers' PA behaviors[3] and is an important setting for promoting PA.[8] Behaviors adopted during this time are likely to be continued in adulthood.[9] Teenagers report the main barrier to meeting PA recommendations is accessibility to PA opportunities.[4,10,11] Accessibility is affected by cost, lack of local facilities, and motivation among teenagers,[10,12] especially those from disadvantaged backgrounds.[13]

Self-determination theory (SDT)[14] has emerged as a popular framework for examining motivation and PA[15] as it differentiates between controlled motivation (e.g., regulated by external pressure or guilt) and autonomous motivation (e.g., regulated by enjoyment).[15] SDT explains why people engage with, adopt, and maintain PA behaviors.[16]

To overcome accessibility barriers, voucher-based interventions to increase PA in the United Kingdom have been tested previously among adults.[17,18] Financial incentives have been effective in increasing PA in adults,[19−21] but it remains uncertain whether a similar approach could work with teenagers.[22] A mixed-method feasibility study of vouchers has been carried out in 1 school with high levels of deprivation. The vouchers were used to empower teenagers to be consumers and enabled access to activities they normally could not afford.[10] The teenagers chose to do unstructured, social activities in their local communities. Additional qualitative work identified a disconnect between what teenagers wanted to do and what was available.[11] This approach was supported by teachers and teenagers who encouraged the development of a larger trial.

The Active Children Through Individual Vouchers Evaluation (ACTIVE) mixed-method RCT[22] was developed following the feasibility study and subsequent conversations with teenagers recommending what they felt was needed to improve PA opportunities and fitness.[4] This RCT aimed to assess whether a voucher-based, 12-month, multicomponent intervention can improve the cardiovascular fitness and cardiovascular health of participating teenagers in 4 intervention (compared with 3 control) secondary schools in South Wales.

METHODS

Study Population

The ACTIVE RCT was based in secondary schools in South Wales, United Kingdom. All teenagers in Year 9 (aged 13−14 years) were eligible to take part in the study with headteachers granting permission for schools to take part. Randomization occurred before baseline data collection into either intervention or control, with 4 schools assigned to the intervention and 3 schools to the control arm. Control schools were encouraged to continue usual practice and received a mindfulness-based stress reduction course for staff as a thank you for their participation. Schools were not blinded. A detailed protocol has been published.[22] The College of Human and Health Science Ethics Committee granted ACTIVE ethical approval (reference: 090516).

The RCT was co-produced by teenagers, which allowed some flexibility as teenagers were able to choose how they used their vouchers. SDT was used in the planning of the intervention to understand the reasons teenagers would be likely to engage with the PA provision promoted by the project. Given the empowering nature of the intervention, autonomous motivation was facilitated, giving teenagers a choice rather than being prescriptive. Prescription would be considered controlled motivation. The latter approach has been used in previous studies with mixed, short-term success.[19,23] There were no changes to the methods from the protocol after the trial commenced. CONSORT guidelines[24] informed the analysis and presentation of the study.

Data collection took place at baseline, 6 months, and 12 months for both arms. Baseline collection took place between September to December 2016 with follow-up occurring November 2017 to January 2018. The measures examined for this paper are listed below, and a more detailed explanation including power calculations can be found in the protocol paper.[22]

A total of 13 schools were assessed for eligibility; 4 did not meet inclusion criteria of being located in one of Wales' most deprived areas. School-level deprivation was derived from the Welsh Index of Multiple Deprivation (WIMD), which is used to identify areas of deprivation based on income, employment, health, education, access to services, community safety, environment, and housing.[25] Schools were coded into 2 groups from this: either more deprived or less deprived for analysis. Two headteachers declined to participate (1 headteacher declined after randomization occurred). This meant 7 secondary schools took part. The demographics of the schools can be seen in Table 1. Figure 1 shows the participant flow of the study; 51 participants were lost from baseline to 12 months (n=38 in the intervention) because of moving schools or being absent during testing.

Following initial school recruitment, participants (in Year 9, aged 13−14 years) were recruited via school assemblies. Consent was voluntary and involved both written parental consent and pupil assent forms. ACTIVE recruited 909 participants. Members of the local council's sport development team (n=15) were also recruited at 12 months for a focus group to assess how partners, who had helped develop the trial, had perceived ACTIVE.

Table 1. Consent Rates

School	Pupils in Year 9, total (boys)	Participants in the study, total (boys)	Consent rate, %
School 1	113 (56)	93 (48)	82
School 2	231 (107)	191 (95)	83
School 3	125 (59)	115 (52)	92
School 4	128 (62)	116 (55)	91
School 5	97 (50)	84 (44)	87
School 6	142 (77)	136 (71)	96
School 7	190 (105)	146 (82)	77

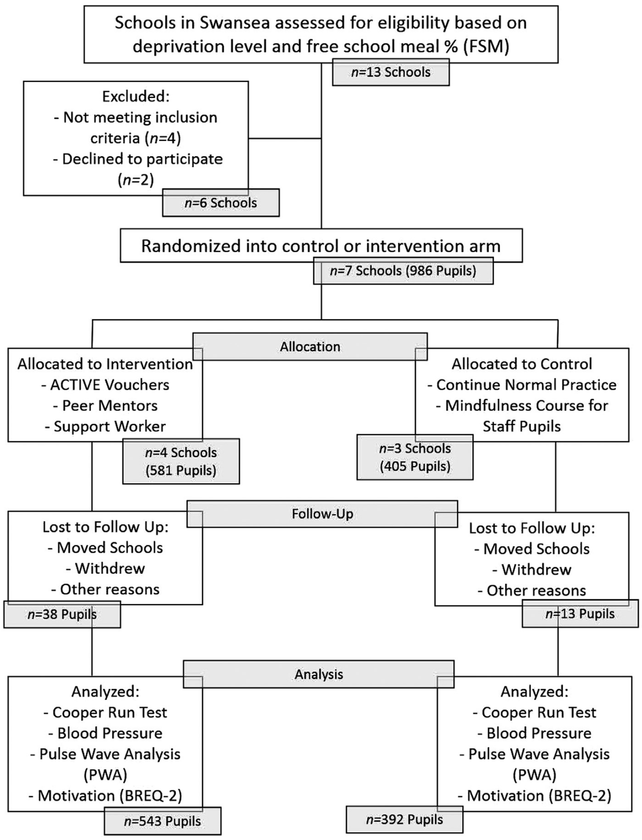

Figure 1. Participant flow of the ACTIVE RCT.

ACTIVE, Active Children Through Individual Vouchers Evaluation; BREQ-2, Behavioral Regulation in Exercise Questionnaire; FSM, free school meal; PWA, pulse wave analysis.

The intervention ran from January to December 2017 and consisted of (1) a voucher scheme, (2) peer mentoring, and (3) support worker engagement. Teenagers received PA vouchers of £20 (4 vouchers in increments of £5) each month for 12 months.[22] Vouchers could be spent on existing PA provision (e.g., gym membership or sports clubs) or could be used to bring new activities into communities or schools. They could also purchase equipment. How the vouchers were spent was directed by the teenagers.

Teenagers were asked to identify peer mentors (10 from each school) via a peer nomination questionnaire in a similar approach to the Stop Smoking in School Trial.[26] Their role was to support and encourage the use of vouchers. Mentors had training via formal workshops throughout the school year from the local council and the support worker. An initial training session highlighting the peer mentors' purpose and developing mentoring skills was provided at the start of the academic year at an external location for the day, and subsequent sessions (1 every half term) took place at the schools lasting 1 hour each. The support worker was based at the University and attended schools to increase pupil awareness of activity provision and encourage teenagers to design new activities through drop-in sessions and school assemblies once a month. All schools received the same amount of contact from the support worker.

The primary aim of this study was to assess the effectiveness of a multicomponent intervention in improving cardiovascular fitness. Secondary aims included evaluating the effects of the intervention on cardiovascular health (as assessed by blood pressure [BP] and pulse wave analysis as an indicator of arterial stiffness), as well as on exercise motivation (using the Behavioral Regulation in Exercise Questionnaire [BREQ-2] and the Relative Autonomy Index).

This study also aimed to explore the qualitative experiences of the intervention from teenagers' and stakeholders' perspectives. This helped to provide some further insight into the intervention's effectiveness. The results reported in this paper do not cover all aims from the protocol as some secondary aims will be written as their own standalone papers.

Measures

All teenagers in Year 9 took part in the Cooper Run Test[27] in the schools during physical education lessons. This was a 12-minute walk/run test where teenagers were instructed by the research team to complete as many laps of their school's sports hall as possible in the time. Two tests were run during the lesson to allow for peers to record each other's scores. Teenagers were categorized as fit based on whether their total meters ran was considered average and above according to normative data.[28]

Participants had their BP measured using an Omron M2 sphygmomanometer. After resting and sitting down for 5 minutes, participants had 3 measurements taken from their left arm with 2 minutes between each and the average recorded. Participants with systolic BP >130 mmHg were categorized as having high BP. Researchers received training from the University's cardiology department to measure BP.

Pulse wave analysis was used to indicate arterial stiffness using the Vicorder.[29,30] Once rested for 5 minutes, participants had 2 measures taken. If both measures of augmentation pressure were within $\pm$ 5 mmHg of each other and augmentation index values were within $\pm$ 5%, the 2 measures were accepted.[22] If not, a third was taken, and the mean of all 3 used. Higher augmentation pressure and augmentation index readings can be used as an assessment of arterial stiffness as they indicate cardiovascular disease risk.[31−33]

The BREQ-2 questionnaire was used to measure teenagers' motivation to exercise in relation to their Relative Autonomy Index.[34] Higher Relative Autonomy Index scores (larger positive weight) indicate greater autonomy to be active, whereas larger negative weights indicate more controlled regulation.[16] The questionnaire consists of 19 items relating to 5 subscales: amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation.[27] Its validity and reliability has been tested in several populations.[35−37] To gain an insight into the degree of autonomy individuals had for being physically active, the Relative Autonomy Index was calculated; this index has been used in similar studies.[16,38] The Relative Autonomy Index is calculated by summing the scores of 5 subscales ($3 \times$ intrinsic motivation $+ 2 \times$ identified regulation $-$ introjected $- 2 \times$ external regulation $- 3 \times$ amotivation).[16] The BREQ-2 was chosen because it is accessible for teenagers, clearly written, and uses a Likert scale for responses. Teenagers were asked to complete the questionnaire individually before either the Cooper Run Test or BP measurements.

