CLIENT PROJECT REPORT CPR2714

Accessible Public Realm: Updating Guidance and Further Research

Technical Annex 3: Ageing, dementia and non-visible disabilities (RQ6)

Sharp R, Fernández-Medina K & Delmonte E

Report details

Report prepared for:	Department for Transport
Copyright:	© TRL Limited
Report date:	January 2020
Report status/version:	V5
Quality approval:	

Anastasia Kounatidou (Project Manager)	*[signature]*	Marcus Jones (Technical Reviewer)	*[signature]*

Disclaimer

This report has been produced by TRL Limited (TRL) under a contract with Department for Transport. Any views expressed in this report are not necessarily those of Department for Transport.

Table of Contents

Executive summary

Considering ageing, dementia, and non-visible disabilities when designing inclusive pedestrian environments is important. The population is ageing and, although ageing within the context of road safety has been widely researched, previous research has tended to focus on the older driver instead of the older pedestrian. Previous research on those with dementia or non-visible disabilities as pedestrians is also very limited. Therefore, this study aimed to gain insight into the functional limitations associated with ageing, dementia, and non-visible disabilities, and to explore how these could be better catered-for within *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces*. TRL conducted a literature review on each topic (ageing, dementia, and non-visible disabilities), before conducting a workshop and individual telephone consultations with nine stakeholders (including members of the DfT steering group) who had a range of expertise on relevant topics.

Findings revealed that the key issues for older people in the pedestrian environment include obstacles (e.g. street furniture and uneven surfaces), crossing the road (including identifying large enough gaps in traffic), tactile paving (particularly when the pavement is sloped), and navigating slopes and ramps. These issues can increase the risk of injury caused by falls and trips and reduce feelings of safety amongst older people.

Existing literature on dementia and active travel was limited, but findings suggested that those with dementia can also experience difficulties with crossing the road and walking on novel surfaces (but not specifically tactile paving). Additionally, the personalisation of spaces and maintenance of instinctive understanding of the pedestrian environment can support the autonomy of those with Alzheimer's disease.

Again, existing literature related to non-visible disabilities and active travel was limited. However, a key finding was that lack of confidence to travel is a major issue for those with non-visible disabilities, which can be exacerbated by negative attitudes of frontline staff members, lack of easily-accessible information, and unfamiliar travel routes or environments.

Generally, stakeholders thought inclusive mobility guidance documents are not updated often enough and not used effectively by those who design the pedestrian environment. Stakeholders recommended the formation of comprehensive, consistent guidance that is easily-adaptable to specific situations and environments and emphasised the importance of including older people, those with dementia, and those with non-visible disabilities in the formation of such guidance. Although stakeholders felt that updating guidance would be beneficial, they felt this cannot improve inclusivity alone. For example, stakeholders recommended improved collaboration between organisations when creating and implementing guidance and increased enforcement to ensure guidance is followed appropriately.

Many stakeholders felt the environment should be as safe and accessible as possible for everyone to use, instead of making specific adjustments for certain demographics. For instance, specific recommendations relating to the design of the pedestrian environment included wide walkways that are better-maintained, less cluttered, and provide enough room for pedestrians to walk around tactile paving if required. Additionally, stakeholders

highlighted the importance of providing information in various ways and formats, such as through an individual's carer, accessible and clear directional signage and bus timetables, and the provision of both audible and visual information.

Education and cultural change as ways of improving inclusivity were mentioned frequently by stakeholders, with the overall aim of improving the general awareness of, and attitudes towards, ageing, dementia, and non-visible disabilities. Stakeholders recommended training on inclusive design for those who design pedestrian environments and implement those designs, as well as improved training (or improved implementation of training) for frontline staff members in the pedestrian environment, which should focus on identifying pedestrians who may need help, responding to issues, and communicating effectively and respectably with everyone. Stakeholders believed that the burden of responsibility should be on service providers to train staff to recognise those who may need help rather than on the individual to draw attention to their condition (e.g. by wearing distinctive lanyards or badges, which some individuals were not comfortable with).

In relation to ageing, stakeholders felt that encouraging active travel amongst older people would be supported by increased colour contrast, the addition of safer and simpler walkways and pedestrian crossings and creating more rest points and accessible toilets in the pedestrian environment. Additionally, stakeholders recommended training for older people on how to navigate the pedestrian environment (ideally before their functional limitations become too severe) to increase their confidence to travel.

Stakeholders were opposed to 'shared space' schemes and 'cross-use' of spaces, as these can be disorientating and confusing for those with dementia. Instead, they recommended simple environments with distinct spaces, clear lines of sight, and clear signage to support easy navigation and feelings of familiarity. As with ageing, stakeholders recommended increasing confidence to travel through providing training to those with dementia on how to navigate the pedestrian environment, ideally before their functional limitations become too severe.

As with the recommendations relating to dementia, stakeholders were opposed to 'shared space' schemes and 'cross-use' of spaces, and recommended distinct, regulated spaces in the pedestrian environment to support navigation and feelings of familiarity. Stakeholders generally supported existing schemes to encourage confidence to travel for those with non-visible disabilities (e.g. the 'Safe Places' scheme and travel training and buddying schemes). In addition, stakeholders suggested increased penalties for those who misuse the Blue Badge parking scheme and additional disabled parking spaces to reflect the recent extension of the scheme to those with non-visible disabilities.

Suggestions for further research also emerged from this study, such as identifying specific aspects of the pedestrian environment that discourage people from walking, the extent of the issues faced by individuals when navigating the pedestrian environment, and key differences or similarities between specific requirements of each demographic when navigating the pedestrian environment. Stakeholders also recommended further exploration of whether appropriate implementation of the existing inclusive mobility guidance encourages active travel by certain demographics.

1   Introduction

1.1   This document

This document forms a Technical Annex to the report *Accessible Public Realm: Updating Guidance and Further Research* prepared by TRL for DfT. It sets out the detailed methodology, findings and recommendations from Research Question 6 (RQ6) of the research project, which investigates the implications of ageing, dementia and non-visible disabilities for the government's guidance on the accessible public realm.

1.2   Background to the research

Recommendations from a previous study, *Updating Guidance on the Accessible Public Realm* (Greenshields, Wells, Barham & Dales, 2018), included further research on ageing, dementia, and non-visible disabilities with a view to including appropriate guidance for them within two UK guidance documents: *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces.* Therefore, the aim of the current study (for the purpose of this document referred to as RQ6) was to gain insight into the functional limitations associated with ageing, dementia and non-visible disabilities, and how they relate to the two aforementioned guidance documents. To achieve this aim, TRL conducted a set of three literature reviews and stakeholder consultations; the method and findings of these tasks are detailed in this report.

1.3   Background to RQ6

Across the world, the population is ageing. Current projections estimate that the proportion of the population aged 60 and above will double by 2050 (United Nations, 2019a). However, ageing (and the functional limitations that accompany the ageing process) is widely recognised as being a heterogeneous process and chronological age is considered a poor predictor of performance, particularly in relation to road safety (Lang, Parkes & Fernández-Medina, 2013). Moreover, age is a risk factor for many conditions which may exacerbate decline in motor, visual and cognitive performance; it also increases the likelihood of using medications that can alter behaviour or impact on performance of everyday tasks. As such, ageing within the context of road safety has been a widely researched topic area, though much effort has focused on the older driver.

Some conditions that relate to ageing include dementia and other disabilities. The impact of dementia on increasing segments of the population has been well established and the number of people in the UK with dementia is forecast to increase to over 1 million by 2025 (Prince et al., 2014). Similarly, while the range and understanding of the impact of disabilities continues to improve, evidence suggests that there are large segments of the population living with non-visible disabilities (disabilities that are not immediately visible to others). While not all non-visible disabilities (or disabilities more generally) are brought on by age, ageing, dementia and disabilities are important factors that must be considered when designing increasingly-inclusive mobility and outside spaces.

With current trends seeing an increase in urbanisation, it is likely that the population demographics within cities will also see an increase of people aged 60 and above. For instance, some projections suggest that 66% of the world's population will live in urban areas by 2050 (United Nations, 2019b). This is partially supported by data from 2014 mid-year population estimates, which show that although people aged 44 and above are still more likely to live in rural areas, the proportion of people aged 44 and above living in predominantly urban areas has increased to 40% in recent years (Department for Environment Food & Rural Affairs, 2019). This would mean a shift in mobility toward increased walking; an activity that has often been associated with risk for certain subgroups of the population, such as older people (Department for Transport [DfT], 2018).

It is understood that the *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces* documents relates primarily to physical mobility (e.g. wheelchair users and visual impairments). While age is a factor for both these conditions, there are various other disabilities that affect older people and, increasingly, younger segments of the population. As such, there is a need to understand how ageing, dementia and non-visible disabilities relate to the different elements of the guidance set out in *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces* and how (or whether) they could be better catered-for within these core documents.

1.4   Rationale and research questions

To determine how best to include ageing, dementia, and non-visible disabilities within the existing guidance, TRL conducted literature reviews that aimed to answer the following research questions:

1. How can ageing, dementia, and non-visible disabilities be defined and what are their key associated functional limitations?

2. How do these functional limitations relate to the existing guidance and what parts of the guidance are most open to modification?

3. Are there any evidence-based practices or recommendations for the management of these functional limitations within pedestrian environments?

4. Would inclusion of ageing, dementia, and non-visible disabilities within the existing guidance be feasible and/or the most effective strategy for increasing inclusivity within the pedestrian environment?

To ensure recommendations from the literature reviews (detailed in section 3.4) were feasible to implement and manage, the project team consulted key stakeholders during a stakeholder workshop and individual telephone consultations.

2   Method

2.1   Literature review method

As an exploratory study[1], the project team designed the literature review method to provide an overview of the functional limitations experienced by older people, those with dementia, and those with non-visible disabilities and identify available evidence that relates to the *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces* documents. The team conducted three individual literature reviews to enable a clearer understanding of ageing, dementia, and non-visible disabilities, and to help answer specific questions for each of these topics:

Ageing
- What are the known age-related functional declines and disability?
- Is there any research relating to inclusive mobility?

Dementia
- What is dementia?
- What are some of the functional declines associated with dementia?

Non-visible disabilites
- What are non-visible disabilities and how are they categorised?
- How are non-visible disabilities managed from a road safety perspective?
- How can we begin to understand non-visible disabilities within the context of current guidance?

TRL has previously undertaken literature reviews on the topic of ageing and road safety. Although these reviews focused primarily on older drivers, the reviews also identified functional limitations associated with ageing. As such, the project team included findings from the following TRL papers in this review:

- Behavioural aspects of elderly as road traffic participants and modal split (Fiorentino, Fornells, Schubert, & Fernández-Medina, 2016)

---

[1] The topic areas included in RQ6 are broad and will include a diverse range of conditions, comorbidities, and functional limitations. As such, and given budgetary constraints, the aim of this research is to provide evidence to support more focused consideration of the various issues and challenges that are present for people with these characteristics.

- Driving choices for the older motorist: the role of self-assessment tools (Lang et al., 2013)

- Review of effectiveness of fitness-to-drive assessment and licensing for older drivers on the Isle of Man (Shepherd, Fernández-Medina, Holcombe, & Sharp, 2018)

For the literature review on dementia, the researchers involved in this study liaised with the task lead on RQ3 to obtain literature identified through the RQ3 literature review on mental health.

To identify additional relevant literature, two researchers used a semi-systematic approach, which involved developing search terms to apply to online literature databases and assessing search results based on the relevance and quality of the literature. Table 1 shows the string of search terms the project team developed using Boolean operators (e.g. 'OR' and 'AND') for each literature review. A basic Google search was also undertaken to identify other relevant literature not held in the online databases.

Table 1: Search terms for the literature reviews

Topic	Search terms
Ageing	(ageing OR old* OR senior OR elder*) AND ("inclusive mobility" OR "tactile pav*" OR pedestrian* OR walk* OR infrastructure) AND (city OR cities OR urban*)
Dementia	(dement* OR Alzheimer*) AND ("inclusive mobility" OR "tactile pav*" OR pedestrian* OR walk* OR infrastructure) AND (city OR cities OR urban*)
Non-visible disabilities	(non-visible OR hidden OR invisible OR "less visible" OR unseen) AND (disabilit* OR impairment*) AND ("inclusive mobility" OR "tactile pav*" OR pedestrian* OR walk* OR infrastructure) AND (city OR cities OR urban*)

Once the researchers had applied the search terms to the online databases (Google Scholar, BASE, ScienceDirect, and PubMed), the researchers made a subjective decision about the inclusion of each paper, based on the relevance of its title and abstract and the quality of the research.

