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Use of Local Public Transport among People with Cognitive Impairments – A Literature Review

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ABSTRACT

Being able to move around in the community including using different modes of transport is a prerequisite for being able to participate in activities outside home. This can be particular challenging for people with cognitive impairments. Still, research regarding public transport for people with cognitive impairments is scarce. In this narrative review scientific literature focusing on people with cognitive impairments and their needs in public transport, was identified and summarized. All aspects in the travel chain perspective were of interest. Literature search engines Scirus, Elin and Cinahl were used during the search.

Thirty-four articles were included and analyzed according to which part of the travel chain they covered in the used model. The results showed that the articles were unevenly allocated to the different parts of the model. Future studies based on real-world experiences are essential, and more user-centred approaches should be adopted. Moreover, there is a need for the development and evaluation of evidence-based rehabilitation. Finally, more research is needed to foster societal awareness of the problems and needs in the public transport of people with cognitive impairments taking the whole travel chain into consideration.

1 INTRODUCTION

Being able to move around in the community including using different modes of transport such as walking, cycling, driving a motor vehicle as well as public transport, i.e. bus, tram and train is a prerequisite for being able to participate in activities outside home (Haak, Fänge, Horstmann & Iwarsson, 2008). Travelling with public transport comprises many different tasks e.g. planning the trip, getting to and from the bus stop/ train station, and buying the ticket. All tasks along a travel route need to be considered as essential aspects to safely and comfortably participate in public transport (Carmien et al., 2005). Previous research within transport research has therefore emphasised the necessity of applying a travel chain perspective. That is, taking all tasks during the whole trip into account, starting with planning the trip and not ending until the final destination is reached (Ståhl, 1997; Wretstrand, & Ståhl, 2008; Waara, 2001). By considering all tasks, adopting a user perspective and including all used modes of transport necessary for a certain route, all potential barriers and facilitators along the whole travel chain can be identified (Ståhl, 1997; Figure 1).

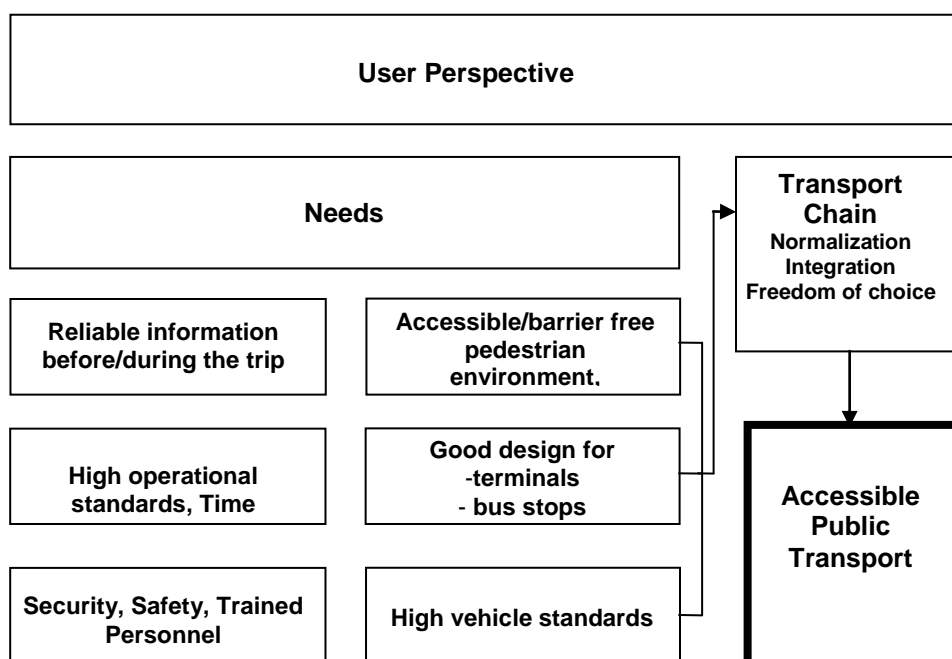


Figure 1. The model “User perspective on accessible public transport” (Ståhl, 1997) showing how all elements in the travel chain need to be considered when discussing accessible public transport systems.

It is well-known that many people stop driving a motor vehicle due to age and/or different disabilities, and recent studies indicate that there is a need for alternative forms of transport for people who stop driving (Adler, & Rottunda, 2006; Windsor, & Anstey, 2006; Lafont et al., 2008; O’Neill, 2010). This fact places a great demand on the public transport system to be accessible for all. While special transport options (i.e. such as private shuttle services, dial a taxi, etc.) are usually available in most countries and become even a viable alternative in regions where no public transport is available for all user groups, focus here is on general local public transport routes. Still, being able to travel with public transport can be difficult for people with disabilities (Marin-Lamellet et al 2001; Waara, 2001; Asplund et al 2012; Neven et al 2013) not the least for those with cognitive impairments (Rosenkvist et al., 2009; Wendel et al., 2010). Still, research regarding public transport for people with cognitive impairments is scarce, and one contributing factor may be that studies are published according to the traditions of different scientific disciplines which make the research difficult to find. Thus, the aim of this review was to identify and summarize scientific literature focusing on people with cognitive impairments and their needs in public transport, applying a travel chain perspective.

2 METHOD

A qualitative systematic literature review was applied in order to make a comprehensive synthesis of previously published information so that gaps in the scientific literature can be identified, and recommendations for future research can be presented (Green, Johnson, & Adams 2006). Compared to a quantitative systematic literature review, the qualitative literature review does not grade

methodological rigour or statistical results in included articles. The following steps were undertaken: Research articles accessible to web-based literature search have been collected and based on the outlined criteria below, each article was screened for inclusion or exclusion. The final set of included articles were then analysed according to a chosen theoretical framework.

2.1 Search strategy and databases used

The literature search was carried out by using the web-based search engines Scirus, Elin and Cinahl, covering a wide range of databases¹. To be eligible for inclusion, the articles had to be written in English, published in peer-reviewed medical and health, technical, or social sciences journals during 1984-2011, and address cognitive impairments in relation to the use of public transport. An overview of the computerized search process and search terms used is presented in Figure 2.

2.2 Selection procedure

During the selection procedure all abstracts of the articles identified were screened in view of the search criteria. After eliminating duplicates, a sample of 198 potential articles remained and the full text versions were acquired. They were then manually screened according to our criteria; the article had to be peer-reviewed and comprise issues in relation to cognitive impairments as well as public transport. The full articles were examined independently by three of the authors (Risser, Lexell and Bell), and if at least one of them judged the article to be included in the sample, it was forwarded to the remaining two authors (Iwarsson and Ståhl) who also assessed the article independently. If they both agreed, the article was either included or excluded; if they did not agree the article was further discussed among all authors until consensus was obtained. This procedure resulted in a sample of 24 articles.

¹ In addition to the above mentioned database search tools Lund's online literature search engine LibHub was used (<http://libhub.sempertool.dk.ludwig.lub.lu.se/>).

Next, the reference lists of these articles were scanned to ensure that relevant articles on the same topic were not missed. By this procedure, another 10 articles were identified and added to the sample, leaving us with a final sample of 34 articles.

