Environmental Demands Associated With Community Mobility in Older Adults With and Without Mobility Disabilities

Background and Purpose. In this study, the influence of 8 dimensions of the physical environment on mobility in older adults with and without mobility disability was measured. This was done in order to identify environmental factors that contribute to mobility disability. **Subjects.** Subjects were 36 older adults (≥70 years of age) who were recruited from 2 geographic sites (Seattle, Wash, and Waterloo, Ontario, Canada) and were grouped according to level of mobility function (physically able [ability to walk ½ mile (0.8 km) or climb stairs without assistance], physically disabled). **Methods.** Subjects were observed and videotaped during 3 trips into the community (trip to grocery store, physician visit, recreational trip). Frequency of encounters with environmental features within each of the 8 dimensions was recorded. Differences in baseline characteristics and environmental encounters were analyzed using an analysis of variance or the Fisher exact test, as appropriate. **Results.** Mobility disability among older adults was not associated with a uniform decrease in encounters with environmental challenges across all dimensions. Environmental dimensions that differed between subjects who were physically able and those with physical disability included temporal factors, physical load, terrain, and postural transition. Dimensions that were not different included distance, density, ambient conditions (eg, light levels and weather conditions), and attentional demands. **Discussion and Conclusion.** Understanding the relationship of the environment to mobility is crucial to both prevention and rehabilitation of mobility disability in older adults. Among older adults, certain dimensions of the environment may disable community mobility more than others. [Shumway-Cook A, Patla AE, Stewart A, et al. Environmental demands associated with community mobility in older adults with and without mobility disabilities. *Phys Ther.* 2002;82:670–681.]

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The ability to walk safely and independently, referred to as "mobility," is a fundamental part of both basic activities of daily living (BADL) and instrumental activities of daily living (IADL).[1] One definition of *impaired mobility* is the inability to walk a specified distance, such as 0.8 km (½ mile), and or climb stairs without assistance.[2–4] Among older adults, one of the functional consequences of chronic disease is a limitation in mobility that can lead to dependence in activities of daily living (ADL).[2] In adults over the age of 65 years, the prevalence of impaired mobility is 7.7%, and the prevalence of impaired mobility rises to 35% in adults over the age of 80 years.[5] Risk for dependency in ADL is 5 times greater in older men (>65 years of age) and 3 times greater in women with impaired mobility than in those without impaired mobility.[6] The prevalence of impaired mobility suggests that among older adults, preserving mobility is a critical part of maintaining function and preventing further disability.

Understanding factors leading to disability is critical to developing interventions aimed at preventing or postponing disability in older adults.[2] New models of disability recognize that disablement is a dynamic process, subject to change, and influenced by both intrinsic factors within the individual and extrinsic factors such as physical and social features within the environment. When the individual cannot meet the demands of the environment, independence is compromised and disability results.[7,8] Thus, among older adults, an inability to manage environmental demands on mobility can lead to disability in the mobility domain. This has been referred to as "mobility disability."[1]

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Although new models of disablement emphasize the role of the environment as a determinant of disability, the factors within the physical environment that constrain mobility and result in disability in older adults are not known. Lerner-Frankiel and colleagues,[9] in order to identify the requirements associated with community ambulation, examined the mobility requirements associated with a range of IADL tasks in the Los Angeles, Calif, area. Their requirements included the ability to walk 332 m continuously, negotiate a 17.8- to 20.3-cm (7- to 8-in) curb, climb 3 steps and a ramp without a handrail, and walk 70 m/min in order to cross a street in the time allotted by a traffic light. Cohen et al[10] examined community ambulation in older adults with and without physical limitations and reported the following physical requirements: the ability to walk a minimum of 360 m, manage stairs and curbs, and walk 73 m/min (the speed required to cross a street controlled with a traffic light). They reported that only 8 of 15 older adults without physical limitations and 1 of 15 older adults with mobility impairments were able to walk at this speed. In both of these studies, the researchers examined requirements associated with community ambulation in minimum distance walked, gait speed required to cross a street, and the ability to negotiate terrain characteristics such as ramps, curbs, and stairs.

Patla and Shumway-Cook[1] have suggested that the physical requirements associated with community mobility are complex and should not be limited to the variables of distance, speed, and terrain. They presented a conceptual model in which attributes of the physical environment are grouped into 8 categories, referred to as "dimensions." Dimensions include distance, time, ambient conditions (eg, light level, weather conditions), terrain characteristics, physical load, attentional demands, postural transitions, and traffic level. These dimensions represent the external demands that have to be met for an individual to be mobile within a particular environment. These dimensions are described in more detail in Figure 1. We consider these environmental dimensions as critical determinants of mobility disability in older adults because disability, in our view, is inversely related to the ability to deal effectively with these dimensions.

