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168

Merja Rantakokko

Outdoor Environment, Mobility Decline and Quality of Life Among Older People

JYVÄSKYLÄN YLIOPISTO

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ABSTRACT

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The purpose of the study was to examine the effects of perceived barriers in the outdoor environment on outdoor mobility and quality of life in older people. In addition, two new concepts related to outdoor mobility decline, fear of moving outdoors and unmet physical activity need, were introduced.

This study is based on baseline data (n=727) and follow-up data of the control group (n=314) used in the SCAMOB (Screening and Counseling for Physical Activity and Mobility in Older People) project with a total follow-up time of 3.5 years. Participants were 75- to 81-year-old, community-dwelling people living in a Jyväskylä city center neighborhood. Data on perceived barriers in the outdoor environment, perceived walking difficulties, fear of moving outdoors, unmet physical activity need and quality of life (QoL) were obtained in face-to-face interviews. Additionally, maximal walking speed was measured in the study centre.

Perceived barriers in the outdoor environment predicted development of walking difficulty in the 3.5-year follow-up. Perceived barriers in the outdoor environment also underlay fear of moving outdoors, which in turn predicted development of walking difficulty and unmet physical activity need. However, fear of moving outdoors predicted walking difficulties independently of the environmental factors. Unmet physical activity need was more common among ambulatory community-dwelling older people who had health and mobility problems and reported barriers in the outdoor environment. Barriers in the outdoor environment which encumbered outdoor mobility increased perceptions of fear of moving outdoors and unmet physical activity need, and resulted in poor QoL in older people.

The results of the present study indicate that reducing barriers in the outdoor environment may help older people to maintain outdoor mobility which is a prerequisite for independent living in the community. In addition, ways of overcoming fear of moving outdoors and barriers to physical activity need to be developed to promote opportunities for physical activity participation, and so improve quality of life among older people.

Keywords: Outdoor environment, outdoor mobility, mobility decline, quality of life, older people

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In Jyväskylä, March 2011
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LIST OF ORIGINAL PUBLICATIONS

The thesis is based on the following Papers, which will be referred to in the text by their Roman numerals. Additionally, some unpublished data are included in the thesis.

I Rantakokko M, Iwarsson S, Mänty M, Leinonen R, Rantanen T. 2011. Perceived barriers to mobility in the outdoor environment and development of walking difficulty in older people. Submitted for publication.

II Rantakokko M, Mänty M, Iwarsson S, Törmäkangas T, Leinonen R, Heikkinen E, Rantanen T. 2009. Fear of moving outdoors and development of outdoor walking difficulty in older people. Journal of the American Geriatrics Society 57, 634-640.

III Rantakokko M, Iwarsson S, Hirvensalo M, Leinonen R, Heikkinen E, Rantanen T. 2010. Unmet physical activity need in old age. Journal of the American Geriatrics Society 58, 707-712.

IV Rantakokko M, Iwarsson S, Kauppinen M, Leinonen R, Heikkinen E, Rantanen T. 2010. Quality of life and barriers in the urban outdoor environment in old age. Journal of the American Geriatrics Society 58, 2154-2159.

ABBREVIATIONS

95 % CI	95 % Confidence Interval
ADL	Activities of Daily Living
ANOVA	Analysis of Variance
CES-D	Center for Epidemiologic Studies Depression Scale
CI	Confidence Interval
DfA	Design for All
GEE	Generalized Estimating Equations
GIS	Geographic Information System
HR	Hazard Ratio
MMSE	Mini-Mental State Examination
OR	Odds Ratio
P-E fit	Person-Environment fit
QoL	Quality of Life
SCAMOB	Screening and Counselling for Physical Activity and Mobility in Older People
SD	Standard Deviation
SES	Socioeconomic status
WHO	World Health Organization

CONTENTS

1 INTRODUCTION

Among older people, loss of the ability to move outdoors may threaten their independent living in the community and participation in social and physical activities. Outdoor physical activity, particularly walking, plays a key role in the maintenance of functional independence in old age (Simonsick et al. 2005).