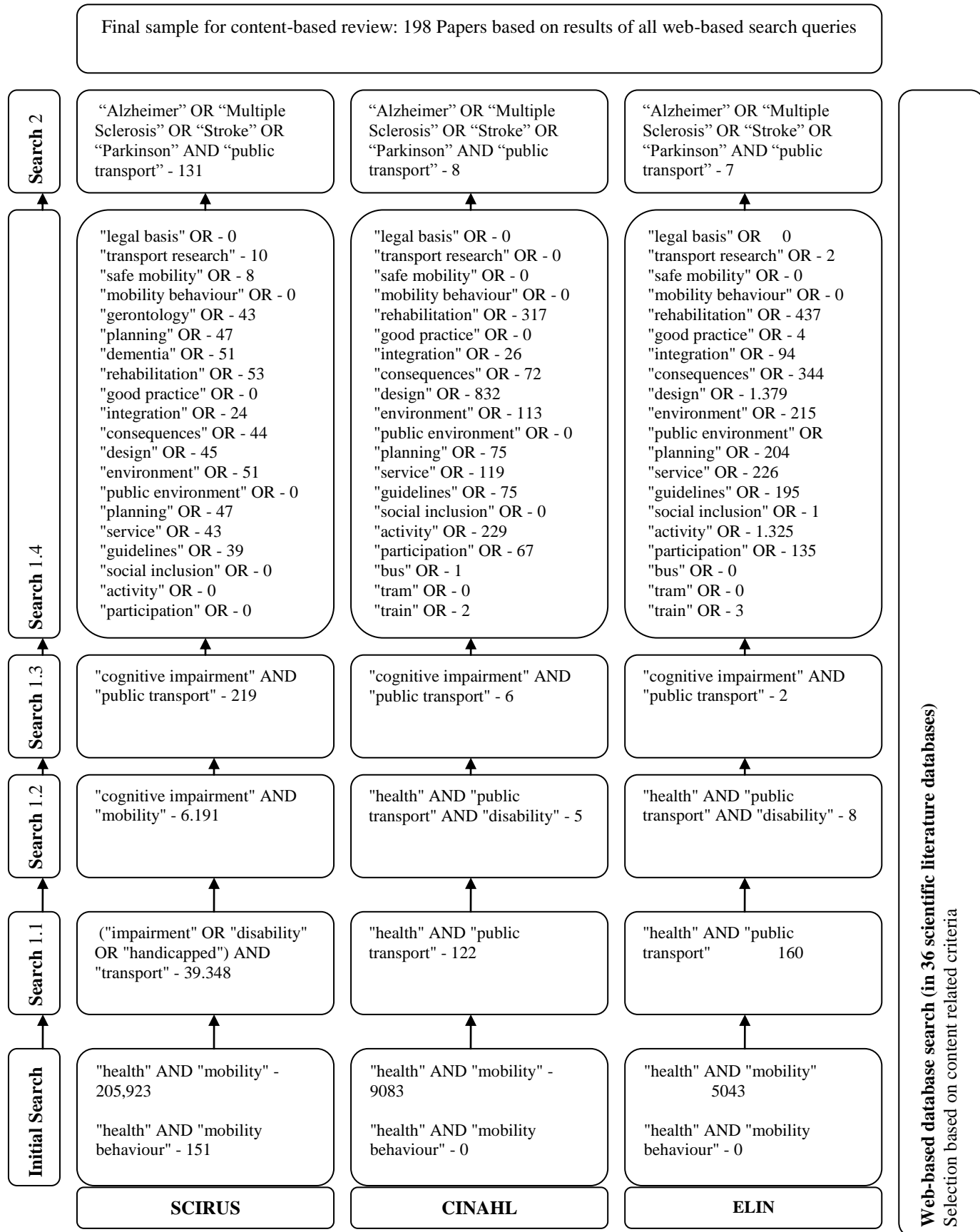


Figure 2: An overview of the computerized search process and used search terms.

2.3 Data analysis

To analyse the 34 articles according to aspects of the whole travel chain, the theoretical model by Ståhl (1997) was used (Figure 1). This model was chosen because it emphasizes the travel chain perspective, including different tasks in relation to public transport. Accessible public transport is strongly dependent on the user perspective which is in turn dependent on a variety of needs. These needs have to be assessed comprehensively to allow for an integrated transport system which poses no barriers in either section of the transport chain. As the model presented in Figure 1 integrates these aspects into one framework by especially considering the user perspective and a travel chain approach, it served as the theoretical basis for the literature screening.

First attempts were made to analyse and categorise each article according to the different dimensions of this model. However, since some of the articles did not fit into any of the existing dimensions, a modified version was developed. This “Modified model of accessible public transport - the perspective of the user” adds two new dimensions; i) Using public transport is a problem for activities of daily living; and ii) Attitudes and opinions towards public transport (Figure 3).

Subsequently, all articles were allocated to a dimension of the modified model; two articles (nos. 9, 27) were allocated to more than one dimension. This analysis was initially performed by two of the authors (Risser and Bell) and then validated by the remaining authors. In addition, the contents from all articles were summarised and described.

