Do Age Stereotype-Based Interventions Affect Health-Related Outcomes in Older Adults? A Systematic Review and Future Directions.

AGE STEREOTYPE INTERVENTIONS AND HEALTH

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Data availability statement:

The data that supports the findings of this study are available in the supplementary material of this article.

Acknowledgements:

This work was supported by a Cotutelle PhD Scholarship from Swansea University and Université Grenoble Alpes. We have no known conflict of interest to disclose. No part of the content of this manuscript has been presented elsewhere. Our thanks to Parisa Eslambolchilar for assistance with the development of the initial review protocol.

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Abstract

Purpose - Developing interventions that target population-specific motivational barriers to promote health behaviours is crucial, especially for older adults who are confronted with negative age stereotypes. This systematic review evaluates randomised and non-randomised field studies that tested the effects of age stereotype-based interventions on health outcomes, in adults aged 50 years and over.

Methods - MEDLINE, SPORTDISCUS, Scopus, Web of Science Core Collection and PsychINFO were searched to identify articles published up until May 2019. Data were extracted from all articles independently and assessed for risk-of-bias using Cochrane Collaboration tools.

Results - Ten articles met the inclusion criteria. Health-related outcome measures were identified across three domains: physical, psychological/psychosocial well-being, and quality of life/subjective health, with age stereotypes reported as an additional outcome. Intervention structure varied substantially between studies regarding content, duration, frequency, and length of follow-up.

Conclusions – Most studies showed that age stereotype-based interventions significantly improved physical function or physical activity, as well as self-perceptions of ageing. However, more rigorous studies are needed. Indeed, given the detrimental health effects of age stereotypes, the potential for impact of interventions designed to challenge them is important. Future research should explore: the implications of intervening on different stereotype mechanisms; whether intervention effects are comparable across health domains;

and whether age stereotype-based interventions are more effective than non-age-specific interventions. PROSPERO Registration CRD42018094006.

Keywords: ageism; physical activity; quality of life; psychological well-being

Introduction

The world's population is ageing. By 2030, it is predicted that 25% - 30% of the European population will be at least 65 years old (Mamolo & Scherbov, 2009). Despite globally reported statistics indicating that average life expectancy is continuing to increase, 10% - 13% of life years are still lived in poor health (World Health Organization [WHO], 2019). The consistent engagement of older adults with behaviours known to positively influence physical and mental health, such as physical activity, provides one of the biggest contemporary challenges (Forberger et al., 2017). Indeed, older adults remain one of the least active population segments, with 60% of adults aged 65 years and older not reaching adequate physical activity levels worldwide (Hallal et al., 2012).

Combatting physical inactivity and promoting health behaviours in older adults requires the development of behavioural interventions that effectively promote healthy habits. However, many behaviour change techniques used with younger adults, such as goal setting, self-monitoring, or providing feedback, are not effective for older adults (for a review see French et al., 2014). This is due, at least in part, to older adults having distinct, population-specific, motivational barriers with suggestions that such barriers may be partially subjective and result from the influence of *age stereotypes* (Levy, 2009).

Age stereotypes are characteristics, generalisations or assumptions about how individuals at a particular age are viewed and should behave (Ory et al., 2003). They often negatively depict later life (e.g., ill health, decreased functional ability). Importantly, longitudinal prospective studies show negative age stereotypes are associated with adverse effects on older adults' physical and functional health (Levy et al., 2002; Wurm et al., 2010) and longevity (Kotter-Grühn et al., 2009). Moreover, controlled, experimental studies have shown that inducing negative stereotypes may increase autonomic responses to stress (Levy

et al., 2000), inhibit cognitive function and memory (Barber et al., 2015; Haslam et al., 2012), and reduce physical function (Chiviacowsky et al., 2018).

Several mechanisms could explain the effects of age stereotypes on older adults' health. *Stereotype embodiment theory* (Levy, 2009) proposes that age stereotypes are internalised into self-perceptions of ageing in later life, which affect health behaviours (Levy & Myers, 2004), and subsequently health outcomes, such as recovery from acute myocardial infarction (Levy et al., 2006), dementia development (Levy et al., 2018), or longevity (Levy, Slade et al., 2002). *Stereotype threat theory* (Steele & Aronson, 1995) proposes that individuals underperform or disengage when they feel at risk of confirming negative views about their abilities. In a meta-analysis of 22 published and 10 unpublished studies, Lamont, Swift, and Abrams (2015) identified that age-based stereotype threat significantly affected performance across health domains in older adults (mean $d = 0.32$) regardless of gender, age or underlying health status. Finally, stereotypes may also influence health outcomes more directly. *Ideomotor theory* applied to age stereotypes (Levy, 2009) suggests that priming stereotypes (usually implicitly) may directly affect behaviours, without mediation by self-perceptions of ageing, or concerns of being negatively stereotyped. For example, subliminally presented positive age stereotypes have improved older adults' physical function (Levy & Leifheit-Limson, 2009) and influenced their will to live (Levy et al., 1999-2000).

Overall, this literature indicates that age stereotypes can be a barrier to older adults' engagement in health behaviours. Thus developing interventions which reduce the negative impact of stereotypes on health outcomes may offer a promising approach to promote healthy ageing. Whilst previous reviews have investigated how manipulating age stereotypes affects health outcomes, these only included laboratory-based studies (see Armstrong et al., 2017; Lamont et al., 2015). To our knowledge, no systematic review has examined the effects of

field interventions targeting age stereotypes on health outcomes in older adults. The current review investigates this question in community dwelling older adults aged ≥ 50 years.

Methods

This review was designed and conducted in line with the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA, Liberati et al., 2009) and registered with PROSPERO; registration number CRD42018094006 available at: https://www.crd.york.ac.uk/prospero/.

Article Selection Criteria

Table 1 provides a full breakdown of article inclusion/exclusion criteria. Although older adults are defined by WHO (2015) as aged ≥ 65 years, initial literature scoping identified that previous research has used an inconsistent age range to define someone as an "older adult", varying from 50 years of age upwards. To ensure a comprehensive overview of all relevant studies targeting "older adults", the age range criterion was defined as any study including participants aged ≥ 50 years. Studies meeting this criterion, but which also included participants under 50 years, were excluded.

-------*Insert Table 1 Here*------

Data Sources, Searches and Study Selection

Electronic databases (EBSCOhost MEDLINE, EBSCOhost SPORTDiscus, Scopus, Web of Science Core Collection and EBSCOhost PsychINFO), limited to academic journals published in English from 1995 – April 2018, were searched by RLK. Database alerts were set, and new citations screened, until May 2019. Search terms were verified by a subject librarian and agreed by the review team. The Boolean terms used included, but were not limited to, ("older adul*" OR "senio*" OR "elderly") AND ("age stereotyp*" OR "ageism" OR "positive priming" OR "stereotype prejudice") AND ("memory" OR "physical activity" OR "quality of life" OR "views-on-ageing").

One author (RLK) screened all retrieved citations and abstracts; JH independently reviewed 10% of articles screened and all those coded "maybe" to ensure there were no discrepancies. The reviewers independently reviewed all articles retrieved in full text against the pre-defined inclusion/exclusion criteria. Disagreements were resolved through discussion. For details of secondary and grey literature search strategies, database specific restrictions, an example of the full search terms applied, and full details of the study selection process, see the online Supplementary Material.

Data Extraction

A form based on a Cochrane Collaboration template (Higgins et al., 2019), was used to extract data by RLK, including: authors; publication year; study design, setting, aim, hypothesis and methodology; sample size, participant demographics and baseline characteristics; outcome measure(s); exposure and follow-up time-point measurement; empirical results, and, risk-of-bias assessment information. Where applicable, The Behaviour Change Technique Taxonomy V1 (Michie et al., 2013), a nomenclature that classifies intervention components into 93 different behaviour change techniques, was used independently by two appropriately trained reviewers (RK and JH) to characterise the

'active' elements of interventions. A third unblinded reviewer (MM) independently reviewed all extracted data. No discrepancies were identified.

Quality Assessment

Two reviewers (RK, and MM or AC) independently assessed risk-of-bias and study quality for each reported outcome measure using the ROB 2.0 tool for randomised studies (Sterne et al., 2019) and the ROBINS-I tool for non-randomised studies (Sterne et al., 2016). In line with guidance, algorithms were followed to obtain a judgement for each assessed domain using the published article and available supplementary material. Studies with at least one domain scored as *high* risk-of-bias or with four or more domains of *some concerns,* were subsequently classified overall as high risk-of-bias. Studies were classified overall as *low* risk-of-bias only if all domains achieved this criterion (Sterne et al., 2019). Disagreements were resolved through discussion. No studies were excluded due to low quality or risk-of-bias, rather, all issues were considered when interpreting the results.