2.2   Stakeholder engagement method

The project team used two methods of consultation for this research to facilitate engagement with key stakeholders (including members of the DfT steering group) who had a range of expertise on relevant topics: a stakeholder workshop and individual telephone consultations. Five stakeholders attended the workshop and four stakeholders participated in the telephone consultations. These stakeholders represented or were affiliated with the following organisations:

- Alzheimer's Society

- Centre for Accessible Environments (CAE)

- Chartered Institute of Highways and Transportation (CIHT)

- Community Transport Association (CTA)

- Driving Research

- Institute for Transport Studies (ITS)

- International Longevity Centre UK

- Sue Sharp

- Transport for All

During the workshop and telephone consultations, the following information was shared with the stakeholders:

- Details of what is included in the existing *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces* documents surrounding ageing, dementia, and non-visible disabilities

- Findings from the literature review conducted by TRL for this research (presented in section 3.4)

Following the sharing of this information, the facilitators encouraged stakeholders to:

1. Review and discuss findings from the literature review	Example question: *'Are the findings what you would expect?'*
2. Identify limitations of the literature review and/or areas that may require further investigation	Example questions: *'Do you know of any additional findings in relation to this topic?'* *'Do you know of any other evidence that suggests otherwise?'*
3. Discuss how the literature review findings could be applied to improve government guidance on how our streets and highway infrastructure are designed, and to further the inclusive mobility agenda	Example questions: *'What is the best approach to increase inclusivity for older people/those with dementia/those with non-visible disabilities within urban environments?'* *'What measures are feasible for increasing inclusivity, given current constraints in design of the built environment?'*

Two researchers facilitated the workshop and telephone consultations and took notes of key discussion points. Findings from these stakeholder engagement exercises are detailed in section 4.

3 Literature review findings

3.1 Ageing

3.1.1 Definitions and context of ageing

The result of the natural ageing process is a decline in functional abilities relating to visual, motor and cognitive capabilities. Although research in this area tends to focus on people aged 60+ years, it has been challenging to operationally define what 'older' means in a road safety context as evidence suggests that chronological age is a poor predictor of functional impairment (see Lang et al., 2013). For example, some research suggests that decline of key abilities can begin for some in their 50s (Dennis & Cabeza, 2008); other research suggests that, while onset of functional decline can begin early, the limitations become more evident (and detrimental) at later stages of life (Tournier, Dommes, & Cavallo, 2016). Moreover, Kim (2011) suggests that personal health and well-being are more important than age in analysing the mobility (and the level of transportation deficiency) of older people.

Nonetheless, chronological age is widely used as an indicator of the onset of functional limitations. The most notable example is found in licencing practices, where age-related restrictions can start as early as 45 years of age (Spain), but vary from 50 (e.g. Italy and Luxembourg), to 75 in the UK. Other countries such as Belgium, Germany and France don't have such age-related controls in place, which has sparked debate regarding the effectiveness of such age-related controls as comparisons between European countries have failed to show reduced collision risk for older people in countries with more stringent controls (Mitchell, 2008; Hakamies-Blomqvist & Peters, 2000).

To date, the impact of age on road safety has mainly focused on the older driver and a large body of research has investigated key risks faced by drivers as they age. Decline in physical strength and range of movement, the visual system and the cognitive processes that enable quick and efficient response to challenging situations have all been highlighted as problematic for drivers as they age. However, decline in these areas can also increase risk for older people both on and off the road.

Walking is an important physical activity for older people as it supports with healthy ageing and allows people to remain in touch both with their environment and social lives. However, statistics from Road Casualties GB shows that pedestrian KSIs are on the rise (DfT, 2018); although it is worth noting that this may be partly due to the increase in the number of people over the age of 65. Similarly, research by Niebuhr, Junge and Rosen (2016) found that older pedestrians (60+ years of age) have a higher risk of high severity or fatal injury than their younger counterparts. This is usually associated with the increased frailty in older people.

Falls are a major risk for this age group and a risk that could be exacerbated by the environment; for example, Tournier et al. 2016 discuss that tripping over obstacles (which can include things like stones and cracks, and uneven surfaces) is one of the most common causes of falls among older adults.

As the proportion of people aged 65+ continues to increase, it will be important to support healthy mobility and ensure the safety of this vulnerable road user group. Walking is an

important part of healthy ageing, but research has shown that the conditions need to be right for older people to feel safe within their walking environment.

The following sections provide an overview of the age-related impairment categories that have been identified through previous research (section 3.1.2), before summarising the key findings from research into inclusive mobility (section 3.1.3).

3.1.2 *Impairment related to ageing*

Age-related decline of motor, visual and cognitive abilities are extensively researched areas. Much of the research has focused on driving risk and how these categories of decline can impact on the driving task. This said, and despite the limited evidence available relating to the impact of functional decline on pedestrian safety (a similar conclusion reached by Dunbar, Holland and Mayor, 2004, in their critical review of literature), walking ability (and the ability to safely navigate the environment as a pedestrian) has also been shown to relate to these impairment categories.

The information on age-related impairment categories shown in Table 2 has been identified through previous research (Lang et al., 2013; Fiorentino et al., 2016; Shepherd et al., 2018) and will provide context for the more specific research discussed in section 3.1.3.

Table 2: Age-related impairment categories as identified by previous research

Category	Specific areas of decline
Motor	- Range of movement and flexibility - Reduced upper limb movement (including difficulty reaching and extending arms) - Reduced joint flexibility (particularly the ability to rotate the neck) - Reduced psychomotor coordination - Loss of strength
Visual	- Visual acuity (the ability to perceive spatial detail at a given distance, usually associated with challenges perceiving environmental cues such as signs, vehicles and other road users) - Contrast sensitivity (the ability to detect an object against its background) - Cataracts and other conditions affecting vision
Cognitive	- Executive function - Processing speed - Attention - Working memory - Task-switching

3.1.2.1   Links to risk in the pedestrian environment

Although it was beyond the scope of this task to conduct a detailed assessment of the capabilities that relate to pedestrian risk, some research was identified that specifically assessed the links between areas of functional impairment and pedestrian safety.

In 2004, Dunbar et al. (2004) undertook a comprehensive review of the research literature relating to older pedestrians. In this work, the authors compiled evidence linking decline in visual, auditory, motor and cognitive performance to pedestrian risk. The work identified several factors that relate more closely to an increased risk of older people being involved in a collision as a pedestrian. Among these, crossing the road emerged as one of the key scenarios of difficulty for older people, as these complex scenarios require integration of sensory, motor and cognitive functions. The authors also discuss other age-related challenges that can also impact on walking safety, falls being a key issue identified.

A more recent review of the safety and mobility issues faced by older pedestrians was undertaken by Tournier et al. (2016). In this review, the authors identify challenges relating to walking and obstacle negotiation, wayfinding and street crossing. In relation to functional decline, the authors highlight research in various areas.

In relation to the impact of motor decline (e.g. physical changes), Tournier et al. (2016) discuss the association between an age-related decline in muscle strength and slower walking and increase in risk of falling. Conditions such as osteoporosis can also have a detrimental impact on older people's mobility as it represents an important risk of fractures and falls.

Sensory changes are also discussed by the authors, particularly the impact of decline in visual acuity, visual field of view and contrast sensitivity. These areas of functional decline have been suggested as playing a role in older people's difficulty perceiving vehicles within the environment. The impact of visual diseases such as cataract, glaucoma and macular degeneration are also discussed as they link to unsafe road crossing decisions.

In terms of cognitive decline, processing speed has been shown to be associated with slow walking speed and a higher risk of falling. Executive function and the associated capacities can also impact on pedestrian safety, and associations have been found with a reduced ability to inhibit inconsistent or useless information and gait control. Finally, on this topic, Tournier et al. (2016) highlight evidence that suggests that walking is no longer an automatic process with advancing age. As such, this activity requires additional attentional resources and coordination of executive functions, which can prove challenging given the age-related decline in these capabilities.

As identified by Tournier et al. (2016), and previously Dunbar et al. (2004), street crossing has been shown to be a particularly risky activity for older people. A study by Oxley, Ihsen, Fildes, Charlton, and Day in 2005 found that old-old adults selected insufficiently large gaps when crossing the road. Moreover, it was found that the selection of unsafe gaps was not affected by the time participants in the study had available to inspect the scene and under time constrained conditions, older-old had trouble integrating speed and distance info about approaching vehicles. The analysis concluded that had these crossing behaviours been adopted in the real world, drivers would have had to take evasive action to avoid a collision with these pedestrians (Oxley et al., 2005).

Another study by Dommes, Cavallo, and Oxley (2013) sought to identify the functional measures that predict risky street crossing decisions in older people. The study involved three categories of participants: aged 20-35 (young; n=16), aged 60-67 (younger-older; n=17) and aged 70-84 (older-old; n=18). The participants undertook a street crossing task in a simulated two-way road environment and completed several tests measuring perceptual, cognitive and motor abilities. The results of the analysis identified the performance measures that were most closely linked with dangerous crossing choices (e.g. accepting gaps that were too short and, thus, having the potential to result in a collision with approaching cars):

- Walking speed

- Time-to-arrival estimate

- Visual processing speed and visual attention

- Attention shifting

Another noteworthy finding in these studies is the limited availability of research relating specifically to how sensory, motor and cognitive decline affect older pedestrians (particularly as a result of healthy ageing). However, both Tournier et al. (2016) and Dunbar et al. (2004) note the similarities between the key skills required to drive and walk safely.

3.1.3   Ageing and inclusive mobility

Research supports the notion that design of the physical environment plays a role in older people's ability to get outdoors and, as a result, their health and well-being. For example, work undertaken as part of the I'DGO (Inclusive Design for Getting Outdoors) project suggests that the perceived quality of paths and walking areas is important in encouraging older people to be outdoors. Among these, "paths easy to walk on" and "enjoyable to walk on" are highlighted as important. The authors also identify research that found that people who had/ believed they had good paths on the way to their local open space (e.g. parks/ green spaces) were twice as likely to achieve the recommended levels of healthy walking activity as those with poor quality paths (Engineering and Physical Sciences Research Council, 2010).

Similarly, in a qualitative study involving 200 people aged 65 and above, Newton, Ormerod, Burton, Mitchell, and Ward-Thompson (2010) concluded that older people's quality of life can be improved by good street design. This was based on findings showing that, if preferred components/ street attributes identified by older people (including aspects such as adequate seating and smooth pavements) are absent from their environment, this could limit older people's outdoor activities.

Bernhoft and Carstensen (2008) found that older people look for marked pedestrian crossings and signalised intersections to safely navigate the road environment. The study involving a survey sent to over 1000 people aged 70+ (as well as 888 respondents in a control sample of people aged 40-49). The questions in the survey included "Which of the following traffic situations do you regard as being the most dangerous when you are walking/cycling in your hometown?" and "Which of the following conditions are most important for your route choice when walking/cycling in your hometown?". Participants

could select up to 3 of 8 response options. The results showed that 85% of older pedestrians reported they walk in their hometown on a regular basis. Although the research also found that some older pedestrians (particularly those in poor health) felt the need to avoid the inconvenience of walking up to a signalised intersection, this provides some evidence that older people face (even if just perceived) increased inconvenience and delay of having to travel further to find safe crossing places. Added to the evidence presented earlier, this could be a significant barrier to getting outdoors.

However, some authors have argued that inclusive mobility is more than the physical environment. When it comes to designing more inclusive environments, Webber, Porter and Menec (2010) stated *"it is important that we are able to conceptualise mobility in a broad fashion that applies to all older adults, regardless of living situation or functional ability"*. Lid and Solvang (2016) also discuss how focusing purely on the physical accessibility of the environment and infrastructure will not provide a full understanding of accessibility; instead, the authors argue that the relationship that people have with the environment is equally important and that it is often left up to the individual to manage situations where mobility was obstructed; they state *"the level of courage and stamina the interviewee was willing to exercise stood out as being crucial when the physical environment presented hindrances to mobility"* (Lid & Solvang, 2016).

This aligns well with the position proposed by Webber et al. (2010) in their paper on older adult mobility, where the authors discuss how mobility is likely to have several dimensions or determinants, including cognitive, psychosocial, physical, financial, and cultural aspects.

Hence approaches to providing accessible mobility to older road users will need to consider the physical environment as well as the people who interact with it (and their own experiences, biases and limitations).

