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How can transport provision and associated built environment infrastructure be enhanced and developed to support the mobility needs of individuals as they age?

Future of an ageing population: evidence review

Foresight, Government Office for Science

How can transport provision and associated built environment infrastructure be enhanced and developed to support the mobility needs of individuals as they age?

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Executive summary

Mobility touches every aspect of most of our lives. Restrictions on our mobility are perceived as a loss of freedom, and we seek wherever possible to regain that mobility, or replace it with other forms of mobility. While we immediately think of physical mobility, virtual mobility is increasingly becoming another world that we inhabit and move around in.

Older people, however, are the most likely to experience mobility deprivation. The need to be mobile and to travel is related to psychological well-being in older age, and a reduction in mobility can lead to an increase in isolation, loneliness and depression and overall a poorer quality of life. Mobility is important to older people. There are also benefits to society as a whole in increasing travel for older people, including the economic benefits of older people spending more in shops, of them looking after grandchildren, undertaking voluntary work, and carrying out other caring responsibilities.

In order to develop a framework of the mobility of people as they age, we formulated a set of guiding principles that underpin this Evidence Review. These principles are drawn from current thinking in applied gerontology in the many differing fields that cover mobility issues and represent a shift from individual discipline-based silo thinking to person-centred thinking that attempts to cross traditional disciplinary boundaries. The key principles are:

- Adopting an **ecological model of ageing**.
- Placing the user at the heart of mobility in order to take a **person-centred approach**.
- Mobility behaviour and perceptions should take a life-course approach that builds upon **whole life experiences and choices**.
- Understanding older people's mobility requires a **relationship-centred approach**.
- Images of ageing can be positively changed through an **inclusive design approach** to transport provision and built environment infrastructure.
- Mobility is multi-faceted and as such should be considered as a **whole systems approach**, moving away from traditional transport planning.
- The **physical environmental context** in which mobility is conducted is important to acknowledge and understand.
- There is a need to **balance diverse requirements**.
- Addressing the **wider societal challenges** such as loneliness and isolation, civic participation, connectivity and health and well-being in relation to mobility is important.

Underpinning the principles is user engagement – the need to involve older people in decisions that affect their mobility needs, desires and wants, and to work co-productively with them to understand the barriers and enablers to mobility from their perspective.

Through this review of evidence, including both academic and grey literature, and using the above principles to focus our study, we set out the current state of knowledge in this complex

and diverse subject area. The scope of transport is vast, and we acknowledge that any such search of evidence is limited by both time and the documentary evidence freely available to the authors. We conclude that there are evidence gaps that require further research, that other gaps may well emerge, and that there is still much to be understood. As such, this is very much the start of a journey, rather than the end.

We consider that the following areas require further investigation to provide evidence on how the transport provision and associated built environment infrastructure can be enhanced and developed to support the mobility needs of individuals as they age:

- Transport decisions and the effect of these into older age need to be investigated across the life course.
- We need a better understanding of the role of virtual mobility.
- Individual differences are important, and so we need to have a better understanding of which mobility interventions will affect which people, and why.
- Understanding train travel from the point of view of older people to help identify barriers to use.
- Social capital and networks and mobility in later life and how these might enable mobility.
- Future research and interventions must acknowledge that a variety of modes are used to complete travel and a door-to-door approach is advocated.
- To gain a greater, more holistic understanding of transport in later life, future research should look beyond literal or corporeal mobility to include constructions of travel related to virtual, potential, imagined, aspirational and emotive mobilities, utilising not just transport studies, health and geography but also sociology, gerontology, and arts and humanities.
- Technologies, driverless vehicles and driver support. Clearly there is a need to better understand the impact of these technologies on different cohorts of older people, not just in terms of driving, but also on health, well-being and quality of life.
- Transport can play a significant role in helping a person with dementia to stay active and independent for longer, but this is an under-researched area.
- We need to understand cycling among the older population, and how this affects independence, health and well-being.
- Driver safety – rich qualitative data may be able to inform existing transport policy in a more meaningful way than quantitative data alone.
- Falls, as a pedestrian and on public transport, require further research, particularly in understanding the impact of a fall on subsequent mobility and independence.
- Segregated space between older pedestrians and other transport users is important for older people’s mobility, but we need to better understand how sharing space affects older people – which people, why, and in what ways?

- There is a need to ensure there is an awareness of the mobility, transport and built environment issues of older people made by health and social care professionals regarding the mobility of people who have returned home from hospitalisation.

- Economic evaluation – there is a need for research to be able to put a cost/benefit both on staying at home, and also on interventions that get the person out and about.

- The over-emphasis on problematising older people's mobility. More research is needed to identify the benefits of involving older people within the context of mobility as a whole, rather than simply involving older people in identifying barriers and issues.

- More research is needed to provide the evidence base for priority areas for older people's mobility in times of austerity.

- We recommend that an independent robust evaluation is undertaken, examining whether courses really improve driver skill and awareness and whether they reduce accidents.

1. Introduction

1.1 Background

With widespread decreases in birth rates and significant, steady increases in life expectancy, the median age of the UK population is rising. Results from estimates suggest the population of the UK aged 65 and over was 11.1 million (17.4% of the UK population) in mid-2013), up by 290,800 from mid-2012 and has increased by 17.3% since 2003 (Office for National Statistics, 2014a).

As stated above, in mid-2013 the population of the UK aged 65 and over was approximately 11.1 million (17.4% of the total UK population). Of this, approximately 3 million were aged 80 and over (Office for National Statistics, 2014a); the number of centenarians has also risen by 73% over the last decade, to 13,350 in 2012 (Office for National Statistics, 2014b). A total of 3.8 million (36%) people aged 65 and over live alone in Great Britain, and just over two-thirds (70%) of these are women (Office for National Statistics, 2013a).

Looking forward, the proportion of people aged 65 and over is expected to rise from 17.7% currently to 23.5% in 2034 (Office for National Statistics, 2013b). In addition, the population that is aged 85 and over is predicted to double in the next 20 years, and treble in the next 30 years (Office for National Statistics, 2013b). With rapid changes in size and age structure of the UK population, it is important to understand the impact and implications of these changing demographics for policy and service delivery within the context of transport.

Despite people generally being in better health, and with more opportunities to be physically fitter than ever before, those aged 65 and over are the group most likely to be physically restricted when needing to travel. For example, they are more likely than younger people to be unable to walk or cycle for long periods of time, and have more difficulty in physically accessing public transport (Schlag *et al*., 1996). They are also likely to be reducing the amount they drive or indeed have given up driving altogether (Box *et al*., 2011). Hence older people are the most likely group to experience mobility deprivation (DfT, 2001), and those aged 75 and over report the greatest difficulties in accessing local amenities (Age UK, 2014) and also report difficulties in engaging with and feeling part of their local community (Shergold *et al*., 2012).

The need to be mobile and to travel is also related to psychological well-being in older age, and a reduction in mobility can lead to an increase in isolation, loneliness and depression (Ling and Mannion, 1995; Fonda *et al*., 2001), and overall a poorer quality of life (Schlag *et al*., 1996; Gabriel and Bowling, 2004). There are also benefits of increasing travel for older people for society as a whole, including the economic benefits of older people spending in shops, of them looking after grandchildren, undertaking voluntary work, and carrying out other caring responsibilities (WRVS, 2013).

1.2 Principles

In order to develop a framework to aid our understanding of the mobility of people as they age, we formulated a set of guiding principles that underpinned this Evidence Review. These principles are drawn from current thinking in applied gerontology in the many differing fields that cover mobility issues. They represent a shift from individual discipline-based silo thinking, often

covering only one mode of transport, to person-centred thinking that attempts to cross traditional disciplinary boundaries. The key principles are:

1. Adopting an **ecological model of ageing** enables an understanding of the complex relationships between biological, behavioural, social, cultural and environmental factors that occur over the life course of individuals, families, neighbourhoods and communities in order to understand older people's mobility needs within the wider social and cultural systems.

2. Placing the user at the heart of mobility in order to take a **person-centred approach** is crucial. How the older person experiences mobility and how the environment impacts on them are central to our understanding of mobility and transportation. Consequently changes in infrastructure, systems or technologies need to be viewed from the perspective of individuals and the impact these changes may have on them.

3. Mobility behaviour and perceptions should take a life-course approach that builds upon **whole life experiences and choices**. Places familiar to older people may be more comfortable and usable as pedestrians; driving behaviours established over a lifetime may restrict options when mobility transitions occur (giving up driving, for example); lack of alternative transport facilities through life and perceptions of the environment developed over a life course may exclude older people from certain places and the take-up of alternative transport modes.

4. Understanding older people's mobility requires a **relationship-centred approach**. The relationship with the environment and other people that use that environment – vehicle drivers, cyclists and pedestrians, different modes all interacting together and influencing one another, and the challenge of creating positive interactions and influences – the rise in the number of mobility scooters, shared spaces between drivers and pedestrians, are examples of possible tensions.

5. Images of ageing can be positively changed through an **inclusive design approach** to transport provision and built environment infrastructure, where solutions are both functional and appealing to users. By flipping from a concept of dependence to interdependence underpinned by inclusive design, we can reduce the stigma of using mobility aids and adaptations, e.g. smart clothing integrated with navigational devices.

6. Mobility is multi-faceted and as such should be considered as a **whole systems approach**, moving away from traditional transport planning and recognising that (a) a range of domains such as imaginary mobility and electronic mobility should be considered, where appropriate, in addition to corporeal (out-of-home) mobility; (b) mobility will occur in a range of contexts from a room in one's home to the neighbourhood and beyond; (c) the need for travel extends beyond utilitarian reasons – the purpose could be for socialising, purchasing, working, for leisure, or even the journey itself; (d) the whole journey should be considered (from A to B and back again) and it may be multi-modal (for example walking to the bus stop then catching a bus).

7. The **physical environmental context** in which mobility is conducted is important to acknowledge and understand. Time, speed and distance as key factors in consideration of mobility and transport are often not considered in relation to the mobility of older people. For example, travel in the context of the high street will highlight different needs and issues for older shoppers and consumers in contrast to older workers who need to commute.

Local transport and mobility needs (older people as shoppers) will be different to global travel needs (older tourists).

8. There is a need to **balance diverse requirements**. This may be (a) related to the individual such that we better understand how mobility is affected by such factors as age, ethnicity and co-morbidities; (b) related to the design and use of space such that, for example, we understand the implications of providing tactile paving for vision-impaired people and the effect this may have on older people using mobility aids, or who are frail and have the potential to fall.

9. Addressing the **wider societal challenges** such as loneliness and isolation, civic participation, connectivity and health and well-being in relation to mobility is important. This is particularly crucial in rural areas where transport is costly and sparse. Likewise inner cities can be lonely and disconnected places for older people, despite having excellent transport infrastructure with potential for increased mobility.

10. Underpinning the principles is user engagement – the need to **involve older people** in decisions that affect their mobility needs, desires and wants, and to work co-productively with them to understand the barriers and enablers to mobility from their perspective, thus creating meaningful interventions that enhance mobility and quality of life. While the earlier principle of a person-centred approach focuses on the impact to the individual, this could be undertaken using a professional's point of view only, without seeking any user engagement, hence the need to ensure that all of the above principles are undertaken in conjunction with older people who are involved from the outset.

1.3 Methodology

Our initial approach proposed to use a critical realist review of the literature (Pawson *et al*., 2005; Keady *et al*., 2012) to describe the relevant historical drivers for change (past 25 years), and to describe what is known about the current situation. While the team accessed academic research literature through databases such as PubMed, SSCI, Web of Knowledge/Science, pubPsych, CINAHL, etc. as well as extensive grey literature, there was a paucity of evidence-based articles, which prevented the critical realist review being fully undertaken. At this point in our approach, we took inspiration from Edgley *et al*. (2014: 12) that a critical realist review "offers an excellent opportunity to explore novel and controversial literature, with the added incentive of taking a journey on a subject without knowing quite where it will end up". With this in mind, we have not set out tables of the keywords used, nor frequency of evidence-based articles found, as they were low in number. Instead we have focused on the evidence and grey literature itself, where it exists, to highlight the issues.

2. Conceptualising mobility and travel needs of older people

Mobility in the spatial or geographical sense means making journeys using modes of transport including, for example, walking, cycling, driving (as driver or passenger) and using public transport, and it is often termed 'out-of-home' mobility, corporeal mobility or travel behaviour. Mobility is multi-faceted and as such should be considered as a whole systems approach, highlighting the entire journey from door to door. Webber *et al*. (2010) portray mobility as a conical model (see Figure 1) based on different layers of community environment from home to the world, and view mobility through five determinants (cognitive, psychosocial, physical, environmental and financial), with gender, culture and biography (personal life history) viewed as cross-cutting influences. Although we know that out-of-home mobility is believed to be correlated to quality of life in older people (Marottoli *et al*., 2000; Bannister and Bowling, 2004; Mollenkopf *et al*., 2004; Schwanen and Ziegler, 2011), it is argued (Metz, 2000) that the relationship between mobility and quality of life in older age is ill defined, being largely based on anecdotal evidence such that the efficacy of interventions aimed at enhancing mobility are hard to assess.

It can be said that some forms of mobility do not require us to move outside of the home, and the work of Ziegler and Schwanen (2011) has corporeal mobility as only one of five domains of mobility in later life (see Figure 2). This is consistent with Parkhurst *et al*. (2014), who propose a model that involves virtual, potential and imaginary mobility, in addition to corporeal mobility. Within the context of this Evidence Review, the emphasis will be on corporeal mobility, with inclusion, as appropriate, of the other domains of mobility.