Data Synthesis

A descriptive summary and explanation of evidence robustness for each study is presented as a lack of homogeneity between studies in terms of design, interventions and outcome measures precludes a meta-analysis from being conducted. Themes focus on the effect of different intervention types on specific outcome domains. Findings are collated in a tabulated summary, grouped and synthesised according to study design and characteristics.

Results

Electronic database searching identified 14,236 articles, with a further 21 identified from secondary searches. Following removal of duplicates, 9,742 articles were screened, with 9,655 that did not meet the inclusion criteria excluded. The remaining 87 articles were retrieved in full text and assessed for eligibility, with 10 articles retained for the final analysis

(Figure 1). An overlap between four articles was identified[1], indicating the 10 articles represented the results of eight independently conducted studies. For clarity, the characteristics, results and risk-of-bias for each individual article are presented separately, but, where appropriate, findings between those linked are discussed together.

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Study Characteristics and Participants

All articles included in the review were published in English between 2009 and 2019, six were randomised control trials (RCTs) and four were non-randomised. The summation of participant data was deemed inappropriate due to the potential overlap between articles (Fujiwara et al., 2009 with Sakurai et al., 2016; Warner et al., 2016 with Wolff et al., 2014). Individual data for each article is presented with the study characteristics in Table 2. The REPRINTS study (Fujiwara et al., 2009; Sakurai et al., 2016) and AgingPlus Program (Brothers & Diehl, 2017) included some participants aged < 65 years old, however, normal distribution analysis showed at least 94% and 83% of participants, respectively, were aged > 64 years old. Although all studies provided demographic information on participant age and sex, only some provided further details, such as ethnicity (Belgrave, 2011; Brothers & Diehl, 2017; Levy et al., 2014) or health status (Brothers and Diehl, 2017; Warner et al., 2016; Wolff et al., 2014).

Intervention structure (content, duration, session frequency) and where utilised, control group parameters, varied substantially between the eight independent studies (see

[1] Fujiwara et al. (2009) and Sakurai et al. (2016), and, Warner et al. (2016) and Wolff et al. (2014) present different outcome data components and/or time-points from the same overall studies

Table 2). Follow-up periods ranged from two-weeks to seven years. Concerning content, two independent studies reviewed the impact of providing positive experiences through intergenerational contact (Belgrave, 2011; Fujiwara et al., 2009; Sakurai et al., 2016), a concept that it has been proposed could challenge age stereotypes, leading to positive health gains, through the provision of positive experiences and reductions in stereotype threat and negative attitudes (Abrahms et al., 2008; Pettigrew & Tropp, 2006). One study reviewed the impact of implicit and explicit priming of positive age stereotypes (Levy et al., 2014), one the impact of inducing positive views-on-ageing coupled with non-age-specific behaviour change techniques (Warner et al., 2016; Wolff et al., 2014) and four based their intervention around exercise provision. Whilst in Klusmann et al. (2012) exploring the implicit impact of exercise was the only intervention strategy, others targeted an additional component – perceptions of participants' own ageing (Beyer et al., 2019), suppressing negative attitudes and general thoughts about ageing (Brothers & Diehl, 2017; Emile et al., 2014). Health-related outcomes from three domains were identified: physical, psychological/psychosocial well-being and quality of life/subjective health, with age stereotype domain outcomes additionally categorised.

Six independent studies stated or implied their intervention was theoretically underpinned by a stereotype model. All relied on the stereotype internalisation process proposed by Levy (2009) within stereotype embodiment theory. Specifically, Beyer et al. (2019); Brothers and Diehl (2017); Emile et al. (2014); Klusmann et al. (2012); Levy et al. (2014); Warner et al. (2016), and Wolff et al. (2014), based their studies on this theory.

Risk-of-Bias

The risk-of-bias summaries for the six RCTs and four non-randomised articles are presented in Figures 2 and 3, respectively. Despite multiple domain assessments of *some concerns* indicating that the overall article risk-of-bias should be considered *high*, following

discussion between authors, Warner et al. (2016) and Wolff et al. (2014) were instead deemed to have an overall risk-of-bias of *some concerns*. This classification was based on the level of identifiable concern within each domain and partial provision of evidential support between the articles and within the study, that decreased, but did not nullify, these concerns. The online Supplementary Material presents the supporting justification for each study's individual outcomes.

------*Insert Figures 2 & 3 Here*------

Study Descriptions

Non-Randomised Studies

Four articles presenting three independent studies used non-randomised designs. Belgrave (2011) measured generativity and self-esteem in older adults following participation in an intergenerational music therapy intervention, compared with a usual-routine control group. During 10 sessions over a 12-week period, participants formed dyads with different children (mean age 9.5 years). Fujiwara et al. (2009) and Sakurai et al. (2016) also explored the effects of intergenerational contact during the REPRINTS study. Usual walk speed, hand-grip strength and self-rated health were measured nine months from baseline, with maximal walk speed, functional reach, one-leg stand, depression level and self-esteem additionally measured at a seven-year follow-up. Intervention group participants volunteered at Education or Child Care facilities once every one or two weeks. The control group continued life as usual. Participants who withdrew or changed groups/engaged in associated activities were excluded from analysis.

Conversely, Brothers and Diehl (2017) used a case-series design to establish the preliminary effects of an eight-week multi-component experimental personalised goal achievement programme. The intervention, based on the Health Action Process Approach (HAPA; Schwarzer, 2008), aimed to challenge negative views-on-ageing, operationalised as a composite of awareness of age-related change, age stereotypes, expectations regarding one's own ageing, and subjective age. Views-on-ageing, self-perceptions of ageing, and self-reported physical activity levels were measured four-weeks post-intervention. Additional measurements of views-on-ageing and self-perceptions of ageing were taken at week four. The moderation of age on training effect was also examined.

RCTs

Six articles, including five independent studies, used randomised designs. Beyer et al. (2019) embedded a psychological intervention into an exercise session for older adults. Information targeting self-perceptions of ageing in losses and gains domains was provided once a week for 12 weeks. Differences in physical function and depression level were measured at baseline and at a four-week follow-up and compared to an exercise-only control group. Effects on self-perceptions of ageing were measured at baseline, mid-intervention, post-intervention and at a four-week follow-up. Similarly, Emile et al. (2014) examined the effects of providing counter-stereotypical information to sedentary older women during a twice weekly individualised, supervised walking programme. Post-intervention, quality of life, self-reported physical activity (supported by a six-minute walk test, classified by the authors as measures of physical capacity), and views-on-ageing were measured and compared with non-intervention controls.

Klusmann et al. (2012), as part of a wider cognitive ageing study, evaluated how an exercise-only intervention, delivered three times a week for six months, affected self-perceptions of ageing and age dissatisfaction in females. Comparisons were made with an

active control group undertaking an equal length computer course and a passive non-intervention control group. The authors also tested whether direct approach (defined as the most emotionally gratifying orientation by Mees & Schmitt, 2008) mediated the relationship between exercise and age stereotypes.

Taking a different approach, Levy et al. (2014) investigated whether subliminally presenting positive age stereotypes four times over an eight-week period could: improve physical function, strengthen positive and decrease negative views-on-ageing, and, increase positive and decrease negative self-perceptions of ageing. Comparisons were made with a group that received an explicit-positive prime only and a control group that received neutral versions of both priming techniques. No data or results are presented for an additionally stated implicit-positive plus explicit-positive prime group, however the study used a 2x2 design, and the findings presented address the three study hypotheses.

Warner et al. (2016) and Wolff et al. (2014) developed a brief single session intervention based on a battery of behaviour change techniques underpinned by the HAPA (Schwarzer, 2008). Aiming to induce positive views-on-ageing, five weeks after baseline assessment, intervention group participants received additional information about positive aspects of ageing and the association between positive views-on-ageing and health outcomes. Change in self-reported physical activity levels (supplemented by accelerometery data in Warner et al., 2016) was compared with an alternate intervention group that received an additional planning sheet of comparable length, an active control group targeting volunteering and a passive control group. Wolff et al. (2014) additionally measured attitudes towards older adults as a participant outcome but did not present data for any outcome measure for the passive control group. For details of reported outcome measures, their associated follow-up periods, and presented statistical results see Appendices A and B.

------Insert Table 2 here------

Study Findings

Physical Domain

Within this domain, results are split between two separate constructs: physical function and physical activity.

Physical Activity. A significant direct effect on physical activity was reported by two studies; one RCT (Emile et al., 2014) and one case-series design (Brothers & Diehl, 2017). In Emile and colleagues' study (2014), both self-reported physical activity, and capacity for physical activity significantly improved from baseline to three-month follow-up in the intervention group, in comparison to the control group, where they remained stable. A positive correlation was identified between stereotypes of the perceived benefits of exercise for older adults and physical activity score and a negative correlation between stereotypes of the perceived exercise risks for older adults and physical activity score.