3.1.3.1   Tactile paving

Several research studies were identified through the search that explored the interactions between older people and tactile paving surfaces. Research by Ormerod et al. (2014) found that tactile paving can be problematic for older people (and even blind/ partially sighted), under certain conditions. In a study involving a sample of around 200 participants, eight crossings in Edinburgh were selected and structured observations were made by researchers. In addition to older people, the sample also included wheelchair users (both pushed and self-propelled), people with hearing disabilities and a very small group of (*n*=8) people with mobility impairments. The findings showed that blisters were particularly problematic for pedestrians when on slopes. In addition, the qualitative findings showed that slopes in tactile paved areas make older pedestrians feel particularly unsafe. It should be noted that the research by Ormerod et al. (2014) involved a relatively small sample (particularly since multiple disability/ needs groups were included), and assessments (e.g. categories) about participants were made by visual inspection. That said, the research was undertaken in a real-world environment and the crossings selected for the study were evaluated to ensure the crossing features were within the guidance requirements.

A study by Thies et al. (2011) sought specifically to assess older adults' 'gait' (a person's manner of walking) in relation to walking on tactile paving surfaces. This was based on previous research that has indicated that reduced gait speed may be associated with fear of

falling in older adults, as well as findings that older adults may exhibit a more conservative gait on tactile blister paving compared to smooth paving. The research by Thies et al. (2011) involved 32 participants (and 320 observations; 32 participants x 5 trials x 2 paving types) <60 years old and tests were undertaken in a controlled laboratory environment.

Of the measures assessed during the trial, the 'stop trials' (e.g. participants walking and stopping with either an 'early' or 'late' trigger before the curb) are probably most interesting as the researchers found that paving type (e.g. tactile paving) had a significant effect on successful stopping. This means that participants were less able to stop successfully on tactile paving, with the proportion of successful stops increasing from 7% on a smooth paving, to 15% on tactile paving. In addition, low variability in timing of foot placement is considered an indicator of safe gait; however, the study found that rhythmic gait becomes more variable on tactile paving (particularly, on the ramp section right before the curb). The authors suggest that this could be an indication of balance being challenged in these walking conditions.

The work by Thies et al. (2011) is robust in terms of the method, but there are some limitations relating to the lab setting (e.g. the authors comment on the study presenting participants with ideal pavement and walking conditions, including the perfect condition of the pavement and lighting) and the small sample size. This said, the work also links to the study by Ormerod et al. (2014) as both seem to suggest that tactile paving could be particularly problematic for older people when on sloped areas.

Other, albeit less robust, research has focused on older people's subjective experience of walking on tactile paving surfaces. For example, Newton et al. (2010) found that participants preferred flat and wide footways; on kerbs with tactile paving, participants were concerned about the trip hazard and discomfort it causes. Some comments to questions around the experience of walking on tactile paving provided by participants seemed to point to an overall challenging experience, e.g.: "really uncomfortable"; "I prefer to walk around them"; "I don't feel safe, I feel I may trip".

Another study by Childs and Tyler (2012) suggests that blisters can be challenging even for the blind and partially sighted. A study involving 106 blind and partially sighted participants of different ages (18-40 = 22; 41-64 = 71; 65+ = 13) was carried out in a laboratory environment. The depth of blisters seemed to have an impact on detection; however, it was the stopping distance from the edge of the footway that was most problematic. The authors suggest that starting the tactile paving further from the edge could be a potential solution to allow earlier detection and better stopping times. Given the findings on how older people experience tactile paving, this type of recommendation could benefit some groups but impact on others.

Overall, the research identified suggests that tactile paving can be problematic for older people. Not only does it potentially increase the perceived risk of falling and generate discomfort, it can also increase risk by limiting older people's ability to safely stop when hazards emerge at key points in their journey (for example, at road crossings).

3.2 Dementia

3.2.1 *Definitions and context of dementia*

Dementia is not a condition in itself, but a set of symptoms including memory loss and difficulties with thinking, problem solving and language (Alzheimer's Society, 2019). According to Dementia UK (2017), there are over 850,000 people with dementia in the UK; this figure is set to rise to over one million by 2025. Although Alzheimer's disease is the most common cause of dementia, another cause is brain damage as a result of diseases or stroke. According to the Alzheimer's Society (2019), dementia is not exclusive to older people; more than 42,000 people in the UK under the age of 65 have dementia. Hence, this disease can affect people of different ages, and the effects (in terms of severity and impact on abilities) can vary greatly between individuals. Moreover, Dunbar et al. (2004) highlight that diagnosis of dementia may not necessarily mean an individual will present relevant functional limitations, as the disease is progressive. In this sense, the challenges relating to the heterogeneity of dementia are similar to those relating to the effects of ageing.

There are several types of dementia; these are described in Table 3.

Table 3: Types of dementia[2]

Type	Brief description	Prevalence (UK)
Alzheimer's disease	A physical disease that affects the brain where the connection between nerve cells are lost. It's a progressive disease and with time, more parts of the brain are damaged. This results in a worsening of symptoms.	520,000 + people; around 60% of diagnoses
Vascular dementia	Caused by a reduced blood supply to the brain, which is in turn caused by diseased blood vessels. There are several sub-categories of vascular dementia, including: Post-stroke dementia, Single-infarct and multi-infarct dementia, Subcortical dementia and Mixed dementia (vascular dementia and Alzheimer's disease)	~ 150,000 people
Dementia with Lewy bodies	Caused by a deposit of proteins in nerve cells in the brain. Shares symptoms with Alzheimer's and Parkinson's and can be mistaken for Alzheimer's disease, though people with a Lewy body disorder can have problems with the movement and changes in mental abilities at the same time.	Accounts for ~ 10-15% of all cases of dementia
Frontotemporal dementia	Occurs as a result of nerve cells in the frontal and/or temporal lobes of the brain dying, and changes to the pathways that connect the lobes. It's a significant cause of dementia in people under 65	Least common form of dementia

[2] Alzheimer's Society (2019); Dementia UK (2019)

Although not strictly a unique category, young onset dementia is often referred to and relates to dementia in people under the age of 65. It is caused by similar diseases to dementia in older people; however, there are a wider range of diseases that can cause young onset dementia and it is more likely to be hereditary than late onset dementia. Those with young onset dementia account for an estimated 42,000 (representing around 5%) of all people diagnosed with dementia in the UK.

3.2.2 Impairment related to dementia

Dementia is generally associated with decline in memory and thought processes, but symptoms of dementia can vary greatly. The mental functions that relate to dementia are as follows:

- Memory

- Communication and language

- Ability to focus and pay attention

- Reasoning and judgement

- Visual perception

According to the Alzheimer's Association (2019), the symptoms associated with dementia must be severe enough to reduce a person's ability to perform everyday tasks. However, because there are different types of dementia, other functions can also be affected. For example, Dementia with Lewy bodies can be accompanied by tremors and walking difficulties. Frontotemporal dementia can cause changes to behaviour and personality. The symptoms and functional decline presented in vascular dementia will be dependent of the brain regions immediately affected (and the functions associated with these).

3.2.2.1 Links to risk in the pedestrian environment

As mentioned in section 3.1.2, cognitive decline has been identified as a contributor to older people's risk as pedestrians. However, the specific role of dementia in limiting mobility and increasing risk as a pedestrian has received little attention.

Tournier et al. (2016) discuss Alzheimer's disease and cognitive impairment within their work; according to the review this disease has been found to be strongly associated with falls and risk of injuries for older people while crossing the road. As discussed in section 3.1, cognitive decline and its impact on functions like processing speed has been shown to be associated with slow walking speed and a higher risk of falling. This is supported by studies like Taylor et al. (2013), where the authors sought to identify risk factors for falls in people with cognitive impairment. Participants (n=174) provided usable data, which showed that higher fall rates were associated with slower reaction times, impaired balance and poorer performance on cognitive tests, among other factors (Taylor et al., 2013).

A study by Fang, Lin, Liu and Ou (2018) investigated differences in road crossing behaviour between healthy older adults and patients with Alzheimer's disease. A sample comprising 12 pedestrians with mild Alzheimer's disease and 24 age, gender and education-matched control participants were asked to perform several tests in a simulated two-lane, one-way

road crossing situation (as well as completing cognitive, visual and motor tests). The crossing time and safety margin for pedestrians engaging on the task was determined for several conditions relating to vehicle speed, time gaps and time of day. The study found that patients with Alzheimer's disease were more vulnerable when crossing the road, and were more vulnerable to increasing vehicle speed, shorter time gaps between vehicles and daylight conditions.

A recent study by Sverdrup et al. (2018) assessed nearly 700 nursing home residents (over the age of 65) in Norway. The aim of the study was to assess the association between mobility and degree of dementia. Mobility was assessed using the Short Physical Performance Battery, a clinical test including measures of static balance, gait speed and lower limb strength. The authors found that nursing home residents with severe dementia had significantly lower levels of mobility than residents with moderate dementia (Severdrup et al., 2018). Thus, and similarly to the ageing process, those experiencing dementia are also a heterogeneous group and the onset of mobility impairments is likely to be gradual. This presents a challenge to the development of inclusive mobility guidance.

3.2.3   *Dementia and inclusive mobility*

Very little evidence immediately discussing inclusive mobility with the context of those living with dementia was identified. One study is worth highlighting, a dissertation undertaken in Canada in 2012, sought to address this research gap by undertaking analysis of documentation relating to urban design and planning as well as undertaking interviews with governmental representatives and city planners. The findings from the review showed that very few documents mentioned the word 'dementia' or 'Alzheimer's' specifically (six out of 51 documents in total). Moreover, when present, the information relating to these mentions mostly related to wider education, support programmes, etc.

Analysis of the interviews undertaken as part of this work identified that representatives had limited understanding of dementia and how to design urban mobility in a way that supports people experiencing it. There was also a perception that support is already in place indirectly (e.g. as an association to design and practice relating to older people; Przydatek, 2012). This is a very similar finding to that from the previous TRL study, where (although experts actively pointed out that inclusive mobility should consider pressing issues, such as the impact of ageing on mobility), it is clear that more work is needed to specifically identify the challenges that people with dementia experience in relation to their mobility and how inclusive mobility guidance can best integrate and apply this knowledge.

Another publication, this time from New Zealand, tackled the issue of design for young onset dementia. The review and qualitative research aims were primarily to further understand the needs of care for people with young onset dementia as, according to the author, care facilities (and care provision, overall) for people living with young onset dementia often fail to meet the needs of younger, fitter and healthier people with dementia. The author discusses the importance of design that provides a sense of "dwelling" through personalisation of spaces, as well as using spatial relationships to aid in maintaining an instinctive understanding (and navigation) of the surroundings. This can help support autonomy, safety and a sense of privacy while accounting for challenges such as memory loss (Lambert, 2015). This presents a further challenge in an already heterogeneous group,

as those with young onset dementia are likely to have different challenges and needs to people with later onset dementia.

3.2.3.1 *Tactile paving*

Although no research was identified directly assessing the impact of tactile paving on the mobility of people with dementia, some research suggests that gait and balance can also be a challenge for people with dementia. A study by Gras et al. (2015) with 13 community-dwelling older adults with very mild Alzheimer's disease and 13 gender matched controls (without Alzheimer's disease) undertook a series of balance and gait tests. The study found that gait and balance deficits were present in people in the early stages of Alzheimer's disease; moreover, the researchers found that novel surfaces may affect gait speed and concluded that gait speed in people with mild Alzheimer's disease may be affected by changes in walking conditions which do not seem to affect the gait speed of healthy age-matched controls without Alzheimer's disease. This was operationalised as a reduced walking speed in participants with Alzheimer's disease in the condition involving an instrumented rubber mat, GAITRite®. Although the mat does not include features like those of tactile paving, the finding that some groups may be differentially affected by even small changes to the walking conditions (even in a lab environment, where safety is carefully managed and communicated) could be associated with the experience of other footway features, such as tactile paving.

3.3 Non-visible disabilities

The core definition of a disability according to the Equality Act 2010 is a "physical or mental impairment that has a 'substantial' and 'long-term' negative effect on one's ability to do normal daily activities" (UK Parliament, 2010).

Most people with a disability in the UK are not born with a disability, but acquire a disability later in life (Dodenhoff, 2015). Therefore, the prevalence rate of disability increases with age, which, in combination with an ageing population, means that the percentage of people with a disability in the UK has steadily increased over recent years. In 2017/18, 21% of the UK's population (13.3 million people) reported a disability, which is an increase from 18% (10.9 million people) in 2007/08. In particular, the proportion of children and working-age adults reporting a disability increased by 2% and 4%, respectively. However, the amount of State Pension age adults reporting a disability decreased from 46% to 44% (Department for Work and Pensions, 2019).