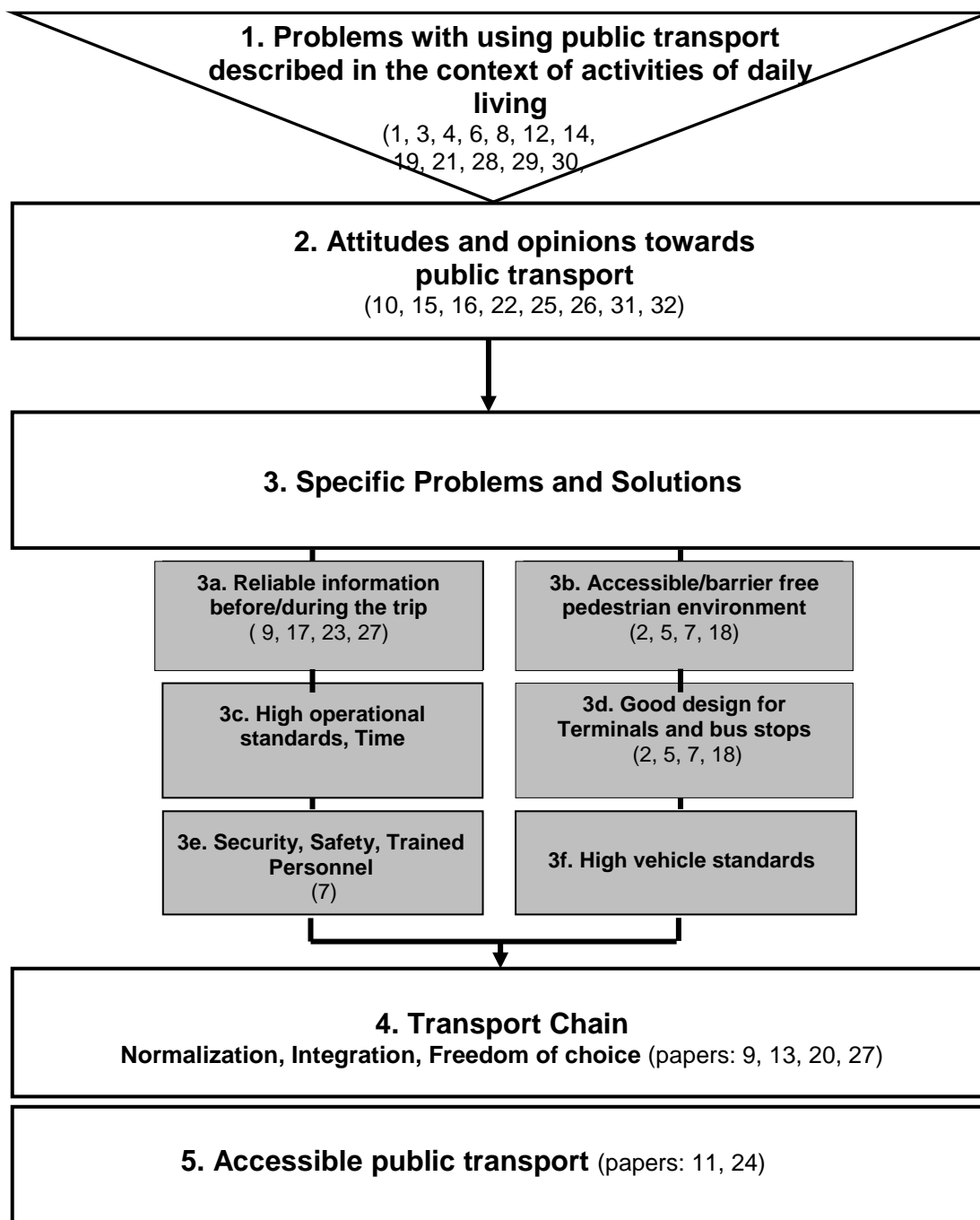


Figure 3: Modified model of “Accessible public transport - the perspective of the user” by Ståhl (1997) with the numbers of analysed articles allocated to the elements of the model.

3 RESULTS

3.1 General characteristics of the sample

During the publication period targeted, in terms of frequency there was a peak during 2003-2005, in a wide variety of journals. Four journals had more than one publication on cognitive impairment and public transport. Disability and Rehabilitation had published four of the articles whereas Archives of Gerontology and Geriatrics, Journal of Head Trauma Rehabilitation, and Brain injury each had published two (see Appendices A and B). Fifteen of the articles originated from the U.S. or Canada, five articles from Sweden, four were from the United Kingdom (UK), and the remaining ten were spread over different countries in Europe, Asia and Oceania.

3.2 Description of articles in relation to the “Modified model of Accessible public transport - the perspective of the user”

The 34 articles represent all of the five dimensions in the modified model. The five dimensions that describe people with cognitive impairment in relation to public transport taking a travel chain perspective are: 1) Using public transport is a problem for activities of daily living; 2) Attitudes and opinions towards public transport; 3) Specific problems and solutions, comprising six sub-dimensions; (a) reliable information before/during the trip; b) accessible/barrier-free pedestrian environment; c) high operational standards, time; d) good design for terminals and bus stops; e) security, safety, trained personnel; and f) high vehicle standards); 4) Transport Chain – Normalisation, Integration, Freedom of choice; and 5) Accessible Public Transport. In Figure 3, the five dimensions and the categorisation of articles are presented.

3.2.1 Using public transport is a problem for activities of daily living

Fourteen articles were categorised to this dimension. Twelve of these applied a quantitative, non-experimental design, one had a descriptive design and one was based on a literature review.

The articles dealt with people with cognitive impairments due to different diagnoses (e.g. Alzheimer's disease, stroke, traumatic brain injury, etc.), and their problems in relation to public transport as one aspect among many other activities of daily living (ADL). Different assessment tools had been used, focusing on aspects of Personal ADL (PADL) and/or Instrumental ADL (IADL), including items in relation to public transport. Sum scores for different variables were presented, describing the magnitude of the problems when using public transport, also suggesting that a more severe disability caused more difficulties.

The authors of the articles also identified methodological limitations. For instance, they described a lack of longitudinal research designs and exhibited difficulties during the sampling procedure, especially in view of assessing the consequences of cognitive impairments among different age groups and at different stages of cognitive decline. The authors stated that they had applied survey and screening methodologies on small samples focusing on only some groups of people with cognitive impairments, resulting in limited generalizability. Therefore, they concluded that future studies should use more rigorous research designs, and also be performed in real world contexts so that potential solutions viable for people with cognitive impairments can be developed.

3.2.2 Attitudes and opinions towards public transport

Eight articles were categorised into this dimension; three applied a quantitative non-experimental approach, one was quasi-experimental, and four had qualitative research designs.

The results from the studies showed that access to and use of public transport is dependent on the ability to balance internal (i.e., knowledge, ability and willingness to use public transport) and external factors (i.e., accessible and usable infrastructure, and personal support from staff of infrastructure service providers). The importance of informing people with cognitive impairments about the possibility to stay mobile through the use of public transport was underlined, as public transport often is dismissed too early as a possible option to stay mobile among people with cognitive impairments.

Another finding was that public transport was not judged or experienced as an option when driving cessation for one reason or another was a fact. Instead, individuals rather wanted to go by car driven by informal caregivers (friends or family members).

In the articles, the authors stated that previous research projects do not give any clear picture or answers to the problems identified. They just give hints at potential causes for mobility and accessibility issues with no clear specifications provided. The authors therefore concluded that additional research that directly focuses on attitudes among people with cognitive impairments towards public transport is needed, as well as further studies about how such attitudes actually affect the use of public transport among this user group. This applies not only for those actually affected by cognitive impairments, but also for caregivers.

3.2.3 Specific problems and solutions

Eight articles were categorised to this dimension, and allocated to its six sub-dimensions. Four of the articles were categorised to more than one of the sub-dimensions, and in these cases, the sub-dimensions are merged. No articles were allocated to the sub-dimensions 3c and 3f (Figure 3). Three articles had a

quantitative research design (one non-experimental, one quasi-experimental, one randomised controlled trial, RCT, and one had a qualitative design. Four studies were based on literature reviews.

3.2.4 Reliable information before/during the trip

Four studies discussed pre-trip and on-trip traveller information, and the training and education of personnel who are providing such information. The articles identified that people with cognitive impairments often have problems related to orientation and navigation. Further, a lack of both assistive devices and trained personnel helping and assisting with orientation to achieve a stress-free navigation was pointed out.

The authors argued that future research needs to focus more strongly on comprehensive evaluations of information systems as well as on programs for education and training of people with cognitive impairments to use public transport. Thus, in order to have an impact on people's lives, authors suggested that studies should be performed in real world contexts.