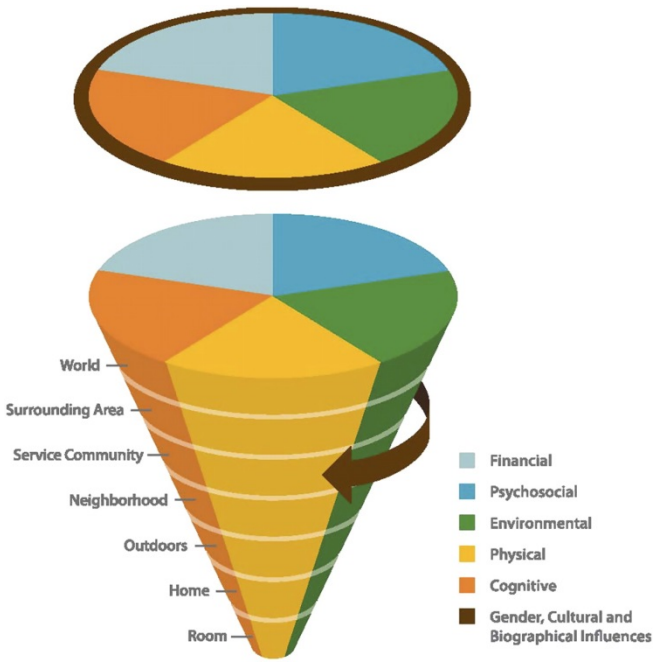

Figure 1: Conical model of the theoretical framework for mobility in older adults illustrating seven ascending life-space locations, each composed of mobility determinants – cognitive, psychosocial, physical, environmental and financial factors. A ring representing gender, culture and biographical influences surrounds the entire cone, exerting influence on all of the mobility determinants (after Webber *et al*., 2010)

Dimension	Explication
Mobility practices	These encompass acts of moving between different locations at various temporal frequencies (from daily or weekly travel for shopping to occasional trips to visit relatives or for holidays), practices that accompany moving through physical space (even within a restricted area such as the dwelling), as well as practices to maintain or increase physical and mental fitness, such as exercise, gardening, doing crosswords and interacting with other people.
Mobility of the self	The general will or psychological disposition to connect with the world and with difference.
Attitudes towards mobility practices	Attitudes towards pursuing hobbies and personal interests or towards the car. These attitudes can be thought of as disposition towards specific sequences of acts in everyday life and are more concrete than the previous dimension of mobility of the self. These more concrete dispositions mediate between mobility of the self and mobility practices.
Imaginary mobility	Cognitive processes (memory and imagination) that recollect or construct events in other times (past or future) and other places.
Electronic mobility	Electronic communication or information retrieval as a substitute for mobility or to supplement physical mobility, as with the internet, telephone and television.

Figure 2: Types of mobility in later life (after Ziegler and Schwanen, 2011)

Similarly, it is common to talk about the need for travel at only a utilitarian level, and this narrow focus is hugely contested (see Zeigler and Schwanen, 2011) because we know that the need for travel is much more than this. To gain a greater and more holistic understanding of transport in later life, it is important to look beyond literal or corporeal mobility to include constructions of travel related to virtual, potential, imagined, aspirational and emotive mobilities (Parkhurst *et al*., 2014). Musselwhite and Haddad (2010a) propose a model of needs and motivations for travel in later life around three main levels of hierarchical need – utilitarian/practical, psychosocial/affective and aesthetic needs (see Figure 3). They suggest that travel or mobility in later life is important at all three levels but most provision for older people, especially for those who have limited mobility and have given up driving, centres only on utilitarian needs being satisfied with the psychosocial and aesthetic needs not being provided for. The psychosocial/affective level of need is also well described by Mollenkopf *et al*. (2011) who found, among other travel needs older people have, mobility as a social need; mobility as an expression of personal autonomy and freedom; and the ability to move about as a reflective expression of the person's remaining life force. The aesthetic need – the need to travel simply to get out and about for its own sake – has also been found to be important in other studies (e.g. Marottoli *et al*., 2000; Harrison and Ragland, 2003; Davey, 2007; Mollenkopf *et al*., 2011).

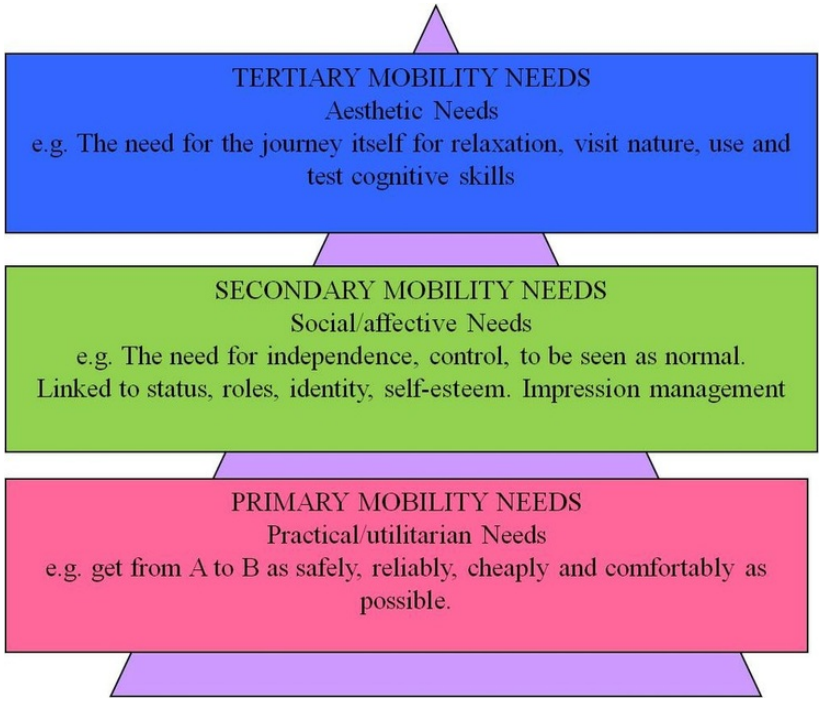

Figure 3: Hierarchy of travel needs in later life (after Musselwhite and Haddad, 2010a)

Understanding the older person within the wider social and cultural system is important. Adopting an ecological model of ageing (Webber *et al*., 2010) that identifies person–activity–environment fit (Lawton and Nahemow, 1973), and recognises the complex and nested relationships (Bronfenbrenner, 1989) between biological, behavioural, social, cultural and environmental factors that occur over the life course of individuals, families, neighbourhoods and communities is critical (Satariano *et al*., 2014).

Ecological models are increasingly being used to explain the interactional relationship between the external environment and an individual's behaviour. Environments are surroundings that "encompass the person and affect their understanding of themselves and the culture in which they live" (Peace *et al*., 2006: 8). Such models suggest that the connection between the psychobiological development and ongoing behaviour of an individual is due to a bidirectional relationship with the immediate physical and social environment. Bronfenbrenner's ecological systems model (Bronfenbrenner, 1979, 1989, 2005) has been applied to many different contexts of human behaviour, for example the relationship between children's play and the wider environment (Holt *et al*., 2008), work–life balance in families (Kulik and Rayyan, 2006), rural ageing (Keating and Phillips, 2008) and risk taking and transport (Musselwhite *et al*., 2014). It suggests that there are different layers that affect a person's development or behaviour.

The ecological model (see Figure 4) adopted for this Evidence Review proposes four layers: the microsystem, the mesosystem, the exosystem and the macrosystem, and a temporal direction of the chronosystem. The microsystem is the layer closest to the individual, containing structures within which the individual immediately interacts. It includes the home and objects in the home, the built environment of buildings, roads and other amenities, and the natural environment including climate and topography (Keating and Phillips, 2008), people's connections to others, including networks of family members, friends and neighbours who can be a source of social capital that helps people interact with and navigate their surroundings (Peace *et al*., 2006; Keating and Phillips, 2008). Finally, it includes both objective elements and

the meaning or evaluation of those elements (Lawton, 1999; Peace *et al*., 2006; Keating and Phillips, 2008). The mesosystem layer provides the connection between the different structures of microsystems (Berk, 2000). The exosystem layer defines the larger social system within which the individual does not function directly, including policy, laws and rules. The outermost layer, the macrosystem, comprises cultural values, customs and ideologies (Berk, 2000). In addition to these four layers, the chronosystem encompasses the dimension of time over the life course, for example the physiological changes that occur with ageing.

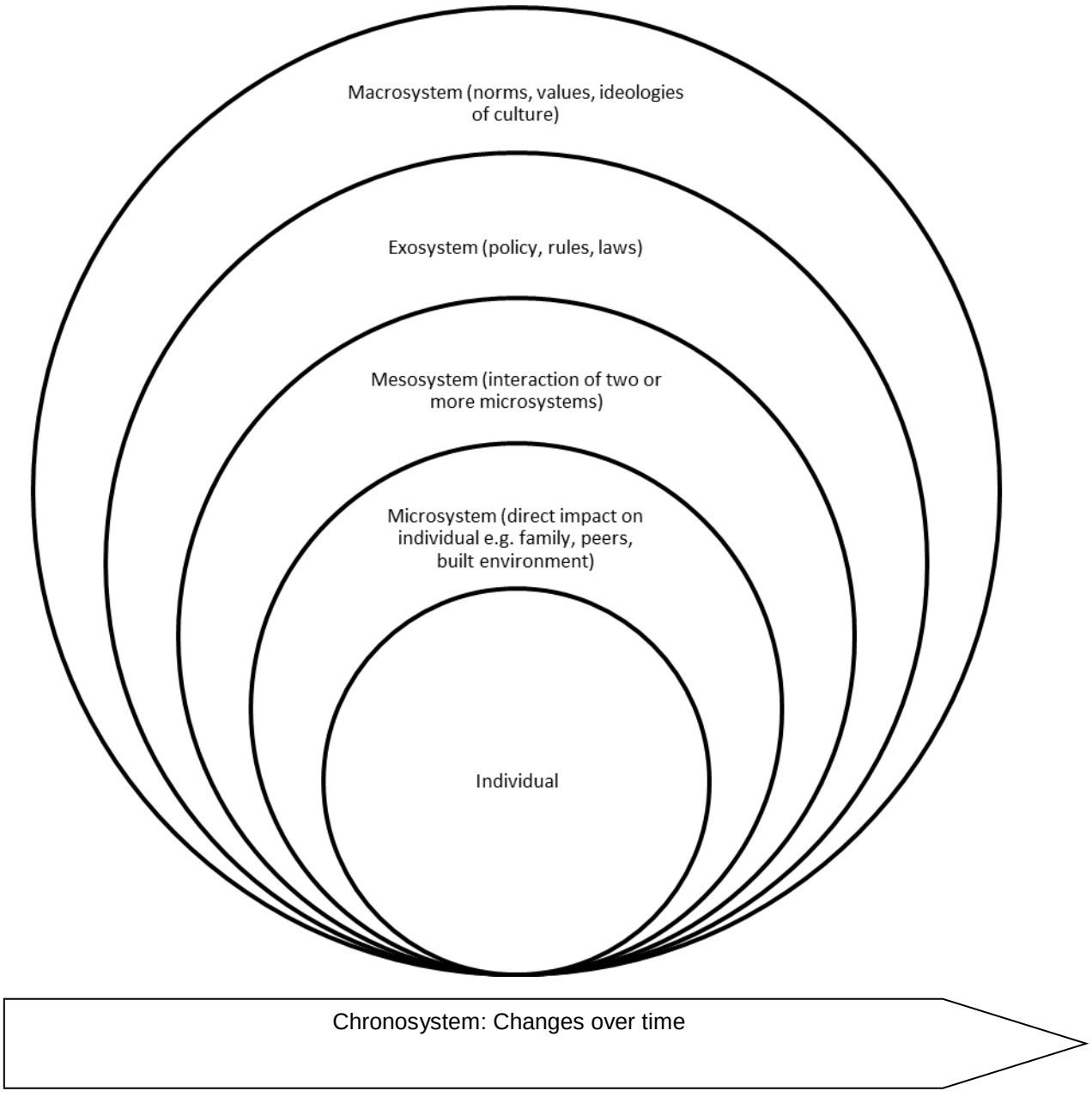

Figure 4: Model of Bronfenbrenner's ecological systems theory (Bronfenbrenner, 1979, 1989, 2005)

The critical approach to gerontology stems from inequalities in power within society that marginalise older people (Phillipson and Walker, 1986). More recently this has been applied to a spatial approach and environmental context, examining the relationship between the imposed accepted wisdoms of disengagement with the environment in later life and the agency,

adaptation and reconstructive abilities of older people to shape their environment (Phillipson *et al*., 2000; Scharf *et al*., 2005; Peace *et al*., 2006). Keating and Phillips (2008) also added an extra dimension of critical gerontology to the ecological model in their description of ageing in rural areas. Spaces, places and the links between them can be viewed as being ageist and excluding older people through the over-reliance on private mobility, the preserve of the young and fit at the expense of public, community or even active forms of mobility (Keating and Phillips, 2008). Yet it is important to highlight that there is no one singular experience of ageing because everyone is unique and ageing in relation to the environment is different in different contexts and different places/spaces. The relationship of meaning attached to ageing in place is therefore important because transport not only provides connections between spaces of activity and between origin and destination, but is also creating important psychosocial connections within the transport itself. The secondary and tertiary levels of Musselwhite and Haddad's (2010b) model are therefore important in understanding a holistic ecological experience of transport use. So how can the ecological model be applied to the mobility of older people?