Outdoor mobility requires a certain level of functional capacity along with the ability to concentrate and react to environmental stimuli. Thus outdoor mobility limitation is among the first signs of the disablement process (Shumway-Cook et al. 2003). For example, among women, approximately 40% of those aged 70-79 years, and over 60% of those over 80 years reported restrictions on their mobility outside the home (Wilkie et al. 2006).

A number of studies have investigated individual risk factors for mobility decline. These include physiological changes in muscles, physical inactivity, low socio-economic status, depression and illnesses that have been observed to predict incident mobility limitation (Penninx et al. 1998, Hirvensalo et al. 2000, Boyle et al. 2007, Nordstrom et al. 2007). While the individual risk factors for mobility decline have been widely studied, knowledge of environmental effects on the development of mobility decline or overall well-being in older people is rather limited. It has been stated that environmental features can facilitate or restrict participation in outdoor activities (World Health Organization (WHO) 2001) and older people with mobility limitations report more barriers in their environment than people without limitations (Shumway-Cook et al. 2003). For example, environmental features, such as poor street conditions and lighting, correlate with a lower level of physical activity and walking and higher prevalence of outdoor mobility limitation (Booth et al. 2000, Brownson et al. 2001, Beard et al. 2009a). Although this association has been established in several cross-sectional studies, it remains unclear whether older people perceive their environment as challenging because of mobility limitations or whether a challenging environment leads to mobility decline.

A common cause of avoidance of outdoor activities among older people is fear. The most widely studied of such fears is fear of falling, which is common among older people (Austin et al. 2007) and restricts participation also among

those who have not fallen (Friedman et al. 2002, Fletcher & Hirdes 2004, Deshpande et al. 2008). It has been suggested that fear of falling may be part of a more generalized fearfulness (Myers et al. 1996, Lawrence et al. 1998), which affects people's possibilities to participate in desired activities. However, fear-related activity avoidance as a result of mismatch between the environment and the individual, and its consequences have not been widely studied.

Avoidance of outdoor mobility leads to a situation where opportunities for physical activity are perceived as diminished. The need for physical activity is fundamental to human beings of all ages. Because of its health benefits, such as preventing chronic diseases and related conditions, mobility loss and maintaining independence in the community (Hirvensalo et al. 2000, Gill et al. 2003, Boyle et al. 2007), it is recognized that older people need to be encouraged to maintain and adopt an active life-style (e.g. the Second World Assembly on Ageing in 2002) (United nations 2002). Some older people may perceive that they have no opportunities for physical activity, despite their wanting to be physically active. These older people experience unmet physical activity need, which is a personal feeling of the adequacy of their physical activity. Physical activity can be seen as a basic need, which, if not met, may lead to adverse health events such as depression (Blazer et al. 2007), thus also affecting quality of life (QoL). However, this issue has not previously been studied.

Quality of life has been used as a main outcome measure in many health intervention studies. Social relationships, independence, autonomy and health are frequently mentioned as determinants of QoL in older people (Kalfoss & Halvorsrud 2009). The importance of the environment for QoL has been acknowledged, even if not yet widely studied. In particular, little research has been published on the specific environmental features affecting QoL in old age.

Mobility decline in older people is a major public health concern. Mobility limitations increase the need for health care services and institutionalization (von Bonsdorff et al. 2006). Current health care policy in Finland favors home care instead of institutional care. This emphasizes the need to find ways of supporting community mobility and thus preventing home confinement among people at risk. Knowledge about the environmental barriers to outdoor mobility and physical activity is important when planning residential areas intended for recreation by people of all ages. Understanding the factors affecting outdoor mobility in older adults can help in finding ways to motivate as well as assist older adults to move outdoors, thus potentially preventing the development of disabilities and improving well-being in this increasing group of people.

The purpose of this research was to examine the effects of barriers in the outdoor environment on outdoor mobility decline and quality of life in old age. In addition, two new concepts related to outdoor mobility, fear of moving outdoors and unmet physical activity need, are introduced.

2 REVIEW OF THE LITERATURE

2.1 Environmental gerontology

Environmental gerontology studies the relationship between aging persons and their physical and social environment, and how these relationships shape health, functioning and quality of life in old age. Aging-related losses in functional capacity have a direct impact on the relationship between the older individual and the environment, exposing the older person in particular to environmental barriers (Wahl & Weisman 2003).