In our study, we examined environmental challenges encountered by older adults without mobility impairments while walking in the community in order to identify the physical requirements associated with community mobility. In addition, we examined community mobility in older adults with physical disabilities in order to identify characteristics of the environment that limit community mobility. Based on unpublished pilot data, we hypothesized that the extent of mobility disability would not be associated with a uniform decrease in abilities in all 8 dimensions, but rather certain dimensions would be more critical in contributing to disability than others.

Methods

Subjects

The subjects were 36 older adults who were living independently within the community. Subjects included 19 older adults who were physically able and without mobility disability (we defined the absence of disability as the ability to walk 0.8 km and climb stairs without assistance) and 17 older adults with mobility disability (ie, they required assistance to walk 0.8 km or climb stairs). Twenty subjects were recruited from Seattle, Wash, and 16 subjects were recruited from Waterloo, Ontario, Canada. Inclusion criteria were: age ≥70 years, community dwelling (living at home or in an independent living retirement center), and regularly making ≥3 trips a week into the community alone or accompanied. Exclusion criteria were: presence of a diagnosed neurological condition such as stroke or Parkinson disease, severe visual impairment requiring assistance to move through the environment, inability to understand experimental procedures, and inability to give informed consent.

Health Status Measures

After obtaining informed consent, subjects completed a self-report health status questionnaire that sought information on age, residential status, marital status, medical history, coexisting medical conditions, any history of imbalance problems, types of assistive device used for ambulation, and number and type of prescription medications being taken. Questions from the Disability Supplement to the National Health Interview Survey were used to determine level of difficulty in 7 BADL tasks (ie, walking inside, bathing, dressing, eating, transferring, toileting, and walking outside) and 8 IADL tasks (ie, meal preparation, shopping, money management, telephone use, light housework, heavy housework, transportation, and medication management). Subjects reported the amount of difficulty experienced when performing ADL tasks. For each item, scores were 0 ("no difficulty"), 1 ("some difficulty"), 2 ("a lot of difficulty"), and 3 ("unable to do"). Total scores ranged from 0 ("no difficulty on any item") to 21 ("unable to perform any item") on the BADL scale and from 0 ("no difficulty on any item") to 24 ("unable to perform any item") on the IADL scale.[11]

Performance Measures

Mobility was evaluated by asking subjects to walk for 3 minutes at their preferred speed over a 91.4-m (300-ft) indoor course that contained 4 turns. Distance walked was measured, and speed for self-paced gait was deter-

1. Distance: mean distance walked (in feet) as measured by a survey wheel
2. Temporal Factors: percentage of trips in which stoplights and busy streets were encountered, percentage of trips in which subjects were able to maintain the same speed as those around them
3. Ambient Conditions: percentage of trips made when it was raining, average temperature; average outside light levels as measured by a lux meter
4. Physical Load: average number and weight of packages carried, percentage of trips in which manual doors were encountered
5. Terrain: percentage of trips in which subjects encountered stairs, curbs, slopes, uneven surfaces, elevators, escalators, grass, and obstacles
6. Attentional Demands: percentage of unaccompanied trips (travel alone), percentage of trips in which distractions in the environment were present
7. Postural Transitions: the average number of times subjects stopped, backed up, turned their head, reached above shoulder height, reached beyond the length of their arm, reached below knee height, or changed directions during a 10-minute period, sampled randomly within a trip
8. Traffic Density: the average number of people within arms range, the percentage of trips in which unexpected collisions or near collisions occurred between a subject and another person.

Figure 1.
Methods used to measure physical features within the 8 environmental dimensions.

mined. Balance was evaluated using the Berg Balance Test.[12] Performance using that test is scored from 0 ("cannot perform") to 4 ("normal performance") on 14 different tasks, including ability to sit, stand, reach, lean over, turn in a complete circle, and step. The total possible score on the Berg Balance Scale is 56, indicating excellent balance. The Berg Balance Scale has been shown to have excellent interrater and test retest reliability (intraclass correlation coefficient=.98) and good internal consistency (Cronbach alpha=.96).[12] It had been shown to be correlated with other tests of balance and mobility, including the Tinetti Mobility Index ($r=-.91$) and the Get Up & Go Test ($r=-76$).[13] Lower-extremity performance was evaluated with the Short Physical Performance Battery (SPPB).[14] Time to complete the following items was recorded: repeated chair stand, 2.4-m (8-ft) walk test, and up to 3 hierarchical balance tests (side-by-side stance, modified tandem stance, or tandem stance). Time measurements were then converted to ordinal-scale values, with a range of 0 (lowest performance) to 12 (highest performance). Test-retest reliability of data obtained with the SPPB is good, with intraclass correlation coefficients for measurements taken 1 week apart ranging from .88 to .92.[15] The SPPB has been shown to be a strong predictor of decline in physical function in older adults.[16,17]

Community Mobility Measures

Activity/trip log. Once a week for 3 weeks, an in-person administered questionnaire, which was completed in the subject's home, was used to collect information on the number of trips taken into the community and about other activities done during these trips for the previous 3 days. Subjects were asked to list all trips taken off their property during the 3 days previous to the interview. In addition, subjects were asked to report all activities done while on each trip. Activities included things such as grocery shopping, going to a drugstore, visiting a friend, going to a restaurant, walking a dog, or visiting a heath care professional. Information on transportation into the community also was gathered. The average number of trips made outside the home over the 9-day period was summarized for each individual. In addition, the total number of days in which 0, 1, or 2 trips per day also was determined (no subjects reported more than 2 trips off their property in a single day). The average number of activities per trip was calculated, and an activity-to-trip ratio was determined for each subject and for both groups.

