

TYPE OF INFRASTRUCTURES	REFERENCE	ORIGIN/CITY	TARGETED INDIVIDUALS	AIM / OBJECTIVES / HYPOTHESES	JUSTIFICATION	PARTICIPANTS	METHODOLOGY / SET UP	RESEARCH TOOLS	VARIABLES / INDICATORS STUDIED	ANALYSIS / INTERPRETATION	RESULTS	STARTED LIMITS	CONCLUSION (THE BEST INFRASTRUCTURE/PRACTICE)	QUALITY
Sidewalk, curb ramp, ramp, pedestrian crossing, lighting	Rosenberg, D.E., Huang, D.L., Simonovich, S.D., & Betts, E. (2012). Outdoor built environment barriers and facilitators to activity among middle and older adults with mobility disabilities. The Gerontologist, 53 (2): 268-279.	King County, Washington, United States	Elderly	Gain increased understanding of the barriers and facilitators to neighborhood-based physical activity for adults over 50 years old with mobility disabilities. The goal was to include anyone who used an assistive device to ambulate and was not condition or disease based.	Nearly 40% of adults over age 45 have difficulty with physical movement. People with disabilities are at risk to a variety of secondary health conditions that physical activity can prevent, including osteoporosis, decreased fitness, pain and fatigue, weight gain and obesity, decreased quality of life, increased functional impairment, and depression. Current physical activity guidelines (37.7%) compared with those without (46.4%). In addition, as adults with disabilities age, their physical activity levels decline at a greater rate than those without disabilities. An important barrier to performing neighborhood-based physical activity for persons with disabilities is access to built environments that support active designs. When the built environment was supportive, individuals can use the outdoors from multiple activities including exercise and utilitarian purposes and can better access exercise facilities.	n = 42 adults (phone line to indicate interest in the study). Inclusion criteria: 50+ years, use of an assistive device to ambulate, reside in the county, speak and read English, and having home 33 days per week. 7 were not eligible or did not accept to enroll. n total = 35 participants. Recruitment: e-newsletters MS Society, Arthritis Foundation, and senior center newsletters, and distributing flyers at community events, senior centers, and senior housing facilities.	Qualitative design: Participants were instructed to wear a GPS device for 3 days, including 2 weekdays and 1 weekend day. Interviews were selected to obtain detailed information about perceptions of the built environment.	In-depth interview (structured protocol): Open-ended questions (prompts to facilitate interview process): 2 researchers visited the participants in their homes to conduct a 2-h interview (1 interviewer and 1 noted verbatim answers 5-10 training). Protocol based on: residential density, access to useful destinations, street connectivity, facilities for walking (the sidewalk), aesthetics, traffic, and crime safety. The protocol was reviewed by 5 experts for face validity and was pilot tested with one older adult. 4 key portions of the interview centered on barriers and facilitators: a) accessing and using the locations visited while using the GPS device, b) use of motor physical activity locations in the neighborhood, c) use of outdoor physical activity locations in the neighborhood, d) accessing utilitarian locations in the neighborhood. If the participants were deemed not to be at risk for falling using a brief screening questionnaire, a brief tour of their outdoor immediate local area was made and they were prompted to provide their impressions of built environment features shown to relate to walking based on urban planning literature.	Interviews: Residential density, Access to useful destinations, Street connectivity, Facilities for walking, Aesthetics, Traffic, Crime safety, Barriers and facilitators	The typed, detailed interview notes were uploaded into Atlas.ti version 6. A list of list of outdoor built environment codes were created by a study team members using an inductive approach after thoroughly reviewing the interview content. Codes were developed based on latent content analysis of participants' perceptions of the outdoor built environment in the interview notes. The codes represented major theme groupings from participants' perceptions of the built environment (e.g. sidewalks, fast speed of car traffic at crossings, aesthetics, street crossings, lighting). The 2 codes independently coded all interview notes and compared results. Iterative procedures were performed to conduct team meetings where coding was discussed until consensus was achieved. Coding agreement was 100% after discrepancies were discussed.	