Impairments resulting from disability that are most frequently reported in the UK are those that impact mobility, lifting, or carrying (Dodenhoff, 2015). Along with this finding, the increasing prevalence of disability in the UK highlights the importance of taking disabilities into consideration in relation to mobility and road safety.

The following sections of this report discuss non-visible disabilities, including related impairment and how non-visible disabilities have been considered in relation to road safety.

3.3.1   Definitions and context of non-visible disabilities

There is no one core definition for non-visible disabilities (also referred to in existing literature as 'hidden', 'invisible', 'less visible', or 'unseen' disabilities), although existing literature suggests that non-visible disabilities are disabilities that are not visible or immediately apparent to onlookers due to a lack of visible signs of impairment or assistive equipment such as a wheelchair, crutches, or hearing aids (Disabled World, 2019; Dodenhoff, 2015; Invisible Disabilities Association, 2018; Invisible Disabilities UK, 2019; Moore, 2009).

Most disabilities are non-visible disabilities (Brisbois, 2014; Dodenhoff, 2015; Enable, 2017; Moore, 2009). For example, less than 8% of people who are registered as disabled in the UK use a wheelchair (Dodenhoff, 2015; Enable, 2017). In the USA, an estimated 10% of people have a medical condition that could be considered as a type of non-visible disability (Anderson, 2010) and 96% of those with chronic medical conditions were living with a non-visible disability in 2002 (Disabled World, 2019).

3.3.2   Non-visible disability categories

Non-visible disabilities encompass a diverse and heterogeneous group of thousands of illnesses, disorders, diseases, dysfunctions, congenital disabilities, impairments, and injuries (Invisible Disabilities Association, 2018). There are no established categories of non-visible disabilities, although non-visible disabilities can be neurological, mental, or physical in nature (Invisible Disabilities Association, 2018). Therefore, examples of neurological, mental, and physical conditions that could be considered non-visible disabilities are provided below. However, these examples are not exhaustive.

3.3.2.1   Neurological conditions

Most non-visible disabilities are neurological in nature (Disabled World, 2019). Neurological conditions affect the central and peripheral nervous system, including the brain, spinal cord, cranial nerved, peripheral nerves, nerve roots, automatic nervous system, neuromuscular junction, and muscles (World Health Organization, 2016).

Table **4** provides examples of neurological conditions that are typically not immediately apparent to onlookers.

Table 4: Examples of neurological conditions that could be considered as non-visible disabilities[3]

Condition	Brief description	Prevalence
Chronic pain (e.g. fibromyalgia)	Pain that lasts or recurs for more than three months	~ 20% of people worldwide

---

[3] Barber et al. (2018); British Society of Audiology (2016); Elphick, Staniforth, Blackwell, and Kingshott (2017); Hunter, James, and Paxman (2017); International Association for the Study of Pain (2019); Neligan and Sander (2009); NHS.uk (2017); Parkinson's UK (2018); Prince et al. (2014)

Condition	Brief description	Prevalence
Chronic dizziness (e.g. vertigo)	Dizziness or unsteadiness lasting at least three months	~ 3-10% of people in the UK at some point in their lives
Parkinson's disease	A progressive nervous system disorder that affects movement	~ 2.7% of people in the UK at some point in their lives
Dementia (topic covered in section 3.2)	A group of brain diseases (including Alzheimer's disease) that cause ongoing decline of brain functioning	~ 1.3% of people in the UK
Epilepsy	A disorder in which brain activity becomes abnormal, causing seizures or periods of unusual behaviour, sensations, or loss of awareness	~ 0.6% of people in the UK
Acquired brain injury (ABI)	Brain injury resulting from trauma, tumours, stroke, or infection	~ 0.5% of people in England at some point in their lives
Cerebral palsy	A group of neurological conditions that affect movement and co-ordination	~ 0.25% of people in the UK
Chronic fatigue (e.g. Chronic Fatigue Syndrome, myalgic encephalomyelitis)	Extreme fatigue lasting at least six months and does not ease with sleep or rest	~ 0.2-0.6% of people in the UK
Narcolepsy	Lifelong dysregulation of sleep/wake cycles	~ 0.02-0.05% of people in the UK

3.3.2.2   Mental conditions

Mental conditions can affect emotions, cognitive functions, and behaviour. A variety of factors contribute to mental conditions, such as biological factors (e.g. genetics or brain chemistry) and life experiences (MentalHealth.gov, 2019). Table 5 provides examples of mental conditions that could be considered as non-visible disabilities.

Table 5: Examples of mental conditions that could be considered as non-visible disabilities[4]

Condition	Brief description	Prevalence
Mental illness (e.g. major depression, bipolar disorder, schizophrenia, anxiety disorders, post-traumatic stress disorder)	Characterised by abnormal thoughts, emotions, behaviour or relationships with others	~ 25% of people in England
Learning disability (e.g. dyslexia, dyspraxia, Attention Deficit-Disorder, Attention-Deficit/Hyperactivity Disorder)	Reduced intellectual ability that affects the learning process	~ 2% of people in England

[4] Baker (2018); Brugha et al. (2012); Dodenhoff (2015)

Condition	Brief description	Prevalence
Communication and social impairments (e.g. Asperger's syndrome, autism)	Persistent and significant difficulties with communicating or interacting with others	~ 1.1% of people in England

The topic of mental conditions is covered in RQ3 report.

3.3.2.3   Physical conditions

Chronic physical conditions are enduring physical health problems that last for at least three months and can be managed or treated, but not cured. Table 6 provides examples of chronic physical conditions that could be considered as non-visible disabilities.

Table 6: Examples of chronic physical conditions that could be considered as non-visible disabilities[5]

Condition	Brief description	Prevalence
Musculoskeletal conditions (e.g. arthritis, rheumatism, osteoporosis)	Conditions affecting bones, joints, and muscles	~ 28.9% of people in the UK
Respiratory diseases (e.g. asthma, Chronic Obstructive Pulmonary Disease)	Diseases of the airways and other structures of the lung	~ 20% of people in the UK
Cardiovascular disease (e.g. coronary heart disease, angina, heart attack)	Diseases of the heart or blood vessels	~ 10% of people in the UK
Autoimmune diseases (e.g. lupus, Chron's disease, type 1 diabetes)	Illness or disorder caused by the body's immune system destroying healthy cells	~ 6.2% of people in the UK
Cancer	A group of diseases involving abnormal cell growth	~ 3.8% of people in the UK
Cystic fibrosis	A genetic disorder that affects the body's ability to control the movement of salt and water between cells	~ 0.04% of people in the UK

3.3.2.4   Other conditions

Visual and hearing impairments can also be considered as non-visible disabilities and are defined as partial or total inability to see or hear, respectively. Both visual and hearing impairments can have physical causes (e.g. damage to the eyes or ears) or neurological causes (e.g. damage to the areas of the brain that are responsible for sight or hearing).

---

[5] Arthritis Research UK (2018); British Heart Foundation (2019); British Lung Foundation (2016); Charman, Connon, Cosgriff, Lee, and Carr (2018); Garcia (2018); Macmillan Cancer Support (2019)

Visual and hearing impairments will not be covered in this review due to their existing inclusion in the *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces* guidance documents.

3.3.3 Impairment related to non-visible disabilities

Like disabilities in general, non-visible disabilities have a 'substantial' and 'long-term' negative effect on one's ability to perform daily tasks, which vary between individuals (Invisible Disabilities Association, 2018). In the USA, around 25% of those with a non-visible disability have difficulty executing tasks or actions (Disabled World, 2019). Non-visible disabilities can relate to a wide range of limitations, including:

- Physical limitations, such as:

  - Impaired mobility and imbalance (e.g. resulting from ABI, chronic dizziness, musculoskeletal conditions, Parkinson's disease, or cerebral palsy)

  - Weakness or paralysis (e.g. resulting from ABI or cerebral palsy)

  - Breathlessness (e.g. resulting from respiratory diseases)

  - Pain (e.g. resulting from chronic pain or musculoskeletal conditions)

  - Fatigue (e.g. resulting from chronic fatigue or ABI)

- Cognitive limitations, such as:

  - Loss of awareness (e.g. resulting from epilepsy)

  - Poor concentration or memory (e.g. resulting from chronic fatigue or ABI)

  - Lack of understanding (e.g. resulting from dementia, cerebral palsy, or learning disability)

  - Impaired reasoning and judgement (e.g. resulting from ABI, dementia, or cerebral palsy)

  - Reduced problem-solving ability (e.g. resulting from ABI)

  - Lack of interpersonal communication skills (e.g. resulting from communication and social impairments, ABI, or cerebral palsy)

- Emotional and behavioural limitations, such as depression, anxiety, distress, and anger

3.3.3.1 Links to risks in the pedestrian environment

Individuals with non-visible disabilities may experience any of the limitations mentioned in the previous section (with varying degrees of severity), some of which may result in a lack of skills required to make a journey, including walking. A literature review conducted by Mackett (2017) revealed skills that are required to make a journey (including walking) to reach a desired destination include:

- Recalling information obtained previously (e.g. using information from past experiences to plan a journey or remembering a chosen route or destination)

- Being able to communicate effectively with others (e.g. to ask for assistance or directions)

- Understanding information from explicit sources (e.g. visual information from signs or verbal information given by people)

- Understanding personal safety and security

- Making decisions based on information (e.g. which direction to walk or which actions to take in the event of an issue)

- Being able to cross a road safely

In the UK, an estimated 20% of people living with disabilities reported difficulties accessing transport that are related to their disability or impairment (Gov.uk, 2014). Non-visible disabilities can present just as much of a barrier to travel as visible disabilities (DfT, 2018b). For example, cerebral palsy can hinder judgements about where steps and spaces start and finish and cognitive processing of sensory information, such as light and sound (NHS.uk, 2017).

Additionally, individuals with dyslexia have reported numerous difficulties when travelling, predominantly surrounding the processing of visual or auditory information such as reading signs for directions and listening to instructions given by others (Lamont, Kenyon, & Lyons, 2013). Other reported difficulties included difficulty distinguishing between names or labels that represent opposing special concepts (e.g. 'left' and 'right'), expressing verbal requests for assistance or information, and spelling the names of desired destinations (Lamont et al., 2013).

The literature review conducted by Mackett (2017) also revealed that individuals who had suffered a stroke reported that they were afraid of falling during a journey, which could cause injury or embarrassment, and that they had inadequate information about environmental factors (e.g. the weather) and transport services, causing a lack of confidence in travelling.

Although it is apparent that individuals with non-visible disabilities may lack skills required to travel, they may not receive enough support with travelling because their disabilities are not immediately apparent to onlookers.

3.3.4   *Non-visible disabilities and inclusive mobility*

In the USA, an increasing number of organisations, governments, and institutions are implementing policies and regulations to accommodate members of society with non-visible disabilities (Disabled World, 2019). The UK Equality Act 2010 includes a duty on service providers to make 'adjustments' where people with disabilities are at a substantial disadvantage (compared with people without disabilities) by taking reasonable steps to avoid the disadvantage (Office for Disability Issues, 2011).

The UK government set out the Inclusive Transport Strategy to support those with non-visible disabilities (DfT, 2018b). One main theme of this strategy was ensuring that technological advances and new business models provide opportunities for all, and that people with disabilities (including those with non-visible disabilities) are involved in their

design. Another main theme includes improving physical infrastructure to ensure that stations and streetscapes are designed, built, and operated in a way that is accessible and easy for all to use. Local authorities are responsible for the design of their streets and ensuring that any pedestrian environment scheme is inclusive and meets the requirements of the Equality Act 2010 (DfT, 2017a; 2018b). For example, local councils may restrict pavement parking where pedestrians (including those with non-visible disabilities) may be forced into the road due to inadequate pavement space to walk around a parked vehicle (DfT, 2018b). DfT (2017b) published guidance to help local authorities design and implement walking infrastructure that suits the needs of all users and encourages local authorities to consult with those with non-visible disabilities when developing plans and schemes.

A Blue Badge permit provides car parking concessions for people with disabilities in the UK, allowing any car that they are travelling in to be parked closer to their destination. The aim of the Blue Badge scheme is to reduce walking distance and reliance on public transport for those with disabilities, not only to make it easier for them to reach their destinations and promote independence, but also to reduce any risks to their health and safety associated with walking longer distances or using public transport (Gov.uk, 2018). Traditionally, Blue Badges were available predominantly to those who found walking difficult due to mobility issues. However, as part of the UK government's initiative to "build a society that works for all", the Blue Badge scheme will be extended to those with non-visible disabilities in 2019 to reduce the impact of other barriers to travel, such as psychological distress caused by walking longer distances (Gov.uk, 2018).