Brothers and Diehl (2017) also found a significant trend for increased physical activity throughout their study. Participants doubled their mean weekly minutes of physical activity from baseline (M = 84.95; SD = 91.17) to a four-week follow-up (M = 171.55; SD = 97.26). However, using a much briefer intervention, an RCT reported by Warner et al. (2016) and Wolff et al. (2016) found no significant direct group effects on physical activity for the main intervention plus views-on-ageing group. The only significant effect evident in the two intervention groups was at a 14-month follow-up, in favour of the intervention plus planning group.

Wolff et al. (2014) also explored the indirect effect of different components of attitudes towards older adults (measured by the German Semantic Differential) on changes in physical activity. Despite an overall non-significant effect, they identified a marginally significant indirect effect to change physical activity from the intervention plus views-on-ageing (versus active control) via changes in integrity. For mean change in integrity, physical activity levels were predicted to increase by 42 minutes per week.

Physical Function. Two out of three studies, one RCT (Levy et al., 2014) and one non-randomised control trial (Fujiwara et al., 2009; Sakurai et al., 2016), found a notable effect on any measure of physical function. Although Beyer et al. (2019) reported a significant latent change from baseline to a four-week follow-up across their whole sample, embedding a positive self-perceptions of ageing component into an exercise intervention did not lead to physical function changes between baseline and at four-week follow-up or the intercept at mid-intervention.

Levy et al. (2014) reported that only the implicit-positive intervention had a significant strengthening effect. Improved physical function at week eight was predicted by level of positive self-perceptions at week six. Additionally, the implicit intervention had a direct impact on physical function in the predicted direction. The only significant group effect found by the REPRINTS study (Sakurai et al., 2016) was on functional reach at a seven-year follow-up, with observed decline in reach distance significantly less in the intervention group.

Quality of Life/Subjective Health

A single RCT by Emile et al. (2014) found a trend for group effect between the exercise plus counter-stereotypical information and non-intervention control group in the WHOQoL-26 domains of physical health, and psychological health. Additionally, a positive correlation was identified between stereotypes of the perceived benefits of exercise for older

adults and psychological health. The main effect of group in a non-randomised intergenerational contact versus usual-routine control study found no reportable effect on mean subjective self-rated health at nine-month or seven-year follow-up (Fujiwara et al., 2009; Sakurai et al., 2016).

Psychological/Psychosocial Well-Being

In Beyer et al. (2019), the group variable significantly predicted the change between baseline and four-week follow-up; only participants randomised to the exercise plus self-perceptions of ageing intervention demonstrated a decrease in mean depression level. The group variable also significantly predicted the intercept at a four-week follow-up. Conversely, depression and self-esteem level at seven-year follow-up did not change significantly between groups in a study where participants were given the option to join the intergenerational intervention or usual-routine control group (Sakurai et al., 2016). These findings mirrored those of Belgrave (2011) in a prior non-randomised 12-week intergenerational study. Differences between post-intervention scores for generativity and self-esteem were not significant.

Age Stereotypes

Within this domain, results are split between two separate constructs: self-perceptions of ageing and views-on-ageing. While self-perceptions of ageing refer to people's satisfaction with their own ageing; this is not the case for views-on-ageing, which refer to individuals' general beliefs about older adults. The latter was included in the review as a manipulation check indicating whether the intervention has been effective in changing age stereotypes.

Self-Perceptions of Ageing. Significant effects were reported by three RCTs (Beyer et al., 2019; Klusmann et al., 2012; Levy et al., 2014) and one-case series design (Brothers & Diehl, 2017). Implicit priming with positive stereotypes significantly strengthened positive, and weakened negative, self-perceptions of ageing, when compared with the neutrally primed

control group (Levy et al., 2014). Using a completely different intervention strategy, Klusmann et al. (2012) found that dissatisfaction with ageing was lower immediately following a six-month exercise intervention compared to both the passive and active control groups. The authors additionally concluded the significant effect on exercise was mediated through direct approach, and that age had a significant partial effect on age dissatisfaction.

The positive self-perceptions of ageing component embedded by Beyer et al. (2019) into their exercise intervention, again, had a significant effect on measured self-perceptions of ageing from baseline to intervention completion for ongoing development (i.e., ageing as a time of growth) and physical losses (i.e., ageing as a time of decline). Nevertheless, this effect was not fully sustained four weeks later, decreasing but remaining significant for ongoing development factors and no longer maintaining the group effect for physical losses. Brothers and Diehl (2017) observed a similar effect pattern when utilising strategies designed to target the suppression of negative attitudes and general thoughts about ageing. Whilst significant improvements in self-perceptions of ageing were observed during the intervention period, a significant decline in sustained effect was observed at a 12-week follow-up.

Views-on-Ageing. Some significant effects were presented by four studies; three RCTs (Emile et al., 2014; Levy et al., 2014; Wolff et al., 2014) and one case-series design (Brothers & Diehl, 2017). A significant intervention effect was observed on attitudes toward older adults, and more particularly the integrity scale of the German Semantic Differential (Wolff et al., 2014). From baseline to six-week follow-up study participants who received the additional views-on-ageing component had more positive attitudes towards older adults at the end of the intervention compared to the active control group. The group effect significantly increased perceived benefits of exercise for older adults, and decreased perceived risks of exercise for older adults, when views-on-ageing and exercise were targeted via a three-month

supervised walking programme (Emile et al., 2014). No group effect was reported for the psychological barriers component of views-on-ageing.

Brothers and Diehl (2017) reported a significant effect of the intervention for all views-on-ageing measures: age stereotypes/views-on-ageing scale, awareness of age-related change (gains), and awareness of age-related change (losses). However, age stereotypes and gains-related factors demonstrated a significant decline between the end of the formal education component and a four-week follow-up. Implicit priming with positive stereotypes also significantly strengthened positive, and weakened negative, views-on-ageing when compared with a neutrally primed control group (Levy et al., 2014). Whilst the explicit-positive intervention also strengthened positive views, the effect of the implicit intervention was reported to be 30% greater.

Discussion

This systematic review examined the effects of interventions that have targeted age stereotypes on health outcomes in community-dwelling older adults. Six of the eight independent studies focused on health outcomes within the physical domain (Beyer et al., 2019; Brothers & Diehl, 2017; Emile et al., 2014; Fujiwara et al., 2009; Levy et al., 2014; Sakurai et al., 2016; Warner et al., 2016; Wolff et al., 2014), five of which reported significant (Brothers & Diehl, 2017; Emile et al., 2014; Fujiwara et al., 2009; Levy et al., 2014), or marginal (Wolff et al., 2014), improvements in physical function or physical activity due to the intervention. However, only three studies (Brothers & Diehl, 2017; Levy et al., 2014; Wolff et al., 2014) did not present an overall high risk-of-bias. As such, although the results are generally consistent, they should be interpreted with caution given the low number of studies and the varied risk-of-bias.

Other health outcomes investigated relate to psychological well-being. Half of the independent studies examined at least one dimension of this domain: quality of life (Emile et

al., 2014), subjective health (Fujiwara et al., 2009), generativity (Belgrave, 2011), depression (Beyer et al., 2019; Sakurai et al., 2016), and self-esteem (Belgrave, 2011; Sakurai et al., 2016). Results consistently demonstrated no impact by the interventions (with the exception of depression in Beyer et al., 2019).

It is noteworthy that most independent studies (six out of eight) were theoretically underpinned (Beyer et al., 2019; Brothers & Diehl, 2017; Emile et al., 2014; Klusmann et al., 2012; Levy et al., 2014; Warner et al., 2016; Wolff et al., 2014). These studies focused exclusively on one specific mechanism of stereotype influence: the internalisation of stereotypes into self-perceptions of ageing (stereotype embodiment theory; Levy, 2009). All seven studies found significant effects on either age stereotype endorsement or self-perceptions of ageing, providing support to stereotype embodiment theory (Levy, 2009). Although these results are promising, two studies had a high overall risk-of-bias (Beyer et al., 2019; Emile et al., 2014), thus their results need to be considered with caution. Additionally, interpretation is limited by the fact that studies have used different operationalisations of stereotype internalisation. They examined intervention effects on self-perceptions of ageing (Beyer et al., 2019; Klusmann et al., 2012), on endorsement of age stereotypes (Wolff et al., 2014; Emile et al., 2014), or on both (Brothers & Diehl, 2017; Levy et al., 2014), whilst mostly using the same terminology of *views-on-ageing*.

Future Directions

The present review reveals consistent effects of age stereotype-based interventions on health outcomes in the physical domain. These results are promising, and more research is needed to better understand when, and how, such interventions may be effective. First, although the physical health domain is important, other health outcomes, (e.g., cognitive abilities), deserve further investigation. Interestingly, cognitive outcomes have been the main focus in laboratory-based studies investigating the effects of experimental manipulations of

stereotypes (for a review see Lamont et al., 2015). The generalisability of these laboratory-based findings to real-life settings remains to be elucidated.