3.2.4.1 Accessible/barrier-free pedestrian environment and good design for terminals and bus stops

In the four literature reviews categorized into these two sub-dimensions, the design of terminals, bus stops and accessibility issues in the pedestrian environment were presented in conjunction with each other. A broad spectrum of problems as well as solutions, design aspects as well as other adaptations of the pedestrian environment was presented. For example, it was pointed out that public transport design needs to consider issues of familiarity, legibility, distinctiveness, comfort, and safety in order to meet the needs of, for example, people with dementia. The findings of the literature reviews underlined that terminals and bus stops as well as walkways must

have appropriate seating, lighting and shelter. The pedestrian environment must also be well-maintained, be even in level and constructed in a material that give a flat paving in order to facilitate outdoor mobility.

The authors argued for a rising demand for scientific discussion and empiric analyses with regard to the design of the outdoor environment, and the development of infrastructure guidelines in the planning process. In line with this, in order to provide people with cognitive impairments with suitable solutions, evaluations of new technological achievements were strongly recommended.

3.2.4.2 Security, safety and trained personnel

The only study under this sub-dimension focused on technological solutions and how these might support people with cognitive impairments to safely and independently use different transport systems. The authors discussed technological solutions in combination with trained service personnel. For instance, they described the development of a digital travel assistant system for caregivers that uses real-time GPS data with a mobile client. In addition, education and information of transport service personnel for onsite support were brought forward.

Potential problem areas and fields for future studies mainly focused on personal safety and education in connection with new technologies. It was emphasized that training service personnel to interact with, and support, people with cognitive impairments can greatly improve experiences of the target group.

3.2.5 Transport chain – normalisation, integration, freedom of choice

Four articles were categorised into this dimension; two studies used qualitative research designs and two applied a quantitative approach.

These articles described how a travel chain for people with cognitive impairments could be achieved, including aspects such as availability and freedom of

choice. The articles also provided suggestions for improvements and interventions that should allow the target group to carry out trips from door to door, making use of public transport, by training people to move independently along the whole transport chain. The articles provided evidence that specific training programs successfully could enable people with cognitive impairments to use public transport. One study provided a model focusing on all abilities necessary to successfully move around outdoors as well as the challenges that people with cognitive impairments are faced with. It considers door-to-door mobility as an essential aspect to be able to use public transport, including pre-traveller information and assistance by trained personnel, with all the tasks connected to the travel chain.

The articles demanded future research to focus on specific prompt modes for routing devices based on the abilities and needs of the target group. Additional suggestions included development of strategies to support travelling to self-selected destinations besides trained fixed-route public transport use and specifically adapted forms of assistance, that is, trained personnel to aid in certain situations.

3.2.6 Accessible public transport

Two articles were categorised into this dimension, whereof one used a qualitative research methods and the other one applied a mixed methods approach.

The articles studied how an accessible public transport system should be designed in order to provide appropriate preconditions for people with cognitive impairments to stay mobile as autonomously as possible. Compared to the previous dimensions of the model (Figure 3), these studies took a more overarching view of the issues at target. One of the articles postulated that measures solely based on technological advancements are neither sustainable nor efficient. Instead, the authors

strongly emphasised the need of education, of both public transport users and service personnel. The other article showed that an accessible and usable public transport system is undermined by trivial barriers to accessibility and usability of the existing infrastructure. These barriers are frequently related to a complex interplay of personal (negative experiences with public transport, difficulties in the communication with other persons, etc.) and contextual factors (information and design, etc.), resulting in challenges (usability and accessibility issues) that need to be considered. The authors concluded that a combination of an adapted environment, societal awareness of this groups' specific need, and knowledge and skills of those responsible for environmental planning and design are key factors for the development of accessible public transport systems as well as for accessible public spaces in general.

The authors of the articles concluded that more in-depth knowledge is needed on how different technological advancements can be used in society since some solutions can be a facilitator for some and a barrier for others, depending on the type of disability. For people with cognitive impairments, it is essential that information are easily provided and understood, for instance that displays presenting timetables or other additional information are not complex. Moreover, the authors argued that the tendency of automation in public transport systems in favour of economic factors and general efficiency can have negative effects in critical situations when personal support is needed. There is also a lack of knowledge about actual user experiences with new technologies, and about coping strategies of different groups and individuals.

4 DISCUSSION

The goal of this qualitative literature review was to give an overview of existing literature concerning use of public transport by people with cognitive impairments. A considerable proportion of the previous research, which takes people with cognitive impairments into account, considered outdoor mobility as one of many activities of daily living without discussing outdoor mobility more in detail. Furthermore, many articles are of rather general character and treat the use of public transport as one of many everyday tasks.

Since outdoor mobility is vital in order to be able to participate in society, it is reasonable to incorporate outdoor mobility in IADL assessment tools. However, in many of the studies outdoor mobility is just mentioned in a general sense, and only present an overview of IADL problems, but detailed information of difficulties in relation to the complexity of tasks involved during public transport is not revealed. Since assessment tools like IADL are very much used in practice and rehabilitation, research on how to develop these tools to better capture outdoor mobility issues and difficulties for this particular group in society are strongly called for.

Another issue of vital concern is that the attitude studies that were conducted proved to be of a rather mechanistic character. That is, people with cognitive impairments were observed, but no real dialogue with the participants took place. Only in few cases we detected an interactive approach where people with cognitive impairments were directly involved in the development process of measures to improve upon the use of public transport. There is a growing interest for research that involves participants as actors in the research process and also examples of such studies are at hand (see e.g. Ståhl et al., 2008). As yet, such studies involving people

with cognitive impairments are very scarce. Interaction with this specific user group is challenging (Rosenkvist et al., 2009), but more research that actively involves people with cognitive impairments, such as field trials, focus group interviews, training procedures etc. in the research process are important. In order to be able to understand the mechanisms behind the difficulties this particular user group encounters when being exposed to use of public transport, such studies are necessary. Studies performed in a real-life context proved to yield usable results on how to develop and provide a sustainable public transport especially for people with cognitive impairments.

While much remains to be done in this compelling area of research, there are examples of studies where attempts have been made to describe and categorise the complexity of cognitive impairments (see e.g. Wendel et al., 2008, 2010). Categorisation of different user groups with similar needs and problems in regard to public transport is a first and necessary step for valid knowledge development, but still uncommon. In order to increase the knowledge of the interaction between people with disabilities and the environment, valid classifications of the impairments of the respondents in studies are imperative (Slaug et al., 2012). This would facilitate the process of developing solutions that different group may benefit from. It would also make it possible to find similarities and differences with other user groups. Similar needs of different groups are an advantage in providing synergy effects to influence public transport planning more progressively.

The sample of articles included a number of studies that targeted both technological and psychological aspects of public transport and people with cognitive impairments. Main aspects in the articles reviewed were those relating to the built environment and to user attitudes towards real and perceived barriers (see Blackman et al, 2003; Carmien et al, 2005; Doukas et al, 2011; Mitchell et al, 2003).