'Shared space' schemes are urban design approaches that minimise the segregation between different types of road users (e.g. drivers and pedestrians) by removing features such as kerbs, road surface markings, traffic signs, and traffic lights. The aim of these schemes is to improve safety by increasing uncertainty over who has priority over the space, thereby encouraging drivers to reduce their speed. However, literature suggests that these schemes can be confusing for those with non-visible disabilities, especially those with cognitive impairments (DfT, 2018a).

As part of 'Safe Places' schemes in Great Britain, public shops and services have staff members that receive training about awareness of vulnerable people and display the 'Safe Places' logo on their buildings, which are visible to those passing by. People with non-visible disabilities can enter these buildings to ask staff members for assistance (e.g. to ask someone to give them directions or to contact their carer). Mackett (2017) suggests that schemes such as 'Safe Places' increase the confidence of those with non-visible disabilities to travel.

Travel training and buddying or mentoring schemes that are currently available across the UK have been found help those with non-visible disabilities build their confidence and independence when travelling (DfT, 2017a). As such, DfT have supported the development of these schemes in recent years (DfT, 2017a). An example of such a scheme is the travel buddying service offered by the Brandon Trust to support those with learning difficulties in Bristol, south Gloucestershire, and north Somerset. This scheme provides its users with road safety and awareness skills and helps them to plan travel routes to desired destinations (House of Commons Transport Committee, 2013).

3.3.4.1   Tactile paving

Individuals and organisations that responded to the draft Accessibility Action Plan (AAP) consultation (DfT, 2017a) suggested that although individuals with visual impairments find tactile paving helpful, those with non-visible disabilities that experience mobility issues or poor balance can find tactile surfaces slippery (DfT, 2018a).

3.3.4.2   Recommendations for future guidance

Lack of confidence to travel is a major issue for those with non-visible disabilities (DfT, 2017a). Findings from Mackett's literature review (2017) suggested that interventions aimed at reducing barriers to travel for those with non-visible disabilities should be focused on increasing the confidence of people with non-visible disabilities before and during journeys. This suggestion is supported by the UK government (DfT, 2017a; 2018b). Based on the literature, Mackett's (2017) proposed methods of increasing confidence included:

- Providing clear information in appropriate formats (including verbal communication) so that it can be easily understood

- Simplifying journeys to aide decision-making

- Promoting greater understanding about non-visible disabilities and empathy in society

The provision of accessible information is vital to independent travel for those with non-visible disabilities (DfT, 2017a; Mackett, 2017) and because the needs of individuals with non-visible disabilities differ, providing information in different formats may be necessary (Mackett, 2017). Understanding information (e.g. signs or maps) can be challenging for people with cognitive limitations, so providing clear and concise information is essential for their inclusion (Mackett, 2017). Mackett (2016; 2017) suggests that mobile phone apps have the potential to assist pedestrians with non-visible disabilities by providing real-time route information and allowing their carers to monitor their location. A study by Lemoncello, Sohlberg, and Fickas (2010) concluded that using landmarks was the best way to provide navigational information to those with ABI and that the landmarks should be as unambiguous as possible. Furthermore, individuals and organisations that responded to the draft AAP consultation (DfT, 2017a) suggested that all road users should be informed of, and encouraged to adopt, safe practices when using shared spaces to reduce confusion (DfT, 2018a).

Having to take an unfamiliar route can cause stress or inconvenience for those with non-visible disabilities, which highlights the importance of minimising disruption to established routes (Mackett, 2017). Additionally, DfT (2017a) stated that poorly thought out design of pedestrian and built environments can be a deterrent to travel for those with non-visible disabilities. DfT (2018b) suggested that keeping pavements well-maintained, appropriately placing dropped kerbs, and ensuring routes are navigable and legible would have a significant positive impact of the lives of those with non-visible disabilities. Additionally, responses from individuals and organisations to the draft AAP consultation (DfT, 2017a) suggested that people with non-visible disabilities could benefit from clear segregations in paving (e.g. colour contrasts between cyclist and pedestrian areas), greater enforcement of

illegal pavement cycling, stricter regulations on pavement parking, a minimum pavement width, and functioning audible signals at pedestrian crossings (DfT, 2018a).

DfT (2017a) suggested that negative attitudes of those who work in the pedestrian and built environment sector can be a deterrent to travel for those with non-visible disabilities. Mackett (2017) suggested that training individuals on how to assist those with non-visible disabilities increases understanding of non-visible disabilities and empathy towards those with non-visible disabilities. Training can include topics such as improving awareness and understanding of the needs of people with non-visible disabilities, as well as how to communicate with and present information to those with non-visible disabilities. Responses from individuals and organisations to the draft AAP consultation (DfT, 2017a) indicated considerable demand for improvements to training around disability awareness (and particularly around awareness of non-visible disabilities) for staff at bus and train stations (DfT, 2018a). DfT (2017a) suggested that such training would ensure customer-facing staff members are better-equipped to manage the needs of those with non-visible disabilities.

3.4   Summary of literature review findings

Overall, the literature search suggests that there is little in the way of formal evidence that explicitly links functional limitations relating ageing, dementia and non-visible disabilities with inclusive mobility.

The topic of ageing has received the most attention of the three topics in previous research, with some research focusing on specific aspects of the environment such as tactile paving surfaces. Findings from this literature review revealed that the key issues for older people in the pedestrian environment include obstacles (e.g. street furniture and uneven surfaces), crossing the road (including identifying large enough gaps in traffic), and tactile paving (particularly when the pavement is sloped). These issues can create discomfort and reduce feelings of safety for older people, as well as increasing their risk of injury caused by falls and trips. Overall, these issues can discourage healthy mobility, which is an important part of ageing.

Dementia, although an umbrella term for a range of symptoms, also causes difficulties with mobility though (similarly to the ageing process) it is heterogeneous both in terms of onset (e.g. different causes of dementia can bring about different symptoms) and severity of symptoms that can be present in individuals with the same condition. Like ageing, findings from this literature review suggest that those with dementia can also experience difficulties with crossing the road and walking on novel surfaces (but not specifically tactile paving). Additionally, the personalisation of spaces and maintenance of instinctive understanding of the pedestrian environment can support the autonomy of those with Alzheimer's disease.

Again, existing literature related to non-visible disabilities and active travel was limited, which could be due to the large and diverse range of conditions and functional limitations that fall under the umbrella of non-visible disabilities. Most of the existing literature tends to focus on topics that were of little relevance to the review undertaken as part of this work, such as comparing non-visible disabilities to 'visible' disabilities or issues surrounding equality, education, and employment. Additionally, literature tended to focus less on infrastructure and people with non-visible disabilities as pedestrians, and more as drivers or users of public transport. However, a key finding from the literature review was that lack of

confidence to travel is a major issue for those with non-visible disabilities, which can be exacerbated by negative attitudes of frontline staff members, lack of easily-accessible information, and unfamiliar travel routes or environments. The lack of relevant existing literature emphasises the need for future research on how best to take non-visible disabilities into consideration when designing infrastructure and cities. As a starting point, future research should focus on expanding knowledge on how impairment related to non-visible disabilities affects travelling, identifying barriers to travel for this road user group, and establishing ways to overcome these barriers.

4 Stakeholder consultation findings

4.1 General findings

4.1.1 Discussion around functional limitations

Stakeholders identified common functional limitations across ageing, dementia and non-visible disabilities, including:

- Impaired balance and mobility
- Reduced sensitivity in feet
- Impaired memory, reasoning, and judgement
- Difficulties when navigating unfamiliar routes

Stakeholders also identified a lack of discussion surrounding the crossover between functional limitations of older people and disabled people in the literature review, as the functional limitations associated with ageing and disability are likely to be related in some respects.

4.1.2 Discussion around existing guidance

Generally, stakeholders felt that existing guidance on inclusive mobility is not updated as regularly as it should be. Although there are overlapping functional limitations experienced by older people, those with dementia, and those with non-visible disabilities, stakeholders also pointed out that the language used in existing guidance tends to focus on disabled people, so it is not clear that older people and those with dementia may also be covered.

Additionally, stakeholders were aware that existing guidance is not always considered or adhered to when designing public spaces. For example, one stakeholder mentioned that they had encountered accessible toilet facilities in which the toilet roll holder cannot be reached from the toilet.

4.1.3 Recommendations for improving inclusivity

In general, stakeholders held the view that the pedestrian environment should be safe and accessible for everyone, instead of making specific adjustments aimed at specific demographics or groups of road users.

4.1.3.1 Updating guidance

Stakeholders felt that there are currently too many sources of guidance for those involved in the planning or implementation of policies, infrastructure and transport, which can cause confusion. Therefore, they suggested the formation of comprehensive, consistent guidance that is easily-adaptable to specific situations and environments, and which also refers to other guidance on relevant issues. However, stakeholders expressed concern that catering to the functional limitations of all individuals would be difficult, particularly because

implementing a change to guidance that could benefit some individuals may disadvantage others.

Stakeholders expressed desire to be consulted in the early stages of developing guidance or policies so that inclusivity can be maximised. However, they felt that advice is currently often given reactively (in response to individual queries from those involved in planning and implementation), which can be a burden on resources for those organisations who provide advice. As such, stakeholders suggested that guidance should be provided proactively where possible.

Stakeholders also emphasised the importance of focussing on overlapping functional limitations when updating guidance (as opposed to focussing on individual limitations) and suggested that guidance should be updated continuously to reflect the ever-changing environment and ever-increasing complexity of traffic. Generally, stakeholders felt that updating existing guidance would be beneficial (particularly for advising local authorities). However, they also believed that guidance alone cannot improve inclusivity.

4.1.3.2   Improving collaboration

Stakeholders suggested that improved collaboration between organisations (and particularly Government departments) is required when updating or creating policy and guidance to ensure these are not disjointed. There should also be improved communication between those who create policies, those who design and construct infrastructure, those who design and manage public transport, frontline staff members (e.g. customer-facing staff at train stations), and health and social care services. To achieve greater collaboration, stakeholders suggested that all parties be made aware of the wider health agenda (e.g. encouraging independence and active travel), and how working towards this agenda could benefit each party.

4.1.3.3   Implementing guidance

Whilst stakeholders felt that creating adequate guidance is a positive starting point to improve inclusivity, implementation of guidance is key and needs to be taken seriously. For example, stakeholders proposed that awareness of guidance should be raised, and that guidance should be incorporated into policy – policy should then also be governed more thoroughly. Stakeholders talked about how the lack of laws and enforcement surrounding the design or construction of the pedestrian environment means that organisations are not incentivised to ensure the environment is inclusive or challenged when the environment is not inclusive. One stakeholder also proposed increased enforcement in relation to members of the public (e.g. pavement parking and riding bicycles or scooters on pavements).

Although stakeholders agreed that enforcement would be advantageous and more robust than guidance, they acknowledged that such enforcement could be difficult, costly and time-consuming, and would not be as adaptive or flexible as guidance. Stakeholders suggested that a 'watchdog' organisation could help to evaluate infrastructure and designs for infrastructure and hold organisations accountable.

Additionally, stakeholders mentioned that cost and other commercial decisions can become a barrier to inclusive design, and that these barriers should be addressed.

Stakeholders advised that consultations, enforcement and checks on infrastructure need to be more than a simple 'tick box' exercise. For example, design consultations usually happen too far along in the design process, which means that the design cannot generally be altered in line with the advice given. Instead, the inclusivity of a design should be monitored and measured throughout the process. Additionally, checks should be made to ensure infrastructure is appropriate to the settings and members of the public with a range of functional limitations should trial the infrastructure.

In addition, stakeholders highlighted the importance of managing and maintaining the pedestrian environment. Stakeholders referred to a lack of understanding by local authorities about how footways should be maintained (and designed), and about how designing and maintaining the pedestrian environment appropriately can encourage active travel. For example, stakeholders highlighted the importance of ensuring cracks and bumps in pavements are repaired and slippery surfaces are rectified in a timely manner to reduce the likelihood of falls and trips.

4.1.3.4   Designing the pedestrian environment

There was a general uncertainty amongst stakeholders surrounding what could be done to address issues that some pedestrians experience with tactile paving, as tactile paving is known to be very helpful for some groups of people (e.g. those with visual impairments). Rather than removing tactile paving, stakeholders thought it could be beneficial to ensure the pavement is wide enough to allow people to walk around the tactile paving if required. Stakeholders stated that the blisters should be big enough to be detectable, but small enough to avoid causing problems for individuals.