Second, age stereotype-based intervention effects have mostly been examined on self-perceptions of ageing, within the stereotype internalisation hypothesis. More research is needed to investigate whether such interventions may also affect stereotypic concerns, as per stereotype threat theory (Steele & Aronson, 1995). Again, this question has only been investigated in laboratory-based studies. Addressing this unknown is important, as intervening on stereotypic concerns might require different techniques to intervening on self-perceptions of ageing. Indeed, suppressing the endorsement of negative age stereotypes, as is typically done in stereotype internalisation-based interventions, might not be effective on stereotypic concerns. Susceptibility to stereotype threat effects may occur simply because individuals are aware of the existence of negative stereotypes about their group, even if they do not endorse them (Steele, 1997). Techniques that help individuals to adopt a malleable conception of their competence (e.g., Emile et al., 2017) or that stimulate intergenerational contact (e.g., Abrams et al., 2008), may represent a promising approach to reduce stereotypical concerns, but these need to be tested further in real-world settings.

Third, concerning the stereotype internalisation hypothesis, given that studies have used different operationalisations of this concept, future research should endeavour to disentangle the constructs of interest. Intervening on older adults' age stereotypes (i.e., the underlying cause) may have different implications than intervening on their self-perceptions of ageing (i.e., the proximal mechanism). Adopting a mechanistic approach towards the influence of stereotypes could therefore be useful, by testing the mediating role of self-perceptions of ageing in the effect of a stereotype-based intervention on health outcomes. The study of Levy et al. (2014) demonstrates promise in this regard, however more research is needed to further support the mediating role of self-perceptions of ageing.

Finally, other potential avenues for future research include investigating whether: i) age-specific behaviour change techniques are more effective than non-age-specific techniques. Only one RCT has examined this question (Warner et al., 2016; Wolff et al., 2014); ii) some components of stereotype-based interventions are more effective than others. Studies have used different ones (i.e., exercising, challenging negative stereotypes, presenting positive stereotypes, avoiding negative thoughts and attitudes about one's own ageing, or a combination of these); iii) interventions are equally effective irrespective of sex. A significant proportion of participants in previous studies were female (75% - 100%), and, iv) the effects of stereotype-based interventions depend on intervention duration, and if these effects are sustained over longer time-periods. Indeed, the preliminary work of Brothers and Diehl (2017) suggests this may not be the case.

Limitations

A rigorous, systematic approach, following a pre-defined protocol and using validated risk-of-bias tools, was employed within this review. Whilst every effort was made to identify all relevant articles during the screening process, a lack of standardisation within the nomenclature of terms used by authors when describing age stereotype constructs, and the diversity of potential 'health-related' outcomes, may have resulted in some studies not being captured. It is also important to acknowledge, only studies published in English were included. The moderate-to-high risk-of-bias within studies, heterogeneous nature of the interventions, and inclusion of some studies that involved participants < 65 years old, limited the interpretation of findings, and strength of conclusions that could be drawn.

Conclusion

Age stereotypes are detrimental to older adults' health. Whilst some postive effects were identified on components of physical function or physical activity, and self-perceptions of ageing, this review highlights a paucity of high quality research on the use of real-world interventions that

endeavour to positively impact health outcomes by directly or indirectly targeting stereotypes of ageing. Nevertheless, the potential for impact should not be dismissed as the range and robustness of available studies is limited. Given that more subtle strategies, implemented over longer time-periods may be needed (Brothers & Diehl, 2017; Emile et al., 2014; Levy et al., 2014), the role of intergenerational contact should not be overlooked on the basis of the reported null findings (Belgrave, 2011; Fujiwara et al., 2009; Sakurai et al., 2016). Increasing life expectancy and the current lack of consensus on how to effectively influence healthy ageing indicates taking a pragmatic approach towards intervention development, and, that research in real-world settings could be vital.

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Table 1

Study Inclusion/Exclusion Criteria

Variable	Inclusion Criteria	Exclusion Criteria
Population, or participants and condition or interest	Older adults – Aged ≥ 50 years Any gender Not restricted to the UK	Studies with participants aged 50 and over, that also included participants under 50 years of age
Intervention or exposures	Interventions that incorporate or are based on processes that either promote positive, or suppress negative, views-on-ageing and/or self-perceptions of ageing, or reduce the impact of stereotype threat, and were designed to elicit positive effects on either health-related variables and behaviours, or any age stereotype construct	Laboratory-based studies that only induced and reported the immediate or very short-term effects of a single stereotype priming session (e.g., the next day, Chivacowsky et al., 2018)
Comparisons or control groups	No restrictions were placed on the alternative intervention, control group or pre/post intervention outcome measurement	
Outcomes of interest	A change in any health-related outcome (i.e., cognitive function, PA) or measured age stereotype construct (i.e., attitudes towards own ageing) from baseline to any available follow-up, with no restriction on intervention length or type, measurement tool or minimum length of follow-up period	Studies that do not have at least 1 outcome measure that can be directly or indirectly associated with participant health, their age stereotypes or views-on-ageing
Setting	Any community or research facility setting	Hospital/inpatient settings
Study designs	Any intervention-based study design (RCT, non-randomised control trials, cohort, intervention comparison, controlled before-and-after intervention studies	Observational studies where no intervention or manipulation occurs Studies not providing original results such as systematic reviews, meta-analysis, general reviews or editorials

Note. PA = physical activity; RCT = randomised control trial; UK = United Kingdom

Table 2

Study Characteristics

Author (Location)	Design	Participants	Intervention description	Intervention length	Control group (s)	Stereotype prime	Target stereotype construct	BCTs intervention group	BCTs Control group
Belgrave (2011) (USA)	CBA	*n* = 27 Age range not reported Mean age = 84.75 years SD not reported Female = 88.89%	Intergenerational music therapy - dyadic pairings (not the same every week) with children from local school. Activities included singing, structured conversations, instrument playing, moving to music.	10-weeks 10 x 30 min sessions 1x week over 12-week period (2-week vacation)	Passive control group - Maintained ordinary routine & attended other normal non-intergenerational activities at their living facility	Implicit	N/A	12.2 Restructuring the social environment (++)	None
Beyer et al. (2019) (Germany)	RCT	*n* = 89 Age range 65-88 years Mean age = 76.54 years SD = 5.4 Females = 34.8%	Group exercise training sessions targeting improving balance, strength, endurance, flexibility & reducing fear of falling + 4x 20-30 min psychological intervention, aimed at changing SPA, embedded in the second half of the exercise sessions at weeks 2, 5, 8 & 11	12-weeks 60 min sessions 1x week	Active control group - Exercise only	Explicit	SPA	3.1 Social support (unspecified) (+) 4.1 Instruction on how to perform a behaviour (+) 6.1 Demonstration of behaviour (+) 8.1 Behavioral practice/rehearsal (+) 13.2 Framing/Reframing (++) 5.1 Information about health consequences (+) 3.3 Social support (emotional) (++)	4.1 Instruction on how to perform a behaviour (+) 6.1 Demonstration of behaviour (+) 8.1 Behavioural practice/rehearsal (+)
Brothers & Diehl (2017) (USA)	Case Series	*n* = 62 Age range 52-82 years Mean age = 65.26 years SD = 6.62 Females = 83.9%	Multi-component program targeting NVoA Educational component (weeks 1-4) - attitudinal & motivational pieces for enacting behaviour change Experiential component (weeks 5-8) - worked towards personalised PA goal & completed daily PA logs	8-weeks Weeks 1-4: 4x 120 min education sessions 1x week Weeks 5-8: 4x 10-15 min semi-structured interview + telephone support 1x week	N/A	Explicit	VoA	1.2 Problem solving (++) 1.3 Goal setting (outcome) (++) 2.3 Self-monitoring of behaviour (++) 3.1 Social support unspecified (+) 5.3 Information about social and environmental consequences (+) 13.2 Framing/Reframing (++)	N/A
Emile et al. (2014) (France)	RCT	*n* = 52 Age range 67-97 years Mean age = 78.54 SD = 7.37 Females = 100%	Individualised non-standardised supervised walking program & education component that incorporated strategies to suppress negative age stereotypes & activate positive ones	12-weeks 40-60 min sessions 2x week	Passive control group - Maintained normal daily routine	Implicit & Explicit	VoA	1.3 Goal setting outcome (+) 2.4 Self-monitoring of outcome(s) of behaviour (+) 3.3 Social support (emotional) (++) 5.3 Information about social and environmental consequences (+)	N/A
Fujiwara et al. (2009) (Japan)	NRCT	*n* = 143 Age range not reported Mean age = 68.46 years SD = 5.3 Females = 62.23%	Intensive training sessions followed by group activity sessions with school children. Activities included pre-group meeting to share information, playing hand games & with toys, picture book reading, additional monthly meetings with area wide group/time to engage with further training		Passive control group – Maintained normal daily routine	Implicit	N/A	12.2 Restructuring the social environment (++)	None