Sidewalks: Presence of a grass strip to separate pedestrians from motorized traffic, surfaced/improved, flat/level, clutter-free, wide. Undesirable elements: Lack of sidewalk, inconsistent sidewalk surface quality and conditions (uneven surfaces due to trees and roots, sidewalks undulate due to ditches, potholes, cracks, debris), sidewalk obstructions (utility poles in the middle of sidewalks, sandwich boards blocking sidewalks, bicyclists on sidewalks, garbage cans, cars parked in driveway blocking sidewalk, overgrown), not wide enough, wet or icy sidewalks. Difficulty on circulation through cobblestones and brick surfaces and over uneven surfaces (for assistive mobility devices). Curb ramps: When there are no curbs, subjects need to walk or wheel along the street. They are sometimes just on one side of the street. Dangerous curb conditions: steep curb ramps, bumpy textures. Ramps: Need for handrails. Destinations with stairs are difficult to access and must be avoided, possible problems with ramps (location, slippery material, steepness and inconvenient to access). Stairs: Undesirable elements (presence of stairs, lack of handrails on stairs, no alternative entry to stairs, stairs with open risers). Street crossings: Clearly marked crosswalks, lots of places to cross, push buttons, flashing lights, crosswalks, adequate lighting (15 required visual impairments). Undesirable elements: ramps out of crosswalks, inadequate number of lights, lack of lighting in key places. Aesthetics: Attractive features such as secluded areas, views, nature, trees, greenery, flowers, community gardens, well-maintained spaces. Unattractive features: garbage, litter, smoking, graffiti. Parking: Lack of handicapped spaces, parking far from final destination, lack of driver awareness (poor visibility of pedestrians, need to cross parking lot to access destination), structural problems with parking lots (limited space between vehicles, no clear pedestrian route, speed bumps, slopes). Weather: Undesirable elements: snow, ice, cold, wind, rain, puddles, slippery pavement, heat, sun, slippery pavement, places to not becoming wet, problems with traction on hills, and metal grating embedded in sidewalks becoming slick. Average age: 67 years old, predominantly women and white, and lived in areas considered somewhat walkable. About 13.0 % of the participants reported no physical activity. The majority of the participants used more than one type of assistive device (54%), being canes, walkers, and wheelchairs the most common ones) and had multiple chronic conditions. Canes, walkers and wheelchairs were the most common assistive devices used by participants. Other types of assistive devices were roller-skis, shoes, a bicycle, a guide dog, and a specially adapted walker.	1) There are complex relationships between mobility, built environment, and health, which need to be better understood in this population and cannot be understood by examining only one form of mobility (e.g. driving or physically active transportation). 2) A limitation of this study is the lack of recording and transcribing the interviews, due to confidentiality issues related to the participants. As an alternative, a detailed note being approach was used. 3) The lack of recording responses may be more relevant for these times of year. 5) The interviews were conducted in one urban and suburban county in Washington. Findings may not apply to other regions within and outside the United States. 6) Only the neighborhood built environment was considered, not the social environment or the home environment (walkability). 7) Focus was brought on defining mobility disability as use of an assistive device; however, there are many ways to define mobility disability, including people's perception of whether they have difficulty with mobility which may be more relevant.	Some themes were mentioned by some participants as barriers, as others considered them facilitators. For example, the tunneled domes (raised bumps) covering curb ramps were noted to become slip in rain and dangerous, which impacted participant mobility. However, other found them not so; nothing from them as they approached an intersection. Such findings have implications for universal design in which certain built environment adaptations may be helpful for some and not others. Regardless of the features present, our sample was highly adaptive in figuring out ways to get to places they need to go.	54
Street design, sidewalk, curb ramp, ramp, pedestrian crossing, bus stop, step	Newton, R., Ormerod, M., Burton, E., Mitchell, L., & Ward-Thompson, C. (2010). Increasing independence for older people through good street design. Journal of Integrated Care, 18 (3): 24-29.	United Kingdom	Mobility Impaired and elderly	Report the preferences of older people for design aspects of street environments. It builds on previous work by the authors, who provide further guidance on external environments for older people.	Although older people want to lead active, independent and secure lives, there is a risk that an older person will become isolated and dependent as they become more frail because of the everyday barriers in the external environment. While designs for disabled people will have some positive impact on the experience of older people in accessing and using their local neighbourhood, a more rigorous evidence base is needed to support implementation of design decisions to a variety of design.	