Generally, the articles show that accessibility and usability problems of the existing infrastructure stem from flaws in the interplay between personal and contextual factors (see Crabtree, Troyer and Justiss, 2009). Information being another important aspect, the provision of appropriate pre-trip and on-trip information is vital for this group (Risser et al. 2011). However, the articles reviewed did not sufficiently consider the aspect of information. Further, the difficulties generated by the design of the built environment are often caused by shortcomings in the design and planning processes. All these aspects were touched upon in several articles (see e.g. Blackman et al, 2003), but seldom analysed in-depth because no user-centred nor a consequent design approach in regard to public transport were applied. A striking observation is that the barriers and problems reported are very much in line with those of people with physical impairments (see Waara et al, 2013). Yet, there are also differences. For example, for people with cognitive impairments attitudes seem to play an important role (see Rosenkvist et al., 2008) leading to the conclusion that issues related to psychological barriers due to actual experiences and rather negative attitudes have to be differentiated. This is also supported by Asplund (2012) who concluded that for people with cognitive impairments not only physical environmental barriers need to be considered but also perceived barriers, and anticipated restrictions. Thus, while psychological aspects, such as fear or negative attitudes, among people with cognitive impairments actually can limit public transport use, these aspects are generally not as important as actual negative experiences due to existing physical barriers. Furthermore, personal motivation to stay mobile after being confronted with a cognitively impairing condition was also found to be a key factor when wanting to achieve or continue to manage public transport. Thus, the importance of the individual view on the opportunities that public transport provides for people with cognitive impairments is underlined.

Nevertheless actual issues related to how information is provided to specific user groups in public transport, in all stages of the trip, during planning and on-trip, services provided by specifically trained personnel and not least the actual capacity of the affected persons need to be addressed first.

Because there is a portion of people with cognitive impairments who do not at all consider using public transport as an option (Risser et al. 2011), there is a need for rehabilitation programs that can promote and encourage this group of users to use public transport. Only a few of the articles included in this review described and/or evaluated the effects of interventions (see Fickas et al 2008; Hunter-Zaworksi & Hron, 1999; LaDuke et al, Logan et al, 2004 and Newbigging and Laskey, 1995), showing that specifically adapted interventions can improve mobility and enable people with cognitive impairments to use public transport. Still, our review shows that research is scarce in the field of outdoor mobility rehabilitation interventions for people with cognitive impairments. Still, rehabilitation is not the only solution to facilitate public transport for people with cognitive impairments. The built environment needs to be adapted to the specific needs of people with cognitive impairments, e.g. by supporting orientation and by repeatedly providing information during the trip is also necessary. Different types of solutions that are recommended in the available literature could be successfully combined.

Finally, reflecting on methodological issues, the sample of articles reviewed was very heterogeneous. Furthermore, we used the model by Ståhl (1997) to analyse the articles but had to slightly modify the model since not all articles could be categorized into the existing dimensions of the model. In retrospective, another model may have been better suited to describe our articles, such as the hierarchical model of decision levels by Keskinen (1996), based on Michon (1985), which provides insight into causing factors of behaviour on strategic, tactical and

operational levels. Another option would have been the NOA (needs, abilities and opportunities) model by Steg and Vlek (2009), which provides grounds for assessing the actual quality of available services and corresponding causes and effects on behaviour, as well as the interaction between the environment and the target group at hand. Still, the aim of this review was not to test the model in itself, but to identify articles in relation to public transport and cognitive impairments, and which areas these articles target so that knowledge gaps in the literature could be revealed. Another limitation is that literature found that was published in peer-reviewed journals in other languages, such as German, French, Japanese or languages from Scandinavian countries, was not included.

5 CONCLUSION

This review shows that there is a knowledge gap on public transportation and people with cognitive impairments, and closing these gaps is an important task for future research. A specific problem of research on problems with daily activities among cognitively impaired people is that issues with local public transport use are identified but not further specified. Here a more in-depth assessment of causing factors and actual barriers experienced in all sections of the travel chain would yield insights helping to improve both accessibility and usability for these specific user groups. Studies based on real-world experiences are essential, and more user-centred approaches should be adopted. Moreover, there is a need for the development and evaluation of evidence-based rehabilitation. Finally, more research is needed to foster societal awareness of the problems and needs in the public transport travel chain of people with cognitive impairments.

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7 REFERENCES

Adler, G., Rottunda, S. (2006). *Older adults' perspectives on driving cessation*. Journal of Aging Studies, 20, 227-235.

Asplund, K., Wallin, S., Jonsson, F. (2012). *Use of public transport by stroke survivors with persistent disability*. Scandinavian Journal of Disability Research 1: 1-11.

Agüero-Torres, H.; Thomas, V. S.; Winblad, B.; Fratiglioni, L. (2002). *The impact of somatic and cognitive disorders on the functional status of the elderly*. Journal of Clinical Epidemiology 55 (2002) 1007–1012.

Blackman, T.; Mitchell, L.; Burton, E.; Jenks, M.; Parsons, M.; Raman, S.; Williams, K. (2003). *The accessibility of public spaces for people with dementia: A new priority for the 'open city'*. Disability & Society, Vol. 18, No. 3, 2003, pp. 357–371.

Brown, M.; Dijkers, M.; Gordon, W.; Ashman, T.; Charatz, H.; Cheng, Z. (2004). *Participation Objective, Participation Subjective - A Measure of Participation Combining, Outsider and Insider Perspectives*. J Head Trauma Rehabil Vol. 19, No. 6 (2004), pp. 459–481.

Campbell, A. J.; Busby, W. J.; Robertson, M. C.; Lum, C. L.; Langlois, J. A.; Morgan, F.C. (1994). *Disease, impairment, disability and social handicap: a*

community-based study of people aged 70 years and over. Disability and Rehabilitation, 1994; VOL. 16, NO. 2, 72-79.

Carmien, C.; Dawe, M.; Fischer, G.; Gorman, A.; Kintsch, A.; Sullivan, F. J. (2005). *Socio-Technical Environments Supporting People with Cognitive Disabilities Using Public Transportation.* ACM Transactions on Computer-Human Interaction (TOCHI), Volume 12, Issue 2, June 2005.

Crabtree, J. L.; Troyer, J.D.; Justiss, M. D. (2009). *The intersection of driving with a disability and being a public transportation passenger with a disability.* Topics in Geriatric Rehabilitation Vol. 25, No. 2, pp. 163–172.

Doukas, C.; Metsis, V.; Becker, E.; Le, Z.; Makedon, F.; Maglogiannis, I. (2011). *Digital cities of the future: Extending ±home assistive technologies for the elderly and the disabled.* Telematics and Informatics 28 (2011) 176–190.

Tomaszewski Farias, S.; Harrell, E.; Neumann, C.; Houtz, A. (2003) *The relationship between neuropsychological performance and daily functioning in individuals with Alzheimer's disease: ecological validity of neuropsychological tests.* Archives of Clinical Neuropsychology, 18 (2003) 655–672.

Fickas, S.; Sohlberg, M. K.; Hung, P. F. (2008). *Route-following assistance for travelers with cognitive impairments: A comparison of four prompt modes.* Int. J. Human-Computer Studies 66 (2008) 876–888.

Green, B. N.; Johnson C. D.; Adams; A. (2006). *Writing narrative literature reviews for peer-reviewed journals: secrets of the trade.* Journal of Chiropractic Medicine, 5 (3), 101-117.

Gladwell, N. J.; Bedini, L. A. (2004). *In search of lost leisure: the impact of caregiving on leisure travel.* Tourism Management 25 (2004) 685–693.