3. Ecological model – the chronosystem

The chronosystem's underpinning temporal direction helps us to understand how changes in people's mobility across the life course are important by establishing:

- how changes in life affect mobility;
- how mobility can affect changes in life.

As well as an individual's change over time, there are also changes in mobility between different cohorts of people between different times. Tilley (2013) argues that by constructing pseudo-cohorts, repeated cross-sectional data can help to distinguish cohort and age effects by comparing age groups from pseudo-cohorts for different years. Using data from the UK National Travel Survey, Tilley (2013) tracked cohorts over time, allowing changes in mobility to be compared within and between cohorts and finding that although mobility amongst older people is rising in general, there would actually be declining mobility were it not for the Boomer cohort.

Changes in health, wealth, aspirations, expectations and norms mean different mobility use among different generations of people. In addition, focusing in this way on the timeline shows that decisions made and events occurring at an earlier stage in life can impact upon a person when they then reach a later stage.

Due to increased life expectancy and better physical health, coupled with an ever-increasing hypermobile society (where people live further away from their family, friends, work, services and shops than ever before), older people are on average achieving higher mobility when compared with earlier generations (Noble and Mitchell, 2001). This provides new challenges for the provision of transport services (Su and Bell, 2009), alongside challenges more likely to be faced by this age group such as the ability to use certain forms of transport, changes in lifestyle (such as reducing travel commuting or for work, children leaving home, more time and, for many, less money) and motivation to use subsidised transport services (free bus use, specialised transport services, etc.). There is increasing recognition of the changing patterns and lifestyle choices of people over the age of 55 who have the opportunity to travel (Borja *et al*., 2002). It has long been recognised that for some people, later life can be a time of freedom for leisure and pleasure (Bernard and Meade, 1993). Also, issues of reducing physical mobility are often ameliorated by going on travel cruises (Leidner, 2006) and companies target the older market in selling packages that remove as much exertion in getting to the destinations as possible. Obtaining reasonably priced travel insurance cover at a certain age is more of a barrier to travel than physical impairment and this is a milestone event that the chronosystem can identify.

Throughout our entire life course our mobility patterns change and are heavily influenced by life events and milestone points in time, some of which are unexpected turns in life and others hopefully planned transitions, such as downsizing and changing commitments in a move towards retirement from paid employment. What does past evidence show us about the mobility of older people?

Statistics from the UK suggest, as would be expected, miles travelled commuting to and from work or for work purposes falls dramatically for over 70s (95 miles/person/year against an average across all ages of 1,899 miles/person/year). However, the over 70s are more likely than average to travel more miles for shopping (1,094 miles/person/year against an average

across all ages of 769 miles/person/year) (DfT, 2014; see Table 1). Trip chaining, whereby people combine their trips for a variety of purposes, is still prevalent amongst older people, particularly car users.

Table 1: Miles per person by age and purpose, England, 2013 (DfT, 2014)

Purpose	All ages	50–59	60–69	70+
Commuting	1,279	2,033	699	68
Business	620	1,200	467	27
Education	227	15	4	–
Escort education	106	96	50	23
Shopping	769	991	1,254	1,094
Other escort	473	607	454	203
Personal business	446	567	698	571
Visit friends at private home	1,009	1,100	1,215	825
Visit friends elsewhere	286	312	390	287
Sport/entertainment	442	460	580	319
Holiday/day trip	880	1,041	1,144	762
Other including just walk	48	56	58	37
All purposes	6,584	8,479	7,014	4,215

While the DfT (2001) found that one-third of older people would wish to engage in more activities than they currently do, transport difficulties are mentioned by upwards of one in four of those wanting to do more activities (with the exception of sport/leisure activities), and this is particularly so for people aged 80 and over.

According to the National Travel Survey 2009 (DfT, 2010a) (*n* = approx. 16,000), 36.1% of trips under 2 miles and 53% of journeys under 5 miles are undertaken by car, with walking accounting for 23.4% of all trips and cycling only 1.5% of all journeys. When compared to other European countries, while levels of walking are broadly similar, cycling in Britain is substantially less common than elsewhere. For instance in Sweden and Finland, 9% of all trips are by bicycle, in Germany 10%, in Denmark 18% and in the Netherlands 26% (Buehler and Pucher, 2010). Further statistics (NTS, 2010) suggest that around 27% of 60–69 year olds actually own a bike, but only 1 in 9 of these use it.

As people age they walk fewer miles, but the amount of walking in relation to other modes increases. People over the age of 70 walk 112 miles/person/year, which is fewer miles than the average (187 miles/person/year). Walking declines in later life, from 166 miles/person/year for 50–59 year olds and 162 miles/person/year for 60–69 year olds and 112 miles for 70+ (DfT, 2014, Table 2). However for the over 70s, walking makes up a greater percentage of their overall mileage (2.66%) than 50–59 year olds (1.96%) and 60–69 year olds (2.31%).

In later life, miles travelled on buses increases for the over 70s (529 miles/person/year for over 70s compared to 331 miles/person/year across all ages; see Table 2). Decline in driving and

more recently the addition of a concessionary bus pass will have contributed to this. There is a big decline in people aged 60 and over using trains, some of which is linked to decreasing travel as commuters or for work purposes (DfT, 2014).

As people give up driving due to age, taxis are more frequently used – but often quite reluctantly as taxis are often viewed as an expensive form of transport (TfL, 2009). However, taxis are seen as a lifeline in rural areas, particularly where public transport is less frequent.

There is a strong preference for car use among older people when there is a car available in the household (Schmocker *et al*., 2008). The increase in the number of driver's licence holders and car availability is reflected in travel mode choice among older people, and both men and women maintain their car use habits in older age. A cohort analysis (Hjorthol *et al*., 2010) of National Travel Surveys of Denmark, Norway and Sweden in a 20-year perspective showed a significant period effect in car ownership and use among older people, with a clear increase during the past 20 years, especially for women. Similarly in the UK, there has been a large increase in driving licences among older people, increasing from 15% of over 70s in 1975 to 62% in 2013 (DfT, 2014), with a similar trend of 35% to 82% for 60–69 year olds. It is still true that fewer females hold licences than males across all ages, although trends suggest this is changing, especially for older females, with an increase from 4% in 1975/6 to 47% in 2013.

Overall, as people age they drive fewer miles, but recent cohorts drive more than previous generations. Older people today travel more than the comparable age groups 20–25 years ago, everyday trip rates are higher and activities outside home are more common. Since 1995, the increase in miles driven has fallen across all age groups by 8%, however for those aged 60–69 and those aged 70 and over miles driven have increased (37% and 77%, respectively) (DfT, 2014). Also, older people do more of their miles as a passenger than when they were younger (DfT, 2014; Table 2).

Table 2: Miles per person per mode, England, 2013 (after DfT, 2014)

Mode	All ages (miles)	All (%)	50-59 (miles)	50-59 (%)	60-69 (miles)	60-69 (%)	70+ (miles)	70+ (%)
All people:								
Walk	187	2.84	166	1.96	162	2.31	112	2.66
Bicycle	49	0.75	53	0.63	33	0.47	10	0.23
Car/van driver	3,235	49.14	5,321	62.76	4,116	58.69	1,905	45.18
Car/van passenger	1,865	28.33	1,622	19.14	1,682	23.98	1,278	30.32
Other private transport	154	2.33	155	1.83	157	2.23	132	3.13
Local and non-local buses	331	5.03	211	2.49	332	4.73	529	12.55
Rail	650	9.87	780	9.20	447	6.37	199	4.73
Taxi/minicab	54	0.83	48	0.56	42	0.60	40	0.95
Other public transport	58	0.88	120	1.42	44	0.63	11	0.25
All modes	6,584	100	8,479	100	7,014	100	4,215	100

3.1 Example issue – safety as a pedestrian

Older people are not over-represented in road safety statistics, as can be seen from Figure 4. However, Figure 5 shows that they are much more likely to die from being a road casualty, almost certainly due to increased physiological chance of doing so from 40 years onwards, with a steep rise at 70–79, and over 80 years old. This is especially true of pedestrians, who are more likely to die as a result of collision the older they get (see Figure 6). Note that these figures do not include deaths due to non-collision such as outdoor falls (see later section).

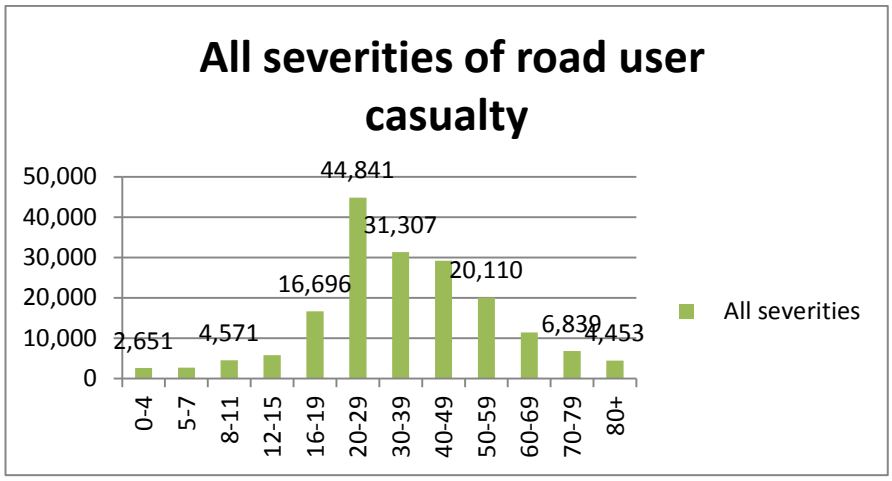

Figure 4: Number of reported casualties across all road users by age, Great Britain (DfT, 2014)

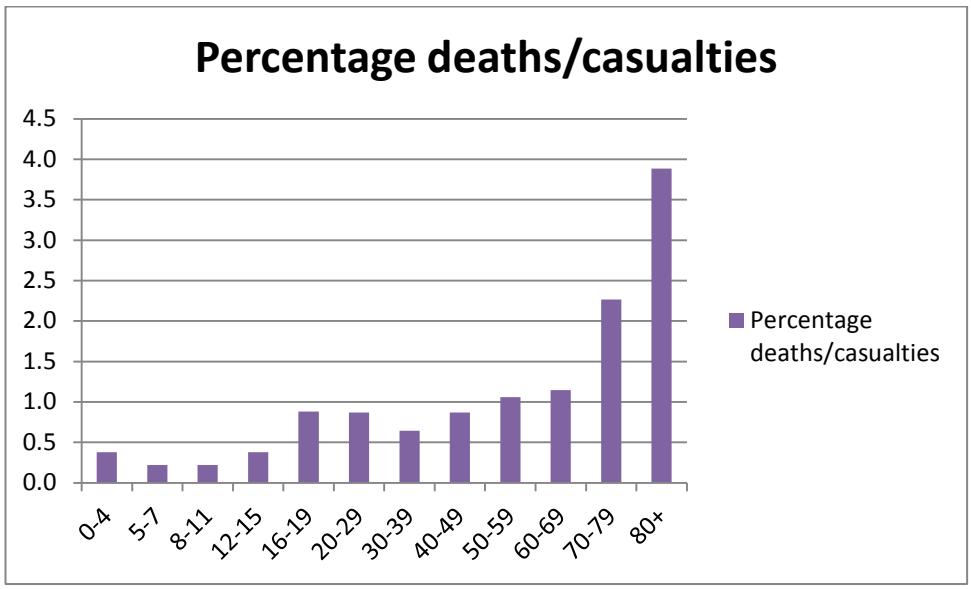

Figure 5: Percentage of deaths per casualty across age groups, all road users, Great Britain (DfT, 2014)

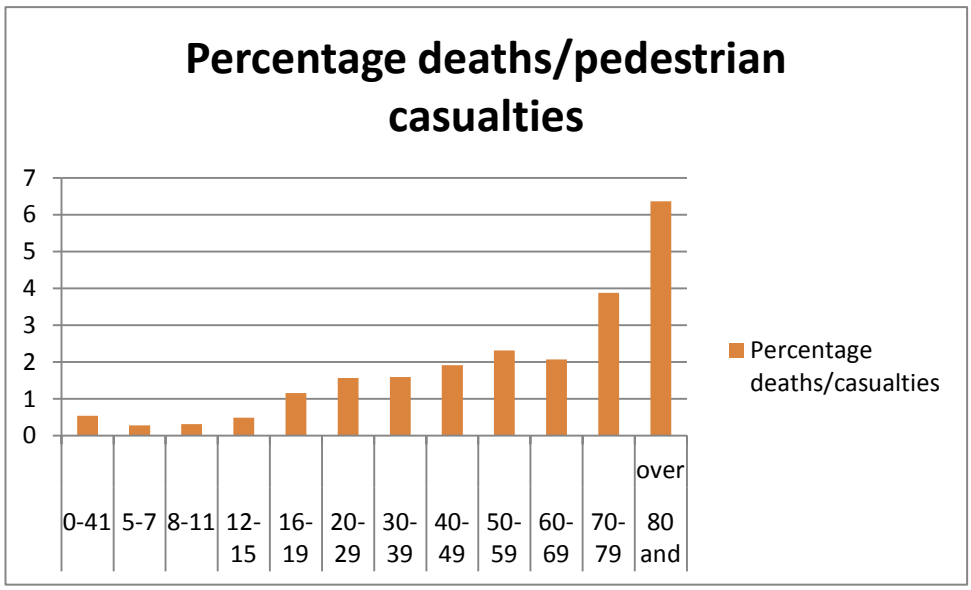

Figure 6: Percentage of pedestrian deaths from each pedestrian casualty by age in Britain in 2013 (DfT, 2014)

3.2 Example issue – driver safety

Casualty rates for older drivers per mile driven are at their lowest for 70 year olds, but this rises from 75 years onwards (see Figure 7), in part due to the increased chance of death or injury if involved in a collision. An increase in blame for a collision does, however, occur from 75 years onwards. Older people are over-represented in collisions at junctions, in merging traffic, with turns across the road and in busy traffic (Clarke *et al*., 2009). Generally, older people feel they are able to compensate for their perceived reduction in ability by choosing when, where and how to drive (Rabbitt *et al*., 1996; Holland, 2001; Rabbitt and Parker, 2002; Baldock *et al*., 2006; Musselwhite and Haddad, 2010a; Musselwhite and Shergold, 2013). However, they may not be very accurate at perceiving their own ability (Cushman, 1996; Marottoli and Richardson, 1998; Charlton *et al*., 2001), although Musselwhite and Haddad (2010b) suggest this can be improved through discussion groups, which improve focus and encourage reflection on action.