n = 200 adults of 65 years old. They were selected on the basis of geographical settlement, housing ownership, deprivation and social arrangement. Most participants had lived in their neighborhood for at least five years. Walking was their main form of transport. 51% had mobility vision and hearing difficulties to the extent that daily activities were limited. 35% used some form of mobility aid, and 20% had stumbled or fallen outside within 6 months of the date of interview.	Qualitative design: In-depth interviews were performed.	Questionnaire: used as the basis for the interview and was supported by environmentally contextualized photographs of various street features. These photographs enabled participants to engage in in-depth dialogue.	Compilation of the answers to the questionnaire.	Footways Pedestrian and traffic segregation Kerbs at road crossing points Changes in level (ramp and step design) Pedestrian crossings Navigation Bus stop Seating Wayfinding (street signage)	Well-maintained, firm, flat and wide footways. Tarmac was the preferred material for walking on. Avoiding shared path with cyclists to ensure a feeling of security. What made the participants feel less safe were narrow footways and a shared path with cyclists. Plain dropped kerbs without tactile paving on it was the preferred type. Normal upstand kerbs are sometimes obstacles for scooter users. Dropped kerbs are useful for scooter users and individuals with balance issues. Kerbs with tactile paving on it are useful for visually impaired individuals, but can be uncomfortable to walk or to run over. Participants preferred to have the choice of whether to use a ramp on inclines or a short flight of steps, with easy to reach handrails on both sides. Color contrast on the edge of steps. Controlled crossing which forces the traffic to stop (pelican crossing), provision of both a visual and audible signal to cross and a short crossing distance. Zebra crossings were acceptable on roads with low volumes of traffic. If islands are installed, they must provide enough space for scooters that stop step midway. Obstacles on the street are a hazard for older people because they have to walk around them, and can easily fall over them. Parking on pavements is a problem (walk on the road to pass parked cars). A bus stop with accompanying open shelter (does not obstruct the way for scooters, gives a clear view) or enclosed shelter (best protection against weather, but difficult to get inside) and seat. Avoiding elements that become obstacles. Seating features that are frequent, warm, supportive, well-maintained are preferred. Participants referred to the limited number of rest points between homes and their local facilities, and described using informal rest points such as garden walls, seating in a shop or event concrete litter bins. The most preferred material was wood because it is warm. Arm supports are important for transfers. Higher seats (18 inches) are preferable for individuals who cannot bend much (knee and hip replacements). Seat maintenance was also stated as important, as well as padding. Simple, easily visible and understandable signage. "Good" signs were street name signs placed on both sides of the road, and direction signs with pointers, particularly in areas of unfamiliarity. "You are here" maps and information boards were not used. The main criticisms were that the signs did not have enough information on them, the text size is often small, so they are difficult to read, and it is confusing to have a combination of symbols and text.	More research is now needed to assess the relative importance of the design attributes of the street so that an assessment can be made of the design priorities and costs for both the provider and the user.	32	
Street design, sidewalk	Lavery, I., Davey, S., Woodside, A., & Ewart, K. (1996). The vital role of street design and management in reducing barriers to older people's mobility. Landscape and Urban Planning, 35, 181-192.	Jordanstown, Northern Ireland	Older people and mobility-impaired people (bipartially sighted people, people who have hearing problems, people who have difficulty walking and bending limbs, people who have medical problems affecting balance and stamina)	Highlight the awareness of professionals working in different disciplines of the vital importance of street design in reducing built environment barriers to travel.	