Haak, M.; Fänge, A.; Horstmann, V.; Iwarsson, S. (2008). *Two dimensions of participation in very old age and their relations to home and neighborhood environments*. American Journal of Occupational Therapy, 62, 77–86.

Hunter-Zaworski, K.; M. Hron. (1999). *Bus accessibility for people with cognitive disabilities*. Transportation Research Record 1671, paper No. 99-8111 (1999) 34-39.

Keskinen, E. (1996), *Why do young drivers have more accidents?*. Referate der Esten Interdisziplinären Fachkonferenz 12-14. Berichte der Bundesanstalt für Strassenwesen. Mensch und Sicherheit, Heft M 52,

Konno, K.; Katsumata, Y.; Arai, A.; Tamashiro, H. (2004). *Functional status and active life expectancy among senior citizens in a small town in Japan*. Arch. Gerontol. Geriatr. 38 (2004) 153–166.

LaDuke, R. O.; LaGrow, S. J. (1984). *Photo-Bus-Route-Map: an intervention to produce independence in bus travel for mentally retarded adults*. The Mental Retardation and Learning Disability Bulletin, 1984, 12, 71-75.

Lafont, S. ; Laumon, B. ; Helmer, C.; Dartigues, J. F.; Fabrigoule, C. (2008). *Driving cessation and self-reported car crashes in older drivers. The impact of cognitive impairment and dementia in a population-based study*. J Geriatr Psychiatry Neurol. 21(3):171-82. Epub 2008 May 23.

Lee, Y.; Choi, K. (2002). *Functional disability of older persons in long-term care facilities in Korea*. Archives of Gerontology and Geriatrics, 34 (2002) 93–106.

Logan, P. A.; Gladman, J. R. F.; Radford, K. A. (2001). *The Use of Transport by Stroke Patients*. British Journal of Occupational Therapy 64(5):261-264.

Logan, P. A.; Dyas, J.; Gladman, J. R. F. (2004). *Using an interview study of transport use by people who have had a stroke to inform rehabilitation*. *Clinical Rehabilitation* (2004) 18: 703.

Logan, P. A.; Gladman, J. R. F.; Avery, A.; Walker, M. F.; Dyas, J.; Groom, L. (2004). *Randomised controlled trial of an occupational therapy intervention to increase outdoor mobility after stroke*. *BMJ* 2004;329:1372.

Michon, J.A. (1985). *A critical view of driver behavior models: what do we know, what should we do?* In: Evans, L. and Schwing, R. (Eds.) *Human Behavior and Traffic Safety*. Plenum Press, New York,

Mitchell, L.; Burton, E.; Raman, S.; Blackman, T.; Jenks, M.; Williams, K. (2003). *Making the outside world dementia-friendly: design issues and considerations*. *Environment and Planning B: Planning and Design* 2003, volume 30, pages 605-632.

Marin-Lamellet, C.; Pachiaudi, G.; Le Breton-Gadegbeku, B. (2001). *Information and orientation needs of blind and partially sighted people in public transportation: BIOVAM project*. *Transportation Research Record*, 1779, 203–208.

Muò, R.; Schindler, A.; Vernerio, I.; Schindler, O.; Ferrario, E.; Frisoni, GB. (2005). *Alzheimer's disease-associated disability: an ICF approach*. *Disability and Rehabilitation*, December 2005; 27(23): 1405 – 1413.

Newbigging, E. D.; Laskey, J. W. (1995). *Riding the bus: teaching an adult with brain injury to use a transit system to travel independently to and from work*. *Brain Injury*, 1995, Vol. 10, No. 7, 543-550.

O'Neill, D. (2010). *Deciding on driving cessation and transport planning in older drivers with dementia*. *European Geriatric Medicine*, Volume 1, Issue 1: 22-25.

Ostir, G. V.; Granger, C. V.; Black, T.; Roberts, P.; Burgos, L.; Martinkewiz, P.; Ottenbacher, K. J. (2006). *Preliminary Results for the PAR-PRO: A Measure of Home and Community Participation*. Arch Phys Med Rehabil 2006;87:1043-51

Rapport, L. J.; Hanks, R. A.; Coleman, B. R. (2006). *Barriers to Driving and Community Integration After Traumatic Brain Injury*. J Head Trauma Rehabil, Vol. 21, No. 1, pp. 34–44.

Risser, R.; Iwarsson, S.; Ståhl, A. (2011). *How do people with cognitive functional limitations post stroke manage the use of buses in local public transport?*

Transportation Research Part F

Robinson D, Griffith J, McComish K, Swasbrook K. (1984). *Bus training for developmentally disabled adults*. American Journal of Mental Deficiency, 1984, Vol. 89, No. 1, 37-43.

Rosenkvist, J.; Risser, R.; Iwarsson, S.; Ståhl, A. (2010). *Exploring Mobility in Public Environments among People with Cognitive Functional Limitations—Challenges and Implications for Planning*. Mobilities, Volume 5, Issue 1, pages 131-145 (2010).

Rosenkvist, J.; Risser, R.; Iwarsson, S.; Wendel, K.; Ståhl, A. (2009). *The Challenge of Using Public Transport: Descriptions by People with Cognitive Functional Limitations*. Journal of Transport and Land Use, Vol 2, No 1 (2009)

Rosenkvist, J. (2008). *Mobility in Public Environments and Use of Public Transport. Exploring the situation for people with acquired cognitive functional limitations*. Thesis for the degree of Licentiate of Faculty of Engineering, Department of Technology and Society, Lund University. 2008.

Slaug, B.; Schilling, O.; Iwarsson, S.; Carlsson, G. (2011). *Defining profiles of functional limitations in groups of older persons: How and why?* Journal of Aging and Health, 23, (3), 578-604.

Sohlberg, M. M.; Todis, B.; Fickas, S.; Hung, P.; Lemoncello, R. (2005). *A profile of community navigation in adults with chronic cognitive impairments*. Brain Injury, December 2005; 19(14): 1249–1259.

Sohlberg, M. K.; Fickas, S.; Lemoncello, R.; Hung, P. F. (2009). *Validation of the Activities of Community Transportation model for individuals with cognitive impairments*. Disability and Rehabilitation, 2009; 31(11): 887–897.

Sveen, U.; Bautz-Holter, E.; Sédring, K. M.; Bruun Wyller, T.; Laake, K. (1999). *Association between impairments, self-care ability and social activities 1 year after stroke*. Disability and Rehabilitation (1999) vol. 21, no. 8, 372 – 377.

Stephens, B. W.; McCarthy, D. P.; Marsiske, M.; Shechtman, O.; Classen, S.; Justiss, M.; Mann, W. C. (2005). *International Older Driver Consensus Conference on Assessment, Remediation and Counseling for Transportation Alternatives: Summary and Recommendations*. Phys Occup Ther Geriatr. 2005 Nov; 23(2-3): 103-121.

Stephens, S.; Kenny, R. A.; Rowan, E.; Kalaria, R. N.; Bradbury, M.; Pearce, R.; Wesnes, K.; Ballard, C. G. (2005). *Association between mild vascular cognitive impairment and impaired activities of daily living in older stroke survivors without dementia*. J Am Geriatr Soc. 2005 Jan; 53(1): 103-7.