More generally, stakeholders mentioned that walkways should be wide enough for several people to use it at the same time and less cluttered (e.g. with street furniture and advertising boards), especially as crowded walkways can exacerbate fear of falls and trips. Additionally, one stakeholder recommended the addition of more dropped kerbs and standardisation of tactile paving to make it easier for those with mobility issues to cross the road.

4.1.3.5   Services in the pedestrian environment

During the consultations, one stakeholder pointed out that providing easily-accessible travel-related information through new technologies (e.g. smartphone apps) can be problematic, as some individuals are not willing or able to use these technologies. Therefore, more traditional ways of communicating this information may be more beneficial for older people, those with dementia, or those with non-visible disabilities (e.g. improved directional signage or providing information through an individual's carer). In addition, one stakeholder recommended the provision of accessible and clear information at bus stops and train stations (e.g. bus timetables and contact details to use in the event of journey complications) and suitable alternatives for when bus stops are temporarily out-of-use, as well as both audible and visual means of providing of information to address the needs of various demographics.

Additionally, one stakeholder suggested provision of travel companions could increase confidence to travel.

4.1.3.6   Education and cultural change

Stakeholders suggested that education and training about inclusivity should be provided to those who implement the design of infrastructure to ensure that they understand the importance of inclusive planning, rather than encouraging focus on saving money and time. Whilst courses focusing on inclusivity have been designed in the past, these have either had minimal impact or have been abandoned.

Stakeholders also recommended that frontline staff should be better equipped and trained to identify those who may need help, responding to issues, and communicating effectively and respectably with everyone (including older people, those with dementia, and those with non-visible disabilities). Stakeholders felt that a lack of such training could render inclusive design, planning, or infrastructure useless. Although such training already exists, stakeholders suggested that it is not always implemented as it should be. Stakeholders also believed that the burden of responsibility should be on service providers to train staff to recognise those who may need help rather than on the individual to draw attention to their condition (e.g. by wearing distinctive lanyards or badges, which some individuals were not comfortable with).

Additionally, one stakeholder suggested raising public awareness of regulations that are implemented to increase inclusivity of pedestrian environments (e.g. a ban on pavement parking, which is aimed at preventing obstruction of pavements and damage to pavement surfaces by vehicles). Furthermore, one stakeholder suggested that general understanding of tactile paving and its purpose should be improved.

Stakeholders felt that instilling a cultural change is crucial to increasing inclusivity, which should be focused on improving awareness of, and attitudes towards, older people and those with dementia and non-visible disabilities. However, stakeholders noted that such change would be difficult to achieve.

4.1.3.7   Further research

After presenting the findings of the literature review, stakeholders queried why some topics had not been researched further, such as:

- Identification of specific aspects of the pedestrian environment that discourage people from walking

- The extent of the issues faced by individuals when navigating the pedestrian environment

- Whether there are any key differences or similarities between specific requirements of each demographic when navigating the pedestrian environment

- Whether implementation of existing inclusive mobility guidance encourages active travel by certain demographics

During the consultations, several stakeholders recommended using a pedestrian environment simulator in further research to trial changes to the pedestrian environment with a variety of individuals. Trials such as these could ensure that the changes are suitable for a range of functional limitations before the changes are implemented.

4.2   Ageing

4.2.1   Discussion around functional limitations

Stakeholders pointed out that older people's difficulties when stopping at a crossing are exacerbated by slopes or ramps, especially if they are steep. One stakeholder also mentioned that cross slope and a lack of rest points on long stretches of sloped walkway can cause difficulties with walking for older people. In addition, stakeholders agreed that tactile paving can be uncomfortable, and fear of falls and trips is common amongst older people.

4.2.2   Discussion around existing guidance

Stakeholders were generally aware of what was included in the *Inclusive Mobility* and *Guidance on the Use of Tactile Paving Surfaces* documents regarding ageing and no stakeholders thought there was anything in the guidance that should not be included. In general, stakeholders thought that older people are quite well-considered in existing guidance, especially when compared to the guidance of some other countries.

4.2.3   Recommendations for improving inclusivity

One stakeholder pointed out that reduced feelings of safety in the pedestrian environment can be a barrier to active travel amongst older people, which can lead to loneliness and isolation. Therefore, increasing feelings of safety amongst older people is especially important.

4.2.3.1   Updating guidance

Stakeholders suggested that some needs of older people are not currently being met by existing guidance and emphasised the importance of updating guidance to reflect the ageing population.

4.2.3.2   Designing the pedestrian environment

Stakeholders mentioned issues surrounding a lack of safe pedestrian crossings designed with older people in mind and suggested that safe crossings should be somewhat standardised, better demarcated, and simpler to understand. Additionally, one stakeholder recommended the addition of more safe walkways in rural areas (as opposed to grass verges).

Stakeholders also felt that the current levels of colour contrast between different pavement surfaces are insufficient and should be increased to help older people navigate the pedestrian environment, due to their decreased visual acuity.

In addition, one stakeholder recommended adding rest points on long stretches of sloped walkway.

As older people can have health problems which require frequent toilet use, a lack of accessible toilets could discourage some older people from walking. Therefore, stakeholders highlighted the importance of providing more accessible toilets and providing older people with radar keys to access these facilities. Although these radar keys are available for anyone to buy, stakeholders also suggested that awareness of this should be raised. However, one stakeholder suggested that nobody should need to use a radar key to use accessible toilets, as everyone should automatically have access to them.

Furthermore, stakeholders mentioned that although reducing the distance between bus stops would reduce walking distance for older people and may encourage walking, implementing this change may lengthen travel times and reduce traffic flow due to buses having to stop more frequently. One stakeholder recommended having more frequent bus services (particularly in rural areas) to encourage older people to travel. Additionally, stakeholders highlighted the importance of adequate lighting at bus stops to reduce anxiety about traveling at night-time. One stakeholder suggested providing additional seats at bus stops, which should be designed to discourage use by those who are not using the bus service; these seats should also have arms to help older people stand up and to discourage an individual from using multiple seats at one time.

More generally, another stakeholder suggested the provision of additional seating in the pedestrian environment.

4.2.3.3   Services in the pedestrian environment

One stakeholder proposed a proactive scheme whereby older people are prepared for active travel before their functional limitations are too severe and before driving cessation. This scheme could teach older people how to navigate the pedestrian environment safely and deal with common issues that could arise, which could increase their confidence.

4.2.3.4   Education and cultural change

Stakeholders suggested that general levels of understanding around the functional limitations of older people needs to improve, and that local authorities should understand that encouraging older people to walk should not just be focussed on physical infrastructure.

In addition, stakeholders highlighted the importance of encouraging more positive attitudes of older people towards the pedestrian environment and their ability interact with it, which could increase their confidence to travel. One stakeholder also recommended educating older people on how to use pedestrian crossings safely.

4.2.3.5   Further research

After presenting the findings of the literature review, stakeholders queried why some topics had not been researched further, such as:

- The extent of the functional limitations experienced by older people

- The underlying mechanisms that increase the risk of older people falling when they encounter tactile paving

- How well the guidance is currently working for older people (i.e. as demonstrated through evaluating the impact of existing guidance)

- Other general areas where older people are not considered enough

One stakeholder also highlighted the importance of including older people in research.

4.3 Dementia

4.3.1 Discussion around functional limitations

Stakeholders generally thought that dementia is an under-researched topic. During the consultations, one stakeholder pointed out that literature focussing on functional limitations of those with dementia is limited, especially as there are over one hundred different types of dementia, each with their own associated limitations. Furthermore, existing literature tends to focus functional limitations that are associated with early stages of dementia rather than later stages, and on navigation of indoor settings (e.g. care homes and hospitals) rather than the outdoors pedestrian environment.

Stakeholders indicated that dementia was traditionally seen as part of the ageing process, although awareness that the two are not always linked has improved.

4.3.2 Discussion around existing guidance

Stakeholders were generally not surprised by the lack of existing guidance surrounding dementia; they suggested that dementia is not always linked with ageing or disability, and so potential perceptions that dementia is taken into consideration adequately in existing guidance may not be accurate.

4.3.3 Recommendations for improving inclusivity

4.3.3.1 Designing the pedestrian environment

One stakeholder pointed out that landmarks and visual and olfactory cues are key to being able to navigate an environment for those with dementia, and that simple environments with clear lines of sight are important. Therefore, stakeholders were opposed to 'shared space' schemes and 'cross-use' of spaces (e.g. the commercialisation of public spaces), as these can be disorientating and confusing for those with dementia. Stakeholders illustrated this point with the example of Birmingham New Street railway station, which is now combined with the Grand Central shopping centre, meaning that no trains can be seen when entering the building. Instead, stakeholders emphasised the importance of distinct spaces in the pedestrian environment to support easy navigation and feelings of familiarity. Stakeholders also highlighted the importance of creating consistent environments to support feelings of familiarity and decrease anxiety (e.g. familiar routes and frontline staff members), although it was acknowledged that creating such environments can be difficult. However, one stakeholder pointed out that making environments too consistent could also

cause confusion for those with dementia (e.g. if all train stations look the same, it would be difficult for someone to identify which station they are at). Therefore, this stakeholder suggested that distinct features are still important.

As with older people, stakeholders felt that the current levels of colour contrast between different pavement surfaces are insufficient and should be improved to help those with dementia navigate the pedestrian environment. As those with dementia can also experience difficulties with interpreting road safety signs, stakeholders suggested that these signs should be as clear as possible. More generally, stakeholders thought that there should be more clear signage in the pedestrian environment to aide navigation by people with dementia.

4.3.3.2   Services in the pedestrian environment

As with ageing, one stakeholder proposed a proactive scheme whereby those with dementia are prepared for active travel before their functional limitations are too severe and before driving cessation. This scheme could teach those with dementia how to navigate the pedestrian environment safely and deal with common issues that could arise, which could increase their confidence.

Stakeholders also emphasised the importance of providing support for active travel to those with dementia. For example, one stakeholder suggested the use of a 'virtual' travel companion, whereby technology can be used to confirm details of a journey in real-time. However, not all people with dementia would be able to use such technology.

Additionally, stakeholders thought provision of clear information in various formats is important for helping those with dementia to navigate the pedestrian environment. Stakeholders supported the provision of both auditory and visual information on buses.

4.3.3.3   Education and cultural change

Stakeholders expressed their awareness that dementia is not generally well-understood and there is an associated general lack of awareness and knowledge of how to cater for such conditions. To improve awareness of dementia and its associated functional limitations, stakeholders suggested campaigns, updating guidance, or providing training. Stakeholders felt that training of frontline staff members in relation to dementia is important to ensure that they have awareness of the needs of individuals with dementia and how to deal with associated issues that may arise. Additionally, one stakeholder suggested training frontline staff members to identify someone who might be lost in the environment so that they can offer their help.

Additionally, one stakeholder suggested that making individuals with dementia aware of their functional limitations may encourage them to adopt safer behaviours when navigating the pedestrian environment and seek support for active travel. Another stakeholder also suggested instilling more positive attitudes of people with dementia towards their ability to navigate the pedestrian environment, which could increase their confidence to travel.

4.3.3.4 Further research

After presenting the findings of the literature review, stakeholders queried why some topics had not been researched further, such as:

- The underlying mechanisms to increased risk of falling for those with dementia when they encounter tactile paving

- The impact of walking from one surface type to another

4.4 Non-visible disabilities

4.4.1 Discussion around functional limitations

One stakeholder noted that speech difficulties that are largely non-visible and have high prevalence rates (e.g. stutters and stammers) were not covered by the literature review. This stakeholder mentioned that these difficulties can greatly affect one's ability or confidence to navigate the pedestrian environment, as communication with others is usually difficult for them.

4.4.2 Discussion around existing guidance

Generally, stakeholders were aware that those with non-visible disabilities were not catered-for as well as those with visible disabilities in existing guidance.

4.4.3 Recommendations for improving inclusivity

Stakeholders felt that it could be difficult to cater for all non-visible disabilities. However, there was a consensus among stakeholders that increasing confidence to travel in those with non-visible disabilities is vital.

4.4.3.1 Updating guidance

During the consultations, one stakeholder discussed an example of a recent positive approach to updating guidance. This approach engaged many key stakeholders and members of the public with non-visible disabilities in consultations before updating and publishing new guidance. This approach ensured that a variety of views were captured and that non-visible disabilities and associated functional limitations were taken into consideration appropriately.