A street can have an unfriendly environment for a wide range of mobility-impaired people, many of whom are elderly. Within few decades retired people will comprise 25% of the population of the United Kingdom, many of whom will have considerable spending power. Thus, both from the social 'quality of life' perspective and the economic perspective, public transport services and local and city centre streets will increasingly be required to be 'retired people friendly' to ensure that older people will be able to maximize their mobility and their access to shops and other opportunities. In general the populations of developed countries are getting older owing to lower fertility and longer life expectancy. At the present time over 60 million EU residents are over 60 years of age and the proportion of elderly people in the population will increase from 16.4 million approximately 100 million people are aged over 50. There would appear to be at least a major barrier in addressing the problem of built environment barriers the scale of the problem in mobility terms, the complexity of design systems and changes in cross-falls and longitudinal falls, and design and retro-fitting terms, the interdisciplinary nature of the problem.	Not presented. Presentation of other studies and official documents	Category "General Information"	Barriers to transportation Barriers to good access Surfacing: general Surfacing: skid resistance Surfacing: end-use location Surfacing: water saturation Surfacing: frost action Surfacing: rideability	The three greatest barriers to bus travel are getting to the bus stop, waiting at the bus stop, and getting on and off the bus. No designated parking spaces, lack of dropped kerbs, dropped kerbs with no adjacent tactile warning surfaces, entrance steps and internal steps and stairs, narrow doorways, slippery surfaces, steps or stairs with too shallow, poorly designed or no handrails, poor sight lines, poor lighting or poor colour contrast, badly located/designated and furnished/paved, controls that are too high, controlled road crossings giving no audible or tactile signals. Car parking at bus stops, lack of bus shelters and seating, crossing difficulties (i.e. busy roads, light-controlled pedestrian crossings (insufficient crossing time), crossing in dangerous locations, poor access across busy roads to pedestrian areas, obstructions in pedestrian areas/high streets, such as shop displays, parked cars, pavements poorly designed and maintained. Research by staff at the University of Wales (Tranter et al., 1991) indicates that four out of the six most prevalent built environment barriers are to do with surfacing. Uneven pavements, kerbs that don't drop smoothly, hills, cross-falls and longitudinal falls, broken pavements, broken pavements. If a continuous unpaved concrete pavement is used the skid resistance value provides an adequate indication of the slipability. Testing indicated that layout pattern had a greater influence when assessed in a wet state, and secondly, it showed that the reduction in skid-resistance between wet and dry relates to the block layout. Research showed that a 60° herring bone pattern provided the best skid-resistance value. As each paver is in contact with others, greater structural stability is also obtained. Pavers which had a high resistance to abrasion were preferred for use in areas of skid-resistance whilst some dry product finishes the 'high heel' test, which could be of importance to people using walking sticks. This ensures that the brick choice will have the ability to withstand the in situ conditions experienced, for example, a covered pedestrianized area compared with a busy high street situation. Durability will be influenced by resistance to fuel and the 'high heel' test, whereas the abrasion test will be influenced by saturation by water, freeze/thaw, de-icing salts and the abrasive action of traffic all need to be considered. Saturation can be minimized by designing to ensure maximum run-off following rain or by preventing situations where water is left ponded either on the surface or in the subsoil. This requires correct drainage systems and channels, cross-falls and longitudinal falls, and selection of a suitable bedding medium for the pavers. A 6% increase in volume when water at 0°C is converted to ice at the same temperature. Provide accessible spaces within the paver pore structure for expansion to take place. Contrary to popular opinion, it is not extremes of temperature or wet/dry weather which leads to frost failure, but rather repetitive freeze/thaw of saturated pavers causing fretting and spalling of the paver surface. A characteristic only applicable to those in wheelchairs or pushchairs and perambulators. Passengers in the latter case find difficulty in expressing their opinions so it was considered prudent to use a wheelchair with weights substituting as a passenger as a means of assessing the 'bumpiness' or roughness of the ride. By the use of accelerometers it has been possible to measure the movement of the human body while travelling in a wheelchair. The jarring effect which is caused by the intersection of the tyre and the irregular surface finish is another physical feature which may be measured and is directly related to the constructional methods, dimension of the blocks and strength of subbase support.	Research has shown that concrete pavers laid out in a 90 degree herring bone pattern provide the superior surface when evaluated by means of their mechanical and skid-resistance characteristics. However, aesthetically, many might prefer the appearance of the clay product, but the designer should consider the end-user and provide the most acceptable surface for the least able user - a mobility-impaired person.	15			