Ståhl, A. (1997). *Elderly and functionally impaired persons' needs of public transport: problem inventory and present situation. (Aldre och funktionshindrades behov i kollektivtrafiken: probleminventering och nulaegesbeskrivning.)*. Bulletin 148. Lund: Lund University

Ståhl, A.; Carlsson, G.; Hovbrandt, P.; Iwarsson, S. (2008). *“Let’s go for a walk!”: identification and prioritisation of accessibility and safety measures involving elderly people in a residential area*. *European Journal of Ageing*, 5, (3), 265-273.

Steg, L.; Vlek, Ch. (2009). *Social science and environmental behaviour*. In: J.J. Boersema & L. Reijnders (Eds.), *Principles of environmental science*, pp. 97-141. Amsterdam/Boston: Kluwer Academic Publishers.

Taylor, B. D.; Tripodes, S. (2001). *The effects of driving cessation on the elderly with dementia and their caregivers*. *Accident Analysis and Prevention* 33 (2001) 519–528.

Waara, N. (2001). *The need of information in public transport. Elderly and disabled people`s pre-journey travel information requirements*. University of Lund, Department of Technology and Society.

Wahl, H. W.; Fänge, A.; Oswald, F.; Gitlin, L.N.; Iwarsson, S. (2009). *The Home Environment and Disability-related Outcomes in Ageing Individuals. What is the Empirical Evidence?* *The Gerontologist* (2009) 49 (3): 355-367.

Wendel, K.; Risberg, J.; Pessah-Rasmussen, H.; Ståhl, A.; Iwarsson, S. (2008). *Long-term cognitive functional limitations post stroke: objective assessment compared with self-evaluations and spouse reports*. *International Journal of Rehabilitation Research*, 31, (3), 231-239.

Wallergård, M.; Eriksson J.; Johansson, G. (2008). *A suggested Virtual Reality methodology allowing people with cognitive disabilities to communicate their knowledge and experiences of public transport systems*. *Technology and Disability*, Volume 20, Number 1/2008, 9-24.

Waara, N. (2001). The need of information in public transport. elderly and disabled persons pre-journey travel information requirements. licentiate thesis. Bulletin 206, Department of Technology and Society, Technical University, Lund, Sweden.

Waara, N.; Risser, R.; Ståhl, A. (2013). *Exploring the influence of online traveller information services on the use of public transport by older people and people with functional limitation: A mixed methods approach*. *Technology and Disability*, 25 (2013) 15–25.

Wendel, K.; Ståhl, A.; Risberg, J.; Pessah-Rasmussen, H.; Iwarsson, S. (2010). *Post-stroke functional limitations and changes in use of mode of transport*. *Scandinavian Journal of Occupational Therapy*. 2010; 17: 162-174.

Wilms, H. U.; Kanowski, S.; Baltes, M. M. (2000). *Limitations in Activities of Daily Living: Towards a Better Understanding of Subthreshold Mental Disorders in Old Age*. *Comprehensive Psychiatry*, Vol. 41, No. 2, Suppl. 1 (March/April), 2000: pp 19-25.

Windsor, T.; Anstey, K. (2006). *Interventions to reduce the adverse psychosocial impact of driving cessation on older adults*. *Clinical Interventions in Aging*, 1 (3), p.205-211, Sep 2006.

World Health Organization. (2001). *International Classification of Functioning, Disability and Health*. WHO Library Cataloguing-in-Publication Data. OECD Publishing. (2009). *Cognitive Impairment, Mental Health and Transport. Design with Everyone in Mind*. International Transport Forum. Published by : OECD Publishing.

Wretstrand, A.; Ståhl, A. (2008). *User needs and expectations relative to accessible transport. Framework for mobility planning*. For a European Accessibility of public

8 APPENDIX

8.1 Appendix A. Overview of included articles, aims, research designs, samples and measures.

Study	Aim	Research design	Sample	Measures	Data retrieved in (Country)	Journal
Agüero-Torres et al. 2002 (1)	Understand cognition	Quantitative, Non-experimental	345 healthy, 98 cognitively impaired, and 225 demented \geq 75 yrs	MME, Katz ADL index, ICD8	Sweden	J Clin Epidem
Blackman et al 2003 (2)	Review literature on in- and outdoor design	Review	People with dementia	N/A	N/A	Disabil Soc
Brown et al 2004 (3)	Develop the measure Participation Objective, Participation Subjective (POPS)	Quantitative, Non-experimental	454 community-living individuals with traumatic brain injury (TBI)	The POPS - instrument, Life 3, BDI, and BISQ	USA	J Head Trauma Rehabil
Campbell et al 1994 (4)	Investigate disability	Quantitative, Non- experimental	782 individuals \geq 70 years	IADL-scale by Lawton & Brody	New Zealand	Disabil Rehabil
Carmien et al, 2005 (5)	Present cognitive barriers in the transportation	Review	People with Cognitive impairments	N/A	USA	ACM Trans Comput Hum

	systems in U.S. cities					Interact
Crabtree, 2009 (6)	Explore disability and speculate on possible interventions	Review	Individuals with a disability	N/A	USA	Top Geriatr Rehabil
Doukas et al 2011 (7)	Technical overview of home assistive technologies	Review	Individuals with a disability	N/A	N/A	Telemat Inf
Farias et al 2003 (8)	Relationships between neuropsychological tests and functional status	Quantitative, Non-experimental	42 individuals with Alzheimer's disease.	DAFS, IADL- assessment	USA	Arch Clin Neuropsychol
Fickas et al, 2008 (9)	Evaluate electronic device prompts and effects on pedestrian route	Quantitative, Quasi -experimental	20 participants with severe cognitive impairments due to acquired brain injury	Different prompt modes	USA	Int J Hum Comput Stud.
Gladwell et al 2004 (10)	Caregiving and leisure travel behaviors	Qualitative	13 caregivers	In-depth interviews analyzed with Grounded theory	USA	Tourism Management
Hunter-Zaworski & Hron, 1999 (11)	Transportation possibilities, problems and	Mixed-methods, descriptive	9 people (4 trainers, 1 with BI and 4	Interview and survey	USA	Transport Res Rec

	training programs for people with cognitive impairment		coordinators)			
Konno et al 2004 (12)	Understand transition patterns, functional status, and active life expectancy	Quantitative, Non-experimental	638 senior citizens	Interview based on Katz ADL-scale	Japan	Arch Gerontol Geriatr
LaDuke et al 1984 (13)	Effectiveness of an transit intervention	Quantitative, Quasi-experimental	4 persons with mental retardation	Ratings of behavior	USA	Ment Retard Learn Disabil Bull
Lee, 2002 (14)	Functional disability and factors associated with functioning	Quantitative, Non-experimental	1105 older persons with functional disability	ADL and IADL questionnaire	Korea	Arch Gerontol Geriatr
Logan et al 2001 (15)	Transport in stroke patients and relationship to ADL and mood.	Quantitative, Non-experimental	Stroke patients (Records for 90 and survey of 50)	Records and survey of patients and records	UK	Brit J Occup Ther
Logan et al 2004a (16)	Explore attitudes and barriers to the use of transport	Qualitative	24 community-dwelling people with a stroke	In-depth interviews analyzed with constant comparative method.	UK	Clin Rehabil