Digitally recorded semistructured focus groups were conducted at 12 months (n=8) by 2 researchers, one who led the conversation and one who made notes to provide feedback to participants as a form of respondent validation.[39] These consisted of 6−8 teenagers per group, with boys and girls in separate groups, lasting between 20 and 40 minutes, and were conducted at the schools. Participants were selected purposively to gain a variety of viewpoints from those engaging well with the intervention and those whose activity was not based on voucher usage. The aim of the focus groups was to provide a greater understanding of the mediating factors that influenced PA and which aspects of the intervention were successful or unsuccessful.[22] Members of the local council's community sport development team also took part in a focus group at 12 months to assess how external partners had perceived the intervention. This meant the total number of focus groups was 9.

Deprivation was measured using the WIMD, the official measure of small area deprivation in Wales.[25] This was done using postcode/lower layer super area output to determine a geographical hierarchy from Welsh Government data. This ranks lower layer super area outputs from most to least deprived.

Statistical Analysis

Linear mixed effects multilevel regression with intention-to-treat principles was used to analyze the effects of the intervention on the primary outcome in terms of distance. This was clustered by school and at an individual level in Stata, version 12. Logistic regression was also used to assess whether the intervention had an effect on whether pupils were fit or not fit. For secondary outcomes, comparisons were made between baseline and 12 months with differences and CIs presented for a measure of estimation. Data analysis occurred February−April 2018.

Two independent statisticians carried out parallel data analysis on all outcomes to avoid researcher bias. Multiple imputation of missing data because of absence during some testing was conducted using the chained equations[39] command in Stata. Data for the primary outcome of cardiovascular fitness was imputed for

102 participants at baseline and 170 at follow-up using measures of fitness at other timepoints (baseline/follow-up), sex, and deprivation. This generated one complete data set, which was used for analysis.

Transcription of the focus groups were verbatim, and NVivo, version 10 was used to manage, code, and analyze the data with 2 researchers validating the themes derived from the data via triangulation. Braun and Clarke's Phases of Thematic Analysis[40] identified and reported codes and themes in the focus groups.

RESULTS

Baseline characteristics of both the intervention and control groups can be seen in Table 2. There was very little difference in the percentages of boys and girls in both arms. The intervention group was more deprived according to the WIMD but received a lower percentage of free school meals.

Regression models were run for the primary outcome (Appendix Table 1, available online) and secondary outcomes (Appendix Table 2, available online). However, for clarity and succinctness, comparison between outcomes for the intervention and control groups can be seen in Table 3.

The 6-month data showed the same observed trends for the outcomes. However, for clarity, comparisons have been presented between baseline and 12 months.

Linear mixed effects multilevel regression (Appendix Table 1, available online) showed that, overall, the intervention group ran fewer meters than the control group. However, the interaction between group and time (being in the intervention at 12 months) showed a trend that the intervention improved the distance run by teenagers, although this was not statistically significant. Therefore, the intervention group showed a trend to run farther than the control group at 12 months.

The number of teenagers categorized as fit in the control group declined by 5.4%, but there was only a reduction of 0.6% in the intervention group at 12 months. Logistic regression showed significantly higher odds of being fit at 12 months in the intervention group than the control group (OR=1.21, 95% CI=1.07, 1.38, p=0.002) (Appendix Table 1, available online). Girls in the intervention group showed a trend to become fitter (3% more children were fit) and the girls in the control group became less fit (7.5% more children were unfit).

Table 2. Baseline Characteristics

Characteristic	Control	Intervention
Total, *n* (%)	385 (42)	524 (58)
Sex, *n* (%)		
Boy	213 (55)	254 (48)
Girl	172 (45)	270 (52)
School deprivation		
WIMD, mean	1,156	531
Free school meal %, mean	33	23

WIMD, Welsh Index of Multiple Deprivation.

The proportion of participants with high BP in the intervention group fell (baseline, 5.3% [28/524]; 12 months, 2.7% [14/524]), whereas the proportion of participants with high BP in the control increased (baseline, 1.6% [6/384]; 12 months, 3.1% [12/384]). Augmentation pressure and augmentation index improved in both arms. Deprived children in the intervention group saw a significant decrease in augmentation pressure compared with the control group.

Participants were autonomously motivated, with between 96% and 99% of teenagers in both arms autonomously motivated at baseline and 12 months. Total motivation showed a decreasing trend between the 2 timepoints. Girls in the intervention showed a significant decrease (0.6, 95% CI=0.0, 1.1), as well as deprived teenagers (0.6, 95% CI=0.0, 1.1). However, this change in the mean did not impact the percentage of participants who were autonomously motivated in the intervention.

Trampolining accounted for almost half of the voucher usage (49.1%), followed by laser tag (11.5%) and the waterpark (slides and surfing, 7.3%) (Appendix Table 3, available online). ACTIVE helped set up lunchtime clubs in 2 different schools at the request of teenagers, an unstructured football session, dance, and parkour.

The participants used 26.2% (7,545/28,800) of all the vouchers available, and boys made up 52% of the vouchers spent. Common themes for not using the vouchers included the lack of local provision (Appendix Table 4, available online).

Focus group conversations about the impact of the intervention flowed around 2 themes, the breaking down of cost barriers and changes in perception of PA. Teenagers reported they no longer had to ask their parents for money, which had often been a barrier. One boy said he was able to "go places and do different things" because of knowing more about what was available. The local council echoed this, they felt "...they [the vouchers] are making people more aware of what is in the local area so that they can be active..."

Teenagers reported changes in their local area thanks to the vouchers. A leisure center doubled the value of the vouchers to £10: "...they've doubled up, so like one is now worth £10 because it costs more than £5 for some of the sessions" (girl). In addition to this, the local trampoline park added free food, which made PA feel more social and welcoming. One girl stated, "...because then like you go there, you have food as well, it's like more of a thing."

Table 3. Intervention Compared with Control in Terms of Outcomes

Measure	Control	Intervention	Difference
Cooper run (% fit)			
Total, *n*	384	524	
Baseline, % (*n* or 95% CI)	35.9 (138)	33.5 (176)	2.4 (−3.9, 8.6)
12 months, % (*n* or 95% CI)	30.4 (117)	33.0 (173)	−2.6 (−8.6, 3.6)
Difference, % (95% CI)	5.4 (−0.6, 1.6)	0.5 (−4.5, 5.7)	**4.9 (2.7, 7.6)**
Boys, *n*	212	254	
Baseline, % (*n* or 95% CI)	22.1 (47)	24.4 (62)	−2.3 (−9.9, 5.5)
12 months, % (*n* or 95% CI)	18.3 (39)	20.0 (51)	−1.7 (−8.9, 5.5)
Difference, % (95% CI)	3.8 (−3.5, 11.1)	4.4 (−2.1, 10.8)	−0.6 (−0.2, 4.6)
Girls, *n*	172	270	
Baseline, % (*n* or 95% CI)	52.9 (91)	42.2 (114)	**10.7 (11.5, 20.2)**
12 months, % (*n* or 95% CI)	45.3 (78)	45.1 (122)	0.2 (−9.4, 9.7)
Difference, % (95% CI)	7.5 (−2.8, 17.9)	−2.9 (−10.8, 4.8)	**10.4 (0.4, 9.7)**
Deprived, *n*	146	431	
Baseline, % (*n* or 95% CI)	36.3 (53)	35.0 (151)	1.3 (−7.7, 10.2)
12 months, % (*n* or 95% CI)	30.8 (45)	32.4 (140)	−1.6 (−10.4, 7.1)
Difference, % (95% CI)	5.5 (−4.4, 15.4)	2.6 (−3.1, 8.2)	2.9 (−0.4, 7.9)
Not deprived, *n*	238	93	
Baseline, % (*n* or 95% CI)	35.7 (85)	26.8 (25)	8.9 (−2.4, 20.1)
12 months, % (*n* or 95% CI)	30.2 (72)	35.4 (33)	−5.2 (−16.4, 5.9)
Difference, % (95% CI)	5.5 (−2.4, 13.3)	−8.6 (−20.6, 3.4)	**14.1 (4.1, 19.2)**
Cooper run (distance, m)			
Total, *n*	384	524	
Baseline, m (SD or 95% CI)	1,811.8 (±365.5)	1,781.9(±373.5)	29.9 (−18.9, 78.6)
12 months, m (SD or 95% CI)	1,756.0 (±384.4)	1,762.3 (±421.1)	−6.3 (−59.8, 47.2)
Difference, m (95% CI)	55.7 (11.1, 100.3)	19.6 (−16.7, 55.9)	36.1 (−93.1, 20.9)
Boys, *n*	212	254	
Baseline, m (SD or 95% CI)	1,989.9 (±346.0)	2,010.9 (±335.7)	−21 (−83.1, 41.2)
12 months, m (SD or 95% CI)	1,897.1 (±390.7)	1,953.2 (±400.3)	−56.1 (−128.4, 16.3)
Difference, m (95% CI)	92.8 (26.4, 159.1)	57.7 (0.2, 115.2)	35.1 (−122.2, 52.0)
Girls, *n*	172	270	
Baseline, m (SD or 95% CI)	1,592.2 (±252.1)	1,566.5 (±263.1)	25.7 (−23.9, 75.3)
12 months, m (SD or 95% CI)	1,582.1 (±295.8)	1,582.7 (±356.8)	−0.6 (−64.7, 63.5)
Difference, m (95% CI)	10.1 (−46.6, 66.9)	−16.1 (−61.4, 29.0)	26.2 (−98.5, 46.1)
Deprived, *n*	146	431	
Baseline, m (SD or 95% CI)	1,806.2 (±295.4)	1,783.1 (±371.6)	23.1 (−43.4, 89.6)
12 months, m (SD or 95% CI)	1,770.5 (±359.3)	1,763.5 (±412.5)	7 (−68.2, 82.1)
Difference, m (95% CI)	35.7 (−27.9, 99.4)	19.6 (−19.2, 58.4)	16.1 (−92.2, 60.0)
Not deprived, *n*	238	93	
Baseline, m (SD or 95% CI)	1,815.2 (±403.0)	1,776.3 (±384.1)	38.9 (−56.7, 134.6)
12 months, m (SD or 95% CI)	1,747.1 (±363.2)	1,756.5 (±461.1)	−9.4 (−109.8, 91.1)
Difference, m (95% CI)	68.1 (7.3, 128.7)	19.8 (−79.9, 119.5)	48.3 (−163.2, 66.6)
Blood pressure (% high)			
Total, *n*	384	524	
Baseline, % (*n* or 95% CI)	1.6 (6)	5.3 (28)	−3.7 (−5.5, 0.2)
12 months, % (*n* or 95% CI)	3.1 (12)	2.7 (14)	0.4 (−1.7, 2.9)
Difference, % (95% CI)	−1.4 (−3.7, 0.6)	2.6 (−3.0, 5.0)	−4 (−0.9, 3.0)
Boys, *n*	212	254	
Baseline, % (*n* or 95% CI)	2.4 (5)	6.7 (17)	−4.3 (0.4, 8.3)
12 months, % (*n* or 95% CI)	4.2 (9)	3.5 (9)	0.7 (−2.9, 4.3)
Difference, % (95% CI)	−1.8 (−1.7, 5.7)	3.2 (−0.7, 7.2)	−1.4 (−1.9, 4.4)