Street design, sidewalk	Li, Y., Han, J., A., & Ferris, G. (2013). Aging and the use of pedestrian facilities in winter: the need for improved design and better technology. Journal of Urban Health, 90(4), 602-617.	Toronto, Ontario, Canada	Elderly	Identify built environment and natural features that cause the most problems for accessibility in winter conditions not only by intersections but also at other pedestrian facilities. The purpose of this study was to develop a questionnaire to gather information about different age groups, explore winter-related accessibility issues, assess the impact of adverse weather, assess the performance of pedestrian facilities, and identify barriers and features that need to be improved and enhanced as high priority needs.	The study of the effect of weather on pedestrian accessibility is limited and sometimes neglected. Several studies indicate that most outdoor falls occur on sidewalks, curbs, and streets, and the largest proportion of falls take place during the winter months. Ice surfaces are one of the most cited factors that lead to falls. Few studies have been done to investigate pedestrian perception of how the winter weather changes a normally accessible route to an inaccessible one. Several studies among adults report that poor weather is perceived as a barrier to physical activity and that daily physical levels decrease. The impact of adverse weather, assess the performance of pedestrian facilities, and identify barriers and features that need to be improved and enhanced as high priority needs.	n= 183 (69 from the TRS site, 96 from Spacing Toronto, 18 from community centers). The sample was a convenience sample and participants from diverse geographical and socio-economic contexts were recruited using a hybrid sampling method: (1) a survey invitation was sent to all employees of the Toronto Rehabilitation Institute (TRI); (2) an invitation letter was posted on an online daily news stop called Spacing Toronto; (3) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (4) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (5) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (6) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (7) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (8) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (9) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (10) an invitation flyer was posted on a weekly news stop called Spacing Toronto; (11) an invitation flyer was posted on a weekly news stop called Spacing Toronto; 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TYPE OF INFRASTRUCTURES	REFERENCE	ORIGIN/CITY	TARGETED INDIVIDUALS	AIM / OBJECTIVES / HYPOTHESES	JUSTIFICATION	PARTICIPANTS	METHODOLOGY / SET UP	RESEARCH TOOLS	VARIABLES / INDICATORS STUDIED	ANALYSIS / INTERPRETATION	RESULTS	STATED LIMITS	CONCLUSION (THE BEST INFRASTRUCTURE/PRACTICE)	QUALITY
Sidewalk design, pedestrian crossing	Walker, J.M., Horton, S.A., Wright, J.M., Chan, S.W., & Conway, J.R. (1987). Walking velocities of older pedestrians at controlled crossings. <i>Topics in Geriatric Rehabilitation</i> 3(1), 65-70.	Los Angeles, California, United States	Elderly	Determine whether older persons walked faster or slower than the Los Angeles city standard velocity across controlled crosswalks at various locations. Los Angeles sets its traffic signals such that pedestrians, when crossing controlled intersections using both the "Walk" and "Don't walk" signals, must be capable of reaching a walking speed of 73.2 m/min. To determine whether differences existed in the crosswalk velocities of older men versus older women and whether differences existed in walking speeds during the "Walk" signal versus walking speed during the "Don't walk" signal. The ability of older persons to exceed the speed they achieved within the crosswalk was also investigated.	If older persons are to be independent in their local environment, they must be able to access needed goods and services in their community. In urban environments, this often necessitates use of traffic-signal-controlled crosswalks. For their own safety, these older persons must be able to walk with sufficient speed to cross streets within the set time limits of "Walk" and "Don't walk" signals. Inability to safely use crosswalks in their community may decrease the independence of older persons and impose greater stress. Older men and women walk slower than their younger counterparts, and older men walk faster than older women. Geographic location influences pedestrian walking velocities.	Group 1: n=100 (40 men, 60 women) covertly observed at 4 sites (25 at each) pedestrians. They were selected using subjective criteria such as skin pigmentation, wrinkles, and posture, to estimate age as 60 years or older.	