Logan et al 2004b (17)	Evaluate occupational therapy intervention to improve outdoor mobility after stroke.	Quantitative, RCT	168 people with Stroke: 86 intervention group and 82 control group	Postal questionnaires, Nottingham EADL, Nottingham leisure questionnaire, and general health questionnaire	UK	BMJ
Mitchell et al 2003 (18)	Identify design that is dementia-friendly for internal environments.	Review	People with dementia	A literature review	N/A	Environ Plann B: Plann Des
Muo, et al 2005 (19)	Describe dementia-associated disability in Alzheimer's disease	Quantitative, Non-experimental	Twenty-six AD patients at different stages of disease participated.	MMSE, GDS	Italy	Disabil Rehabil
Newbigging & Laskey, 1995 (20)	Describe transport training in brain injury	Qualitative, single-case	One 28-year old man, 8 years post brain-injury	Direct observation	Canada	Brain inj
Ostir et al 2006 (21)	Develop measure of participation (PAR-PRO)for home and	Quantitative, Non-experimental	594 patients of mixed impairments, admitted for inpatient	Questionnaire (PAR-PRO)	USA	Arch Phys Med Rehabil

	community		rehabilitation			
Rapport et al 2006 (22)	Examine relations among driving status, perceptions of driving barriers and community integration	Quantitative, Non-experimental	51 survivors of TBI	Driving status post injury, Community Integration Measure, and Craig Hospital Assessment and Reporting Technique.	USA	J Head Trauma Rehabil
Robinson et al 1984 (23)	Effectiveness of classroom and community training of bus-riding skills	Quantitative, Quasi-experimental	34 develop-mentally disabled adults, 15-46 years old.	Observations	New Zealand	Am J Ment Defic
Rosenqvist et al, 2010 (24)	Reasons why people with cognitive impairments cease to use public transport.	Qualitative	9 participants with cognitive impairments	In-depth interviews analyzed with qualitative content analysis	Sweden	Mobilities
Rosenqvist et al, 2009 (25)	Explore mobility in public environments among people with	Qualitative	Professionals that work with people with cognitive impairments	Focus group methodology	Sweden	J Trans Land Use

	cognitive impairments					
Sohlberg et al 2005 (26)	Navigation patterns, barriers and solutions to community travel	Qualitative	Six males with severe ABI who all lived in a supported living facility	Focus group methodology, navigational surveys and interviews	USA	Brain inj
Sohlberg et al 2009 (27)	Develop a model and provide a framework for assessment and treatment of necessary travel skills	Qualitative	4 travel training agencies	Focus groups and observations	USA	Disabil Rehabil
Sveen et al 1999 (28)	Explore motor and cognitive impairments, PADL and social activities after stroke.	Quantitative, Non-experimental	65 patients with stroke	Södriing Motor Evaluation of Stroke patients, the Assessment of Stroke, Barthel ADL Index, and the Frenchay Activities Index (FAI)	Norway	Disabil Rehabil
Stephens, S et al	Determine relationship	Quantitative,	339 stroke survivors	Neuropsychological	UK	J Am Geriatr Soc

2005 (29)	between mild vascular cognitive impairment and disability in stroke survivors	Non-experimental	with no dementia, aged 75 and older, from stroke registers.	assessments, Bristol ADL scale		
Stephens, B et al 2005 (30)	To examine three critical issues related to the safe mobility of older drivers.	Descriptive	Older drivers	N/A	N/A	Phys Occup Ther Geriatr AND Community Mobility: Driving and Transport alternatives for older persons.
Taylor & Tripodes, 2001 (31)	Explore how driving loss affects households	Quantitative, Quasi-experimental	Caregivers of people with Alzheimer's disease or a related dementia were queried	Survey	USA	Accid Anal Prev
Wallergård et al, 2008 (32)	Virtual reality technology and people with cognitive disabilities	Qualitative	Seven people with stroke	Video observation and think aloud	Sweden	Technol Disabil
Wendel et al 2010 (33)	Different modes of transport and long-term changes among stroke	Quantitative, Non-experimental	79 persons with stroke	Cognistat screening instrument,	Sweden	Scand J Occup Ther

	survivors with cognitive impairment			Housing Enabler, questionnaire of CFLs, GDS, FYI		
Wilms et al (34)	Description of ADL and IADL in people with dementia and depression	Quantitative, Non-experimental	A representative sample of elderly subjects,	MMSE, Barthel Index	Germany	Compr Psychiatry

8.2 Appendix B. Overview of included journals, years of publication and countries of where the articles were published.

Publication	Year of Publication	Authors	Data retrieved in (Country)
Accident Analysis and Prevention	2001	Taylor & Tripodes	USA
ACM Transactions on Computer-Human Interaction	2005	Carmien et al	USA
American Journal of Mental Deficiency	1984	Robinson et al	New Zealand
Archives of Clinical Neuropsychology	2003	Farias et al	USA
Archives of Gerontology and Geriatrics	2002	Lee	Korea
	2004	Konno et al	Japan
Archives of Physical and Medical Rehabilitation	2006	Ostir et al	USA
British Medical Journal	2004	Logan et al	UK
Brain Injury	1995	Newbigging & Laskey	Canada
	2005	Sohlberg et al	USA
British Journal of Occupational Therapy	2001	Logan et al	UK
Clinical Rehabilitation	2004	Logan et al	UK
Comprehensive Psychiatry	2000	Wilms et al	Germany
Disability and Rehabilitation	2005	Muo, et al	Italy

	1994	Campbell et al	New Zealand
	2009	Sohlberg et al	USA
	1999	Sveen et al	Norway
Disability & Society	2003	Blackman et al	N/A
Environment and Planning B: Planning and Design	2003	Mitchell et al	N/A
International Journal of Human-Computer Studies	2008	Fickas et al	USA
Journal of the American Geriatrics Society	2005	Stephens, S et al	UK
Journal of Clinical Epidemiology	2002	Agüero-Torres et al	Sweden
Journal of Head Trauma Rehabilitation	2004	Brown et al	USA
	2006	Rapport et al	USA
Journal of Transport and Land Use	2009	Rosenqvist et al	Sweden
The Mental Retardation and Learning Disability Bulletin	1984	LaDuke et al	USA
Mobilities	2010	Rosenqvist et al	Sweden
Physical & Occupational Therapy in Geriatrics & Community Mobility	2005	Stephens et al	N/A
Scandinavian Journal of Occupational Therapy	2010	Wendel et al	Sweden
Technology & Disability	2008	Wallergård et al	Sweden

Telematics and Informatics	2011	Doukas et al	N/A
Topics in Geriatric Rehabilitation	2009	Crabtree	USA
Tourism Management	2004	Gladwell et al	USA
Transportation Research Record	1999	Hunter-Zaworski & Hron	USA