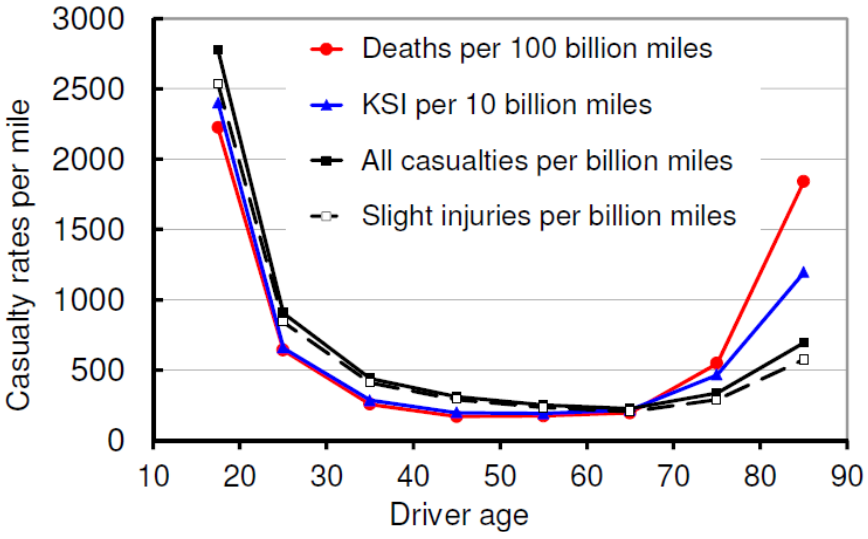

Figure 7: Casualty rates for drivers by age and types of casualty (KSI = killed or seriously injured) (Mitchell, 2012)

4. Ecological model – the individual

At the individual level, the extent and nature of mobility is shaped by an individual's health and well-being, but in turn, mobility may have an effect on an individual's health and well-being. Much research has found correlations, but not necessarily the exact causal pathways. For example, it is likely that someone with health problems gives up driving. Giving up driving is linked to poorer health, but it is not clear whether this is a continuation of the poor health that caused the person to stop driving, or whether stopping driving causes further problems; it is probably a little of both.

4.1 Mobility and health and well-being

In undertaking an Evidence Review there inevitably is a focus on where that evidence exists. From our review we have mainly found evidence on how older people travel and the problems people face as they age in terms of mobility and barriers to travel. This in turn means that this report could be seen to focus on negative aspects of mobility, health and well-being, rather than portraying a more balanced view. This is one of the gaps in knowledge identified.

A number of studies have investigated the experience of loss of mobility from the perspective of the older person. Loss of mobility is often associated with diminished independence and a fear of dependency on others. Participants wanted to "continue to be able to do things for themselves, such as shopping and household tasks" (Gabriel and Bowling, 2004: 687). Supporting this, additional research on the perspective of the older person found that declining mobility is associated with the loss of social connections, reduced participation in the community, greater risk of developing depressive symptoms, and altered abilities to perform self-care, productivity and leisure activities (Mahoney *et al*., 1999; Fonda *et al*., 2001; Finlayson *et al*., 2003).

4.2 Physical mobility

Getting outdoors is a key factor in preserving good physical, mental and social health in all age groups but particularly as people move into older age (Sugiyama and Ward Thompson, 2007). Increasing physical activity levels in the population will help prevent or manage over 20 conditions and diseases including coronary heart disease, diabetes, some cancers and obesity (NICE, 2008). Being more active can help improve mental health, and can also help older people to maintain independent lives (NICE, 2008).

Outdoor falls, both actual falls and fear of falling, are a key inhibitor of getting outdoors for older people (Wijlhuizen *et al*., 2007; Nyman *et al*., 2013). Falls destroy confidence, increase isolation and reduce independence, with around 1 in 10 older people who fall becoming afraid to leave home in case they fall again. We know that for older people aged over 65 the consequences of falls, wherever they occur, are significant with, for example, about one-third of over-65s falling each year (Masud and Morris, 2001), almost 3,200 fall-related deaths in 2012 (Office for National Statistics, 2013b), which would equate to one death due to falls every 3 hours (Age UK, 2015) and falls and resultant fractures account for 4 million bed-days in England alone (Age UK, 2015). While indoor falls have been well researched and supported by policy (e.g. NICE, 2013), little is recorded as to the causes of outdoor falls, including those related to transport, how this impacts on mobility, and what could be done to prevent falls.

Giving up driving has repeatedly been shown to relate to a decrease in well-being and an increase in depression and related health problems, including feelings of stress and isolation and also increased mortality (Ling and Mannion, 1995; Marottoli and Richardson, 1998; Fonda *et al*., 2001; Peel *et al*., 2002; Ragland *et al*., 2005; Windsor *et al*., 2007; Mezuk and Rebok, 2008; Edwards *et al*., 2009; Musselwhite and Haddad, 2010a; Musselwhite and Shergold, 2013; Ziegler and Schwanen, 2013). This may be due to mediating factors like a reduction in out-of-home activities (Marottoli *et al*., 2000; Rosenbloom, 2001; Harrison and Ragland, 2003) and a decrease in associated physical and social functioning (Edwards *et al*., 2009), less frequent healthcare use for check-ups and chronic care (Arcury *et al*., 2005), reduced social networks (Mezuk and Rebok, 2008) and activities (Marottoli *et al*., 2000), and reduced mobility choices and options (Taylor and Tripodes, 2001; Peel *et al*., 2002). Giving up driving is also associated with affect and loss of psychological well-being associated with increased dependency on others (Rosenbloom, 2001), norms of using the car (Musselwhite and Haddad, 2010a; Ziegler and Schwanen. 2013), independence (Adler and Rottunda, 2006; Davey, 2007; Siren and Hakamies-Blomqvist, 2009; Musselwhite and Haddad, 2010a) and the view of using the car being associated with being young and healthy (Musselwhite and Haddad, 2010a; Musselwhite and Shergold, 2013). Ziegler and Schwanen (2012) conclude that driving cessation constitutes a major life event for older people with similar long-term or lasting consequences for well-being as losing one's spouse or losing one's job.

We know that successfully giving up driving is often linked to a social trigger (retirement from work) rather than a health incident or an actual or near-miss road collision (Musselwhite and Shergold, 2013). Musselwhite (2011) suggests that the concept of driver cessation should occur far in advance of actually needing to give up, and be a gradual and planned approach. Initial prompts into the conscious are needed, and Brown (2010) suggests a leaflet at retirement age, hence associating giving up driving with a significant life event outside of the sphere of driving.

4.3 Virtual mobility

Social networking sites result in people remaining in contact with each other without the need to be geographically close and without the need to travel to interact. Telemedicine can mean health can be assessed from the comfort of one's own home. Shopping online has already revolutionised the way people purchase goods, and teleworking provides a respite from the rush hour queue. Travel can occur through virtual 'windows on the world' (e.g. Google Streetview or YouTube videos) and destinations experienced through live webcams. It means that 'travel' for practical, social or aesthetic reasons can take place in a virtual state without the need for physical travel. Hence, it can be proposed that older people's travel needs can be met utilising a virtual world through the use of the internet without the need for physically travelling (very far). However, examining previous research suggests there seems to be psychosocial elements missing when older people engage in virtual travelling – for example casual, unexpected, informal interaction is missing from e-shopping compared to shopping in person (Musselwhite and Haddad, 2010b). Boden and Molotch (1994, 2004) suggest that 'co-present interaction' (the need to physically interact with other people) is the fundamental mode of human intercourse, as well as informal co-present interaction (Urry, 2002). Or a rebound effect might occur with other travel replacing that not made (Shergold *et al*., 2015).

Encouraging people to stay mobile seems to be synonymous with maintaining health and well-being in later life both because it connects people to communities, family, friends, services, shops and activities but it also seems to have intrinsic value, seeing the world and life continuing. How some of these benefits might be realised in a virtual way through technology warrants further exploration. Can shopping online help eliminate the need for travel? Can

telemedicine and telehealth reduce the need to physically travel to hospital or the doctor? Can webcams replace the need to visit beauty spots? What is the importance of being physically co-present to maximise benefits from such activities? More research is needed in this area.

5. Ecological model – the microsystem

At the microsystem level, mobility is shaped by how an individual interacts with a great variety of other structures – home and the objects in that building; the immediate environment surrounding that building, including pavements and roads; moving outwards to other buildings and places; and how climate and topography affect these interactions. Social connections of family, neighbours and friends are included in this layer; it also takes into account the meaning and association that the individual places on these elements. It is useful to think of this layer as comprising many microsystems that mesh and interact with each other via that individual. When conflicts occur between microsystems then mobility can be compromised, or a barrier to mobility created.

5.1 Infrastructure and walking

It is well documented that the supportiveness of neighbourhood environments that make outdoor activity (e.g. walking) easy and enjoyable are conducive to a better health and quality of life for older people (Bannister and Bowling, 2004; Gabriel and Bowling, 2004; Schootman *et al*., 2006; Sugiyama and Ward Thompson, 2007), and are found to increase levels of activity for older adults (Michael *et al*., 2006). King *et al*. (2003) suggest that the ability to make utilitarian walking trips from home and the perception of having favourable neighbourhood surroundings for walking are associated with increased physical activity levels in older women. Importantly, it was found that pleasantness of open space and lack of nuisance were associated with walking for recreation, while good paths to reach open space and good facilities in open spaces were conducive to more walking for transport (Sugiyama and Ward Thompson, 2008), and if street quality could be improved, "the disablement process could be slowed or even reversed" (Clarke *et al*., 2009). In addition, research suggests that maximising the attractiveness or safety of a walking path can be as important, if not more so, than minimising the distance to a destination (Michael *et al*., 2006). Routes should in themselves be interesting and stimulating (Holland *et al*., 2007) and access to the natural environment, especially green spaces, is important.

Research highlights a number of built environment features that improve a neighbourhood environment and help promote outdoor mobility. These include good-quality pavements (Newton *et al*., 2010; Ormerod *et al*., 2014; Curl *et al*., in press), clutter-free pavements (Newton *et al*., 2010), bus stop density (Schmocker *et al*., 2008) and quality of design (including shelters, seating and information) (Newton *et al*., 2010; I'DGO, 2012a; Broome *et al*., 2013), important stopping points en route including toilets and seating (Newton *et al*., 2010; I'DGO, 2012b). It is considered (Living Streets, 2014) that the pedestrian experience could be significantly improved through a default 20 mph in urban areas, stopping unpermitted parking on pavements, and making sure crossing times are fit for pedestrians, which is consistent with recommendations from NICE (2012), and with further NICE guidance (2008) which recommends that pedestrians, cyclists and users of other modes of transport that involve physical activity are given the highest priority when developing or maintaining streets or roads, including widening pavements, providing cycle lanes, and traffic calming to restrict speeds.

One of the particular challenges with regards to older people and walking in the built environment concerns the sharing of space with other users, including pedestrians who are walking more quickly/slowly, mobility scooter users, cyclists using shared footways, and motorists in a 'shared space' environment. Segregated space between pedestrians and other transport users is important for older people's mobility (Newton *et al*., 2010). Within a 'shared space' environment, pedestrians share the carriageway with motorists, and there is an absence

of the traditional demarcation (such as the kerb) between light road users (walking and cycling) and mechanical modes (cars, vans, buses, lorries, etc.). Research on shared space has suggested that people who feel more vulnerable in this environment tend to stay within the location that used to be the old pavement and do not use the carriageway to walk in when shared space is found (Hammond and Musselwhite, 2013; Moody and Melia, 2013; Musselwhite, 2015). This is not so surprising because pedestrians, particularly those that are more vulnerable or less confident, tend to walk close to the buildings rather than in the road. People do use the road to walk in shared space areas, but this is rare and is almost exclusively done by younger males (Kaparias *et al*., 2010; Moody, 2011; Musselwhite, 2015), suggesting the benefits of shared space may be more apparent to males than females and younger rather than older adults (Moody and Melia, 2013; Musselwhite, 2015). Also, we know that older pedestrians may face issues sharing space with younger pedestrians (Holland *et al*., 2007) and this may be a further reason for their tentative approach within shared space areas.