4 sites frequented by a high percentage (19% to 40%) of older persons were used. The 1st site was a commercial area, the 2nd was a shopping area, the 3rd a downtown business area, and the 4th a transitional area (from residential to commercial). All sites were two-way intersections, had ordinary curbs (0.17 to 0.23 m high), ramped curbs, and bus stops. Mean curb-to-curb distance was 22.5 m at the first 3 sites and 28.6 m at the transitional site. Each of the first 3 sites had one uncontrolled left-turn lane; the transitional site had 2. The pretimed signal automatically changed regardless of pedestrian or traffic flow at the first three sites (Walk=12 s, Don't walk=18 s). At the transitional site, the onset of the 8-s "Walk" signal was determined either by traffic or pedestrians; however, the length of the "Don't walk" signal (< 22 s) could only be extended by traffic flow.	Observation. Curb-to-curb distance and distance covered during the "Walk" and "Don't walk" signal measured with a rolling tape measure and "Walk" and "Don't walk" signals. Signal were timed (including until the back foot was out of the crosswalk).	Type of zone	Length of each interval and distance traveled within that interval were used to calculate the velocity during the "Walk" interval and the "Don't walk" interval. The Wilcoxon Signed Rank Test was used to compare within site velocities with the city standard. Between-site variability and velocities of men and women were examined with independent t tests. Chi square contingency analyses were used to examine the relationship between pedestrian characteristics and velocity. An alpha level of 0.05 was used with the Bonferroni adjustment.	Pedestrians in group 1 showed differences in mean velocities (p<0.02) at the 4 sites, those at the transitional site walked the fastest (80.28 ± 13.35 m/min) and those at the downtown business site walked the slowest (61.18 ± 11.67 m/min). Only at the shopping and downtown business sites were velocities similar. Pedestrians in group 2 displayed no significant difference between mean velocities recorded at the small commercial and shopping sites. All but one subgroup of pedestrians (group 2 at the shopping site) walked more slowly during the "Don't walk" signal than during the "Walk" signal. In group 2, the younger subgroup (60-69 years, n=20) tended to walk faster within the crosswalk than the older subgroup (70 years, n=21) (76.5 and 72 m/min, respectively; p=0.05). The younger subgroup, however, walked on the average 13.4 m/min faster in the sidewalk test (compared within the crosswalk test) than did the older subgroup. Pedestrians displayed considerable variability in their cross walk speeds. The mean velocity in group 1 was 6.9 m/min slower at the shopping site than the Los Angeles city standard, whereas at the transitional site the mean velocity was 7 m/min faster.	Differences observed may be related to pedestrian density, destination, or traffic volume. These factors were not examined.	Pedestrian mean velocities varied most between the downtown business site and the transitional site.	
						Group 2: n=50 (25 men, 25 women) observed at 2 of the same sites (small commercial and shopping) selected for Group 1. They selected on the same basis. They were asked their age (in decades) after they had crossed the sidewalk.	Measurements were made between 11AM and 3PM on fair weather days. Curb-to-curb distance was measured with a rolling tape measure, and yellow cloth markers, every fifth sequentially numbered, were placed on the curb crosswalk line. When the "Walk" signal appeared, each subject was timed until the back foot was out of the crosswalk. An investigator followed the subject across the intersection and noted the distance covered during the "Walk" and "Don't walk" signals; these intervals were also timed.		Speed (walking velocity)					
						Only those persons in both groups who came to a complete stop before entering the crosswalk were included.	Observation 2 (with Group 2). The slower mean velocity at the shopping site and the finding that a number of pedestrians walked slower than the city standard at all sites led to the examination of the ability of older pedestrians to walk faster than that observed covertly within the crosswalks. An 18-m distance was marked on the sidewalks within 16 m of each of 2 crosswalks. Pedestrians were asked to walk as fast as possible without running, with any object they carried or used in the crosswalk.		Time needed to cross					
											While 22 members of group 2 crossed the crosswalk at a slower speed than that required by the city standard, 19 of the 22 crossed within the allotted time of the signals. From onset of the green light to onset of the red light, 3 pedestrians who did not cross in the allotted time (velocities range: 41.40 to 56.18 m/min compared with group mean of 74.6 m/min) required an additional 1.37 to 7 s to cross the intersection. Although 2 of these 3 pedestrians were able to increase their velocity in the sidewalk test, only one was able to achieve a velocity slightly greater than the city standard during the sidewalk test (73.87 m/min).			