(continued on next page)

Table 3. Intervention Compared with Control in Terms of Outcomes (*continued*)

Measure	Control	Intervention	Difference
Girls, *n*	172	270	
Baseline, % (*n* or 95% CI)	**0.6 (1)**	**4.1 (11)**	**−3.5 (0.3, 6.6)**
12 months, % (*n* or 95% CI)	1.7 (3)	1.9 (5)	0.2 (−3.3, 2.7)
Difference, % (95% CI)	−1.1 (−1.7, 4.4)	2.2 (−0.7, 5.4)	−3.3 (−2.1, 3.7)
Deprived, *n*	146	431	
Baseline, % (*n* or 95% CI)	2.0 (3)	4.6 (20)	−2.6 (−1.5, 5.3)
12 months, % (*n* or 95% CI)	3.4 (5)	2.3 (10)	1.1 (−1.6, 5.5)
Difference, % (95% CI)	−1.4 (−2.9, 5.9)	2.3 (−0.1, 4.9)	−3.7 (−2.6, 3.0)
Not deprived, *n*	238	93	
Baseline, % (*n* or 95% CI)	**1.3 (3)**	8.6 (8)	**7.3 (2.5, 14.8)**
12 months, % (*n* or 95% CI)	2.9 (7)	4.3 (4)	−1.4 (−2.6, 7.7)
Difference, % (95% CI)	−1.6 (−1.1, 4.8)	4.3 (−3.2, 12.2)	−5.9 (−1.0, 8.9)
Augmentation pressure (mmHg)			
Total, *n*	384	524	
Baseline, mmHg (SD or 95% CI)	4.9 (±2.5)	5.0 (±2.6)	−0.1 (−0.5, 0.1)
12 months, mmHg (SD or 95% CI)	4.1 (±2.2)	4.0 (±2.4)	0.1 (−0.2, 0.3)
Difference, mmHg (95% CI)	0.8 (0.4, 1.1)	1 (0.7, 1.3)	0.2 (−0.1, 0.7)
Boys, *n*	212	254	
Baseline, mmHg (SD or 95% CI)	4.6 (±2.7)	4.6 (±2.6)	0.0 (−0.4, 0.5)
12 months, mmHg (SD or 95% CI)	4.1 (±2.2)	4.2 (±2.5)	0.1 (−0.4, 0.4)
Difference, mmHg (95% CI)	0.5 (−0.0, 0.9)	0.4 (−0.0, 0.8)	0.1 (−0.7, 0.5)
Girls, *n*	172	270	
Baseline, mmHg (SD or 95% CI)	5.2 (±2.3)	5.5 (±2.4)	−0.3 (−0.7, 0.1)
12 months, mmHg (SD or 95% CI)	4.0 (±2.2)	3.9 (±2.2)	0.1 (−0.3, 0.5)
Difference, mmHg (95% CI)	1.2 (0.7, 1.7)	1.6 (1.2, 2.0)	0.1 (−0.1, 0.9)
Deprived, *n*	146	431	
Baseline, mmHg (SD or 95% CI)	4.5 (±3.2)	5.2 (±2.4)	**−0.7 (−1.2, −0.1)**
12 months, mmHg (SD or 95% CI)	4.0 (±2.0)	4.1 (±2.3)	−1 (−0.5, 0.3)
Difference, mmHg (95% CI)	0.5 (−0.1, 1.1)	1.3 (0.8, 1.4)	**0.8 (0.1, 1.4)**
Not deprived, *n*	238	93	
Baseline, mmHg (SD or 95% CI)	5.1 (±2.0)	4.2 (±2.9)	**0.9 (0.3, 1.4)**
12 months, mmHg (SD or 95% CI)	4.1 (±2.3)	3.6 (±2.6)	0.5 (−0.0, 1.0)
Difference, mmHg (95% CI)	1.0 (0.5, 1.3)	0.6 (−0.2, 1.3)	0.4 (−1.2, 0.4)
Augmentation index (%)			
Total, *n*	384	524	
Baseline, % (SD or 95% CI)	9.5 (±4.0)	10.0 (±4.6)	**−0.5 (−1.1, 0.0)**
12 months, % (SD or 95% CI)	7.4 (±3.2)	7.6 (±4.3)	−0.2 (−0.6, 0.3)
Difference, % (95% CI)	2.1 (1.5, 2.5)	2.4 (1.8, 2.9)	−0.3 (−0.4, 1.0)
Boys, *n*	212	254	
Baseline, % (SD or 95% CI)	8.8 (±3.9)	9.1 (±4.8)	−0.3 (−1.1, 0.5)
12 months, % (SD or 95% CI)	7.9 (±3.1)	8.1 (±4.5)	−0.2 (−0.9, 0.5)
Difference, % (95% CI)	0.9 (0.1, 1.5)	1.0 (0.2, 1.7)	−0.1 (−0.9, 1.1)
Girls, *n*	172	270	
Baseline, % (SD or 95% CI)	10.3 (±3.9)	10.9 (±4.1)	−0.6 (−1.3, 0.2)
12 months, % (SD or 95% CI)	6.9 (±3.2)	7.2 (±4.0)	−0.3 (−1.0, 0.4)
Difference, % (95% CI)	3.4 (2.6, 4.2)	3.7 (3.0, 4.4)	−0.3 (−0.7, 1.3)
Deprived, *n*	146	431	
Baseline, % (SD or 95% CI)	8.8 (±4.5)	10.4 (±4.3)	**−1.6 (−2.4, −0.8)**
12 months, % (SD or 95% CI)	7.6 (±3.0)	7.8 (±3.9)	−0.2 (−0.8, 0.5)
Difference, % (95% CI)	1.2 (0.2, 2.1)	2.6 (2.0, 3.1)	**−1.4 (−2.5, −0.4)**

(*continued on next page*)

Table 3. Intervention Compared with Control in Terms of Outcomes (*continued*)

Measure	Control	Intervention	Difference
Not deprived, *n*	238	93	
Baseline, % (SD or 95% CI)	9.9 (±3.6)	8.3 (±5.2)	**1.6 (0.6, 2.6)**
12 months, % (SD or 95% CI)	7.4 (±3.3)	7.0 (±5.5)	0.4 (−0.5, 1.3)
Difference, % (95% CI)	2.5 (1.9, 3.2)	1.3 (−0.2, 2.8)	1.2 (−0.1, 2.5)
Motivation, BREQ-2 (% autonomous RAI)			
Total, *n*	384	524	
Baseline, % (*n* or 95% CI)	98.1 (378)	97.1 (509)	1 (−0.9, 3)
12 months, % (*n* or 95% CI)	97.9 (377)	97.9 (513)	0 (−1.8, 1.9)
Difference, % (95% CI)	0.2 (−1.5, 2.1)	−0.8 (95−2.4, 0.9)	0.9 (−0.7, 1.7)
Boys, *n*	212	254	
Baseline, % (*n* or 95% CI)	98.1 (209)	97.6 (248)	0.5 (−2.1, 3.1)
12 months, % (*n* or 95% CI)	98.5 (210)	97.6 (248)	0.9 (−1.5, 3.4)
Difference, % (95% CI)	−0.4 (−2.9, 1.9)	0 (−2.1, 2.1)	−0.4 (−1.0, 2.6)
Girls, *n*	172	270	
Baseline, % (*n* or 95% CI)	98.2 (169)	96.6 (261)	0.6 (−1.5, 4.7)
12 months, % (*n* or 95% CI)	97.0 (167)	98.1 (265)	−1.1 (−3.9, 1.8)
Difference, % (95% CI)	1.2 (−1.6, 3.9)	−1.5 (−4.0, 1.0)	2.7 (−3.2, 3.0)
Deprived, *n*	146	431	
Baseline, % (*n* or 95% CI)	97.2 (143)	98.1 (423)	−0.9 (−3.5, 1.8)
12 months, % (*n* or 95% CI)	99.3 (146)	98.1 (423)	1.2 (−1.1, 3.5)
Difference, % (95% CI)	−2.1 (−5.0, 0.9)	0 (−1.5, 1.5)	**2.1 (0.4, 5.8)**
Not deprived, *n*	238	93	
Baseline, % (*n* or 95% CI)	98.7 (235)	92.4 (86)	**6.3 (2.1, 10.3)**
12 months, % (*n* or 95% CI)	97.0 (231)	96.7 (90)	3 (−3.8, 4.4)
Difference, % (95% CI)	1.7 (−0.6, 4.0)	−4.3 (−10.3, 17.0)	6 (−1.0, 8.9)
Motivation (total RAI)			
Total, *n*	384	524	
Baseline, RAI score (SD or 95% CI)	9.1 (±3.5)	9.2 (±4.2)	−0.1 (−0.6, 0.4)
12 months, RAI score (SD or 95% CI)	8.6 (±3.2)	8.8 (±3.4)	−0.2 (−0.6, 0.2)
Difference, RAI score (95% CI)	**0.5 (0.1, 1.0)**	**0.4 (0.0, 0.8)**	0.1 (−0.2, 0.6)
Boys, RAI score, *n*	212	254	
Baseline, RAI score (SD or 95% CI)	9.3 (±3.5)	9.4 (±4.2)	−0.1 (−0.8, 0.5)
12 months, RAI score (SD or 95% CI)	8.8 (±3.0)	9.2 (±3.5)	−0.4 (−1.0, 0.1)
Difference, RAI score (95% CI)	0.4 (−0.1, 1.1)	0.2 (−0.3, 0.8)	0.2 (−0.1, 1.0)
Girls, RAI score, *n*	172	270	
Baseline, RAI score (SD or 95% CI)	8.9 (±3.4)	9.0 (±4.2)	−0.1 (−0.8, 0.6)
12 months, RAI score (SD or 95% CI)	8.2 (±3.5)	8.4 (±3.2)	−0.1 (−0.7, 0.5)
Difference, RAI score (95% CI)	0.7 (−0.0, 1.3)	**0.6 (0.0, 1.1)**	0.1 (−0.5, 0.7)
Deprived, RAI score, *n*	146	431	
Baseline, RAI score (SD or 95% CI)	8.7 (±3.8)	9.4 (±3.7)	−0.7 (−1.4, 0.0)
12 months, RAI score (SD or 95% CI)	8.8 (±3.1)	8.8 (±3.4)	−0.0 (−0.6, 0.5)
Difference, RAI score (95% CI)	−0.1 (−0.7, 0.6)	**0.6 (0.1, 0.9)**	−0.7 (−5.6, 6.9)
Not deprived, RAI score, *n*	238	93	
Baseline, RAI score (SD or 95% CI)	9.4 (±3.3)	8.4 (±6.0)	1.0 (−0.0, 1.9)
12 months, RAI score (SD or 95% CI)	8.4 (±3.3)	8.5 (±3.4)	−0.1 (−0.9, 0.6)
Difference, RAI score (95% CI)	**1.0 (0.3, 1.5)**	−0.1 (−1.3, 1.0)	1.1 (−6.9, 9.4)

Note: Boldface indicates statistical significance ($p<0.05$).
BREQ-2, Behavioral Regulation in Exercise Questionnaire; RAI, Relative Autonomy Index.