The Department of Health Prevention Package (DoH, 2009) issued a call for research to prevent outdoor falls and decrease the barriers to physical activity that the environment poses. Many of the environmental risk factors (pavement quality, dilapidation, kerb height) associated with outdoor falls in the pedestrian environment appear to be preventable through better design and maintenance (Li *et al*., 2006). Similarly, transport-related risks such as falls on buses appear to be preventable through considerate driver schemes, yet 800 older people fall on buses every day, and over 2 million older people are worried about falls on buses (Age UK, 2009). Despite this, outdoor falls including transport-related falls are a neglected public health problem due to a lack of standardised methods for evaluating environment hazards (e.g. slippery pavements, slippery bus floors), and the difficulty of associating falls with specific environmental hazards that are dynamic over space and time (Li *et al*., 2006) and in relation to different individuals (Clemson *et al*., 2008; Iwarsson *et al*., 2009).

An important part of being an active pedestrian is being able to safely cross the road. We know that if pedestrians feel unsafe, for whatever reason, then they are more likely to use the car instead (Pooley *et al*., 2011). A study by AARP (Lynott *et al*., 2009) revealed that about 50% of adults aged 50 years or older reported that they cannot cross main roads close to their home safely. Half of those who reported these problems said they would walk or bicycle more if these problems were addressed. Langlois *et al*. (1997) demonstrated that capacity is linked to mobility and they found that older pedestrians who needed help in one or more activities of daily living were 10 times as likely as others to report difficulty crossing the street, and those with the slowest walking speeds were almost three times as likely to also report difficulty crossing the street. Similarly, it has been noted that older people may not perceive time to arrival (TTA) of the oncoming traffic correctly due to an age-related visual and cognitive decline (Dommes and Cavallo, 2011).

Crossing times need to take into account walking speeds of older pedestrians. Older pedestrians typically walk much slower than the 1.2 m/s recommended by the UK's Department for Transport. Musselwhite (2015) suggests that only 11% of older pedestrians walk at 1.2 m/s or above, and that females and those from lower socioeconomic backgrounds fail to meet the required walking speed, suggesting some groups of older people are further excluded from using streets. These findings are in line with previous research and fear of not being quick enough to cross the road is known to restrict people leaving the home or to limit their accessibility when out and about (Zijlstra *et al*., 2007; Lord *et al*., 2010).

Newton and Ormerod (2013) found four statistically significant predictors of feeling safe when crossing the road – less traffic, shorter waiting time, presence of a green man on the opposite

side of the carriageway (including a long duration), and the level and consistency of signage and information as to when to cross. Additionally their work provided eight recommendations for road crossings including minimising diversity between crossing type (pelican, puffin, etc.), bringing back the audible beeping noise, and increasing pedestrian crossing times. Legibility was also found to be important by Dommes and Cavallo (2011).

Interestingly, Pooley *et al*. (2011) found that pedestrians generally were most concerned about threats from other people in a poorly supervised environment, so in effect, an absence of eyes on the street and insufficient pedestrian numbers (footfall). Additionally Holland *et al*. (2007) found that lighting is an issue for older people because they are unwilling or unable to take full advantage of public spaces, especially after dark, due to inadequate facilities, transport, security concerns, and a general lack of activities geared towards their preferences.

5.2 Legibility

Legibility is vitally important in aiding mobility. Places and spaces need to be intuitive, or signposted, in order for people to feel confident in using them. People's sense of place relies on the familiarity of the use patterns, spatial structure and long-established features of that place. Places, spaces and buildings must give clear messages as to their uses and to have easy to find, accessible entrances and for individual neighbourhoods to be defined by their own distinctive, varied characteristics, features and materials. Legibility is particularly important for people with cognitive impairment, such as those with dementia, if they are to remain active and independent. The Alzheimer's Society (2013) defines a dementia-friendly community as "a city, town or village where people with dementia are understood, respected and supported and confident that they can contribute to community life". For people with dementia, places need to have familiarity and meaning (Burholt, 2006) and they should be legible, distinctive, accessible, comfortable and safe (Burton and Mitchell, 2006).

5.3 Travel information

Over the past 40 years, the UK government has taken an increasing responsibility for travel information, with the recognition that it can be used to enhance behaviour change and reduce social isolation for disadvantaged groups (Lyons *et al*., 2003; Lamont *et al*., 2013). Providing better traveller information was one of the themes set out in the Department for Transport's Policy Framework for Intelligent Transport Systems (DfT, 2005a).

Lack of travel information can be a key barrier to getting out and about for older people. Lindsay *et al*. (2012) suggest more mobile older adults attribute their higher levels of mobility to carefully pre-planning their trips through the use of information. Travel information can be used pre-trip, presenting information on a forthcoming journey, allowing individuals to choose between different modes and routes. Computer-based travel information can respond to user requests for information and can give directions, or plot routes on maps. Additional features may include relatively static functions such as times of the day, days of the week and costs, as well as more dynamic functions using real-time traffic data such as traffic predictability. In this way it can be used to encourage people to choose a different mode to normal, with the idea that it can reduce habitual or default car trips. Accuracy is important; discord between information and actual experience can severely damage the trust of the information provider.

Providing travel information to personal needs and requirements pre-trip and en route can create huge difficulties (Sulaiman and Sohaimi, 2010). The interface between the information

required and personalising the information input can be unwieldy and over-complex, incorporating too many choices for individuals to personalise, or providing too much data, both a huge challenge to those with cognitive impairments.

In practice, older people have often lived in their community for many years and are quite aware of the route they need to take to get to the shops without a map telling them how to do it. The reality is that when planning a trip the major obstacles are often: (a) finding the motivation to undertake the trip in the first place and (b) identifying how temporal issues such as roadworks closing off accessible areas of a pavement can disrupt a journey. A better system might look more like a forecasting system that can tell users when a good time to undertake a journey might be, while taking account of a user's personal needs. However, the precise details of such a system should not be determined without consultation with intended users (Lindsay *et al*., 2012).

5.4 Infrastructure and cycling

Much is noted about how the lack of cycling in the UK may be due to poor, or a lack of, dedicated infrastructure for cycling at all ages, reducing habitual and normalisation of cycling through the life course (Jones *et al*., 2014). Pooley *et al*. (2011: 10) found that if the physical environment is perceived as potentially dangerous, for whatever reason, then people will either avoid what they perceive as risky locations, or will travel in the security of their car, and that "traffic is a major deterrent for all but the most committed cyclists". Older people who cycle more regularly are likely to be male, white and live in a rural area (Chatterjee, 2014).

5.5 Weather

Going out into the cold, improperly insulated and undertaking high levels of activity (such as sweeping up snow) are likely to play an important role in excess winter mortality in the UK (Goodwin, 2000) due to thrombosis, to which older people are particularly vulnerable. We also know that falls are an issue, particularly in winter. Emergency hospital admissions for falls on snow and ice vary greatly across winters, and according to temperature, age and gender (Wilkinson *et al*., 2004; Benyon *et al*., 2011). Taking 2009/10 as an example, falls are highest amongst older people, and in particular men over 80, and the total inpatient cost of falls on snow and ice was £42 million (Benyon *et al*., 2011).

5.6 The importance of social networks, family and friends

Support of family and friends in terms of practical and psychological support during the process of making transitions between different ways of travel is important, and driving cessation is a good example of the importance of family and friends. Giving up driving successfully occurs over time, with long periods of trying out new modes and destinations (Musselwhite and Shergold, 2013). The process of driving cessation often begins with a discussion instigated by family members. As Coughlin *et al*. (2004) point out, however, the discussion with family members is not always harmonious, and although almost 60% followed the advice given by family, over half of these were upset by the decision. Older drivers on the whole would welcome more involvement of healthcare professionals, especially GPs and opticians, in deciding whether they should or should not drive (Coughlin *et al*., 2004; Parker *et al*., 2007; Berry, 2011; Musselwhite and Shergold, 2013). However, healthcare professionals are reluctant to be involved and very few give advice on driving cessation; when they do it is almost exclusively to order someone to stop driving rather than raising into the conscious a prompt for a longer

decision-making time (Hawley, 2010; Berry, 2011; Musselwhite and Shergold, 2013). This lack of involvement by healthcare professionals reinforces the importance of social networks, family and friends in the decision-making process.

5.7 Infrastructure and driving

In terms of driving, complex road layouts contribute to accidents involving older drivers. Box *et al*. (2011) suggest that self-explaining roads with perceptual cues are needed, for which existing guidance in the USA could be developed. Examples include high-contrast white lines, clear and unambiguous signage, and reduced speed limits on priority roads approaching high-risk junctions. Many of these changes are likely to benefit the rest of the driving population. Box *et al*. (2011) do suggest that "providing good quality guidance to road traffic engineers and planners on road network design for the older driver should be made a priority". However, while this may well help older people as drivers, it could make other younger drivers even faster and potentially make roads more dangerous (especially for pedestrians). It goes against current thinking on streets, which suggests improving safety can be done by keeping the driver engaged by providing a complex environment (e.g. psychological traffic calming [Kennedy *et al*., 2005] and more recently shared space).

5.8 In-vehicle technology

Advances in in-vehicle technology, coupled with infrastructure changes, may overcome limitations in older drivers if designed to overcome factors such as distraction, feedback, process time and cognitive overload. Driverless cars may potentially aid driving for older people and keep them driving later on in life through intelligent speed adaptation and (adaptive) cruise control, fatigue detection systems, current speed warnings, collision advice systems, and lateral and trajectory position warnings (Musselwhite, 2011). Driverless cars may increase road safety for the older driver as well as other road users, pedestrians and cyclists.

There are high hopes for driverless cars and how they will aid older people's mobility. This is true if older people can trust such technology and that they are able to take over in the event of technology failure (both elements with which they may struggle). In addition, it is imperative to think connectedly about transport and travel and remember an increasing number of people using vehicles will result in further dispersion of community and increased hypermobility. Is this what we want for society? Is this just deferring the inevitable – the need to give up driving?

Car manufacturers are increasingly aware of the importance of designing vehicles to meet the needs of older people, both in terms of appropriate support in the vehicle and also in terms of aesthetics, and older people are increasingly involved in focus groups and market research groups with various motor manufacturers. In terms of designing practical support, for example, Ford Motor Company has designed the Third Age Suit, which is worn by designers and testers and enables them to see limitations associated with ageing, such as stiff muscles, poorer dexterity, weaker eyesight and weaker hearing (see www.youtube.com/watch?v=CEDF9ut7iCc).

6. Ecological model – the mesosystem

The mesosystem layer is where the interaction between two or more microsystems occurs. While some of these interactions may be positive and help the individual, some may conflict and thereby cause exclusion. This is particularly pertinent when addressing barriers to mobility in later life, for example multiple barriers conjoined affect the ability of older people to use buses and the London Underground, rather than one feature of the microsystem alone. In addition, the mixtures of microsystem variables that create or feature in a rural or a deprived area also affect transport use. However, the mesosystem can also be seen more positively in moves to bring elements of the microsystem together, for example in bringing together communication technologies with real-time travel information to help older people, which can broadly be seen as assistive technologies. However, the move through inclusive design would be to mainstream these technologies so that they benefit everyone.

6.1 Complex and interactional barriers

Even if the bus is free at the point of use, there are still many barriers that prohibit or make it difficult for older people to use it (see Table 3). A report by TfL (2009) using accompanied journeys in London highlighted problems for older people, including crowds at the bus stop or on the bus, prams taking up the seats or area at the front of the bus, steps up to the bus being too high (or the driver stopping too far from the kerb), and fear of falling over when the bus moves off. Age UK (2009) quantified this by surveying bus driving behaviour and in 42% of cases, passengers were not given enough time to sit down before the bus was driven away from the stop. In 25% of the cases the bus did not pull up tight to the kerb at the bus stop.

Table 3: Barriers to using the bus, complex and interactional barriers (Gilhooly *et al*., 2002)

Problem	% aged over 70 who agree
Personal security in evening and at night	79.8
Public transport running late	68.3
Having to wait	68.0
Difficulties carrying heavy loads	66.3
The possibility of cancellations	66.0
Behaviour of some passengers	63.5
Lack of cleanliness	53.8
Having to be out in bad weather	53.8
Having to change transport	53.3
Difficulties travelling where I want to	50.0
Difficulties travelling when I want to	48.1

That said, there is evidence older people often cease to use the London Underground and move over to using buses (TfL, 2009). However, despite improvements on the London Underground, it is accessibility that remains the biggest problem among older people, especially with long staircases (perceptions and concerns about), overcrowding and the fast speed of

closing doors, and concern about crime on the underground, particularly during very busy periods (TfL, 2009).

Over the past decade the amount of people using rail has grown significantly in the UK, both absolutely and in terms of percentage of overall distance travelled. Rail travel has increased by 67% between 1995/97 and 2013 (DfT, 2014). The increase is especially noticeable in early and middle-aged adults and is not anywhere near as pronounced in later life – indeed those aged over 70 have stayed around similar levels, fluctuating between 130 and 200 miles (except a peak of 269 miles in 2010) per person per year, accounting for between 4% and 6% of miles travelled. Across the life course, train usage begins to fall from 60 years onwards (DfT, 2014), some of which is linked to decreasing travel as commuters, or for work purposes (DfT, 2014).

Trains can help older people stay connected for longer distances, or for journeys between urban areas. The advent of cheaper tickets for travel off peak (when older people are able to be more flexible about travel), along with discounts through railcards, should encourage older people to travel by train. We know that older people have high satisfaction with their train travel, including being positive about price and the overall journey experience. This may be because of making more recreational journeys than the average train user – leisure users are more satisfied than those using it for work and commuters, but getting a seat on a train is a very high priority for older passengers from 60 years onwards, and it becomes more important than the cost of the ticket (Transport Focus, 2014). Older rail passengers are also more likely than younger rail passengers to want to be kept informed about the journey and delays (Transport Focus, 2014), and less likely to be concerned about availability of Wi-Fi.