Field observations. Subjects were observed and videotaped during 3 trips into the community that required ambulation, including going to a grocery store, a visit to a health care practitioner, and one trip for recreational purposes (eg, visiting a family member, going for a walk). Data we collected during an unpublished pilot study indicated that trips for those subjects were trips that occurred most frequently. In order to determine seasonal variations in environmental demands, the older adults were observed and videotaped taking these trips in the summer and in the winter. The data collected during the summer are presented in this article. For each field observation, a research assistant met the subject at the subject's home. The subject was followed and videotaped during all portions of the trip in which walking took place. For the grocery shopping trip only, subjects also were videotaped while shopping within the store.

The frequency of encounters with environmental challenges to community ambulation in 8 different dimensions was recorded during field trips. Measurements were obtained using of a survey wheel to measure the distance walked, a lux meter to measure light levels outside and inside, a thermometer to measure ambient temperature, and a scale to measure weight of packages carried (including women's purses, backpacks, and assistive gait devices). The postural transition dimension was scored from the videotapes. Otherwise, videotapes were used just to verify scoring done by the research assistant in the field. Figure 1 summarizes the methods used to measure physical features within the 8 environmental dimensions.

Procedures

Research assistant training. Two research assistants, one physical therapist and one exercise physiologist, participated in this study. In order to ensure consistency of scoring between the 2 research assistants, both research assistants were trained by the principal investigator (ASC). Research assistants were trained to administer the Health Questionnaire and to administer other tests (Berg Balance Test, SPPB, and Three-Minute Walk Test). They also were trained to score the Direct Observation of Mobility Analysis form used during field observations. Each research assistant practiced scoring by use of 3 videotaped examples developed for this training purpose. Following training, the research assistants tested and scored one "training" subject (an older adult) at their site. Scores also were obtained independently by the principal investigator. For all categorical measures (Berg Balance Test and SPPB), there was complete agreement between the research assistants and the principal investigator. For items that relied on devices or tests (eg, survey wheel for distance, lux meter for light, thermometer for temperature, distance walked on the Three-Minute Walk Test) or for which no judgments were required for scoring (eg, presence of a curb, traffic light, busy street, obstacles, reaching above shoulder or below the knee), there was 100% agreement. There were 4 items (ie, uneven surface, head turns, people within an arm's distance, and distractions) for which it was difficult to define criteria for scoring. For each of these items, raters' reports varied by no more than 1 or 2 encounters. For example, the number of times in which the subject encountered an uneven surface was reported as 2 by one rater and as 3 by the other rater; the number of times the subject's head turned was reported as 7 by one rater and as 9 by the other rater.

Subject recruitment. Subjects at each site were recruited from among volunteers who responded to advertisements placed in local newspapers and to notices sent to area senior citizen centers. A telephone interview was used to screen potential candidates based on the volunteer's health and mobility status. For the first data collection session, subjects came to the testing facilities for in-person interviews and testing. Informed consent was obtained at that time. Subjects completed the first of 3 trip/activity logs. Three field trips (one per week) were then scheduled.

For each field trip, subjects were met at their home by the research assistant. They completed a trip/activity questionnaire with the research assistant prior to going on the trip. Following completion of the trip/activity questionnaire, subjects were observed and videotaped while completing their trip into the community. Environmental challenges encountered during these trips were recorded on a form that allowed environmental impediments to ambulation to be recorded according to any of the 8 dimensions. Videotapes were reviewed within 48 hours to score the postural transitions dimension and to verify the research assistants' observations relative to the other dimensions. The research assistant walked far enough behind the subject to visualize the entire subject in the field of view. Subjects were videotaped by the research assistant leaving their home and walking to their means of transportation (ie, car or bus). Subjects were met again at the location of the scheduled activity and were videotaped while exiting their car (or bus). Subjects were then videotaped while walking to the location of their destination. For example, subjects were videotaped walking from their car into the waiting area of their physician's office. Subjects were then videotaped leaving the activity, and when they returned home, while entering their home. For the grocery shopping trips only, subjects were videotaped for the entire duration of the shopping trip (both inside and outside the store). During most trips, a volunteer accompanied the research assistant and used the survey wheel to measure distances walked by the subject.