Some participants noted that the study had changed their view of PA. For example, one girl noted, "you don't realize its exercise. . ." For girls, this change of definition seemed to be very helpful as "you don't have to wear sports clothes, and it doesn't matter, but you can make a day of it, so like you can go to town, and then maybe go to Laser Zone" (girl). Changes in the perception were also present in the council focus group who discussed using ACTIVE's data to change their approach to PA provision. One individual said they would "use the results to shape and inform our planning for our areas" as well as tackling the issues associated with teenage inactivity. They noted that the data could underpin "how we can address them [barriers identified in ACTIVE] within our [school and community] programs."

There were some aspects of the study that teenagers said were less positive. There was a lack of clarity about who the peer mentors were, and one boy stated ". . .like I haven't felt the need to like go to one." The participants suggested that the mentors should be chosen differently: "get a gym teacher to look at who does most sports in the school and like who enjoys it most" (boy). One girl said, "I feel like some of the people that have been chosen don't really want to be involved..." and a different selection process may have protected against this.

The teenagers thought that the support worker was beneficial, as they created awareness of what was new or "if anything had changed, which was really informative and nice" (boy, Focus Group 1). However, some teenagers noted that the timings of the support worker were not ideal; in particular, they said morning assemblies were a time when they do not pay attention. Additionally, the local council noted that one intervention school was a Welsh-medium school to which teenagers were likely to have commuted; therefore, the participants would not have benefited from any change in provision around the school.

DISCUSSION

Despite teenagers in the intervention running fewer meters than the control schools at both timepoints, being in the intervention showed trends of improving the distance run and was significant in improving the number of girls classified as fit. This is novel, as it provides evidence that giving teenagers a choice to access unstructured activities can benefit fitness. It is also novel that this study has shown the intervention helped reduce the number of teenagers that had high BP. Teenagers were autonomously motivated[14] even before the implementation of the intervention. This provides a rationale, in line with SDT, as to why teenagers chose to access enjoyable, fun, and social activities on the project rather than more prescriptive, structured forms of PA.

There was some evidence that the intervention decreased autonomous motivation for girls and more deprived teenagers. This could be because the vouchers were perceived as an external pressure to be active.[16] However, the increase in fitness suggests that incentives could be beneficial in the short term while young people explore activity opportunities or used longer term in groups with particularly low fitness. Ultimately, this study highlights that lack of motivation is not the issue; young people do not need to be pressured into being active. What is currently on offer for teenagers is not what they want. The vouchers gave a novel insight into what teenagers enjoy doing and provided evidence that there should be a focus on listening to teenagers[4,11] as opposed to being prescriptive. Activity providers should consult with teenagers to overcome accessibility barriers.

The study highlights some important baseline findings regarding teenage PA. Namely, approximately 65% of children are unfit and this may increase by 5% per year judging by changes in the control group. This is in line with previous findings.[3,7,41] However, listening to what teenagers want and helping them overcome accessibility issues could go some way to preventing this. Previous PA interventions have been prescriptive, with specific activities or teaching strategies given to teenagers.[3,23,38,42] They have had mixed success to date and are often short term.[19,23] The findings from ACTIVE suggest there is a need to focus on allowing teenagers to have a say in activity provision.

The way the vouchers were used showed that unstructured fun activities were favored, which supports findings that teenagers see structured activities as a barrier to being active.[4,10] The popularity of the trampoline park suggests that activities that place emphasis on fun are more appealing to teenagers.[4,11] This is not to say that trampoline parks are a generalizable provision, but rather the nontraditional and social aspects are elements to implement in the future.

This study provides evidence that a co-produced intervention can have wider community benefits. Teenagers said that there had been changes made to local PA provision; one participant said that cost had been altered in a positive way. In addition, the local council used the feedback from ACTIVE to underpin their future planning. This provides evidence of the sustainability of ACTIVE as it helped inform the delivery of community- and school-based PA for teenagers.

Some barriers still existed that the intervention did not overcome. Participants used 26.2% of the vouchers. Some accessibility barriers were still present[43]; teenagers stated they found it difficult to travel to activities further away from their homes. This suggests there is a lack of services and facilities in deprived areas and inability to travel for deprived children. Therefore, more research is needed to develop ways of overcoming this issue, whether addressing the transport itself or bringing more activities to local communities. Some community activities had either an upper age limit of 10 years or a minimum age limit of 16 years, and there was little specifically available and advertised for those aged 11−16 years. The high percentage of autonomously motivated teenagers may also have contributed to low voucher use as they may have perceived the vouchers as an external pressure.

The peer support aspect of the intervention was unsuccessful despite seeing success in previous interventions.[44] Participants noted that the selected individuals were unapproachable, and teenagers would not really ask a peer for advice, help with being active, or take advice on things to do. Care needs to be taken during the selection process of peer mentors. Again, this complements findings that teenagers were autonomously motivated[14] and did not need an external influence to get them more active.

Limitations

Baseline data collection occurred after randomization, and given the nature of the study, participants were not blinded. This study was only able to measure outcomes of teenagers who consented, and they may have been more motivated and interested in being active. Owing to school schedules, there was overlap where some teenagers were still receiving vouchers during the follow-up testing (47%, n=430). This may have influenced some measures. There was also no follow-up after the vouchers stopped, which could have provided evidence of the long-term impact of ACTIVE.

This study was unable to assess whether the vouchers substituted previous activities with more fun activities or added additional PA to the teenagers' weeks. It is unknown if the low voucher use reflects that some students were already very active or if higher voucher use contributed to better outcomes. This is a limitation that could be addressed in future research.

ACTIVE selected deprived schools if they were in a deprived area. However, for one school at least, this was not a good method of identifying deprivation of teenagers. Future work could use free school meal percentage.

CONCLUSIONS

The ACTIVE intervention provides evidence that to improve fitness, health, and perceptions of PA, there should be a focus on listening to teenagers and providing more local opportunities to take part in activities that are fun, unstructured, and social to make a real difference to teenage PA. Future interventions should focus on advocating and empowering teenagers so that PA opportunities are what they want and not what adults think they should have.

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Swansea University designed the study and collected, analyzed, and interpreted the data. The University also wrote this study paper and made the decision to submit. MJ wrote the first draft of the paper and all authors provided critical input and revisions for all further drafts. SB wrote analysis and results section and provided critical input and revisions for all further drafts. MJ, CT, SS, JD, and SB undertook data collection and data analysis. DC, CT, SB, GS, JH, SA, SM, and EE designed the study, aided in interpretation of findings, and supervision of study quality. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at https://doi.org/10.1016/j.amepre.2019.10.005.

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Appendix 11 What Works Best When Implementing a Physical Activity Intervention For Teenagers?

Open access Research

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What works best when implementing a physical activity intervention for teenagers? Reflections from the ACTIVE Project: a qualitative study

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ABSTRACT

Objective This paper explores what aspects of a multicomponent intervention were deemed strengths and weaknesses by teenagers and the local council when promoting physical activity to young people.

Design Qualitative findings at 12 months from a mixed method randomised control trial.

Methods Active Children Through Incentive Vouchers—Evaluation (ACTIVE) gave teenagers £20 of activity enabling vouchers every month for a year. Peer mentors were also trained and a support worker worked with teenagers to improve knowledge of what was available. Semistructured focus groups took place at 12 months to assess strengths and weaknesses of the intervention. Eight focus groups (n=64 participants) took place with teenagers and one additional focus group was dedicated to the local council's sport development team (n=8 participants). Thematic analysis was used to analyse the data.

Results Teenagers used the vouchers on three main activities: trampolining, laser tag or the water park. These appeal to both genders, are social, fun and require no prior skill or training. Choice and financial support for teenagers in deprived areas was considered a strength by teenagers and the local council. Teenagers did not engage with a trained peer mentor but the support worker was considered helpful.

Conclusions The ACTIVE Project's delivery had both strengths and weakness that could be used to underpin future physical activity promotion. Future interventions should focus on improving access to low cost, fun, unstructured and social activities rather than structured organised exercise/sport. The lessons learnt from this project can help bridge the gap between what is promoted to teenagers and what they actually want from activity provision.

Trial registration number ISRCTN75594310

Strengths and limitations of this study

- ► Study methodology is novel. Active Children Through Incentive Vouchers—Evaluation has been coproduced by young people to reflect their wants and needs.
- ► Used a semistructured focus group methodology to promote group interaction, which encourages in-depth discussion.
- ► Only children consenting to take part in the study were able to be involved in the focus groups; these children could potentially be the more active and involved children, perhaps not capturing the views of those less engaged with activity.
- ► Only the council were consulted and the viewpoints of other stakeholders may have differed.

BACKGROUND

A notable decline in physical activity is seen in teenagers[1] and many are insufficiently active.[2–4] Young people should participate in 60 min of moderate to vigorous activity a day[5 6]; however, in Wales, only 11% of girls and 20% of boys meet this recommendation.[7] The main barriers are reported to be cost and location,[5 8–10] especially for teenagers from low socioeconomic backgrounds.[11] Many interventions to improve activity in teenagers have chosen to focus on the school environment as it is considered a useful setting due to its ability to reach a large amount of teenagers.[12 13] Previous interventions in this setting have been prescriptive, with specific activities or teaching strategies given to teenagers.[4 14–16] These interventions have had mixed success to date, often only increasing activity short-term[15 17] as they fail to provide ongoing opportunities.