Additionally, stakeholders emphasised the importance of updating guidance to reflect the 1995 Disability Discrimination Act being superseded by the 2010 Equality Act.

4.4.3.2 Implementing guidance

As mentioned in earlier sections, stakeholders proposed that guidance should be applied to policy and that policy should be governed by an organisation that can influence policy. More specifically, stakeholders were aware that the Office for Disability Issues has limited ability to influence policy. Additionally, stakeholders mentioned that the use of Blue Badge parking

permits and disabled parking spaces by those who are not entitled to use them should be better controlled[6].

4.4.3.3   Designing the pedestrian environment

As with dementia, 'shared space' schemes and 'cross-use' of spaces (e.g. the commercialisation of public spaces) were opposed by stakeholders, as these can be disorientating and confusing for those with non-visible disabilities (especially for those with cognitive impairments). Stakeholders suggested that changing environments can also cause confusion for those with non-visible disabilities. Therefore, stakeholders expressed support for distinct and regulated spaces in the pedestrian environment to support feelings of familiarity and consistency in the environment.

Stakeholders also recommended the implementation of additional accessible toilets and changing rooms to encourage those with non-visible disabilities to travel independently. Additionally, one stakeholder mentioned that some people with non-visible disabilities have difficulty navigating steps, narrow or crowded walkways, and insufficiently-lit areas in the pedestrian environment.

4.4.3.4   Services in the pedestrian environment

Generally, stakeholders supported schemes identified in the literature review such as the 'Safe Places' scheme, travel training and buddying schemes, and the Blue Badge parking scheme. In addition to these schemes, stakeholders also recommended the implementation of additional quiet areas. Anecdotally, these schemes have helped those with non-visible disabilities to gain independence and confidence to navigate the pedestrian environment. Stakeholders suggested that future schemes should be aimed at providing greater flexibility for those with non-visible disabilities, such as less strict parking regulations.

Although stakeholders felt that provisions such as greater flexibility for parking and extending the Blue Badge scheme encourage those with non-visible disabilities to travel generally, some stakeholders were unsure whether these provisions would encourage *active* travel. Additionally, stakeholders highlighted that the extension of the Blue Badge parking scheme to those with non-visible disabilities means that more disabled parking spaces should be created.

Stakeholders also felt that provision of information is important, and that information should be adapted to help those with non-visible disabilities and increase their confidence to travel (e.g. easy-read formats and large font sizes). For example, one stakeholder suggested specialist maps that highlight resources such as waiting areas and 'Safe Places' or easy-to-understand route planners that provide information about various available methods of travel.

---

[6] The Blue Badge parking scheme was extended to those with non-visible disabilities earlier in 2019.

4.4.3.5   Education and cultural change

Although stakeholders felt that awareness of non-visible disabilities is increasing, they expressed awareness that non-visible disabilities are not generally well-understood and there is an associated general lack of awareness and knowledge of how to cater for such conditions. Stakeholders also suggested that people with non-visible disabilities can feel judged by others, which should be addressed to encourage them to interact more with their environment. Therefore, stakeholders thought there should be a greater emphasis on increasing awareness of non-visible disabilities through campaigns, updating guidance, or providing training.

Stakeholders proposed that disability awareness training should be provided not only to frontline staff members, but to everyone involved in transport and active travel (e.g. those who create policy, those who design infrastructure etc.), as this would encourage a culture change and increase inclusivity. One stakeholder pointed out that disability equality training encourages a greater degree of empathy than disability awareness training and focuses on the social model of disability, and so should also be considered alongside disability awareness training. Additionally, stakeholders proposed that training should be delivered consistently, yet tailored to each industry, and that people with non-visible disabilities should be involved in the design and delivery of such training. One stakeholder also noted that online training has limited value when compared with face-to-face training.

Additionally, one stakeholder emphasised the importance of providing adequate numbers of trained frontline staff who are available to offer support to those with non-visible disabilities.

4.5   Summary of stakeholder consultation findings

Stakeholders identified common functional limitations across ageing, dementia, and non-visible disabilities, which include reduced sensitivity in feet, difficulties navigating unfamiliar routes, and impaired balance, mobility, memory, reasoning, and judgement. Generally, stakeholders thought guidance documents are not updated often enough and not used effectively by those who design the pedestrian environment. Although stakeholders felt that updating guidance would be beneficial, it cannot improve inclusivity alone.

In terms of general recommendations for improving inclusivity, stakeholders felt that the environment should be as safe and accessible as possible for everyone to use, instead of making specific adjustments for certain demographics. Other key recommendations included the formation of comprehensive, consistent guidance that is easily-adaptable to specific situations and environments, improved collaboration between organisations when creating and implementing guidance, and increased enforcement to ensure guidance is followed appropriately. Stakeholders also emphasised the importance of including older people, those with dementia, and those with non-visible disabilities in the formation of guidance.

Furthermore, stakeholders offered specific recommendations relating to the design of the pedestrian environment, such as wide walkways that are better-maintained, less cluttered, and provide enough room for pedestrians to walk around tactile paving if required. Additionally, stakeholders highlighted the importance of providing information in various

ways and formats, such as through an individual's carer, accessible and clear directional signage and bus timetables, and the provision of both audible and visual information.

Education and cultural change as ways of improving inclusivity were mentioned frequently by stakeholders, such as improving the general awareness of, and attitudes towards, ageing, dementia, and non-visible disabilities. Stakeholders also recommended training on inclusive design for those who design pedestrian environments and implement those designs, as well as improved training (or improved implementation of training) for frontline staff members in the pedestrian environment, which should focus on identifying pedestrians who may need help, responding to issues, and communicating effectively and respectably with everyone. Generally, stakeholders were opposed to schemes whereby responsibility is given to individuals to self-declare their condition (e.g. wearing distinctive lanyards or badges).

Stakeholder recommendations regarding the design of the pedestrian environment to encourage active travel by older people included increased colour contrast, the addition of safer and simpler walkways and pedestrian crossings, and creating more rest points and accessible toilets. Additionally, stakeholders recommended training for older people on how to navigate the pedestrian environment (ideally before their functional limitations become too severe) to increase their confidence to travel.

Stakeholders were opposed to 'shared space' schemes and 'cross-use' of spaces, as these can be disorientating and confusing for those with dementia. Instead, they recommended simple environments with distinct spaces, clear lines of sight, and clear signage to support easy navigation and feelings of familiarity. As with ageing, stakeholders recommended increasing confidence to travel through providing training to those with dementia on how to navigate the pedestrian environment, ideally before their functional limitations become too severe.

As with the recommendations relating to dementia, stakeholders were opposed to 'shared space' schemes and 'cross-use' of spaces, and recommended distinct, regulated spaces in the pedestrian environment to support navigation and feelings of familiarity for those with non-visible disabilities. Stakeholders generally supported existing schemes to encourage confidence to travel for those with non-visible disabilities (e.g. the 'Safe Places' scheme and travel training and buddying schemes). In addition, stakeholders made several recommendations surrounding the Blue Badge parking scheme, such as increased penalties for those who misuse the scheme and additional disabled parking spaces to reflect the recent extension of the Blue Badge parking scheme to those with non-visible disabilities.

Stakeholders also identified areas which require further research, such as:

- Identification of specific aspects of the pedestrian environment that discourage people from walking

- Exploring the extent of the issues faced by individuals when navigating the pedestrian environment

- Identification of key differences or similarities between specific requirements of each demographic when navigating the pedestrian environment

- Determining whether implementation of existing inclusive mobility guidance encourages active travel by certain demographics

5   Discussion

Maintaining mobility and participating in active travel support the health and well-being of everyone, and are especially important for older people, those with dementia, and those with non-visible disabilities, particularly as the population is ageing and the prevalence of dementia and non-visible disabilities continues to rise. Design of the pedestrian environment is key to achieving inclusive mobility and encouraging active travel amongst as many segments of society as possible. In addition, where pedestrian environments are not easily navigable for older people or those living with dementia and other non-visible disabilities, individuals may find it difficult to access other services or facilities that are important to their mobility and independence, such as bus stops or train stations (DfT, 2018b). While designing for inclusive mobility is challenging, particularly given the heterogeneity of onset and severity of symptoms and functional limitations, identifying common risks can help support improved design.

Findings from this study revealed that key issues for older people in the pedestrian environment include obstacles (e.g. street furniture and uneven surfaces), crossing the road, and tactile paving. Additionally, stakeholders highlighted that older people can also have difficulty navigating slopes and ramps. These issues can increase the risk of injury caused by falls and trips and reduce feelings of safety amongst older people.

Previous relevant literature on dementia was limited but suggests that those with dementia can also experience difficulties with crossing the road and walking on novel surfaces (but not specifically tactile paving). Additionally, the personalisation of spaces and maintenance of instinctive understanding of the pedestrian environment can support the autonomy of those with Alzheimer's disease.

Again, existing literature related to non-visible disabilities was limited. However, a key finding from the literature review was that lack of confidence to travel is a major issue that can be exacerbated by negative attitudes of frontline staff members, lack of easily-accessible information, and unfamiliar travel routes or environments.

6   Recommendations and next steps

Findings from this study uncovered several recommendations for future guidance, such as updating the guidance more regularly to reflect the ever-increasing complexity of traffic and ever-changing demographics of the population. Additionally, the findings indicated the importance of forming comprehensive, consistent guidance that can be adapted to specific situations and environments. Various more specific recommendations were also made by stakeholders and users regarding the design of the pedestrian environment, to be included in guidance (e.g. creating simpler and more consistent environments with distinct features to encourage feelings of familiarity for pedestrians and providing easily-understandable information).

Although updating the guidance would have clear benefits, this study has identified numerous other ways in which inclusivity could be improved, including stricter implementation of guidance, greater collaboration between organisations, and improved inclusivity training and education for all organisations and staff involved in transport and active travel, pedestrians, and other road users. Overall, attention should focus on the wider health agenda behind encouraging active travel and on encouraging a greater degree of empathy in society.

Additionally, several recommendations for further research emerged through this research, including:

- Identification of specific aspects of the pedestrian environment that discourage people from walking

- Exploring the extent of the issues faced by individuals when navigating the pedestrian environment

- Identification of key differences or similarities between specific requirements of each demographic when navigating the pedestrian environment

- Determining whether implementation of existing inclusive mobility guidance encourages active travel by certain demographics.

7   References

7.1   General references

Department for Environment Food & Rural Affairs (2019). *Rural population 2014/15 report.* Report dated 26 September 2019.

Department for Transport (2002). *Inclusive mobility*. London, UK: Department for Transport.

Department for Transport (2018). *Reported road casualties in Great Britain: 2017 annual report.* Report dated 27 September 2018.

Department of the Environment, Transport and the Regions (1998). *Guidance on the use of tactile paving surfaces*. London, UK: Department of the Environment, Transport and the Regions.

Greenshields S, Wells A, Barham P and Dales J (2018). *Updating guidance on the accessible public realm: WP004 final report (CPR2559).* Crowthorne, UK: TRL Ltd.

United Nations (2014). *World urbanization prospects.* New York, NY: United Nations.

United Nations (2017). *World population prospects.* New York, NY: United Nations.

United Nations (2019a). *World population prospects 2019: highlights.* New York, NY: United Nations.

United Nations (2019b). *World urbanization prospects: the 2018 revision.* New York, NY: United Nations.

7.2   References for the literature review on ageing

Bernhoft IM and Carstensen G (2008). Preferences and behaviour of pedestrians and cyclists by age and gender. *Transportation Research Part F: Traffic Psychology and Behaviour, 11*(2), 83-95.

Childs CR and Tyler N (2012). *Walking and stopping over tactile paving*. London, UK: Accessibility Research Group, University College London.

Dennis NA and Cabeza R (2008). Neuroimaging of healthy cognitive aging. *The Handbook of Aging and Cognition, 3*, 1-54.

Dommes A, Cavallo V and Oxley J (2013). Functional declines as predictors of risky street-crossing decisions in older pedestrians. *Accident Analysis & Prevention, 59*, 135-143.

Dunbar G, Holland C and Maylor E (2004). *Older pedestrians: a critical review of the literature.* London, UK: Department for Transport.

Engineering and Physical Sciences Research Council (2010). *Inclusive Design for Getting Outdoors: researching how the design of streets and neighbourhoods can make a difference to older people's wellbeing and quality of life – tactile paving design, siting and laying.* Swindon, UK: Engineering and Physical Sciences Research Council.