Following each observed trip, the subjects were asked to report the degree of difficulty associated with the trip, their level fatigue at the end of the trip, and the degree of satisfaction they felt at the conclusion of the trip using a 5-point ordinal scale (1="not at all tired," 5="extremely tired, I was exhausted").

Data Analysis

Descriptive statistics were used to summarize demographic and health status data in the 2 groups (subjects who were physically able and subjects who were physically disabled). Differences in initial characteristics and data on encounters with environmental features were analyzed using an analysis of variance or the Fisher exact test, as appropriate, to assess the statistical difference between the 2 groups. In this study, a probability value of less than .05 was considered as statistically significant.

In Table 1, comparisons of data for the 2 groups of participants are shown. Also shown are the results from the statistical analysis, including probability values and group differences. Compared with the older adults without mobility problems, the older adults with mobility disabilities were older, had more comorbidities, were more disabled in both BADL and IADL tasks, and did not perform as well on physical performance measures (ie, Berg Balance Test, gait speed, and SPPB).

Table 1.
Comparison of Two Groups of Participants[a]

Factors	Subjects Without Disabilities (n=19)	Subjects With Disabilities (n=17)	*P*
	Demographics		
Age (y)			<.001
$\bar{X}$	77.7	83.2	
SD	4.7	5.7	
Range	70–86	70–92	
Sex (% female)	58	65	.3
Percentage living alone	63	65	.3
	Health Measures		
No. of comorbidities			.001
$\bar{X}$	2.5	3.9	
SD	1.7	1.9	
Range	0–6	1–7	
No. of prescription drugs used			
$\bar{X}$	2.3	3.2	0.3
SD	1.8	2.7	
Range	0–6	0–10	
IADL (0–24)			<.00
$\bar{X}$	0.32	5.5	1
SD	0.7	4.0	
Range	0–3	0–12	
BADL (0–21)			<.001
$\bar{X}$	0.4	5.7	
SD	0.8	3.9	
Range	0–3	0–12	
	Performance Measures		
SPPB score			<.001
$\bar{X}$	10.1	5.3	
SD	1.1	1.4	
Range (0–12)	8–12	3–7	
Berg Balance Test score (0–56)			<.001
$\bar{X}$	54	41	
SD	3	8	
Range	46–56	30–52	
Gait speed (m/s)			<.001
$\bar{X}$	1.24	0.74	
SD	0.3	0.2	

[a] IADL=instrumental activities of daily living, BADL=basic activities of daily living, SPPB=Short Physical Performance Battery.

Results

Differences in Trip/Activity Behavior

The mobility of the older adults with mobility problems was characterized by their taking fewer trips and performing fewer activities than the older adults without mobility deficits. In Figure 2, there is a comparison of trip and activity data from the 2 groups for the 9-day reporting period. The average number of trips was 13.2 for the subjects without disabilities compared with 6.4 for those with ambulation problems. A major difference between the 2 groups was the number of zero trip days. The subjects with ambulation problems had an average of 3.8 zero trip days over the 9-day reporting period; in contrast, the subjects without disabilities averaged 1.1 zero trip days.

In addition to going into the community more often, the trip/activity logs indicated that the older adults without disabilities did more activities per trip than did the older adults who were disabled. As shown in Figure 2, the older adults without disabilities demonstrated a 2:1 activity-to-trip ratio, on average, as compared with the older adults with disabilities, who had a 1:1 ratio. Thus, older adults with disabilities were more likely to go into the community, complete one activity (eg, grocery shopping), and then return home than the older adults without disabilities, who would complete 2 or more

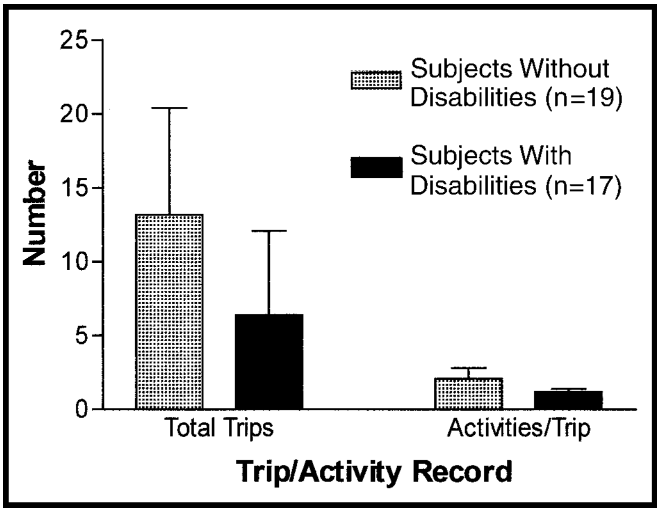

Figure 2.
Comparison ($\bar{X}\pm SD$) of the number of trips off property and activities per trip performed in a 9-day period by the 2 groups of participants.

activities (eg, grocery shopping, going to the dry cleaners, visiting a drugstore) in one trip.