6.2 Rural inequalities in transport

Lower-density populations across Britain are often associated with older people who are moving out to the countryside or seaside locations, while younger people are moving out to find work (see Figure 8). Keating and Phillips (2008) found that these locations tend also to have poorer transport links, but they may have better social capital, meaning mobility needs may be met through emotional and practical support. Shergold *et al*. (2012) found that people in rural areas access a range of local activities with the help of lifts by car and conclude that more emphasis should be placed in rural transport policy on facilitating short-range travel for social purposes, including walking, cycling and the use of mobility scooters, rather than assuming the car is needed for all these journeys.

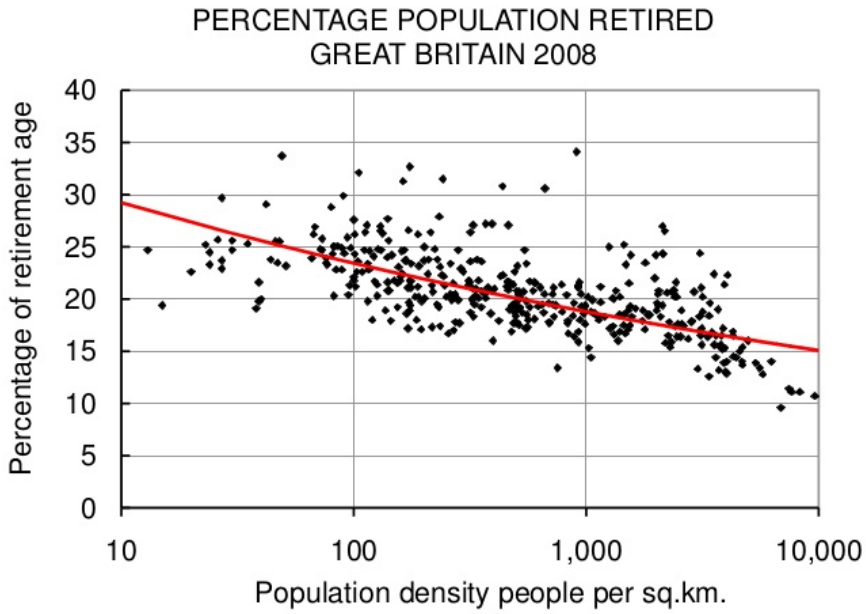

Figure 8: Percentage of people over retirement age in an area plotted against population density of the area (Great Britain) (after Mitchell, 2013)

Results from a European study on mobility in later life found that older adults living in rural areas were particularly at risk of loss of mobility compared to those in urban areas (Mollenkopf *et al*., 2004). The consequences of a lack of, or loss in, mobility disproportionately affects people living in rural and remote areas. For instance, a loss in mobility can result in reduced use of preventative services, primary care and hospital care due to the geographical inaccessibility of the services and the costs and inconveniences of longer journeys. This in turn can lead to worse health outcomes for older adults, in comparison to their urban counterparts (Haynes and Gale, 2000).

6.3 Social deprivation

We know that older people living in socially deprived urban neighbourhoods are susceptible to problems such as social exclusion and decreased quality of life arising from the closure of local services and amenities, social polarisation, crime-related problems, poor housing, etc. (Scharf and Smith, 2004; Buffel *et al*., 2013). For older people with restricted mobility, the loss or lack of local health and social care services, public transport or affordable local shops can be problematic. It can necessitate the use of costly means of transport such as taxis, and/or dependence on others to reach essential services (Scharf *et al*., 2001). A study by Scharf *et al*. (2005) conducted 600 surveys and 130 in-depth interviews with older people aged 60 and over living in England. Results found that older people living in socially deprived inner city areas experienced multiple forms of disadvantage that had an impact on their well-being. These included exclusion from material resources (for example central heating, telephones, access to a car), reduced social relations and civic activities (such as community groups or religious meetings), limited access to basic services (such as public transport), and neighbourhood exclusion. The ability to remain independent was highlighted as important for participants who reported a good quality of life (despite experiencing multiple forms of disadvantage), with mobility problems being identified as a barrier to independence and social inclusion.

6.4 Black and ethnic minority groups

An American study by Rosenbloom (2003) found that there are important variations by race and ethnicity in the travel patterns of otherwise comparable older adults. Even when controlling for income and residential location, black, Asian and Hispanic older adults make fewer and shorter trips than white older adults, and generally less often in a car. Findings showed that ethnic minorities are also less likely to be licensed to drive. In addition, there are greater travel differences between men and women within black, Asian and Hispanic ethnic groups than there are among white older adults. According to Rosenbloom (2003) and Rosenbloom and Herbel (2009), these patterns may reflect a combination of historical income patterns, residential location, voluntary or involuntary residential segregation, current or historical discrimination, and ethnic and cultural differences in attitudes, preferences and the role family members are expected to and do play in the personal mobility of older family members.

The literature on mobility among adults from black, Asian and minority ethnic groups in the UK suggests that they are more likely to depend on public transport than white ethnic groups. However, fear of racial discrimination and difficulties with language represent barriers to public transport use (Smith *et al*., 2006). Research by the Department for Transport (DfT, 2003) found that public transport providers have an inadequate understanding of the transport needs of minority ethnic groups because they are often not included in consultation and customer care surveys, and complaints procedures are often ineffective due to language difficulties.

6.5 Bringing together technologies

Technology can be used to help overcome barriers faced by those with mobility, sensory or cognition impairments. There are many items that can be classed as assistive technology, too many to cover here, and also mainstream devices are increasingly being used to provide assistance in ways not first thought of in the original design. An example would be remotely controlling other equipment via an iPad. Mainstreaming can also work by taking a technological solution designed initially for a particular impairment and using an inclusive design approach to make it appealing to everyone to use. An example would be voice-activated software designed originally for blind computer users, which is increasingly being used by everyone to save typing. Technology can be extremely valuable in aiding communication, navigating and helping to simplify the complexity of the physical environment we are placed in. Tactile paving provided for blind and vision-impaired people to identify hazards, such as road crossing points, is a communication tool (Newton and Ormerod, 2012), however while the benefit is clear for blind users, it can conflict with other users of the pavement (Ormerod *et al*., 2014). It is inevitably a compromise between detectability for blind people and walkability for other users.

However, the pace of change of technology is much faster than our ability to adapt the physical infrastructure to account for that technology. Personal mobility scooters are an example of this, with public transport providers left with the problem of whether to allow scooters on their vehicles, but their vehicles were never designed to accommodate them.

Additionally, while our primary focus is on older people making the journeys, Hubers and Lyons (2013) point out that with the emphasis on ageing in place then more journeys may be made by healthcare workers to the older person in their own home, rather than by the older person themselves. Is a visiting health worker assistive technology? Although telecare may be able to remove the need for some health worker journeys, other health-related tasks will require a physical presence to deliver them.

Assistive technology is increasingly being used to support people with dementia and an area attracting ethical debate is the use of GPS systems. GPS devices for people with dementia are considered useful by older people, people with dementia and family caregivers to support independence and increase self-confidence. Potential users appear less concerned with the ethical issues relating to ‘tagging’ than academics and the media (White and Montgomery, 2014). The bigger issue is how such devices might be used to promote independence, perhaps as a person living with dementia, rather than just offering caregivers peace of mind.

7. Ecological model – the exosystem

Organised societies create rules, guidance and laws to help the operation of that society on a day-to-day basis. The exosystem represents the layer in the ecological model where these operate in a way that facilitates governance over the individual and microsystems, and mediates between conflicts occurring between different microsystems in the mesosystem layer. So those that act on behalf of a society create rules that decide what level of support should be given, to whom it should be given, and when it should stop being provided. Some of these rules become enshrined in law, with penalties incurred for transgression, while others remain as guidance to be adhered to by those that see the benefit, and others in some cultures remain hidden, with those from outside that culture unaware of their existence.

Policies, rules and laws that affect transport may stem from a wide variety of sources as mobility is an important factor in addressing many of the wider societal challenges facing the UK, such as loneliness and health and well-being. These wider issues are addressed through legislation, or policy to steer members of society towards a particular goal. We cannot hope to cover the extent of rules, guidance and laws on mobility-related issues, so instead focus as an illustration on some areas of interest.

7.1 Concessionary bus use for older people

Possibly one of the most interesting mobility and popular related initiatives for older people in Britain has been the provision of concessionary bus use – the 'free' bus pass. There is compelling evidence that use of the bus system increases with 'free' travel for older people (Mackett, 2013a). In 2005, the year before free local travel, the percentage of older people with a bus pass was 50% male and 61% female (Scott and Humphreys, 2012); this then steadily rises as shown in Figure 9 to 79% female, 73% male by 2013 (NTS, 2014). It is suggested (Scott and Humphreys, 2012) that ownership of a free bus pass is higher (around 80–82%) among those on lower income (less than £15,000). This group are also more likely to use the bus once a week than those on higher incomes, who use it less frequently.

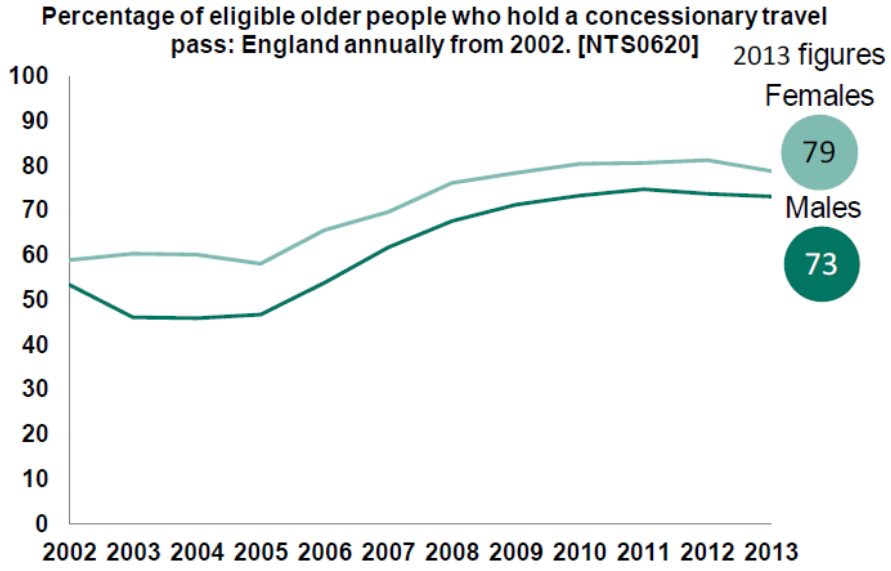

Figure 9: Take-up of concessionary travel schemes by gender: in England (NTS, 2014)

Dargay *et al*. (2010) modelled bus use against what would have happened if no free bus pass had been introduced and suggests the number of bus stages used by older people increased by 45.4% in rural areas and 26.5% in urban areas due to the 'free' bus pass. The journeys made are not just more numerous but also often longer in duration and distance (Andrews, 2011). The most commonly reported activity older people cite as their destination across all these surveys is shopping, followed by social and leisure, day trips, visiting friends, and then medical (Mackett, 2013b). Additionally Andrews (2011) found 74% of his respondents stated that the 'free' bus pass improved their quality of life.

Hirst and Harrop (2011) found 74% of their older respondents in Manchester saying that having a pass enabled them to engage in new pursuits and visit new places. Andrews (2012) also notes the importance of buses, not just in terms of reaching the destination and engaging in activities, but also in terms of the social nature of travel for older people who travel together. Andrews (2012) encountered older people who swapped stories, shared photos and generally chatted on buses. He also found a group of older people who played bus roulette, choosing a different bus to travel on by a throw of a dice, meaning they got to travel a different route and destination each time. In addition, Musselwhite (2011) moots that the intergenerational element of travelling on buses and the community found therein, the random chance encounter, and seeing other people from nearby places are all important to community and well-being. Similarly Green *et al*. (2014) found travelling on a bus as part of the 'general public' created a sense of belonging and visibility in the public arena for older people. They suggest this as being a socially acceptable way of tackling chronic loneliness. They conclude bus travel can be a major contributor to well-being, rather than as it is often seen, a transport choice of last resort (Thomas *et al*., 2014).

The 'free' bus pass is also beneficial to society as a whole. A recent report by Greener Travel (2014), in conjunction with KPMG LLP, used DfT guidance on economic appraisal and found for every £1 spent on the 'free' bus pass for older people, £2.87 is returned back into the economy. This is confirmed by Mackett (2014: 1), who suggests that "older people make a significant contribution to society, improving their access would enable them to increase their contribution, the policy of free off-peak travel for older people in Britain is a good example of this, and the economic contribution of older people to society will increase in the future".

7.2 Community transport

Community transport is a user-oriented form of public transport characterised by flexible routing and scheduling of vehicles, operating between pick-up and drop-off locations determined according to the needs of passengers. However in the UK, provision of community transport is varied and overall serves only a small number of users. In some cases it has been reported to be unreliable, especially with regard to arrival time (TfL, 2009). That said, users are extremely satisfied with the community service when it is provided. The journey experience is highly valued and passengers report travelling for social as well as practical purposes (e.g. shopping, GP appointments, etc.) (Webber *et al*., 2010). There is also the added value of the community transport driver as quasi-carer, which is of vital benefit to the user as much as the journey itself (Webber *et al*., 2010; Musselwhite, 2011). Musselwhite (2011) suggests the value of community transport clearly goes way beyond fulfilling utilitarian travel needs, and offers social and emotional interaction amongst its users and volunteer and paid drivers. Not surprisingly due to its popularity, community transport and dial-a-ride services are often oversubscribed, so people face a long waiting list (TfL, 2009).