Fiorentino A, Fornells A, Schubert K and Fernández-Medina K (2016). *Behavioural aspects of elderly as road traffic participants and modal split.* Brussels, Belgium: European Commission.

Hakamies-Blomqvist L and Peters B (2000). Recent European research on older drivers. *Accident Analysis & Prevention, 32*(4), 601-7.

Kim S (2011). Assessing mobility in an aging society: personal and built environment factors associated with older people's subjective transportation deficiency in the US. *Transportation Research Part F: Traffic Psychology and Behaviour, 14*(5), 422-429.

Lang B, Parkes A and Fernández-Medina K (2013). *Driving choices for the older motorist: the role of self-assessment tools.* London, UK: The Royal Automobile Club Foundation for Motoring Ltd.

Lid IM and Solvang PK (2016). (Dis)ability and the experience of accessibility in the urban environment. *Alter, 10*(2), 181-194.

Mitchell C (2008). The licensing of older drivers in Europe – a case study. *Traffic Injury Prevention, 9*(4), 360-6.

Newton RA, Ormerod MG, Burton E, Mitchell L and Ward-Thompson C (2010). Increasing independence for older people through good street design. *Journal of Integrated Care, 18*(3), 24-29.

Niebuhr T, Junge M and Rosen E (2016). Pedestrian injury risk and the effect of age. *Accident Analysis & Prevention, 86*, 121-128.

Ormerod MG, Newton RA, MacLennan HA, Faruk M, Thies SBA, Kenney LPJ, Howard D and Nester C (2014, August). Older people's experiences of using tactile paving. *Municipal Engineer, 168*(1), 3-10.

Oxley JA, Ihsen E, Fildes BN, Charlton JL and Day RH (2005). Crossing roads safely: an experimental study of age differences in gap selection by pedestrians. *Accident Analysis & Prevention, 37*(5), 962-971.

Shepherd J, Fernández-Medina K, Holcombe A and Sharp R (2018). *Review of effectiveness of fitness-to-drive assessment and licensing for older drivers on the Isle of Man (RPN4378).* Crowthorne, UK: TRL Ltd.

Thies SBA, Kenney LPJ, Howard D, Nester C, Ormerod MG, Newton RA, Baker R and MacLennan HA (2011). Biomechanics for inclusive urban design: effects of tactile paving on older adults' gait when crossing the street. *Journal of Biomechanics, 44*(8), 1599-1604.

Tournier I, Dommes A and Cavallo V (2016). Review of safety and mobility issues among older pedestrians. *Accident Analysis & Prevention, 91*, 24-35.

Webber SC, Porter MM and Menec VH (2010). Mobility in older adults: a comprehensive framework. *The Gerontologist, 50*(4), 443-450.

7.3 References for the literature review on dementia

Alzheimer's Association (2019). *What is dementia?* [online]. Available from https://www.alz.org/alzheimers-dementia/what-is-dementia

Alzheimer's Society (2019). *Types of dementia* [online]. Available from https://www.alzheimers.org.uk/about-dementia/types-dementia

Dementia UK (2017). *What is dementia?* London, UK: Dementia UK.

Dementia UK (2019). *Types of dementia* [online]. Available from https://www.dementiauk.org/understanding-dementia/types-of-dementia/

Fang CW, Lin CH, Liu YC and Ou YK (2018). Differences in road-crossing decisions between healthy older adults and patients with Alzheimer's disease. *Journal of Safety Research, 66*, 81-88.

Gras LZ, Kanaan SF, McDowd JM, Colgrove YM, Burns J and Pohl PS (2015). Balance and gait of adults with very mild Alzheimer's disease. *Journal of Geriatric Physical Therapy, 38*(1), 1.

Lambert KM (2015). *Reinvigorating life: an architecture for younger onset dementia*. Wellington, New Zealand: Victoria University of Wellington.

Przydatek M (2014). *Remembering community settings: exploring dementia-friendly urban design in British Columbian municipalities*. Victoria, Canada: University of Victoria.

Sverdrup K, Bergh S, Selbæk G, Røen I, Kirkevold Ø and Tangen GG (2018). Mobility and cognition at admission to the nursing home – a cross-sectional study. *BMC geriatrics, 18*(1), 30.

Taylor ME, Delbaere K, Lord SR, Mikolaizak AS, Brodaty H and Close JC (2013). Neuropsychological, physical, and functional mobility measures associated with falls in cognitively impaired older adults. *Journals of Gerontology Series A: Biomedical Sciences and Medical Sciences, 69*(8), 987-995.

7.4 References for the literature review on non-visible disabilities

Anderson G (2010). *Chronic care* [online]. Available from https://www.rwjf.org/en/library/research/2010/01/chronic-care.html

Arthritis Research UK (2018). *State of musculoskeletal health 2018.* Chesterfield, UK: Arthritis Research UK.

Baker C (2018). *Mental health statistics for England: prevalence, services and funding. Briefing Paper number 6988.* London, UK: House of Commons Library.

Barber S, Bate A, Adcock A, Harker R, Roberts N, Woodhouse J and Mackley A (2018). *Acquired brain injury: debate pack number CDP 2018-0145*. London, UK: House of Commons Library.

Brisbois R (2014). *Business benefits of accessible workplaces*. Ottawa, Canada: The Conference Board of Canada.

British Heart Foundation (2019). *Heart and circulatory disease statistics 2019.* London, UK: British Heart Foundation.

British Lung Foundation (2016). *The battle for breath – the impact of lung disease in the UK.* London, UK: British Lung Foundation.

British Society of Audiology (2016). *Commissioning Framework for Audiology: balance working group document V1.* Bathgate, UK: British Society of Audiology.

Brugha T, Cooper SA, McManus S, Purdon S, Smith J, Scott FJ, Spiers N and Tyrer F (2012). *Estimating the prevalence of autism spectrum conditions in adults: extending the 2007 Adult Psychiatric Morbidity Survey.* Leeds, UK: NHS Information Centre for Health and Social Care.

Charman S, Connon R, Cosgriff R, Lee A and Carr, S (2018). *Cystic fibrosis strength in numbers. UK cystic fibrosis registry: annual data report 2017.* London, UK: Cystic Fibrosis Trust.

Department for Work and Pensions (2019). *Family Resources Survey 2017/18*. London, UK: Department for Work and Pensions.

Department for Transport (2017a). *Accessibility action plan consultation: a transport system that is open to everyone.* London, UK: Department for Transport.

Department for Transport (2017b). *Local cycling and walking infrastructure plans: technical guidance for local authorities.* London, UK: Department for Transport.

Department for Transport (2018a). *Accessibility action plan: summary of responses to the consultation on the draft plan.* London, UK: Department for Transport.

Department for Transport (2018b). *The inclusive transport strategy: achieving equal access for disabled people.* London, UK: Department for Transport.

Disabled World (2019). *Invisible disabilities: list and general information* [online]. Available from https://www.disabled-world.com/disability/types/invisible/

Dodenhoff P (2015). *The invisibility of disability in the U.K.* [online]. Available from https://www.disabled-world.com/disability/types/invisible/invisibility.php

Elphick H, Staniforth T, Blackwell J and Kingshott R (2017). Narcolepsy and cataplexy – a practical approach to diagnosis and managing the impact of this chronic condition on children and their families. *Paediatrics and Child Health, 27*(7), 343-347.

Enable (2017). *Survey reveals prejudice towards people with "invisible" disabilities* [online]. Available from http://enablemagazine.co.uk/survey-reveals-prejudice-towards-people-invisible-disabilities/

Garcia P (2018). *Are you #AutoimmuneAware? Report for parliamentarians into autoimmune conditions.* London, UK: Juvenile Diabetes Research Foundation Ltd.

Gov.uk (2014). *Official statistics: disability facts and figures* [online]. Available from https://www.gov.uk/government/publications/disability-facts-and-figures/disability-facts-and-figures

Gov.uk (2018). *People with hidden disabilities to benefit from Blue Badges* [online]. Available from https://www.gov.uk/government/news/people-with-hidden-disabilities-to-benefit-from-blue-badges

House of Commons Transport Committee (2013). *Access to transport for disabled people: fifth report of session 2013-14. Volume I: report, together with formal minutes, oral and written evidence.* London, UK: The Stationary Office Ltd.

Hunter RM, James M and Paxman J (2017). *Counting the cost: Chronic Fatigue Syndrome/Myalgic Encephalomyelitis.* London, UK: 2020health.

International Association for the Study of Pain (2019). *Chronic pain has arrived in the ICD-11* [online]. Available from https://www.iasp-pain.org/PublicationsNews/NewsDetail.aspx?ItemNumber=8340&navItemNumber=643

Invisible Disabilities Association (2018). *How do you define invisible disability?* [online]. Available from https://invisibledisabilities.org/what-is-an-invisible-disability/

Invisible Disabilities UK (2019). *What is an invisible disability?* [online]. Available from http://invisibledisabilitiesuk.weebly.com/

Lamont D, Kenyon S and Lyons G (2013). Dyslexia and mobility-related social exclusion: the role of travel information provision. *Journal of Transport Geography, 26*, 147-157.

Lemoncello R, Sohlberg MM and Fickas S (2010). How best to orient travellers with acquired brain injury: a comparison of three directional prompts. *Brain Injury, 24*, 541-549.

Mackett R (2016). *Facilitating travel by people with mental impairments.* London, UK: Centre for Transport Studies, University College London.

Mackett R (2017). *Building confidence – improving travel for people with mental impairments.* London, UK: Centre for Transport Studies, University College London.

Macmillan Cancer Support (2019). *Statistics fact sheet.* London, UK: Macmillan Cancer Support.

MentalHealth.gov (2019). *What is mental health?* [online]. Available from https://www.mentalhealth.gov/basics/what-is-mental-health

Moore T (2009). *What does disability look like – hidden disabilities* [online]. Available from https://www.disabled-world.com/disability/types/invisible/look-like.php

Neligan A and Sander JW (2009). The incidence and prevalence of epilepsy. In JW Sander, FJ Rugg-Gunn and JE Smalls (eds). *Epilepsy 2009: from benchside to bedside. A practical guide to epilepsy* (pp. 15-21). Chalfont St Peter, UK: International League against Epilepsy and National Society for Epilepsy.

NHS.uk (2017). *Overview: cerebral palsy* [online]. Available from https://www.nhs.uk/conditions/cerebral-palsy/

Office for Disability Issues (2011). *Equality Act 2010 guidance: guidance on matters to be taken into account in determining questions relating to the definition of disability.* London, UK: Office for Disability Issues.

Parkinson's UK (2018). *The incidence and prevalence of Parkinson's in the UK: results from the Clinical Practice Research Datalink. Summary report.* London, UK: Parkinson's UK.

Posner R, Durrell L, Chowdhury S and Sharp R (2018). *Mental health and transport (PPR866)*. Crowthorne, UK: TRL Ltd.

Prince M, Knapp M, Guerchet M, McCrone P, Prina M, Comas-Herrera A, Wittenberg R, Adelaja B, Hu B, King D, Rehill A and Salimkumar D (2014). *Dementia UK: update. Second edition*. London, UK: Alzheimer's Society.

UK Parliament (2010). *Equality Act 2010*. London, UK: The Stationary Office Ltd.

World Health Organization (2016). *What are neurological disorders?* [online]. Available from https://www.who.int/features/qa/55/en/

Accessible Public Realm: Updating Guidance and Further Research

Considering ageing, dementia and non-visible disabilities when designing inclusive pedestrian environments is important. The population is ageing and, although ageing within the context of road safety has been widely researched, previous research has tended to focus on the older driver instead of the older pedestrian. Previous research on those with dementia or non-visible disabilities as pedestrians is also very limited. The aims of this study were to gain insight into the functional limitations associated with ageing, dementia, and non-visible disabilities, and to explore how these could be better catered for *within Inclusive* Mobility *and Guidance on the Use of Tactile Paving* Surfaces. To address these aims, TRL conducted a literature review on each of the three topics, before holding a workshop and individual telephone consultations with nine stakeholders. Several key recommendations emerged from this study, some of which directly relate to updating existing guidance on the public realm such as forming comprehensive guidance that reflects the ever-changing demographics of the population and increasing complexity of traffic; older people, those with dementia, and those with non-visible disabilities should be involved in the formation of such guidance. Additionally, pedestrian environments should be simpler, with distinct features and provision of clear information that aide navigation and confidence to travel. Other key recommendations include stricter implementation of guidance, greater collaboration between organisations, and improved training and education (focusing on the wider health agenda and encouraging empathy) for road users, organisations involved in travel and transport, and frontline staff members in the pedestrian environment.