Table 2

Continued

Author (Location)	Design	Participants	Intervention description	Intervention length	Control group (s)	Stereotype prime	Target stereotype construct	BCTs intervention group	BCTs Control group
Klusmann et al. (2012) (Germany)	RCT	*n* = 259 Age range 70-93 years Mean age = 73.6 years SD = 4.2 Females = 100%	Intensive multi-faceted group exercise targeting aerobic, strength & flexibility training	6-months 90 min sessions 3x week	Passive control group - Maintained normal daily routine Active control group - computer course designed for seniors dealing with common software	N/A	SPA	3.1 Social support unspecified (+) 4.1 Instruction on how to perform a behaviour (+) 6.1 Demonstration of behaviour (+) 8.1 Behavioural practice/rehearsal (+)	Active control group 3.1 social support unspecified (+)
Levy et al. (2014) (USA)	RCT	*n* = 100 Age range 61-99 years Mean age = 81 years SD = 10 Females = 78%	Group 1 - Implicit subliminal priming via computer with words depicting positive stereotypes of ageing plus Explicit neutral – asked to imagine neutral topics Group 2 - Explicit positive asked to "imagine a senior citizen who is mentally and physically healthy" (one of 3 versions) plus Implicit neutral – primed via same method as implicit prime but with random series of letters Group 3 - Exposed to both implicit and explicit positive interventions	4-weeks 4x sessions 1x week over 8-week period (weeks 2, 3, 4 & 5)	Neutral control group - Implicit neutral – primed via same method as implicit prime but with random series of letters, plus Explicit neutral – asked to imageing neutral topics	Implicit & Explicit	VoA & SPA	N/A	N/A
Sakurai et al. (2016) (Japan)	NRCT	*n* = 349 Age range not reported Mean age = 67.7 years SD = 5.7 Females = 82.8%	Intensive training sessions followed by group activity sessions with school children. Activities included pre-group meeting to share information, playing hand games & with toys, picture book reading, additional monthly meetings with area wise group/time to engage with further training.	12-week intensive training Unspecified x 30 min sessions 1x every 1-2 weeks Unspecified x 120mins meetings/additional training 1x week	Passive control group - maintained normal daily routine but 38% were involved in volunteering activities i.e., at welfare facility every week & 42% a few times a month (Mean time per week 1.5hours, SD = 1.7)	Implicit	N/A	12.2 Restructuring the social environment (++)	None

Table 2

Continued

Author (Location)	Design	Participants	Intervention description	Intervention length	Control group (s)	Stereotype prime	Target stereotype construct	BCTs intervention group	BCTs Control group
Warner et al. (2016) (Germany)	RCT	*n* = 310 Age range 64-92 years Mean age = 70.34 years SD = 4.89 Females = 75.2% NB. *n* = 153 randomly selected to wear an accelerometer at baseline and week 11	Intervention group 1 All BCTs targeted to change PA +VoA component - information about positive aspects of ageing, raising & correcting false beliefs or misconceptions of ageing + prompting positive VoA by presenting findings on association between positive VoA & health, longevity & health behaviours Plus, technique taught to empower identification of automatic, unconscious negative thoughts on ageing & as a second step replace them with neutral or positive Intervention group 2 All BCTs targeted to change PA substituting the VoA component with an additional planning sheet	1-week 1x short session 5-weeks after baseline	Passive control group - maintained normal daily routine Active control group - parallel session with techniques targeted to change volunteering	Explicit	VoA	All intervention groups as self-listed by authors 5.1 Health Consequences (+) 15.3 Focus on past success (++) 6.1 Demonstration of behaviour (++) 16.3 Vicarious enforcement (++) 1.3 Goal setting (outcome) (+) 1.1 Goal setting (behaviour) (+) 1.4 Action planning (including implementation intentions) (+) 1.5 Review behaviour goal(s) (+) 2.3 Self-monitoring of behaviour (++) 12.2. Restructuring of the social environment (++) Additional BCTs for VOA group 3.3 Social support emotional (++) 5.1 Health consequences (+) (extra) 13.2 Framing/Reframing (++)	None
Wolff et al. (2014) (Germany)	RCT	*n* = 234 Age range not reported Mean age = 70.34 years SD = 4.9 Females = 75%	Intervention group 1 All BCTs targeted to change PA +VoA component - information about positive aspects of ageing, raising & correcting false beliefs or misconceptions of ageing + prompting positive VoA by presenting findings on association between positive VoA & health, longevity & health behaviours Plus, technique taught to empower identification of automatic, unconscious negative thoughts on ageing & as a second step replace them with neutral or positive Intervention group 2 All BCTs targeted to change PA substituting the VoA component with an additional planning sheet	1-week 1x short session 5-weeks after baseline	Passive control group – not included in study analysis Active control group - parallel session with techniques targeted to change volunteering	Explicit	VoA	All intervention groups as self-listed by authors 5.1 Health consequences (+) 15.3 Focus on past success (++) 6.1 Demonstration of behaviour (++) 16.3 Vicarious enforcement (++) 1.3 Goal setting (outcome) (+) 1.1 Goal setting (behaviour) (+) 1.4 Action planning (including implementation intentions) (+) 1.5 Review behaviour goal(s) (+) 2.3 Self-monitoring of behaviour (++) 12.2. Restructuring of the social environment (++) Additional BCTs for VOA group 3.3 Social support emotional (++) 5.1 Health consequences (+) (extra) 13.2 Framing/Reframing (++)	None

Note. BCT(s) = behaviour change technique(s); CBA = controlled before and after; min = minutes; n = number; N/A = not applicable; NVoA = negative view-on-ageing; PA = physical activity; RCT = randomised control trial; SPA = self-perceptions of ageing; VoA = views-on-ageing; (+) = BCT present in all probability; (++) = BCT present beyond all reasonable doubt.

Figure 1

PRISMA Flow Diagram

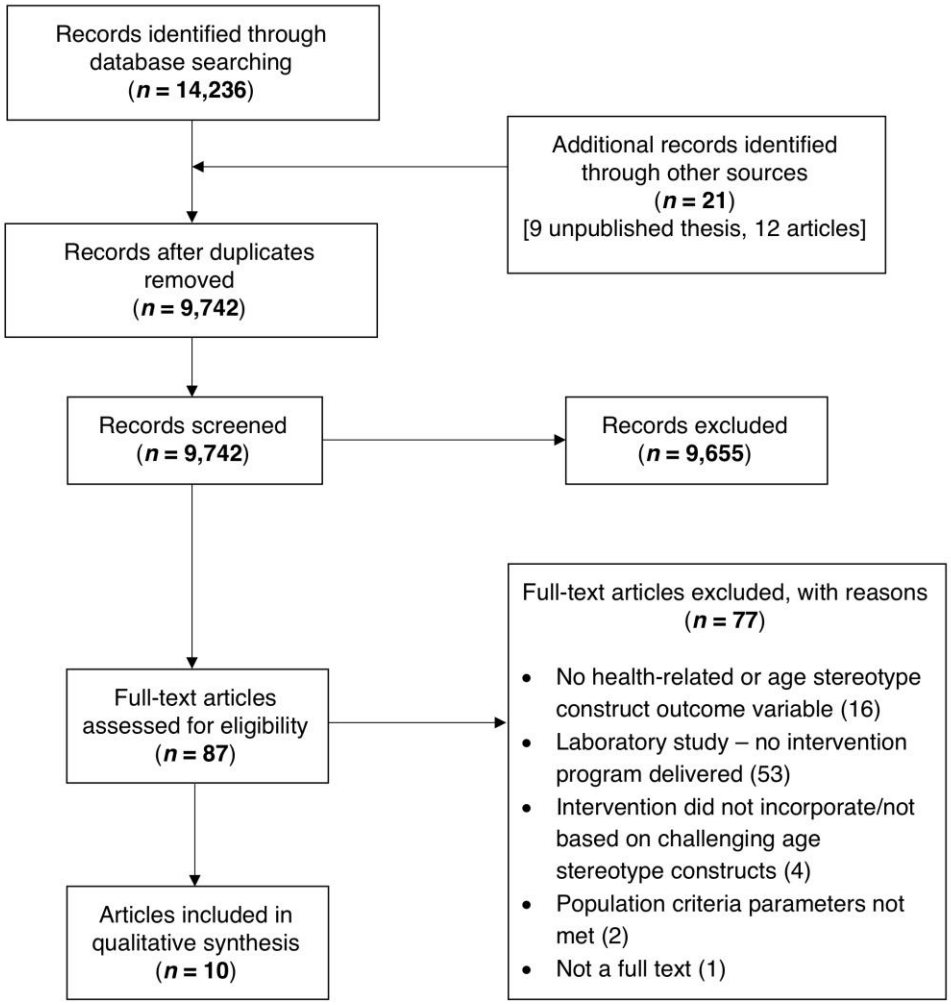
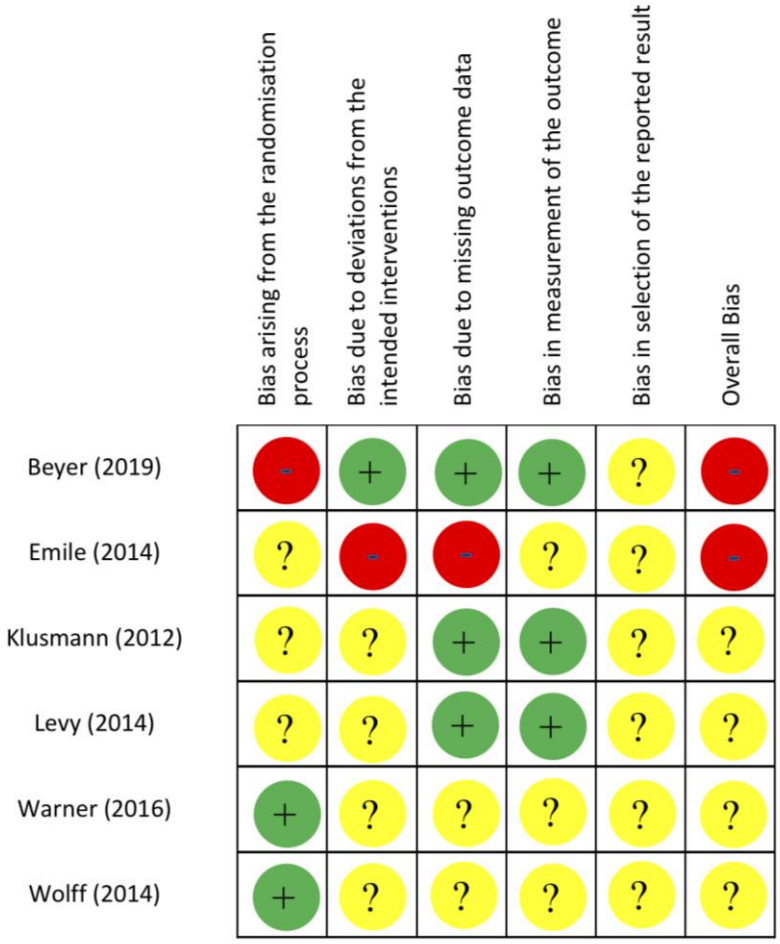