Transportation
In Table 2, there are comparisons of transportation types between the 2 groups of older adults. Ninety-five percent (18/19) of the older adults without disabilities were able to travel unaccompanied into the community. Eighty-four percent drove themselves, while 11% used public transportation. One individual was always driven into the community by a spouse, who remained with the person during the trip. In contrast, only 42% (7/17) of the older adults with disabilities were able to go into the community unaccompanied, 12% (2/17) drove themselves, 12% took a bus, and 18% (3/17) relied on special transportation services for people with disabilities. The remaining 58% were driven by a spouse, family member, or friend, who remained with them throughout the trip.

Environmental Demands on Gait
In Table 3, there are comparisons of environmental features encountered during ambulation between the 2 groups of older adults for the 3 trips combined. The frequencies of encounters (mean and standard deviation, or percentage of trips) for 30 features of the physical environment classified into 1 of 8 dimensions were averaged across the 3 trips and are shown in Table 3.

Distance. There was no difference between the 2 groups on the average distance walked for the 3 observed trips. The older adults without disabilities walked, on average, 366.7 m (1,203 ft) per trip, as compared with the older adults with mobility disabilities, who walked, on average, 304.5 m (999 ft) per trip. The distances walked during the 3 individual activities were

Table 2.
Comparison of Transportation Types

Travels Alone	Subjects Without Disabilities	Subjects With Disabilities
Drives self	84% (16/19)	12% (2/17)
Public transportation	11% (2/19)	12% (2/17)
Transportation for people with disabilities	0% (0/19)	18% (3/17)
Travels accompanied	5% (1/19)	58% (10/17)

also consistent between the 2 groups. Figure 3 illustrates the distance walked for each of the 3 trips by the 2 groups of older adults. All of the observed trips were single-activity trips. Thus, the distance walked was largely determined by the activity performed while on the trip. However, as indicated in the trip/activity logs, under nonobserved conditions, the older adults without mobility problems tended to perform twice as many activities per trip compared with the older adults with disabilities. This finding suggests that during trips that were not observed, older adults without disabilities tended to walk more than those with disabilities because they usually performed more activities during any one trip than did the subjects with disabilities.

Temporal factors. In general, trips into the community did not require participants in either group to cross many streets. As shown in Table 3, streets with traffic lights were crossed during only 4 (7%) of the 57 trips observed in older adults without mobility problems and during only 5 (10%) of the 51 trips observed in those with disabilities. Crossing busy streets without traffic lights occurred more often than crossing a street with a traffic light for both groups. Older adults without disabilities encountered busy streets on 35% of the observed trips compared with 15% in the subjects with disabilities. The requirement to cross a street (with or without a traffic light) was dependent on the mode of transportation used. Those subjects who either walked or took public transportation were more likely to encounter traffic lights and busy streets than those who drove (or were driven). Although traffic lights were encountered infrequently, only 1 of the 4 older adults with mobility disabilities could cross the street in the time allotted by the traffic light. In contrast, all 4 of the older adults without disabilities could cross the street in the time allotted.

Although 100% of the older adults without mobility problems were able to walk at a speed similar to that of other people in the environment in which they were walking, only 10% of the older adults with disabilities were able to maintain this speed.

Table 3.
Environmental Demands on Community Mobility in Two Groups of Participants

Item	Subjects Without Disabilities (n=19)	Subjects With Disabilities (n=17)	P^a
Distance			
Distance walked (m)			NS
$\overline{X}$	366.67	304.50	
SD	417.88	280.11	
Temporal Factors			
Traffic lights (% of trips encountered)	7%	10%	NS
Busy streets (% of trips encountered)	35%	15%	.06
Walking speed (% able to maintain speed of those around them)	100%	10%	<.001
Ambient Conditions			
Precipitation (% of trips encountered)	9%	4%	NS
Temperature (°F)			NS
$\overline{X}$	63	61	
SD	9	8	
Outdoor light level (lux meter)			NS
$\overline{X}$	18,636	19,595	
SD	2,600	3,071	
Physical Load			
No. of packages			.01
$\overline{X}$	1.56	0.98	
SD	1.5	0.8	
Weight of packages (lb)			<.001
$\overline{X}$	6.7	1.5	
SD	9.3	1.8	
Manual doors (% of trips encountered)	28%	35%	NS
Terrain			
One flight of stairs (% of trips encountered)	47%	45%	NS
Two flights of stairs (% of trips encountered)	47%	4%	<.001
Curbs (% of trips encountered)	42%	40%	NS
Slopes/ramps (% of trips encountered)	65%	68%	NS
Uneven surfaces (% of trips encountered)	60%	61%	NS
Elevators (% of trips encountered)	10%	25%	.04
Escalators (% of trips encountered)	0	0	NS
Grass (% of trips encountered)	37%	23%	.04
Obstacles (% of trips encountered)	13%	3%	<.001
Attentional Demands			
Travel companions (% unaccompanied trips)	95%	24%	<.001
Familiarity (% of trips to familiar locations)	100%	100%	NS
Distractions (% of trips encountered)	58%	62%	NS
Postural Transitions			
Stop			NS
$\overline{X}$	2.6	2.9	
SD	2.3	2.2	
Back up			NS
$\overline{X}$	0.78	0.39	
SD	1.2	0.85	
Change head orientation			.01
$\overline{X}$	3.5	1.5	
SD	2.1	1.0	
Reach forward			.047
$\overline{X}$	1.2	0.6	
SD	1.1	1.2	
Reach up			.05
$\overline{X}$	0.78	0.38	
SD	1.3	0.74	
Reach down			.007
$\overline{X}$	0.48	0.26	
SD	1.1	0.9	
Change directions			<.001
$\overline{X}$	4.3	2.0	
SD	3.0	1.0	
Traffic Density			
No. of people			NS
$\overline{X}$	1.1	1.5	
SD	1.1	1.2	
Collision avoidance (% of trips encountered)	6%	0%	.03