This style of intervention design and implementation is 'top down' with the emphasis on policymakers as the experts and sole designers. This results in a disconnect between what is provided and what teenagers actually need and want to do.[8 10 18] Research shows that involving participants and those expected to deliver the intervention at an early stage aids the development of a strong intervention and increases the likelihood of success, effectiveness and sustainability.[19 20] This approach has underpinned the Active Children Through Incentive Vouchers—Evaluation (ACTIVE) Project[2] which was coproduced following discussions with teenagers regarding current activity provision in their area.[18]

The findings from this research confirmed that accessibility to activities was an issue.[8 9] Teenagers wanted more opportunity to try new activities that were social and informal rather than more traditional forms of sport. In response to this, the ACTIVE randomised control trial aimed to empower teenagers to make their own activity choices via a voucher scheme, peer mentoring and support worker engagement.[2] Multicomponent interventions of this nature are thought to be effective approaches to positively change physical activity.[21] Financial incentives and peer mentoring have previously been shown to be beneficial to behaviour change.[17 22–24] A voucher-based intervention to increase activity in the UK has been previously tested in adults.[25 26] However, it remains uncertain whether a similar approach would be well received by teenagers.

The purpose of this paper is to explore what aspects of ACTIVE's multicomponent intervention (financial support, peer support, adult support) teenagers (the participants) and local council (intervention collaborators) perceived as the strengths and weaknesses when promoting physical activity in teenagers in deprived areas. It will also discuss what teenagers used the vouchers to do.

These findings can help inform the direction and implementation of future activity enabling interventions and policies for teenagers and young people.

METHODS

Study design

ACTIVE was a multicomponent intervention based in four secondary schools in Wales. It involved a voucher scheme, where all pupils in year 9 (aged 13–14 years) received £20 to spend on activity/equipment per month for 12 months (January to December) and incorporated peer mentoring and support worker engagement. Pupils selected the peer mentors (10 in each school) to act as 'champions' for physical activity in the school[27] (peer nomination questionnaire can be seen as online supplementary file 1). The support worker, who was a university employee, promoted the voucher scheme in the schools and provided a link between the schools and local council's sport development team. This was to promote collaborative working between the schools and the local council and to feedback any findings from ACTIVE or comments from teenagers. The project was funded by the British Heart Foundation[28] and a detailed protocol of ACTIVE has been published.[2] Consolidated criteria for reporting qualitative research guidelines were used to inform the analysis and presentation of this study.[29]

Patient and public involvement

ACTIVE was developed as a result of discussions with teenagers regarding activity provision and barriers to be active in their local community.[2] Initial discussions resulted in a mixed method feasibility study of one school in a deprived area of Swansea, South Wales.[8] This study was successful in improving fitness and physical activity[8] and confirmed that teenagers found accessibility (eg, cost and lack of local facilities) as barriers. As a result, this trial was developed[2] alongside recommendations made by teenagers. The peer mentoring and support worker aspects were developed to provide ongoing involvement in the project for the teenagers. As findings emerged, ACTIVE reviewed them with the local council and other activity providers to align them better with what teenagers cared about and what they needed most. Findings from the study have been disseminated to participants and collaborators through conferences, social media and videos highlighting the key outcomes of the project.

Outcomes

This paper aims to present what activities teenagers' access when given the opportunity to do so in deprived areas. It also explores what aspects of a multicomponent intervention were deemed strengths and weaknesses when aiming to promote physical activity. Teenagers and the local council's sport development team were both included in this exploration to provide perspectives from those who the intervention targets and those who implement and have the power to change activity provision for this age group.

Participants

To be included in the study, schools needed to be located in one of Wales' Communities First catchment area.[30] Four schools were recruited to the ACTIVE intervention (table 1). Following initial school recruitment, year 9 pupils (aged 13–14 years) gave consent to participate in the project's focus groups (n=176), although all pupils in the year group received vouchers (n=524). Participants were selected to be a part of focus groups purposively to ensure the views of those who had/had not engaged with the study were represented (n=64). Pupils were considered engaged if they had spent more than the mean amount of vouchers (n=18 vouchers) used at the time the focus groups were carried out (n=73/176 consented pupils). The focus groups also included at least one peer mentor. The local council sports development team were recruited via a monthly meeting between them and the project's support worker (n=8). The total number of participants in the focus groups were 72 and 9 separate focus groups were conducted.

Data collection

Semistructured focus groups took place at the 12-month stage in the four intervention schools to assess the strengths and weaknesses of ACTIVE, if there were any recommendations and, whether it had made any

Table 1 Demographics of schools

	Number of pupils in year 9 (n=boys)	Free school meal % in the school	Welsh index of multiple deprivation of the school*	Mean vouchers used per pupil at 12 months
School 1	113 (n=56)	26.4	1660	17
School 2	231 (n=107)	19.2	326	15
School 3	125 (n=59)	10	84	17
School 4	128 (n=62)	38.1	56	21

*The higher the number the more deprived the local area.

difference to physical activity for teenagers. Focus groups were selected as the preferred methodology due to the promotion of group interaction, which encourages in-depth discussion.[31] Eight focus groups lasting between 20 and 40 min took place, with boys and girls in separate groups to establish any gender differences. Members of the local council's sport development team also participated in an additional focus group to get an insight from the perspective of project collaborators and activity providers. The focus groups took place at the schools to ensure pupils remained in a familiar and convenient setting. The exception being the council focus group, which took place at the local council, chambers as part of a sports development team meeting.

A lead moderator facilitated the focus groups to ensure the discussion remained on the topic of interest.[32] A topic guide which reflected the study's aims to ensure consistency across all focus groups and to provide triggers for discussion was used (online supplementary file 2).[33] An assistant moderator was also present and was responsible for taking notes and audio recording. This role allowed key messages to be reported back to participants to ensure interpretation was correct and, to gain clarity over any points were unclear. This was a method of respondent validation.[34] Both moderators had previously met participants during data collection and collaboration.

Analysis

The focus groups were transcribed in verbatim and names were removed to ensure anonymity. NVivo V.10 was used to manage and analyse the data.[35] Two researchers separately analysed the data and compared coding/themes in order to guarantee no new codes/themes emerged and there were instances of the same theme to ensure data saturation.[36] The researchers used thematic analysis (TA) to identify and report patterns in the focus groups. Braun and Clarke's Phases of TA[37] underpinned the coding process. The themes can be seen as online supplementary file 3.

RESULTS

A total of 18 codes were consolidated into three themes that discussed the project's strengths and weaknesses: (1) ability to choose own activities, (2) using external influences (eg, peer mentors and a support worker) and (3) the intervention's settings.

Ability to choose own activities

Teenagers discussed the ability to choose their own activities with the vouchers as a notable strength of ACTIVE. Table 2 shows what the teenagers chose to do with their vouchers. The vouchers were collected directly from the activity providers by the support worker. Notably, all choices were unstructured and informal activities. Trampolining accounted for almost half of the voucher usage (49.1%), this was followed by laser tag (11.46%) and the water park (slides and surfing) (7.27%). Table 2 shows a detailed breakdown of how the vouchers were used. Teenagers spent the vouchers on unstructured and informal activities.

Both boys and girls used the trampoline parks frequently, one boy explained '… I think the most popular would be [trampoline park] and that's quite a multi-sexual sport then, isn't it?' (boy, focus group 7). The choice allowed boys and girls to participate in the same activities which one boy (focus group 3) believed had made girls more active. Girls acknowledged there were 'loads of things' (girl, focus group 4) they could do with the vouchers that were more chilled than typical activity provision on offer. Boys also agreed that activity had become fun. There were a lot of places young people did not realise would count as activity which they saw as a strength of the project as it had changed perceptions of activity for the teenagers.

As well as this, there was no longer a concern about money. One boy noted that young people would find paying for activities as a barrier but 'now you've got the vouchers to pay for it' (boy, focus group 5). There was an agreement among teenagers who the vouchers had helped improve socialisation for this reason. The vouchers gave them the choice of doing 'something in the nights' (girl, focus group 8), on 'Saturday afternoons and Sunday afternoons' (boy, focus group 3) or when you are 'on holiday' (girl, focus group 6). One girl (focus group 8) stated that by being able to use the vouchers in a social capacity had made her more confident to be active.

The local council agreed that giving teenagers a choice was a strength of ACTIVE. They liked that teenagers could decide where and how and considered the vouchers as more of a leisure pass where teenagers could go and enjoy activities with their friends. They also believed that the choice aspect improved the sustainability of ACTIVE's impact on physical activity as some teenagers found an

Table 2 Frequency of voucher use

Activity	Total	%	Girls	Boys
Trampolining	3692	49.10	1914	1778
Laser tag	862	11.46	514	348
Water park	547	7.27	291	256
Football	407	5.41	7	400
Fitness equipment	368	4.89	207	161
Cycling equipment	361	4.80	76	285
Gym membership	357	4.75	182	175
Gym pay and play	211	2.81	134	77
Football equipment	122	1.62	10	112
Skateboard equipment	94	1.25	62	32
Swimming equipment	77	1.02	71	6
Foot golf	69	0.92	19	50
Martial arts equipment	55	0.73	28	27
Parkour	48	0.64	0	48
Swimming	48	0.64	20	28
Miscellaneous equipment	37	0.49	36	1
Equipment from Nash Sport	34	0.45	7	27
Skateboarding	23	0.31	0	23
Equipment for school	19	0.25	0	19
Badminton	13	0.17	5	8
Boxing equipment	13	0.17	0	13
Tennis equipment	13	0.17	0	13
Rock climbing	10	0.13	10	0
Tennis	8	0.11	0	8
Martial arts	6	0.08	6	0
Gymnastics	4	0.05	3	1
Court hire	4	0.05	0	4
Paintballing	4	0.05	4	0
Aqua aerobics	3	0.04	0	3
Kickboxing	3	0.04	0	3
Play area	3	0.04	2	1
Zumba	3	0.04	3	0
Aqua zumba	2	0.03	2	0

activity they really enjoyed or bought equipment that could have a long-term effect.

Using external influences (eg, peer mentors and a support worker)

Using external influences to promote physical activity was a contested issue on ACTIVE. When asked about the peer mentoring scheme, most teenagers were unaware of it. The peer mentors themselves said they did not have anything to do, that they needed more 'recognition of who they were' (girl, focus group 8) or that the scheme would have benefit from 'a meeting, once a month, or something' (boy, focus group 7). Some pupils also said they did not feel the need to go to them. There were issues raised with the selection of peer mentors. They suggested that a teacher should select the peer mentors 'to look at who does most sports in the school' as a good role model (boy, focus group 3). One member of the local council suggested that pupils should put themselves forward and then there be a vote, but another felt that 'perhaps the people that put themselves forward might not be the people that you actually want' (council focus group).