7.3 Stringent testing of older drivers

At the moment in the UK older people self-declare fitness to drive when renewing their licence at 70 years of age and then every 3 years after. Across the world there are different regulations governing licensing of older drivers. There is little evidence that more stringent testing of older people, involving on-road or simulator tests and/or cognitive tests, would lead to fewer road traffic collisions (see Siren and Haustein, 2015, for a review). There is tentative evidence (Nasvadi and Wister, 2009) in British Columbia, for example, that eyesight tests for older people and introducing a graduated licence in later life may have a minor beneficial effect on traffic collisions.

7.4 The inclusive design approach

When designing, we need to be mindful of the diversity of shapes, sizes and abilities of people, as well as gender, cultural and age-related issues. This can be achieved through taking an inclusive design approach, which is a way of designing products and environments so they are usable and appealing to everyone regardless of age, ability or circumstance by working with users to remove barriers in the social, technical, political and economic processes underpinning building and design (Ormerod, 2005). The key aspects of inclusive design are that users need to be involved in the design process ideally from the outset, and the end product or environment should be both functional for the widest range of users possible and should be desirable by them to use. Preferably mainstream solutions should be sought that work for everyone, or that are easily adaptable to varying needs.

Designing specifically for a particular impairment/health condition requires careful consideration if it is to be adopted in everyday settings. The AC Invacar of the 1960s/70s (Figure 10) is a good example of this. It was the only vehicle designed for those with physical mobility impairments in the UK, and continued until it was banned for road use in 2003 due to safety concerns. This vehicle unfortunately typifies what happens when a design for a specific impairment, albeit well intentioned, becomes a stigmatising icon, giving the message that disabled people should only travel alone, they do not want choice, and do not need a vehicle that is appealing. Today we have the Motability service, and while this can be seen as giving more choice of mainstream vehicles, it is still limited to certain models of car.

Figure 10: AC Invacar (courtesy Motoring Picture Library)

Compare the AC Invacar to the more contemporary all-electric Renault Twizy (Figure 11) and the appeal aspect is immediately obvious. Can the Twizy be simply adapted to allow older users and those with a mobility impairment to use it? While probably not in the original design brief, the adaptability of it should certainly be investigated. However, this should not be the only option, but to add to a varied range of solutions catering for individual requirements.

Figure 11: Twizy electric vehicle (courtesy Renault)

7.5 Legislation and guidance

In 1995 the UK started to remove the barriers that many disabled people, including older people with impairments, find in everyday life. The phased introduction of sections of the Disability Discrimination Act (1995 and 2005) allowed time for those responsible under it to be able to replace, adjust or provide alternatives, to make their services accessible and non-discriminatory. While some would argue that this has been a very long journey, with some transport-related aspects still not due until 2020, in theory this has allowed time to prepare well in advance of the deadlines. The Equality Act (2010) brings together nine different strands of discrimination legislation into one unified act, including the Disability Discrimination Act 1995 and 2005.

Additionally, under Section 149 of the Equality Act (2010), public bodies are further encouraged to address discriminatory practices through the Public Sector Equality Duty, which came into force in 2011 (EHRC, 2012). This is a duty on public bodies and others carrying out public functions to ensure that they consider the needs of all individuals in their day-to-day working in shaping policy, in delivering services, and in relation to their own employees. To some extent this has widened the gap, with the public sector being actively proactive, while some private service providers have tended towards a ‘wait and see if anyone actually makes a claim’ approach.

In terms of guidance to support designers in implementing solutions for people with impairments, including disabled people and older people, this has greatly improved for detailed building design (including transport interchanges) with Approved Document M of the Building Regulations (HM Government, 2010) in England and Wales, and the Scottish Standards (The Scottish Government, 2011) in Scotland benefitting from cross-reference to guidance in British Standard BS8300:2009 +A1 (BSI, 2010) and research undertaken on access issues. However, there appears to be far less guidance on external environments, the reliance being on some aspects of the Department for Transport's *Manual for Streets* (DfT, 2007, 2010b), an increasingly outdated *Inclusive Mobility* (DfT, 2005b), which was originally written in 2002 and which fails to reflect issues such as shared space (DfT, 2011), and specialist guidance such as the Inclusive Design for Getting Outdoors *Design of Streets with Older People in Mind* (I'DGO, 2011).

The specific legislation regarding transport is far too large to include here, but generally it is being adhered to in respect of vehicle replacement, station upgrades and interchange design. The Disabled Persons Transport Advisory Committee (DPTAC) has been instrumental in pushing forward this agenda for change. DPTAC was established under the Transport Act 1985, and it advises government on transport regulation, guidance, and on the transport needs of disabled people, ensuring that disabled people have the same access to transport as everyone else. Additionally DPTAC provides a range of useful guidance documents covering many forms of transport modes (car, rail, bus, air, sea) including accessible travel (DPTAC, 2011). However, attitudinal barriers are much harder to overcome. Despite long campaigns to educate service providers, there will always be a continual need to train frontline staff in disability awareness and age-friendly approaches. An accessible taxi is of little use if the driver refuses to take your assistance dog.

The Independent Living Strategy (Disability Rights UK, 2014) aims to give disabled people more choice and control over the support they need and greater access to employment, transport, health and housing opportunities. Independent living means not necessarily doing things for oneself, but having choice over support and equipment, and equal access to public services and opportunities. Bevan and Croucher (2011) in the Lifetime Neighbourhoods report, note that good-quality outdoor spaces have a positive impact on social interaction, health and well-being and have been shown to be cost-effective in terms of reducing health and care costs. The Marmot Review (2010) highlighted that understanding the important interaction between public health, and social and physical environments, is only a recent development, so it is not surprising that a progress report by Disability Rights UK (2014) found no evidence of significant progress in disabled people's experiences of choice and control in their lives since 2008.

The age-friendly cities model initiated by the World Health Organization in 2007 to encourage active ageing (WHO, 2007) has been developed in a variety of policy and practice initiatives to enable people to continue participating in social, cultural, spiritual and civic matters (Buffel *et al*., 2013). In a Research and Evaluation Framework for Age-Friendly Cities, Handler (2014) draws attention to the importance of good social and emotional fabric of the city, highlighting the importance of people's subjective connections with place, the meanings and values attached to places (Phillips *et al*., 2011) and the perceptions of an environment that can give people confidence in a place.

8. Ecological model – the macrosystem

At the macrosystem level, mobility is shaped by cultural values, customs and ideologies (Berk, 2000). What is accepted as the norm creates expectations that individuals behave in certain ways with regards to their mobility within given cultures and contexts. This impacts upon how people move and what modes they use, because society contains expectations of how someone might travel and for what purposes at different stages in the life course. There is a need to be more reflective about such perceptions in order to challenge the status quo, particularly as the nature of ageing and getting older is changing. It is suggested that education and training can go some way to helping change this. We provide an example at the macrosystem level within the context of driving.

8.1 Norms, impression management, status and roles

In terms of driving, Gilhooly *et al*. (2002) found that while car ownership and driving were linked to quality of life, the effect was stronger for men than for women, and we know that men find it much harder to give up driving than women. Musselwhite and Haddad (2010a) and Musselwhite and Shergold (2013) place this down to identification with the vehicle and the role that driving plays within the lives of older males to provide for the family and the desire to stay connected to this role. It is also noted how driving for males and females is seen as normal within society and that not driving is seen as unusual. It was also felt among the participants that giving up driving is often viewed as a sign of weakness and frailty that is linked to being in the final stages of old age. The car was also seen as a status symbol, a sign not only of youth and vitality (Ellaway *et al*., 2003), but also of having done well in life, especially among the men who were more likely to 'wear' their car like a badge of honour. This was important to those who had retired from work, who no longer had that as a source of impression management (Musselwhite and Shergold, 2013). This continued for those who only very rarely used a car, who would keep the car on the drive in good condition in case the need arose to drive, as Metz (2000) coins, the importance of the potential for travel that the car provides. Hence, the desire to continue to drive and also to own a vehicle was fuelled by norms and values within society. There are norms surrounding use of other modes too. Older people who use a bicycle more regularly are most likely to be male, white and live in a rural area (Chatterjee, 2014). Bus use is higher among females, as it is across the life course and this extends into older age, although with the advent of the free bus pass, this has begun to even up among the genders, with more males using the bus than previous generations.

8.2 Education and training to help older people stay mobile

There are a number of driver training centres for older people across the UK. The Forum of Mobility Centres is a network of 17 independent centres aimed at helping older people stay mobile. The primary focus is on improving driver safety, offering on-road or simulator training, tips and advice. There is also help with buying vehicles and appropriate technology to aid driving. The centres involve both self-referrals and those referred to them by medical staff or the Driver and Vehicle Licensing Agency. To date there has been no formal evaluation of such training centres and there are no recognised standardised tests of education or training, but they are well received by participants.

It is suggested that driver training should be accompanied by training that discusses life beyond the car, focusing on both emotional and practical support, aiding planning, which is known to

help successful driver cessation (Musselwhite, 2011; Musselwhite and Shergold, 2013). Liddle *et al*. (2007) has developed and evaluated such a course in Australia, centred around seven modules (Growing Older, Driving Later in Life, Adjusting to Losses and Changes, Experiences of Retiring from Driving, Alternative Transport, Lifestyle Planning, and Advocacy and Support) delivered in a group work format, with the order and time allocated to each module determined by the needs and preferences of the group. Evaluation suggests participation in the course significantly predicted higher use of public transport and walking at immediately post-intervention, and increased aspects of community mobility self-efficacy, and higher satisfaction with transport at 3-month follow-up. However, this study was limited by a high attrition rate (and resulting small sample size), and a convenience sample of volunteers; and so further research is required to clarify the long-term impact of the course (Liddle *et al*., 2013). Older people may have difficulty accessing public transport when they haven't used it for many years, and buddying systems can aid people with re-learning norms associated with public transport use; examples in the UK include Centro (n.d.), HAIL (2013), West Yorkshire Local Transport Plan Partnership (2006) and Wandsworth Council (2014).

9. Conclusions for enhancing the mobility of older people

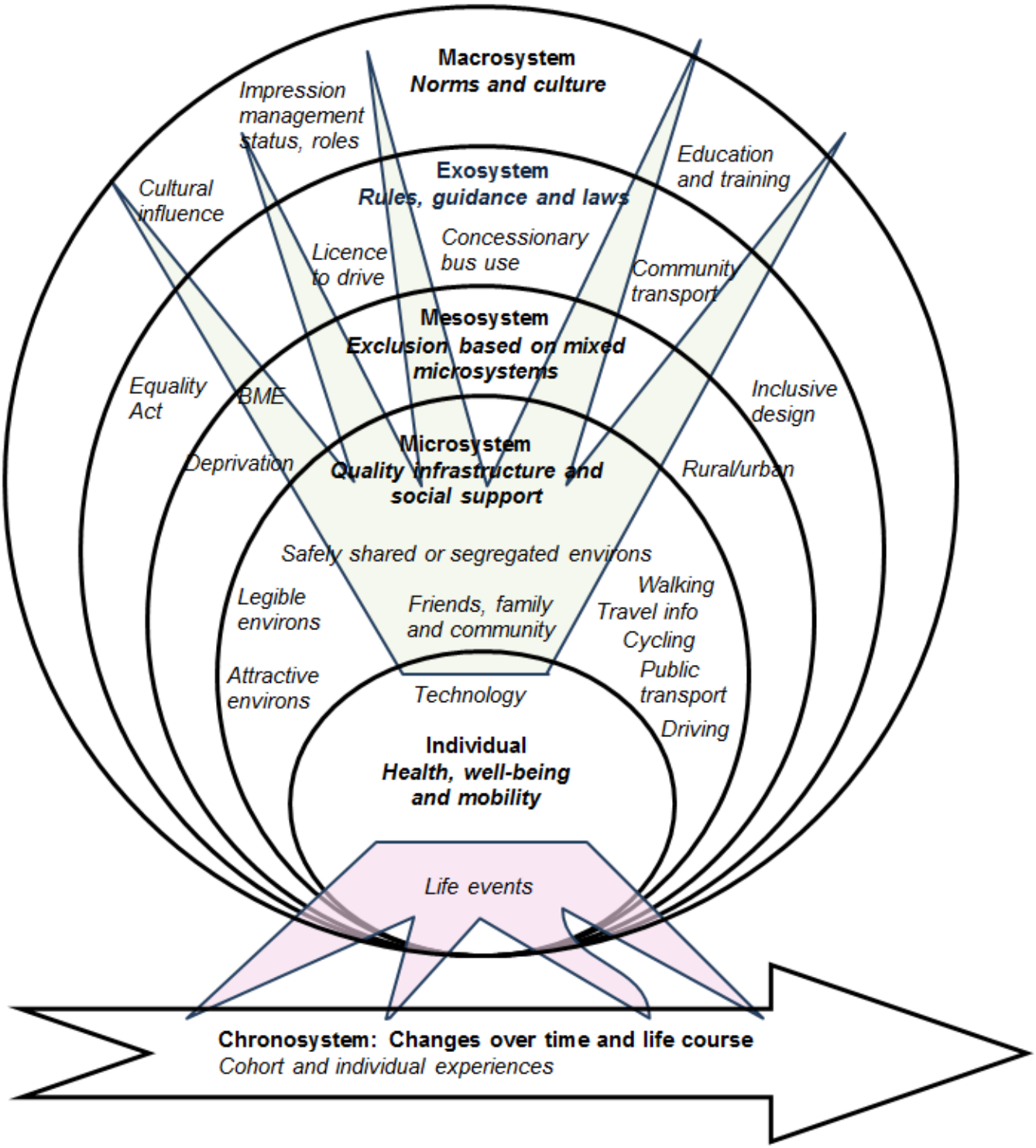

Figure 12: Ecological model of mobility of older people

The various impacts on mobility and transport for older people are illustrated in Figure 12. Mobility is related to health and well-being of older people, in particular driving and active travel. A variety of factors that immediately surround the individual affect older people's mobility.