Ecological model of ageing

The ecological model of ageing (also known as the "Competence-Press model") by Lawton and Nahemow (1973) is a widely used model of the person-environment relationship in environmental gerontology. It considers human behaviour and well-being to be strongly related to the environment where a person lives and to her/his capabilities. In the model, a person is seen as a set of competencies and the environment as a set of demands (Figure 1). Personal competence can also be seen as functional capacity, including biological health, sensory functions, motor skills and cognitive functioning. The environmental component includes the domains of the physical environment, the personal environment, the small-group environment, the supra-personal environment and the social or mega-social environment. One important element in the ecological model of ageing is that for every person there are combinations of individual capabilities and environmental demands which offer an optimal state of functioning. This is called person-environment (P-E) fit.

According to the docility hypothesis presented in the ecological model of ageing, people with lower competence are more prone to environmental press than those with higher competence. When environmental press and individual competence converge, adaptation can be achieved. When personal competence is low, the possibilities for adaptive behavior are fewer than when personal competence is high.

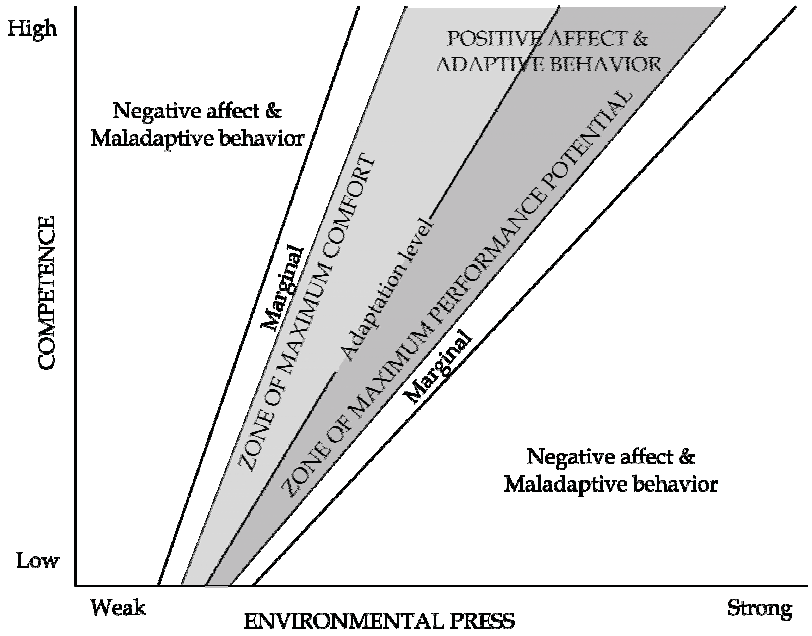

FIGURE 1 The ecological model of ageing (Adopted from Lawton & Nahemow 1973).

Disablement process model

The disablement process model by Nagi (1976), later expanded by Verbrugge and Jette (1994), shows the disablement process pathway from pathology to disability and is a widely used theoretical model in epidemiological studies. The main purpose of the model is to describe how chronic and acute conditions affect functioning and disability and to describe personal and environmental factors that speed up or slow down the disablement process.

According to the disablement process model, pathology, such as chronic conditions, leads to impairments such as dysfunction in the musculoskeletal system, which results in functional limitations like walking difficulties. Functional limitations in turn lead to disability (Figure 2). The disablement process is a socio-medical model, which also takes into account extra- and intra-individual factors as well as risk factors that affect development of disability. Intra-individual factors include lifestyle and behaviour changes, psychosocial attributes and coping mechanisms, and activity accommodations. Extra-individual factors include medical care and rehabilitation, medications and other therapeutic regimens, external supports and the built, physical and social environment. Additionally, it contains risk factors, which are predisposing factors that elevate the chances for functional limitation and disability when chronic conditions occur and progress.