The teenagers thought that presence of the support worker was beneficial as they created awareness of what was new or 'if anything had changed, which was really informative and nice' (boy, focus group 1). However, some pupils noted that the timings of the support worker were not ideal; in particular, they said morning assemblies are a time when they do not pay attention. The council focus group noted that the support worker was a difficult role as it had a variety of responsibilities from voucher distribution to activity promotion and drop-in sessions in schools. They perceived the support worker role to be a hard position and that the personality of the individual was the most important factor when considering who should fill it.

The intervention's settings

Most teenagers stated that there was very little within walking distance and that more activities should be put in the local community. However, the local council felt teenagers did not know all that was available and felt there could be a greater awareness created of community provision. One council member suggested that ACTIVE could have promoted the providers better in the schools. The project could have showed a video, for example, as this might capture the kids or activity providers should promote more of 'showing what they [the teenagers] would get if they went to see these providers' (council focus group). They believed the promotion was a weak aspect of ACTIVE.

There was a lot of discussion centred on physical activity lessons in school. Teenagers wanted more opportunities to be active through 'sports clubs at (lunch) dinner break and break' (boy, focus group 5) in school, for timings of activities to be lengthened, school kit for physical education (PE) lessons to be more lenient and more choice offered. The local council discussed teacher's involvement in ACTIVE, as they believed they had a pivotal role in the project's success. Some teachers were really proactive and 'really pushed the project' (council focus group) therefore, the intervention ran well. However, in other schools, 'there wasn't that many links between the PE department' (council focus group) which hindered delivery.

DISCUSSION

This study identifies three key themes were identified that addressed the strengths and weaknesses of the delivery of the ACTIVE Project. While teenagers and the local council saw choice and support worker engagement as strengths of the project, there were issues explored around peer mentoring and ACTIVE's settings.

Young people felt the vouchers allowed them to overcome the barrier of cost as they were able to pay for activities. This is a significant strength of the project as it addressed the accessibility barrier.[8–10] When empowered to choose activities they wanted, teenagers chose accessible, fun, activities that appealed to both genders, needed no prior skill and no prebooking. This suggests to get teenagers active there should be more of these types of activities promoted and made available.[8 10 18] The informality of the activities promoted socialisation, meaning teenagers could meet up with their friends more outside of school. This was influential in giving teenage girls in particular, the confidence and encouragement to be more active.[18] The local council also believed this choice would benefit the long-term success of ACTIVE as the teenagers could also buy equipment. From this intervention, it appears that choice and chance to speak about their activity preferences is a significant factor in a successful physical activity intervention.

Teenagers and the local council agreed that provision of sport was not the way forward but there needed to be more unstructured, informal opportunities.[10] The use of the vouchers suggested they were used for a range of activities including days out, something to do with friends, ways to improve confidence and self-esteem and to buy equipment. Previous interventions have chosen to promote structured activity[14 15] and this may be a contributing factor to the lack of long-term success of these interventions. ACTIVE highlights that what is currently provided is not what teenagers want to do. Despite the evidence of peer mentoring working in other health interventions in this age group,[22 27] most pupils seemed to have little to no awareness of the peer mentors or they believed there was issues with their selection. It was important for teenagers who the mentors act as role models for activity but noted that those selected ended up being the most popular rather than the most active. Therefore, it is essential that correct characteristics be sought after when selecting peer mentors and that a more rigorous selection process be put in place rather than the use of peer nomination questionnaire.[27] There is not a one size fits all approach to peer mentoring. However, given the participants wanted to be active with their friends in a social and fun environment, it is possible that the peer mentor approach of a mentor is too structured and an 'expert' peer is the wrong approach for motivating teenagers in deprived areas. The support worker was seen as helpful and an important link between pupils, schools and collaborative partners. However, more could be done to strengthen the impact this role had in terms of school visit timings. In future, it would be useful to involve pupils from the beginning to discuss how an external influence could most benefit them.

In terms of the interventions' setting, some pupils queried how much was actually available in their area suggesting that lack of local facilities and accessibility was a significant barrier for these teenagers.[8 9 38] The local council argued that there was a lack of awareness and they suggested that the support worker's role could improve awareness. This does highlight one of the difficulties in the support worker role; should they empower teenagers to be able to access activities they want or promote activities that are available but perhaps ignored by the teenagers.

Pupils agreeing that there was too little time and emphasis placed on activity in school. Teenagers wanted more opportunities to be active during school time and a choice in what they would like to participate in.[10] This is something future physical activity promoting interventions should take note of, as teenagers expressed a need for a wider choice of activity in school. The local council noted that the person taking responsibility as the contact in the school was vital in the delivery of an activity intervention and that buy-in from them would ensure success. This is important as the wrong lead in a school could hinder an intervention. Previous research has acknowledged this as well, noting that those in charge (eg, intervention leads and head teachers) need to be willing to allocate time to increase opportunities for teenagers to be active.[39] A more standardised approach to school and teacher investment would be beneficial, for example, ensuring the PE department are in charge of the project's delivery. School buy-in and promoting the importance of teenage activity levels and health also underpins this. The school is where teenagers spend a significant amount of time and any successful activity intervention needs to engage and have buy in from the school.[14 20]

LIMITATIONS

The use of focus groups enabled a more in-depth exploration of teenager's barriers to physical activity; only children consenting to take part in the study were able to be involved in the focus groups. These children could potentially be the more active and involved children, perhaps not capturing the views of those less engaged with activity and health and subsequently, the ACTIVE intervention. Only the local council were asked to participate in a focus group from the perspective of a collaborator and activity provider. The viewpoints of other stakeholders may have differed based on their voucher usage, promotion from ACTIVE and funding (eg, if they were a charity or privately funded).

CONCLUSION

The ACTIVE Project's delivery had both strengths and weaknesses that could be used to underpin future physical activity promotion. Providing teenagers a choice coupled with financial support in deprived areas was a strength of the ACTIVE. Teenagers reported to be able to do activities they wanted with their friends and changed their perceptions of physical activity. Thus, providing evidence that a voucher scheme works to get young people more active.[25 26] Teenagers would like this choice translated into the school setting and into community provision. However, there is some tension between what teenagers believe is on offer in their local area and what the council believes can be access. The take home message from this study is that more collaboration needs to happen between teenagers, activity provision and policymakers to ensure their wants and needs are met. Further work is needed on how the intervention's strengths and weaknesses can underpin a larger scale project that can reach a bigger number of teenagers. This work highlights recommendations for future work in promoting activity among young people; namely improving access to fun, unstructured and social activities.

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Contributors Swansea University designed the study and collected, analysed and interpreted the data. The university also wrote this study paper and made the decision to submit. MJ wrote the first draft of the paper and all authors provided critical input and revisions for all further drafts. SB wrote analysis and results section and provided critical input and revisions for all further drafts. MJ, CT, SS, EI, JD and SB undertook data collection and data analysis. DC, CT, SB, GS, JH, SA, SM and EAE designed the study, aided in interpretation of findings and supervision of study quality. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. All authors would like to thank the staff at the participating schools for their co-operation during the study and the year 9 pupils for their views and opinions as well as participation.

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Appendix 12 Predictors of Cardiovascular Health in Teenagers (aged 13 – 14 years): A Cross-Sectional Study Linked with Routine Data

Open access Cardiac risk factors and prevention

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Predictors of cardiovascular health in teenagers (aged 13–14 years): a cross-sectional study linked with routine data

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ABSTRACT

Objective To examine the predictors of cardiovascular health in teenagers (aged 13–14 years).

Methods Measures of arterial stiffness (augmentation index (AIx)), blood pressure and cardiovascular fitness were taken from 234 teenage children (n=152 boys) and subsequently linked to routine data (birth and general practice records, education data and hospital admission data). Deprivation at school and at individual level was measured at birth, at 1 year old, at 13 years old and at secondary school using the Welsh Index of Multiple Deprivation. Multivariate regression analysis determined associations between routinely collected data and cardiovascular measures.

Results Teenagers had higher AIx (2.41 (95% CI 1.10 to 3.72)), ran fewer metres (−130.08 m (95% CI −234.35 to −25.78)) in the Cooper Run Test if they attended a more deprived school. However, higher individual level deprivation was associated with greater fitness (199.38 m (95% CI 83.90 to 314.84)). Higher systolic blood pressure was observed in first born children (10.23 mm Hg (95% CI 1.58 to 18.88)) and in those who were never breastfed (4.77 mm Hg (95% CI 1.10 to 8.42)).

Conclusions Improving heart health in deprived areas requires multilevel action across childhood namely, active play and programmes that promote physical activity and fitness and, the promotion of breastfeeding. Recognition of the important early indicators and determinants of cardiovascular health supports further development of the evidence base to encourage policy-makers to implement preventative measures in young people.

Key questions

What is already known about this subject?

► Cardiovascular disease (CVD) is the leading cause of death in the Western world. More recently, greater emphasis has been placed on the role of increased arterial stiffness, high blood pressure and sedentary behaviour as predictors of CVD risk in populations. Identifying and addressing CVD risk factors in early life could prevent or delay disease in later life. We reviewed the literature and found that positive associations have been shown between a child's body mass index and CVD risk in adulthood, particularly among those from lower socioeconomic status. A meta-analysis of interventions targeting obesity and activity as methods of prevention in children concluded that high levels of leisure time activity benefit cardiovascular health. However, there was little evidence regarding the prognostic impact of a child's early environment and cardiovascular phenotype on cardiovascular outcomes. Breastfeeding has been identified in three studies as a protector against high blood pressure but this link has been described as modest.

What does this study add?

► Our study identifies predictors of cardiovascular health in teenagers through data linkage with the Secure Anonymised Information Linkage databank. Routine health data was linked with baseline data collected during a physical activity intervention. There is relatively little previous research into early life and environmental impacts on young people's cardiovascular health. Our study suggests that supporting breastfeeding, improving physical activity opportunities for teenagers in deprived areas, enabling teenagers with chronic health conditions to be active and encouraging active transport at all ages may be beneficial to heart health and reducing CVD risk and warrants prospective evaluation.

How might this impact on clinical practice?

► Our findings highlight issues where public health interventions (eg, breast feeding, parent groups, improving physical activity provision) may improve long-term cardiovascular health outcomes.