[a] NS=not significant.

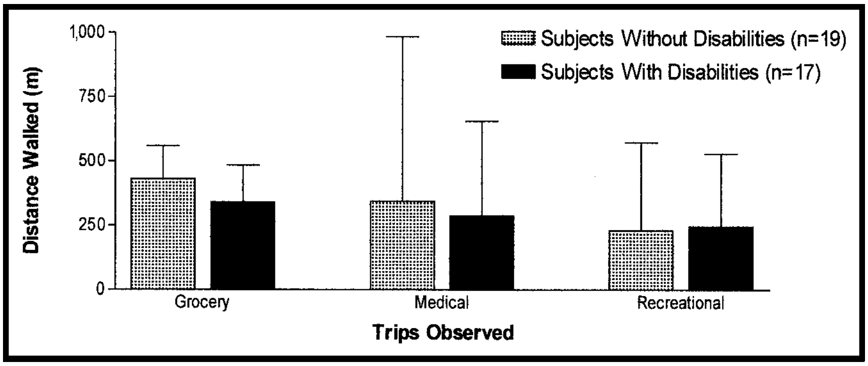

Figure 3.
Comparison ($\bar{X}$±SD) of average distance walked on 3 trips into the community in the 2 groups of older adults.

Ambient conditions. As shown in Table 3, there was no difference between the 2 groups with respect to temperature, level of precipitation, or light levels during observed trips into the community. None of the subjects in either group traveled when it was dark.

Physical load. On average, older adults with mobility disabilities carried fewer objects than did older adults without disabilities (0.98 and 1.56 items, respectively). In addition, there was a difference between groups in the weight of objects carried. The average weight of an object carried by an older adult without disabilities was 3.04 kg (6.7 lb), compared with 0.68 kg (1.5 lb) for the older adults with mobility disabilities. The type of objects carried also varied between groups. Although none of the older adults without disabilities used an assistive device for walking in the community, 11 of the 17 adults with mobility disabilities used canes and 3 used walkers.

Terrain. The 2 groups differed on 4 of 9 features relative to terrain. Older adults without disabilities climbed 2 flights of stairs, walked across grass, and encountered obstacles (eg, sticks) during their travel that required stepping over the obstacle more often. Older adults with disabilities were more likely to take elevators than were older adults without disabilities. Both groups climbed one flight of stairs in about one half of their trips into the community. In addition, the 2 groups were comparable with respect to the percentage of trips in which they encountered curbs (40% of trips), uneven surfaces (60% of trips), and slopes or ramps (65% of trips).

Attentional demands. This dimension was characterized by: (1) the presence or absence of travel companions, (2) familiarity of trip location, and (3) number of distractions (eg, construction noise, music) in the environment. As shown in Table 3, older adults with mobility disabilities rarely traveled alone. The older adults without ambulation problems made 95% of trips into the community unaccompanied. Among the older adults with disabilities, only 24% of trips were unaccompanied. Familiarity with travel destination was comparable for both groups. All of the older adults chose to travel to familiar locations. The level of distraction encountered on trips into the community was relatively high, but comparable for both groups.

Postural transitions. We compared the number of times postural transitions were made during a 10-minute segment of grocery shopping between groups. As shown in Table 3, the older adults with disabilities performed fewer postural transitions than did the older adults without disabilities. Differences were found in the number of times in which older adults with disabilities turned their head, extended their reach (forward, upward, or downward), or changed direction. The 2 groups were comparable with respect to the number of times they stopped and backed up.