Figure 2

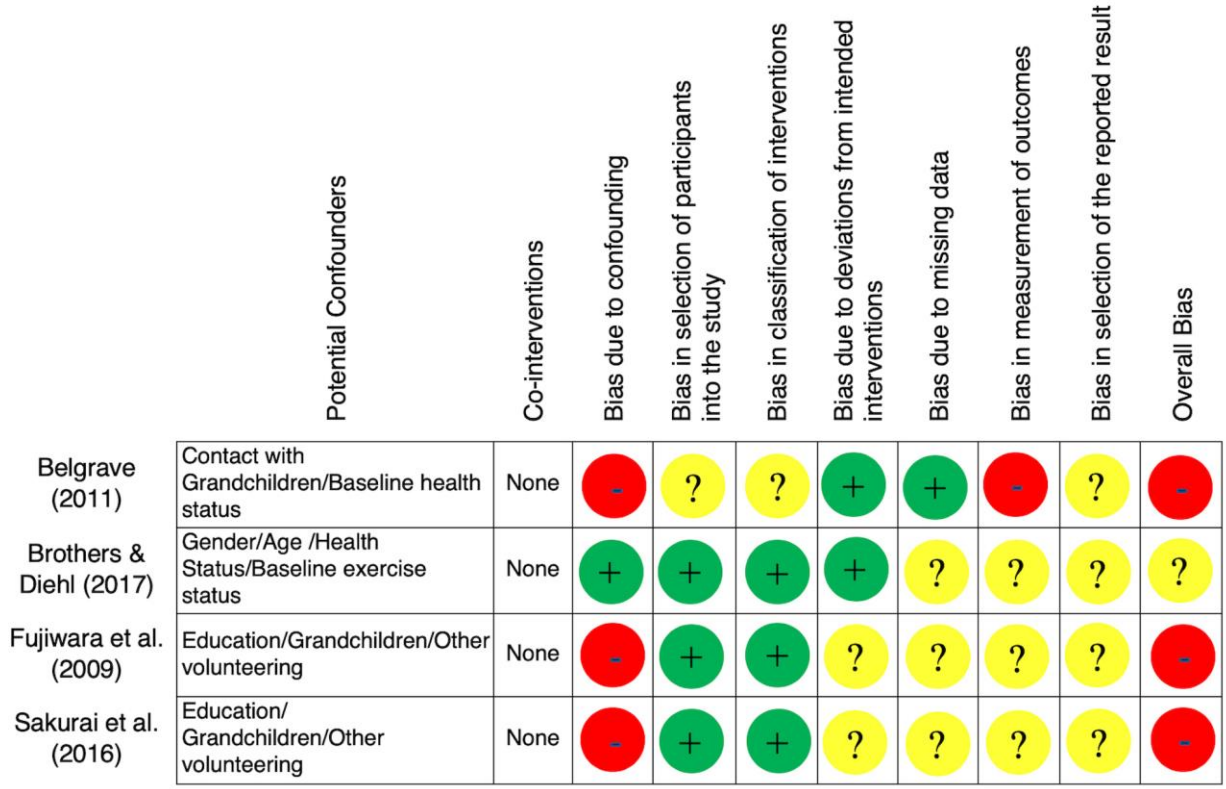
Risk of Bias Summary for each included Randomised Study



Note. Low risk of bias (+), Some Concerns (?), High risk of bias (-)

Figure 3

Risk of Bias Summary for each included Non-Randomised Study



Note. Low risk of bias (+), Moderate risk of bias (?), Serious risk of bias (-)

Appendix A

Outcome Data and Results of Non-Randomised Studies

Author	Outcome Domain	Outcome measure	Group	Baseline *M (SD)*	T1 *M (SD)*	T2 *M (SD)*	T3 *M (SD)*	T4 *M (SD)*	Analysis of results	Time points reported
Belgrave (2011)	Psychosocial Well-being	Loyola generativity scale	Intergenerational	36.71 (10.83)	39.29 (6.45)	_	_	_	Difference between post intervention scores non-significant $U(14,12) = 68$, $p > 0.05$.	Baseline T1 = post intervention (week 13)
			Control	36 (8.21)	35.33 (10.14)	_	_	_		
		Rosenberg self-esteem scale	Intergenerational	22.14 (3.74)	24.71 (4.23)	_	_	_	Difference between post intervention scores non-significant $U(14,12) = 68$, $p > 0.05$.	
			Control	24.92 (3.4)	23.25 (4.25)	_	_	_		
Brothers & Diehl (2017)	Age Stereotypes	AARC - Gains (VoA)	NVoA	17.67 (2.83)	20.58 (2.46)	19.21 (3.47)	_	_	Significant increase over intervention period, $F(2,102) = 24.32$, $p < 0.001$, $n^2_p = 0.32$. Significant improvement weeks 0 - 4 & weeks 0 - 12 ($p < 0.05$) but significant decline weeks 4 -12 ($p < 0.05$).	Baseline T1 = week 4 T2 = 4 weeks after intervention finished/week 12
		AARC - Losses (VoA)	NVoA	11.08 (3.45)	10.83 (2.46)	10.02 (3.76)	_	_	Significant decrease over intervention period, $F(2,102) = 3.73$, $p < 0.028$, $n^2_p = 0.07$. Significant improvement weeks 0 - 12 ($p < 0.05$).	
		Expectations regarding ageing	NVoA	50.18 (16.58)	64.05 (16.39)	60.04 (18.2)	_	_	Significant improvement over intervention period, $F(2,102) = 26.15$, $p < 0.001$, $n^2_p = 0.34$. Significant improvement weeks 0 - 4 & weeks 0 - 12 ($p < 0.05$) but significant decline weeks 4 - 12 ($p < 0.05$).	
		VoA Scale	NVoA	40.85 (7.14)	47.7 (7.64)	43.5 (7.3)	_	_	Significantly more positive over intervention period, $F(2,102) = 22.70$, $p < 0.001$, $n^2_p = 0.31$. Significant improvement weeks 0 - 4 ($p < 0.05$) but significant decline weeks 4 -12 ($p < 0.05$).	
	Physical Activity	Self-report (mean mins /week)	NVoA	84.95 (91.17)	_	171.55 (97.26)	_	_	Result only for $n = 50$ Significant increase over intervention period, $F(2,98) = 24.70$, $p < 0.001$, $n^2_p = 0.34$.	
Fujiwara et al. (2009)	Physical Function	Usual walk speed (m/min)	Intergenerational	86.9 (12.3)	92.1 (15.3)	_	_	_	Main effect of group non-significant	Baseline T1 = 9 months
			Control	81 (11.8)	88.2 (15.6)	_	_	_		
		Hand grip strength (kg)	Intergenerational	25.7 (6.8)	25.4 (6.4)	_	_	_	Main effect of group non-significant	
			Control	26.6 (5.9)	25.1 (6.7)	_	_	_		
	Subjective Health	Self-rated health	Intergenerational	1.9 (0.6)	2.1 (0.7)	_	_	_	Main effect of group non-significant	
			Control	2.1 (0.5)	2 (0.6)	_	_	_		