INTRODUCTION

Cardiovascular disease (CVD) affects seven million people in the UK and is the leading cause of death in the Western world.[1] CVD risk factors should be low in young people, but the rise in childhood inactivity and poor fitness levels has led to an increase in prevalence and potential impact on lifetime CVD risk.[2,3] Identifying and addressing important CVD risk factors in early life could prevent symptoms in later life. Pathological changes in the arterial wall are well recognised to begin in childhood.[4]

Positive associations have been shown between a child's body mass index and CVD risk in adulthood, particularly among those from lower socioeconomic status.[5] Deprivation has been associated with poorer cardiovascular fitness levels, higher obesity levels and consequently higher CVD risk.[6] Young people with lower socioeconomic status are less likely to engage in activity in the form of structured activities and competitive sports[7] and are subsequently at an increased risk of more sedentary lifestyles. These traits may also cluster with other health behaviours (eg, diet) which could also contribute to CVD risk when a child is older. Consequently, prevention strategies that decrease sedentary behaviour and improve nutrition have been designed to combat this issue.[6 8–10]

Early life behaviours may also contribute, for example, breastfeeding may protect against hypertension,[11–13] although this relationship has been described as modest. Less is known about the relationship between early life exposures and subsequent cardiovascular phenotype in young people and longer-term CVD risk. Therefore, increased study of these relationships in early life may provide important insights into how best to implement interventions in young people to prevent CVD.

This paper aims to identify predictors of cardiovascular health in teenagers (aged 13–14 years) which is an under-researched area of teenage health. Cardiovascular phenotype data were collected as part of baseline data collection from the Active Children through Individual Vouchers—Evaluation (ACTIVE) project, a mixed method randomised control trial (RCT) based in south Wales, UK. The ACTIVE RCT aimed to improve the cardiovascular fitness, cardiovascular health and motivation of teenagers to be active[10] and, therefore, included measures of augmentation index (AIx), blood pressure and fitness. This paper is a cross-sectional analysis of baseline measures linked with routinely collected data from the National Community Child Health Database (NCCHD) and the Tagged Electronic Cohort Cymru (TECC). These databases include data from the child health system in Wales, including birth registration, maternal health and monitoring of child health examinations.

The relationships between arterial stiffness, blood pressure and fitness with important early life influences (eg, deprivation and maternal influences) at population level are less well known and exploring these will add to knowledge and inform novel approaches to clinical practice regarding CVD risk. Furthermore, findings can inform early public health intervention approaches in this area. This paper assessed if there are any early life indicators that make teenagers more vulnerable to cardiovascular risk.

METHODS

Participants and settings

The ACTIVE Project was a mixed method RCT based in seven secondary schools in South Wales[10] with the aim of improving the cardiovascular fitness and health and motivation of teenagers. A detailed trial protocol (Trial Number: ISRCTN75594310) has been published.[10] A total of 13 schools were assessed for eligibility to take part in ACTIVE; four did not meet inclusion criteria of being located in one of Wales' most deprived areas. School and individual level deprivation was derived from the Welsh Index of Multiple Deprivation (WIMD) which is used to identify areas of deprivation based on income, employment, health, education, access to services, community safety, environment and housing.[14] For this study, the continuous WIMD scale was used for individual and school level deprivation with one equating to the most deprived areas and 1909 to the least deprived.

Table 1 Demographics of schools

	Wales Index of Multiple Deprivation of the school*
School 1	1660
School 2	326
School 3	84
School 4	56
School 5	1434
School 6	1610
School 7	426

*The Welsh Index of Multiple Deprivation (WIMD) is the official measure of small area deprivation in Wales

Two headteachers declined to participate, one of whom declined after randomisation occurred. This meant seven secondary schools took part in the RCT. The demographics of the schools can be seen in table 1. This paper examines the baseline data collected from ACTIVE and, therefore, includes one cohort prior to randomisation.

Following initial school recruitment and headteacher approval, participants (in school year 9, aged 13–14 years) were recruited for measures via school assemblies and information sheets. Consent was voluntary and involved both written parental consent and pupil assent forms. All pupils in school year 9 were eligible to participate to create a cohort representative of teenagers from deprived areas. No pupils were excluded from participation. A total of 234 (n=152 boys) out of 1023 pupils across the seven schools (23%) were recruited. Basic demographics of participants can be seen as table 2.

Procedures

Cross-sectional measurements of baseline phenotype data were linked to routine data (general practice, hospital and education records) to develop a retrospective cohort. Routinely collected data from the NCCHD, which contains birth information of children, and the TECC, which provides GP visits and hospital admissions for key comorbidities, were linked via the Secure Anonymised Information Linkage (SAIL) databank. These databases include data from the child health system in Wales, including birth registration, maternal health and

Table 2 Population demographics

Variable	Male (n=129) (SD)	Obs	Female (n=105) (SD)	Obs
Arterial stiffness (%)	9.54 (5.58)	129	10.17 (4.67)	105
Blood pressure (mm Hg)	114.47 (13.86)	129	110.42 (11.62)	105
Cardiovascular fitness (metres ran)	2004.98 (412.92)	129	1604.98 (266.19)	105
School deprivation	674.60 (677.01)	129	642.76 (688.17)	105
Deprivation at birth	744.27 (559.9)	109	573.93 (468.94)	86
Deprivation at 1	665.25 (557.14)	108	595.45 (470.16)	84
Deprivation at 13	734.07 (534.4)	126	663.6 (482.38)	102
Birth weight (g)	3368.23 (576.38)	113	3257.35 (597.67)	90
Gestational age (weeks)	38.99 (1.82)	111	38.81 (2.48)	90
Birth number	1.02 (0.15)	128	1.01 (0.13)	102
Maternal age (years)	26.9 (5.78)	120	26.57 (5.88)	94
Breastfed (%)	48.44 (n=62)	128	40.20 (n=41)	102
C section (%)	19.38 (n=25)	129	23.81 (n=25)	105
Hospital admission (total number of admissions)	1.63 (2.01)	125	1.33 (2.85)	101
General Practice (GP) visits (total number of GP visits)	74.17 (43.24)	98	63.67 (34.00)	78
Sedentary time (Week) (min)	627.21 (82.53)	129	601.96 (79.08)	105
Sedentary time (Weekend) (min)	621.55 (115.31)	129	563.62 (120.11)	105
Moderate to Vigorous Physical Activity (MVPA) (Week) (min)	81.39 (22.10)	129	78.47 (24.25)	105
Moderate to Vigorous Physical Activity (MVPA) (Weekend) (min)	56.57 (20.67)	129	61.86 (26.06)	105

monitoring of child health examinations which include exposures that could predict cardiovascular risk.

Further information about the routine data included in the analysis can be seen as online supplementary file 1. All phenotype data included in this study were taken from the baseline data collection of the ACTIVE Project between September and December 2016. Data collection was organised in the schools with the aim of avoiding disruption to school timetables.

This paper uses measures of AIx, systolic blood pressure and cardiovascular fitness (Cooper Run Test (CRT)) as indicators of cardiovascular health. Higher AIx and blood pressure are both associated with increased CVD risk.[15–17] Poorer fitness has also been attributed to CVD risk.[2 3]

Aim

By using data linkage to routine data, this study assessed if there are predictors of poorer cardiovascular health and CVD risk in teenagers in relation to measures of AIx, systolic blood pressure and cardiovascular fitness.

Augmentation index (AIx)

AIx was assessed using the Vicorder (Skidmore Medical Limited, Bristol, UK). Measurements were taken with the participants seated following a 5 min rest during which a SC10 Hokanson cuff was positioned around their upper left arm. The cuff was inflated to measure blood pressure; it was then reinflated to record the brachial artery pulse-pressure waveform. Central AIx was determined from the blood pressure and waveform using a transfer function integral to the software. This process was repeated and if both measures of AIx were within ±5%, the two measures were accepted, if not, a third reading was taken and a mean of all three readings calculated.

Blood pressure

Blood pressure was measured with a standardised upper arm cuff methodology using an Omron M2 sphygmomanometer. After resting seated for 5 min, participants had three measurements taken from their left arm, with the average calculated. If there was a difference of ±5 mm Hg between the readings, researchers took an additional measure. Participants did not fast prior to these measurements.

Cardiovascular fitness

Participants took part in the CRT to assess cardiovascular fitness.[18] This was a 12 min walk/run test conducted during physical education (PE) lessons where participants completed as many laps of a school sports hall as possible in the time. This was then converted to the total distance ran (in metres). The validity of the CRT has been tested in numerous studies in both girls and boys.[19]

Data linkage

Data linkage was carried out through the SAIL databank[20] based at the Swansea University Medical School (UK). This occurred via linking AIx, systolic blood pressure and cardiovascular data with routinely collected health data, for example, deprivation at school and at home, birth weight and hospital admissions. A unique Anonymous Linking Field was assigned to person-based records before it was joined to clinical data via a system linking field.[21]

Routine data came from the NCCHD and the TECC. The full list of covariates and how they were cleaned can be seen as online supplementary file 1. Deprivation at school and individual level was the only variable to be measured at different time points (at birth, at 1 year old and at 13 years old). This was done to explore whether moving in and out of deprived areas during life affects heart health and whether deprivation impacts heart health at a specific age.

Statistical analyses

Linear mixed effects multilevel regression was used to analyse the relationship between routine data on (1) AIx, (2) systolic blood pressure and (3) cardiovascular fitness. Covariates were excluded from the analysis if they had missing data on over 100 participants, and a full list can be seen as online supplementary file 1. Gender was included in the models to assess any differences by gender. The level of significance for the results of statistical analysis was set to p<0.05. Structural equation modelling (SEM) in STATA was also used to show relationships between routinely collected data and the cardiovascular phenotypes collected in this study. Two independent statisticians conducted a parallel data analysis in STATA (V.15.1) to avoid researcher bias.

Multiple imputation of missing data was conducted using chained equations (MICE) command in STATA as data was assumed to be missing at random due to absence during some aspects of baseline testing. Data for the primary outcome of cardiovascular fitness was imputed for 27 participants using gender and deprivation. This generated one complete dataset which was used for analysis.

RESULTS

Table 2 shows the demographics of participants. Boys had higher measures across most variables including deprivation levels, hospital and GP visits and sedentary time. However, these differences were marginal except for differences in cardiovascular fitness which shows boys as a population were fitter than girls at this age. Results from the multilevel analysis are presented as tables 3–5, respectively. Figure 1 shows relationships via SEM.