Traffic density. Although unexpected collisions or near collisions were an infrequent occurrence, there were differences between the 2 groups. Unexpected collisions or near collisions occurred in 6% of the total trips of the subjects without disabilities and in 0% of the total trips of the subjects with disabilities.

Self-Report on Satisfaction, Physical Difficulty, and Fatigue

Figure 4 illustrates a comparison of self-reports related to satisfaction with the trip (ie, they accomplished what they intended to do on the trip), physical difficulty, and fatigue following observed trips into the community in the 2 groups of participants. Older adults with disabilities were comparable to older adults without disabilities on satisfaction and perceived difficulty experienced at the end of observed trips into the community. However, adults with disabilities reported that trips were more fatiguing compared with adults without disabilities.

Discussion and Conclusions

Understanding the relationship of the environment to mobility is crucial to both prevention and reduction of disability in older adults. In our study, we examined environmental features associated with community mobility in older adults with and without mobility disabilities in order to describe the physical requirements associated with mobility outside the home and to identify environmental features that interfere with community mobility in older adults.

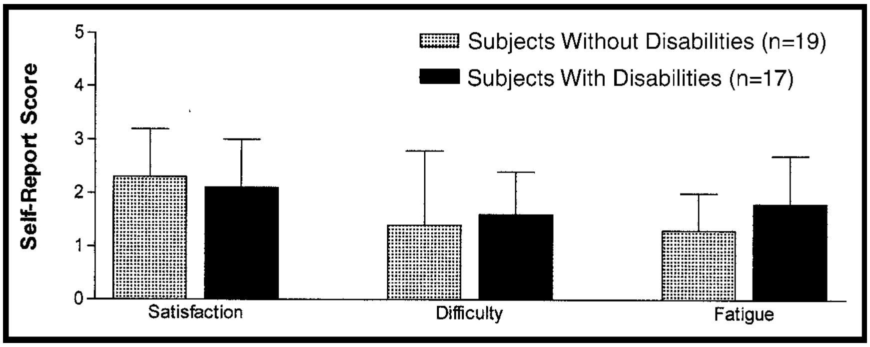

Figure 4.
Comparison ($\bar{X}\pm SD$) of reported satisfaction, difficulty, and fatigue following 3 trips into the community in the 2 groups of participants. A score of 5 indicates extreme difficulty, fatigue, and very unsatisfied.

We believe that our results provide insight into the types of environmental problems encountered by older adults (with or without disabilities) during trips into the community to obtain goods and services. This information, we contend, is critical to health care professionals involved in mobility training. The results of our study, we believe, support the hypothesis of Patla and Shumway-Cook[1] that physical requirements associated with community mobility are complex and are not limited to variables associated with distance, speed, and terrain.

Community mobility in older adults with disabilities was characterized by a decrease in the frequency with which environmental impediments to gait were encountered. However, mobility disability was not associated with a uniform decrease in abilities relative to all environmental categories or dimensions. Certain dimensions were more likely to contribute to decreased mobility in older adults. This suggests to us support for the hypothesis that, among older adults, certain environmental factors may interfere with community mobility more than others. Dimensions that distinguished older adults with mobility disabilities from older adults without such disabilities were temporal factors, physical load, terrain, and postural transition. In contrast, environmental dimensions that did not distinguish between the 2 groups were distance, density, ambient conditions, and attentional demands.

Distance

The results of our study are consistent with those of other studies[9,10] where researchers reported that older adults (with or without disabilities) walk, on average, 300 m (900–1,000 ft) during the performance of IADL tasks such as shopping or visiting a health care practitioner. As suggested by Cohen et al,[10] the distances walked by older adults without disabilities may actually be twice that distance, because most older adults perform 2 or more activities per trip into the community. These data suggest that a current standard for defining independence in walking skills as the ability to walk 45.7 m (150 ft) without assistance[18] seriously underestimates the distances walked by older adults with and without mobility problems when obtaining goods and services within the community.

Temporal Factors

Temporal constraints during community ambulation include not only the ability to cross a street in the time allotted by a traffic light or density of traffic, but also the need to maintain an appropriate speed of walking. As with highway driving where very slow speed can be potentially as dangerous as very high speed,[1] people walking at a very slow speed in a crowded environment may put themselves and others at some risk for collision. In addition, a minimum speed of walking is essential to ensure that a given task is completed in a reasonable time. The results of our study are consistent with those reported by Cohen et al[10] in showing that trips into the community were associated with very few street crossings. Although very few of the older adults with disabilities were able to walk at a fast enough speed to enable them to cross a street, they were rarely called on to cross streets. Thus, this may not be critical a determinant of community ambulation. Gait speed may be a factor in determining the number of activities performed during each trip. Gait speed, calculated in the Three-Minute Walk Test, in the older adults with disabilities was half that of the older adults without disabilities. This finding may explain why the older adults with mobility disabilities performed only one activity per trip, because the time taken to perform that activity (due to walking speed) was double that of the older adults without disabilities. Gait speed during community ambulation was not directly measured, nor was the time taken to complete the trips performed in the community. Thus, it is not clear whether clinical measures of gait speed are consistent with gait speeds in the community.