Outcome Data and Results Non-Randomised Studies Continued

Author	Outcome Domain	Outcome measure	Group	Baseline *M (SD)*	T1 *M (SD)*	T2 *M (SD)*	T3 *M (SD)*	T4 *M (SD)*	Analysis of results	Time points reported
Sakurai et al. (2016)	Psychological Well-being	Geriatric Depression Scale	Intergenerational	2.5 (2.1)	2.3 (2.2)	_	_	_	Main effect of group non-significant	Baseline T1 = 7 years
			Control	3 (2.4)	2.9 (2.9)	_	_	_		
		Rosenberg self-esteem scale	Intergenerational	4.1 (1.5)	4.4 (1.5)	_	_	_	Main effect of group non-significant	
			Control	4 (1.6)	4.3 (1.6)	_	_	_		
	Physical Function (*n* = 147)	Hand grip strength (kg)	Intergenerational	24.7 (6.6)	22.9 (6.1)	_	_	_	Main effect of group non-significant	
			Control	26.2 (6.8)	23 (6.5)	_	_	_		
		Usual walk speed (m /min)	Intergenerational	88.5 (12.3)	88.8 (17)	_	_	_	Main effect of group non-significant	
			Control	86.6 (11.8)	89.9 (14.2)	_	_	_		
		Maximum walk speed (m/min)	Intergenerational	133.4 (20.3)	134.1 (22.1)	_	_	_	Main effect of group non-significant	
			Control	129.9 (17.1)	131.9 (22.4)	_	_	_		
		One leg stand (seconds)	Intergenerational	51.7 (16.9)	45.4 (19.7)	_	_	_	Main effect of group non-significant	
			Control	50.8 (17.6)	46.4 (19.7)	_	_	_		
		Functional reach (cm)	Intergenerational	38.9 (6.7)	37.4 (6.7)	_	_	_	Significant effect for group at follow-up ($p < 0.01$)	
			Control	38.5 (5.7)	34.7 (6.2)	_	_	_		

Note: AARC = awareness of age-related change; cm = centimetres; kg = kilograms; M = mean; m = metres; min = minutes; n = number; NVoA = negative view-on-ageing; SD = standard deviation; SPA = self-perceptions of ageing; VoA = views-on-ageing.

Appendix B

Outcome Data and Results of RCTs

Author	Outcome Domain	Outcome measure	Group	Baseline *M (SD)*	T1 *M (SD)*	T2 *M (SD)*	T3 *M (SD)*	T4 *M (SD)*	Analysis of results	Time points reported
Beyer et al. (2019)	Physical Function	SPPB	Exercise +SPA	8.66 (1.7)	_	_	10.32 (1.42)	_	Significant latent change from baseline to T3 across whole sample $B = 1.31$, SE = 0.26, $p < 0.01$. Group variable did not predict change between baseline & T3, $B = 0.02$, SE = 0.19, $p = 0.92$. Group variable did not predict intercept at T1, $B = -0.04$, SE = 0.17, $p < 0.01$.	Baseline (3 weeks before intervention started) T1 = week 6 (mid intervention/week 8) T2 = week 12 (end of intervention/week 14) T3 = 4 weeks after intervention finished /week 18
			Exercise Only	8.76 (1.63)	_	_	10.04 (1.78)	_		
	Psychological Well-being	CES-D	Exercise +SPA	1.64 (0.3)	_	_	1.54 (0.37)	_	Group variable significantly predicted change between baseline and T3, $B = -0.38$, SE = 0.14, $p < 0.01$. Group variable significantly predicted intercept at T3, $B = 0.31$, SE = 0.11, $p < 0.01$.	
			Exercise Only	1.67 (0.42)	_	_	1.71 (0.3)	_		
	Age Stereotypes	Adapted AgeCog Battery - Ongoing Development (SPA)	Exercise +SPA	2.22 (0.48)	2.31 (0.36)	2.39 (0.5)	2.28 (0.41)	_	Group significantly predicted change from baseline - T2, $B = 0.35$, SE = 0.14, $p = 0.01$. Group variable significantly predicted intercept at T2, $B = 0.27$, SE = 0.13, $p = 0.03$. Significant effect T1 - T2, $B = 0.34$, SE = 0.13, $p = 0.01$ not baseline - T1, $B = 0.04$, SE = 0.18, $p = 0.85$. Group effect decreased but still significant T2 - T3, $B = -0.37$, SE = 0.16, $p = 0.02$.	
			Exercise Only	2.29 (0.57)	2.32 (0.56)	2.23 (0.48)	2.23 (0.56)	_		
		Adapted AgeCog Battery - Physical Losses (SPA)	Exercise +SPA	3.06 (0.33)	2.92 (0.32)	2.83 (0.28)	2.86 (0.37)	_	Group variable significantly predicted change from baseline to T2, $B = -0.29$, SE = 0.14, $p = 0.03$. Group variable did not predict intercept at T2, $B = 0.06$, SE = 0.17, $p = 0.74$. Significant effect occurred between T1 & T2, $B = -0.34$, SE = 0.14, $p = 0.02$ not baseline to T1, $B = -0.01$, SE = 0.16, $p = 0.96$. Significant effect not maintained between T2 & T3.	
			Exercise Only	2.9 (0.47)	2.81 (0.42)	2.85 (0.44)	2.85 (0.43)	_		
Emile et al. (2014)	Age Stereotypes	ASES - Psychological barriers (VoA)	Exercise +CSI	4.63 (1.09)	5.07 (1.42)	_	_	_	No reported group effect	Baseline T1 = 3 months
			Control	4.7 (0.99)	4.61 (0.77)	_	_	_		
		ASES - Perceived Benefits (VoA)	Exercise +CSI	5.98 (1.12)	6.52 (0.56)	_	_	_	Significant group effect, $F(1,49) = 28.08$, $p < 0.01$, $n^2 = 0.36$.	
			Control	5.79 (0.87)	5.71 (0.76)	_	_	_		
		ASES - Perceived risks (VoA)	Exercise +CSI	3.73 (1.36)	2.86 (1.48)	_	_	_	Significant group effect, $F(1,49) = 11.29$, $p < 0.01$, $n^2 = 0.19$.	
			Control	3.34 (0.93)	3.71 (1)	_	_	_		
	Quality of Life	WHO-QoL26 Physical Health	Exercise +CSI	3.96 (0.66)	4.25 (0.79)	_	_	_	Trend for group effect, $F(1,49) = 3.56$, $p = 0.06$, $n^2 = 0.07$.	
			Control	4.16 (0.89)	4.03 (0.85)	_	_	_		
		WHO-QoL26 Psychological Health	Exercise +CSI	4.36 (0.86)	4.68 (0.79)	_	_	_	Trend for group effect, $F(1,49) = 3.28$, $p = 0.07$, $n^2 = 0.06$.	
			Control	4.12 (1.15)	4.22 (1.1)	_	_	_		
	Physical Activity	6MWT (m)	Exercise +CSI	183.97 (54.55)	203.82 (55.47)	_	_	_	Significant group effect, $F(1,49) = 58.26$, $p < 0.001$, $n^2 = 0.54$.	
			Control	185.83 (42.09)	180.83 (41.52)	_	_	_		
		Physical Activity Score	Exercise +CSI	10.56 (3.33)	12.5 (3.53)	_	_	_	Significant group effect, $F(1,49) = 71.85$, $p < 0.001$, $n^2 = 0.59$.	
			Control	12.5 (3.53)	12.39 (3.91)	_	_	_		