Augmentation index

Analysis showed higher AIx measures was associated with a lower school WIMD score (indicating higher levels

Table 3 AIx (linear mixed effects multilevel regression)

Variable	Coefficient	P value	95% CI
School deprivation	−0.003	**0.010**	**−0.005 to −0.0007**
Deprivation at birth	0.0008	0.506	−0.001 to .003
Deprivation at 1	0.001	0.488	−0.002 to .005
Deprivation at 13	−0.0002	0.886	−0.003 to .002
Gender	1.26	0.383	−1.57 to 4.10
Birth weight	−0.002	0.088	−0.005 to .0003
Gestational age	0.314	0.403	−0.423 to 1.05
Birth number	−8.10	0.019	−14.85 to −1.34
Maternal age	−0.072	0.536	−0.300 to .156
Breastfed	1.22	0.513	−0.181 to .050
C-section	0.472	0.780	−2.83 to 3.78
Hospital admissions	−0.363	**0.007**	−0.627 to −0.099
GP visits	0.030	**0.006**	**0.008 to 0.052**
Sedentary time week	−0.011	0.054	−0.046 to .024
Sedentary time weekend	0.011	0.196	−0.005 to .028
MVPA time week	−0.054	0.065	−0.113 to .003
MVPA time weekend	−0.003	0.907	−0.066 to .059
Blood pressure	−0.065	0.268	−0.181 to .050
Fitness	−0.001	0.581	−0.005 to .002

Those highlighted inbold indicate significance (p value < 0.05)

Table 4 Blood pressure (linear mixed effects multilevel regression)

Variable	Coefficient	P value	95% CI
School deprivation	−0.001	0.530	−0.008 to 0.004
Deprivation at birth	0.003	**0.000**	**0.001 to 0.007**
Deprivation at 1	−0.007	0.276	−0.019 to 0.005
Deprivation at 13	0.004	0.348	−0.005 to 0.014
Gender	5.32	0.111	−1.22 to 11.87
Birth weight	−0.0008	0.802	−0.007 to 0.005
Gestational age	0.333	0.795	−2.18 to 2.84
Birth number	**−29.96**	**0.000**	**−46.04 to −13.88**
Maternal age	0.205	0.630	−0.631 to 1.042
Breastfed	**−6.09**	**0.042**	**−11.96 to −0.22**
C-section	**5.15**	**0.012**	**1.13 to 9.16**
Hospital admissions	0.096	0.769	−0.544 to 0.736
GP visits	−0.011	0.677	−0.064 to 0.041
Sedentary time week	0.069	**0.010**	**0.28 to 0.11**
Sedentary time weekend	−0.032	0.037	−0.06 to −0.001
MVPA time week	−0.07	0.972	−0.22 to −0.085
MVPA time weekend	−0.01	0.839	−0.189 to −0.154
AIx	−0.44	0.310	−1.29 to 0.40
Fitness	−0.007	0.079	−0.015 to 0.0008

Those highlighted inbold indicate significance (p value < 0.05)
AIx, augmentation index.

Table 5 Cardiovascular fitness (linear mixed effects multilevel regression)

Variable	Coefficient	P value	95% CI
School deprivation	0.020	0.673	−0.070 to 0.116
Deprivation at birth	0.163	**0.007**	**0.045 to 0.281**
Deprivation at 1	−0.002	0.983	−0.233 to 0.228
Deprivation at 13	−0.112	0.371	−0.358 to 0.133
Gender	**389.50**	**0.000**	**233.693 to 545.307**
Birth weight	−0.001	0.987	−0.202 to 0.198
Gestational age	−9.30	0.729	−61.98 to 43.37
Birth number	**−1216.631**	**0.000**	**−1500.44 to −932.81**
Maternal age	**16.33**	**0.044**	**0.454 to 32.21**
Breastfed	195.72	0.063	−10.69 to 402.13
C-section	93.22	0.372	−111.61 to 298.06
Hospital admissions	−3.74	0.800	−32.77 to 25.27
GP visits	1.23	0.341	−1.30 to 3.76
Sedentary time week	−1.24	0.374	−4.42 to 1.92
Sedentary time weekend	1.48	0.099	−0.375 to 3.35
MVPA time week	−2.85	0.052	−5.73 to .026
MVPA time weekend	−2.08	0.448	−8.38 to 4.20
AIx	−5.42	0.606	−26.05 to 15.20
Blood pressure	−5.16	0.013	−9.23 to −1.08

Those highlighted inbold indicate significance (p value < 0.05)

of deprivation) (−0.003 (95% CI −0.005 to −0.0007), table 3). Lower hospital admissions (−0.363 (95% CI −0.627 to −0.099)) but higher number of GP visits (0.030 (95% CI 0.008 to 0.052)) also had significant relationships with higher AIx. School deprivation was also significant in the SEM (figure 1).

Blood pressure

Lower systolic blood pressure was observed in teenagers who were first born (−29.96 mm Hg (95% CI −46.04 to −13.88), table 4) and those who were breast fed as infants (−6.09 mm Hg (95% CI −11.96 to −0.22). Being born as a result of caesarean meant blood pressure was higher as a teenager (5.15 mm Hg (95% CI 1.13 to 9.16)). As well as this, being more sedentary in the week was associated with higher blood pressure (0.068 mm Hg (95% CI 0.28 to 0.11)). SEM included gender as a predictor of having higher blood pressure too (figure 1).

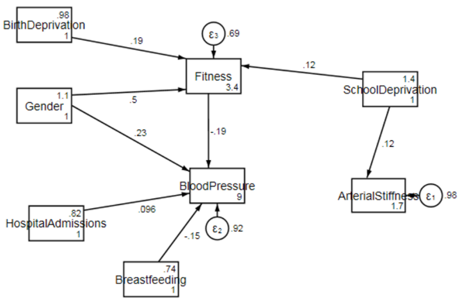

Figure 1 Path analysis.

Fitness

Teenagers who were more deprived at birth ran further in the fitness testing (0.163 (95% CI 0.045 to 0.281), table 5). Boys were more likely to run further than girls (389.50 m (95% CI 233.69 to 545.30), table 4). Interestingly, teenagers were less fit if they were not first born (−1216.63 (95% CI −1500.44 to −932.81)) but were more fit if their mothers were older (16.33 (95% CI 0.45 to 32.2)). SEM showed that school deprivation also had a relationship with fitness that was not present in the multilevel regression.

DISCUSSION

Although a relatively small study, our work demonstrates the feasibility and great value of linking paediatric clinical study data to routinely held healthcare records. This study has revealed interesting relationships between school deprivation and the cardiovascular phenotype in teenagers. First, AIx was greater in pupils attending deprived schools (schools in socioeconomically deprived areas) suggested they already had stiffer arteries by their early teens. Other confounders could explain the adverse cardiovascular phenotype in children attending deprived schools such as poor nutrition, tobacco exposure and increased psychosocial stress but this would require further evaluation.

Teenagers whose mothers reported breastfeeding were associated with lower systolic blood pressure consistent with previous literature.[11] These findings add to the evidence base supporting a beneficial impact of breastfeeding on blood pressure as a teenager. Longer duration breastfeeding has also been shown to have a beneficial effect on cardiorespiratory fitness.[12] Future research should explore this relationship further as supporting and promoting breastfeeding could provide beneficial long-term implications for teenager's health.

This study has shown that being first-born is better for systolic blood pressure and cardiovascular fitness. There is some evidence that early born children have greater access to resources and attention.[22] This may account for better fitness measures if first-born children are having greater access to physical activity opportunities, equipment and facilities. This is worthy of further investigation and, coupled with the finding that older mothers have fitter children, provides evidence that support for larger families, with younger mothers is needed to facilitate equality of activity and socialisation opportunities and resources. Being active in this way at an early age could track into later life and could reduce the risk of poor heart health.[6] Early physical activity promotion in children may provide an accessible and low-cost method of preventing poor heart health in later life.

Boys were significantly fitter than girls were (based on metres ran in the CRT). This is unsurprising as most literature suggests boys are more active and thus fitter.[9 23–25] Boys generally have a higher amount of lean body mass at this age, which could contribute to better cardiovascular fitness levels.[26] Programmes that target girls activity and fitness have been implemented,[27–29] but this study provides evidence there are still differences between boys and girls and more needs to be done. There were no other significant differences between genders for the measures.

Teenagers in more deprived schools appeared fitter. Schools in deprived areas typically offer less PE time[30] and provide fewer opportunities for sports and physical activities in and after school.[30 31] However, this finding suggests that despite being less likely to engage in physical activity, in the form of structured (competitive) sports clubs, it may be that participants from more deprived areas engage more low cost, unstructured activities or active travel due to the cost of running a car or using public transport.[6] This could account for higher fitness levels as, despite being an exposure, MVPA was not significant in influencing fitness.

Research has shown that there are cardiovascular benefits associated with all levels of activity.[32] Active travel in particular has been associated with healthier body compositions and cardiovascular fitness in this age group.[33] As shown by previous research, the importance of promoting different types of activity in young people cannot be overstated,[2 32 34] particularly in the deprived school settings as highlighted by this study. In this instance, school level deprivation was more strongly associated with an adverse cardiovascular phenotype in teenagers than home deprivation, which is worthy of further study.

Limitations

This study was only able to measure cardiovascular measures in teenagers who consented to participate in this study, thus these individuals may have been more motivated and interested in being active. It is possible that the teenagers who did not consent were less interested or motivated to be active. Therefore, this study may be illustrative of the factors associated with the cardiovascular phenotype in predominantly more active teenagers with better cardiovascular fitness and heart health.

This is a relatively small study reporting the findings of 234 teenagers in south Wales; the results may not be generalisable to the wider UK or international populations and will require validation in larger, prospective studies. ACTIVE did not collect data on existing medical conditions, medications, recent infections or anthropometry, which can influence cardiovascular health. This can be seen as a limitation. Future studies could use this level of participant information for more detailed analysis of predictors of cardiovascular health.

The path analysis shows that even though relationships were present, these relationships only explained a small proportion of variation in AIx and blood pressure in particular and warrant further evaluation in larger prospective studies ideally with careful documentation of important covariates including anthropometric and serological measurements to add greater depth to analysis.

CONCLUSION

This study provides evidence of early life indicators, which may make teenagers more vulnerable to poorer cardiovascular health in adolescence and potentially greater lifetime risk of CVD. Interventions could target schools in deprived areas to improve heart health. For example, improving access to and uptake of a variety of activities that promote different types of physical activity, rather than simply aiming to reduce sedentary behaviour such as active travel or low cost, easy to access physical activities outside the school environment. Promotion of breastfeeding and play/socialisation support for younger, larger families may also have a beneficial effect.

Recognition of the important early indicators and determinants of cardiovascular health would warrant further development of the evidence base to encourage policy-makers to implement preventative measures in young people.

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Disclaimer The lead author (MJ) affirms that the manuscript is an honest, accurate and transparent account of the study being reported; that no important aspects of the study have been omitted and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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