In particular the built environment is important in supporting mobility (physical environment context). This must be of high quality to ease mobility, be safe and segregated from other types of road user. When the infrastructure must be shared it must be safe, and facilities placed to allow interaction between vehicles and pedestrians, for example, must take into account older people's needs with regards to speed of walking and sensory input. A legible environment is important; environments must be easy to navigate and understand. These environments must also be attractive to encourage people to use them and access to green space is very important.

The importance of family and friends and the wider community in connecting older people through practical, instrumental and emotional support is important (wider societal challenges). Bringing these elements together at the wider mesosystem level highlights barriers to using particular transport, especially public transport. It also shows how groups of microsystem layer issues come together to conspire against older people actively using transport, for example rural areas have more barriers in accessing public and active travel due to poor service provision, poor infrastructure and dispersed services and communities. However, for some in rural areas an increase in social capital may dampen the negative effect of these, through individuals providing support to one another both formally and informally (relationship-centred approach).

The exosystem layer shows how rules and laws impact on mobility and how often these are from outside the direct transport policy arena. One policy that impacts on a variety of levels but starts at the exosystem level is the concessionary fares policy in the UK, providing free bus travel for older people (after 9.30 am). This encourages travel for older people both in terms of general mobility but also active travel (older people have to walk to and from bus stops, for example). However, it is also threatening the existence of buses in some areas, especially rural areas, as bus companies feel they are not recompensed enough for such services and cuts in such provision from local authorities are forthcoming (diverse needs and interests). Whereas it looks as if the policy is here to stay, the free market approach thrust upon bus services results in the future of bus services looking bleak, especially in rural areas or in the evenings. Community transport may pick up some of this need, but more joined-up thinking is needed in what is at present a rather fragmented service that has a small number of dedicated users, while others feel excluded or that the service isn't for them (person centred). Education and training is vital and needs more direction from this level to deal with the social, habitual, emotive and status issues of transport and travel that are relevant to older people. Training shouldn't just relate to improving driving but should also involve emotional and practical support in giving up driving and moving to other modes.

The chronosystem layer shows the importance of life stages and life course to understanding travel behaviour (whole life experiences and choices). Key events change travel behaviour, including retirement, changes in health, and death or illness of a partner or close relative. Cohort effects link with the macrosystem layer in identifying what older people expect in terms of transport provision. As can be seen throughout the report there is an increasing reliance on private vehicle use. Throughout the model technology plays a substantial part in helping older people fulfil their mobility needs. Travel information can be provided and tailored to needs using mobile and other pervasive technology. Systems of movement, such as cars and buses, can be improved through technology to help overcome barriers to use of such systems, such as reducing cognitive or physical effort (inclusive design). In addition, technology may help bring together new ways of using existing provision, simply through travel information but increasingly through allowing individuals to share transport modes and book out transport to suit their needs, such as the use of Uber and 365 Response, for example, to help older people use

demand-responsive transport better. A whole systems approach is required if the transport provision and associated built environment infrastructure are to meet the needs of an increasingly ageing population. Central to this approach, however, is the voice of older people themselves (involving older people).

9.1 Evidence gaps

Through reviewing the evidence on mobility and transport needs of older people it has highlighted where we consider there are gaps in the knowledge base that are worthy of further investigation.

9.2 In the chronosystem direction

9.2.1 Life course and transport decisions and effect of this into older age

There is a need to better understand how decisions made across the life course affect travel and mobility in later life. If this could be understood, more could be done to help people earlier in their lives with decision-making that may affect their later life choices, and which in turn would have an impact on their health and well-being, for example providing information about the costs of owning and running a car, or barriers to public transport in a rural location.

9.3 At the individual level

9.3.1 Understanding the role of virtual mobility

We know that the need to physically interact with each other is important for most people, yet this is absent when aspects of virtual mobility are used as an alternative to physical mobility. How far this could be replicated in a virtual world needs to be examined. For example, is there a need for a gathering of people to be present while using technology to create a social element to technology (for example group-based e-shopping) and do they physically need to be there or could this occur as a virtual group of people? Is there a need to virtually travel to the supermarket through cyberspace ‘landscape’, rather than actually arriving immediately at the required website? And what would such ‘landscape’ consist of? There has been little in-depth exploration of such factors and typically research in the field has focused on accessibility and usability issues surrounding the World Wide Web and computing for older people.

9.3.2 Individual differences

We are all unique, we all experience mobility differently, and we all experience older age differently too. Yet there is a tendency in research to produce outcomes that subsequently feed into policy which fail to recognise or respond to individuality because we assume that one size fits all. At best, we differentiate between age bands, and across genders, ethnicity and location (rural/urban), etc. Rarely do we attempt to understand health conditions as we age and mobility, and when we do, we assume that an older person only has one health condition (e.g. vision difficulties), whereas a person is likely to have more than one health condition, particularly in older old age, and this will certainly affect their mobility. We therefore need to have a better understanding of which mobility interventions will affect which people, and why.

9.4 At the microsystem layer

9.4.1 Understanding train travel from the point of view of older people to help identify barriers to use

Over the past decade the number of people using rail travel has grown significantly, both in absolute terms and in terms of the percentage of overall distance travelled. This growth is especially noticeable in early and middle-aged adults, but train usage begins to fall from 60 years onwards. The advent of cheaper tickets for travel off peak, along with discounts for older people through railcards, should encourage older people, yet the numbers remain low. More research is needed to examine why this might be. Older people hold lower priorities over length of journey and frequency of services, possibly showing their more intermittent and leisure use. Can these be juxtaposed with the needs of other travellers? For example, the need for a seat may reduce capacity for other users, including those that may need luggage space or may be happy to stand for short distances. The need for information provision can result in over-use of information delivery, which can affect other travellers, especially regular travellers who are aware of such knowledge and do not need it.

9.4.2 Social capital and networks and mobility in later life

There has been an emphasis on the physical infrastructure-based changes that can affect mobility as evidenced in this review. Less is known about the role of social capital and social networks surrounding the older person and how these might enable mobility. Evidence suggests that rural areas are rich with social capital (if you are part of the in-group, that is) (Bryden *et al*., 2000) and this can help reduce isolation and loneliness, but how far it enables mobility needs further research. Also, although urban areas may be rich with infrastructure and mobility services, how does the lack of social capital affect mobility patterns?

9.4.3 Door-to-door transport and multi-modality of older people

There has been a tendency for past research to examine only one facet of travel. It may be that research has examined mobility by mode or by a particular journey type. However, older people use a variety of modes to complete their journeys and meet their needs (Parkhurst *et al*., 2014) and they do not view their journeys in isolation. Future research and interventions must acknowledge that a variety of modes are used to complete travel and a door-to-door approach is advocated.

9.4.4 Multidisciplinary approach to the social aspects and connections with mobility

Transport research, from its engineering and economic roots, has traditionally ignored the social elements of mobility. In research to improve mobility of older people there has been an emphasis on infrastructure-based approaches. While this is important, there is a greater need to understand wider social and cultural issues. More recently this has changed with cultural geography, psychology and sociology (with the mobilities turn, for example). A mobility ‘turn’ (or transformation) began in the 1990s as a result of increased interest in the socio-cultural aspects of movement in relation to individuals and society. These aspects move beyond, but still include, literal mobility (actually moving), to embrace affect and meaning of moving, socio-cultural history of movement, potential, virtual and imaginative movement, while understanding the power that mobility provides within society, which leads to inequalities (for more information see Shelley and Urry, 2006, and Creswell, 2011, for example). To gain a greater, more holistic, understanding of transport in later life, the future of research in this field should perhaps look beyond literal or corporeal mobility to include constructions of travel related to virtual, potential,

imagined, aspirational and emotive mobilities (Parkhurst *et al*., 2014), utilising not just transport studies, health and geography but also sociology, gerontology and arts and humanities.

9.4.5 Technologies, driverless vehicles and driver support

Driver assistance systems and driverless cars have the potential to aid personal mobility for older people and they may also prolong driving or reduce the need to give up driving altogether. Shergold *et al*. (2015) suggest that technologies, not even directly related to travel modes, may also change travel behaviour. Clearly there is a need to better understand the impact of these technologies on different cohorts of older people, not just in terms of driving, but also on health, well-being and quality of life.

9.4.6 Dementia

Dementia is the umbrella term given to over 100 different diseases involving the progressive loss of mental, and ultimately physical, functions. The goal is to improve the quality of life across the trajectory of dementia for people affected by the condition. The key is to help a person with dementia to stay active and independent for longer, and transport can play a significant role in achieving this, but it is an under-researched area.

9.4.7 Cycling

We know very little about older people and cycling, and what we do know is largely (but not exclusively) gathered from National Travel Data, so in particular it is largely quantitative rather than giving us the rich picture that can be provided through collecting qualitative data. This is potentially being addressed through the recently funded CycleBoom (www.cycleboom.org) project, which is a study to understand cycling among the older population, and how this affects independence, health and well-being.

9.4.8 Driver safety

The safety statistics presented in this review identify particular issues for older people in terms of driving and subsequent collisions. These require further investigation, particularly pedestrian injuries, because there is little further data on how this affects the subsequent mobility of the person and the implications of this for the potential loss of independence. In particular, rich qualitative data may be able to inform existing transport policy in a more meaningful way than quantitative data alone.

9.4.9 Falls

Falling over, either as a pedestrian or on public transport, can result in injury and subsequent loss of independence. Even the fear of falling, rather than actual falling, can result in a person not going out of the home. Those falls that happen away from the home require further investigation, and rich qualitative data may be able to inform transport policy in a more meaningful way than quantitative data alone.

9.4.10 Segregated/shared space

Segregated space between older pedestrians and other transport users is important for older people's mobility, but we need to better understand how sharing space affects older people – which people, why, and in what ways? Design interventions can then more appropriately support independence and well-being and this can be evidenced and quantified.

9.5 At the mesosystem layer

9.5.1 Wider engagement of other professionals

There is a need to ensure there is an awareness of the mobility, transport and built environment issues of older people made by health and social care professionals and occupational therapists (for example), particularly regarding the mobility of people who have recently returned home from hospitalisation. Transport is an issue that faces everyone and requires the understanding of a mix of professionals. For example there is an emphasis on re-enablement, in getting older people to be part of groups in their community, but what if they cannot get there? It is suggested that professions working with older people have training in transport and mobility issues, perhaps at pre-registration level.

9.5.2 Economic evaluation

Effectiveness of interventions is vital, but there is also a need to ensure these represent value for money. It must be remembered that any economic evaluation goes beyond simple short-term cost savings and examines the intervention in the wider context. For example, what are the cost savings and economic opportunities in being active and independent and getting out and about? How much does it cost if a person cannot get out of their house (for example taking into account access to services, social isolation, poorer health, informal care, sedentary behaviour, etc.). There is a need for research to be able to put a cost both on staying at home, and also on interventions that get the person out and about.

9.5.3 The over-emphasis on problematising older people's mobility

Research has tended to present a problem–solution based approach that typically stigmatises older people as victims and 'needy'. Co-production of the importance of mobility with older people should steer away from this. More research is needed to identify the benefits of involving older people within the context of mobility as a whole, rather than simply involving older people in identifying barriers and issues.

9.6 At the exosystem layer

9.6.1 Public spending cuts

Austerity cuts could disproportionately affect older people in terms of mobility, especially since there have already been cuts in infrastructure and services in the UK. In terms of walking, poor upkeep of pavements can have a huge effect on older people's confidence to go out and may induce a fall if they do. In addition, there is a real fear about the future of buses and local authorities have reduced their support for unviable bus routes and times, resulting in lower provision in rural areas and in all areas outside of key times of the day, resulting in no buses after around 6 pm in some areas. The future of mobility for older people in light of such cuts needs to be made visible in order to highlight the resulting disproportionality.
Perhaps community-based schemes will have a greater role and take over some of the bus services for those who need it most, but it is harder to see how pedestrian areas can be kept up

for less money. More research is needed to provide the evidence base for priority areas for older people's mobility in times of austerity.

9.7 At the macrosystem layer

9.7.1 The effectiveness of education and training interventions

Education and training interventions aimed at changing mobility behaviour tend to suffer from poor-quality evaluations, and driver behaviour or helping people to cease driving are typical examples. As such, there is little evidence on how successful they are. Despite their popularity, a systematic review of the evidence from randomised controlled trials and pre–post tests suggests that although interventions may improve driver awareness of their own skills and ability there is limited evidence that they improve driver behaviour, especially over a long period of time, and very little evidence that such interventions reduce crashes. Hence we recommend that an independent robust evaluation is needed to examine whether such courses really improve driver skill and awareness and whether they reduce accidents.

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