Outcome Data and Results RCTs Continued

Author	Outcome Domain	Outcome measure	Group	Baseline *M (SD)*	T1 *M (SD)*	T2 *M (SD)*	T3 *M (SD)*	T4 *M (SD)*	Analysis of results	Time points reported
Klusmann et al. (2012)	Age Stereotypes	Age Dissatisfaction Questionnaire (SPA)	Exercise	no data	14.64 (4.32)	–	–	–	Significant main effect for group, $F(2,225) = 5.39$, $n^2_p = 0.05$, $p = 0.05$. Change significantly lower in exercise group compared to passive control group ($B = -1.67$, SE = 0.52, 95% CI [-2.70 to -0.64], $n^2_p = 0.04$) and active control group ($B = -1.11$, SE = 0.50, 95% CI [-2.10 to -0.12], $n^2_p = 0.02$).	Baseline T1 = 6 months
			Active Control	no data	15.95 (4.57)	–	–	–		
			Passive Control	no data	15.51 (4.3)	–	–	–		
Levy et al. (2014)[a]	Age Stereotypes	Images of ageing (Positive VoA)	Implicit Positive	55.62 (1.52)	63.36 (1.86)	61.2 (2.05)	61.56 (2.05)	_	Implicit positive intervention significantly strengthened positive VoA, $F(1,164) = 7.42$, $n^2_p = 0.065$, 95% CI [0.009 - 0.16], $p = 0.004$. Explicit positive intervention strengthened positive VoA, $F(1,162) = 6.09$, $n^2_p = 0.05$, 95% CI [0.010 - 0.120], $p = 0.01$. Even though both effects significant, influence of implicit intervention 30% greater.	Baseline (week 1) T1 = week 5 T2 = week 6 T3 = week 8
			Control	54.54 (1.41)	54.9 (1.49)	55.44 (1.55)	55.8 (1.66)	_		
		Images of ageing (Negative VoA)	Implicit Positive	29.88 (1.13)	26.28 (1.55)	28.44 (1.61)	27.63 (1.51)	_	Implicit positive intervention significantly weakened negative VoA, $F(1,162) = 3.30$, $n^2_p = 0.04$, 95% CI [0.008 - 0.113], $p = 0.04$.	
			Control	31.68 (1.22)	32.04 (1.04)	30.51 (1.41)	30.69 (1.22)	_		
		Images of ageing (Positive SPA)	Implicit Positive	76.32 (1.96)	80.1 (2.2)	79.74 (1.88)	81.54 (1.91)	_	Implicit positive intervention significantly strengthened positive SPA, $F(1,164) = 6.01$, $n^2_p = 0.051$, 95% CI [0.005 - 0.142], $p = 0.008$. No significant reported effect of the explicit intervention.	
			Control	74.88 (1.85)	75.42 (2.14)	73.44 (2.01)	74.34 (2.23)	_		
		Images of ageing (Negative SPA)	Implicit Positive	16.65 (1.34)	15.57 (1.38)	15.93 (1.23)	14.22 (1.25)	_	Implicit positive intervention significantly weakened negative SPA, $F(1,162) = 3.65$, $n^2_p = 0.03$, 95% CI [0.001 - 0.111], $p = 0.03$.	
			Control	18.54 (1.28)	18.99 (1.52)	19.17 (1.26)	18.72 (1.41)	_		
	Physical Function	SPPB	Implicit Positive	6.94 (0.47)	7.61 (0.54)	7.81 (0.49)	8.28 (0.46)	_	Implicit positive intervention significantly strengthened physical function, $F(1,164) = 5.93$, $n^2_p = 0.08$, 95% CI [0.023 - 0.118], $p = 0.008$. No significant reported effect of the explicit intervention.	
			Control	7 (0.56)	7.15 (0.55)	7.12 (0.52)	7.09 (0.55)	_		
Warner et al. (2016)	Physical Activity	Priscus PA Questionnaire (weekly mins)	Intervention +VoA	219.09 (31.83)	218.84 (29.44)	219.29 (32.69)	208.26 (21.33)	213.91 (27.73)	Only significant difference in self report PA between the 2 intervention groups in favour of Intervention +Planning group between baseline & T4, $B = 0.24$, SE = 0.10, $p = 0.01$, $n^2 = 0.058$.	Baseline (intervention 5 weeks after baseline) T1 = 7 weeks after baseline T2 = 11 weeks after baseline T3 = 10 months after baseline T4 = 14 months after baseline
			Intervention +Planning	214.82 (28.81)	210.03 (22.06)	215.2 (19.58)	213.61 (30.29)	229.04 (33.55)		
			Active Control Group	222.57 (27.16)	223.13 (31.49)	220.98 (31.23)	213.41 (28.53)	218.9 (24.2)		
			Passive Control Group	214.25 (29.21)	214.14 (27.22)	215.21 (29.03)	208.49 (29.45)	213.57 (30.35)		
		MVPA/week via accelerometery (only for n = 153)	Intervention +VoA	43.82 (68.76)	_	40.32 (53.56)	_	_	Main effect of group non-significant.	
			Intervention +Planning	60.9 (64.71)	_	77.3 (54.41)	_	_		
			Active Control Group	66.84 (70.83)	_	63.68 (74.21)	_	_		
			Passive Control Group	59.1 (77.77)	_	49.95 (67.04)	_	_		

Outcome Data and Results RCTs

Author	Outcome Domain	Outcome measure	Group	Baseline *M (SD)*	T1 *M (SD)*	T2 *M (SD)*	T3 *M (SD)*	T4 *M (SD)*	Analysis of results	Time points reported
Wolff et al. (2014)	Physical Activity	Priscus PA Questionnaire (MET mins/week)	Intervention +VoA	16.86 (8.05)	16.36 (9.46)	16.86 (8.59)	16.85 (8.52)	_	Indirect effect from Intervention +VoA (vs control) to change in PA via change in integrity marginally significant, *B* = 0.03, 90% CI [0.01 - 0.07], *p* = 0.7; for mean change in integrity (*b* = 0.41), physical activity levels are predicted to increase by 0.7 h per week.	Baseline (intervention 5 weeks after baseline) T1 = 7 weeks after baseline T2 = 11 weeks after baseline T3 = 10 months after baseline T4 = 14 months after baseline
			Intervention +Planning	12.54 (7.2)	14.32 (6.54)	16.67 (6.17)	17.03 (10.11)	_		
			Active Control	15.76 (6.18)	13.44 8.08	17.35 9.65	15.56 8.67	_		
	Age Stereotypes	GSD - Integrity (VoA)	Intervention +VoA	4.12 (1.2)	4.08 1.26	4.26 1.29	4.33 1.26	_	Significant intervention effect for Control group vs Intervention +VoA on integrity scale at T2 (week 11) *B* = -0.14, SE = 0.07, *p* = 0.3; significant intervention effect for Intervention +Planning vs Intervention +VoA on integrity scale, T2 (week 11) *B* = -0.1, SE = 0.04, *p* = 0.3; Intervention +VoA had more positive attitudes towards older adults (on the integrity scale) at end of intervention compared to control from baseline to T2, *B* = 0.17, *p* = 0.1; change in physical activity from baseline to T2 did not predict change in integrity from T2 to T3, *B* = 0.05, *p* = 0.53; change in integrity (baseline to T3) predicted change in physical activity from T2 to T3 (week 11 to 10 months) *B* = 0.2, *p* = 0.01.	
			Intervention +Planning	4.07 (0.76	3.98 1.04	4.15 1.15	4.07 0.9	_		
			Active Control	4.23 (1.43)	4.06 1.07	4.13 1.25	4.44 1.21	_		
		GSD - Autonomy (VoA)	Intervention +VoA	4.12 (1.2)	4.15 1.3	4.06 1.26	4.21 1.25	_		
			Intervention +Planning	4.07 (0.76)	4.14 1	4.06 1.1	3.99 0.95	_		
			Active Control	4.2 (1.33)	4.23 1.03	4.1 1.22	4.34 1.21	_		
		GSD - Acceptability (VoA)	Intervention +VoA	4.04 (1.19)	3.97 1.2	4.04 1.24	4.24 1.22	_		
			Intervention +Planning	4.22 (0.99)	4.15 1.07	4.28 0.8	4.07 0.88	_		
			Active Control	4.05 (1.17)	4.06 1.02	4.02 1.12	4.33 1.16	_		
		GSD - Instrumentability (VoA)	Intervention +VoA	4.17 (1.15)	4.33 1.12	4.33 1.2	4.3 1.19	_		
			Intervention +Planning	4.12 (0.91)	3.98 (1.16)	4.09 (0.97)	4.04 (0.86)	_		
			Active Control	4.38 (1.2)	4.36 (0.99)	4.21 (1.03)	4.4 (1.18)	_		

Note: ASES = age stereotype and exercise scale; CES-D = Center for Epidemiologic Studies Depression Scale; CI = confidence interval; cm = centimetres; CSI = counter-stereotypical information; GSD = German Semantic Differential; kg = kilograms; m = metres; min = minutes; MET = metabolic equivalent; MVPA = moderate-to-vigorous physical activity; *n* = number; PA = physical activity; QoL = quality of life; SE = standard error; SPA = self-perceptions of ageing; SPPB = short physical performance battery; VoA = views-on-ageing; WHO = World Health Organization; 6MWT = six minute walk test.

[a]Levy et al. 2014 figure in parenthesis = SE not SD, no mean data presented for the explicit-positive prime group, no mean data or results presented for implicit-positive plus explicit-positive prime group