Ambient Conditions

Ambient conditions (light level and weather conditions) encountered on trips into the community were comparable for the 2 groups. The majority of trips into the community by both groups were done during daylight hours. Visual deficits may play a role in explaining why older adults (with and without disabilities) prefer daytime travel. Age-related changes in contrast sensitivity and visual acuity are common and are highly dependent on ambient light levels.[19] The ability to detect edges, the size of small obstacles, and other surface properties is adversely affected when the light level is low.[19] In addition, light and dark adaptation is also impaired in the elderly population.[20,21] Daytime mobility can maximize the possibility that walking will be done when light levels are optimal.

Physical Load

Although the older adults with disabilities, in general, carried fewer and lighter items than did the older adults without disabilities, all older adults carried some item during every trip. This suggests to us that the ability to interact with physical loads is a critical part of mobility function. Researchers have shown an age-related decline in both muscle force[22,23] and anticipatory postural control,[24] thus, partially explaining why older adults with mobility disabilities may limit the weight and number of packages carried. In addition, a large percentage of subjects with disabilities used assistive devices for gait, which limited their ability to carry additional items.

Terrain

In clinics, mobility is most often tested and trained on flat, straight, rigid surfaces, even though most community environments rarely afford such an optimum travel surface.[1] Our results are consistent with those of other studies that have shown that trips into the community require older adults, regardless of mobility ability, to manage stairs (one flight), curbs, slopes, and uneven surfaces.[9,10] Abilities related to terrain characteristics that distinguish older adults with mobility disabilities from those without mobility disabilities are the ability to climb 2 flights of stairs and the ability to step over obstacles rather than go around them.

Attentional Demands

The ability to maintain balance while simultaneously walking and performing other tasks such as conversing with a companion, finding a route in an unfamiliar location, and dealing with both visual and auditory distractions places demands on attentional aspects of balance control.[1] Several researchers[25–29] have shown age-related declines in the ability to maintain stability under multi-task conditions in older adults, particularly those with balance impairments. We considered a travel companion to be attentionally demanding because previous research has shown that for older adults, talking while walking has a deleterious affect on mobility and increases the risk of falls.[26,30] Using this definition, older adults with mobility disabilities had greater attentional demands on them because fewer than 24% of trips were performed unaccompanied. This would suggest that an important aspect of training mobility, particularly among older adults requiring travel companions, is the ability to engage in mobility under multi-task conditions.

Postural Transitions

Community mobility requires many postural transitions, including starts and stops, changing direction, reorientation of head independent of a change in direction, and reaching to obtain objects. These postural transitions, in our opinion, are an integral part of mobility and impose demands on the balance control system over and beyond those encountered during steady-state walking.[1] Older adults with disabilities tended to make fewer postural transitions than did those without disabilities. We believe this provides evidence that postural transitions can be important in distinguishing between older adults with and without disabilities. Reduction in postural transitions, we believe, may have been due, in part, to deficiencies in postural control mechanisms. Alternatively, this reduction may have been due, in part, to the fact that most of the subjects with disabilities shopped with someone else who, in general, did the reaching for them.

Traffic Density

Traffic density determines the need for collision avoidance, which is an important aspect of safety when walking in the community.[1] Avoiding unexpected collisions with other people requires anticipating the travel path of another person (or object) and modifying your own travel path by either slowing or stopping, or alternatively by accelerating quickly in order to avoid collision. Unexpected collisions or near collisions were an infrequent occurrence among our subjects. Collision avoidance was more often required of the older adults without mobility disabilities than of the older adults with mobility disabilities. We believe that this was due, in part, to the fact that older adults with disabilities walked more slowly than those around them; thus, other people tended to avoid them, rather than vice versa.

Limitations of the Study

Due to the small number of subjects in each of the groups, our study should only be considered a preliminary study. Results will need to be examined in a larger sample of older adults. In addition, it is not clear whether observing and videotaping subjects had an effect on their performance in the community. We believe that, for the most part, the data collected reflect how the subjects normally perform when not being observed, because subjects performed activities at sites that were part of their normal pattern of trips into the community. However, it is possible that performance was modified by the presence of an observer.

Clinical Implications

An important determinant of independence in community mobility is the capacity to manage physical features within the environment that constrain mobility. By observing mobility in older adults on trips into the community, we identified physical features, classified within 8 environmental dimensions. A reduced ability to manage critical environmental demands on mobility appears to be a characteristic of mobility disability in older adults. Intervention programs that train older adults to effectively modify gait in response to varied environmental challenges likely to be encountered in the community, in our view, may have greater success in optimizing function and reducing disability than do programs designed without regard to these factors.

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