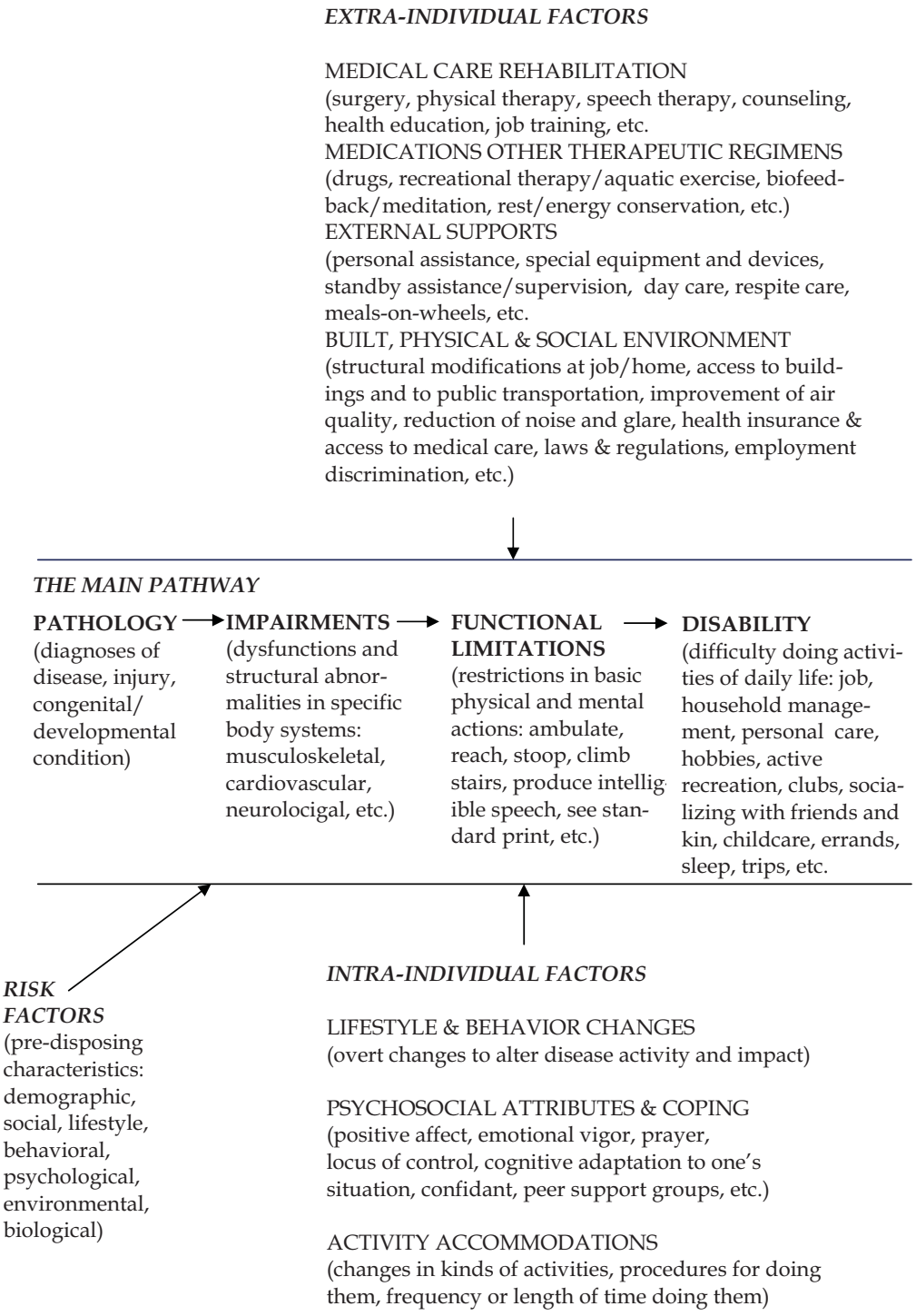

FIGURE 2 A model of disablement process (Adopted from Verbrugge & Jette 1994).

There are similarities between the ecological model of ageing and disablement process model. The person-environment perspective of the disablement process model emphasizes that the environment and the individual are of equal importance in the disability process. The environment is seen on the "demand" side and the person on the "capability" side of the model, similarly as in the ecological model of ageing. Both theories emphasizes that disability occurs when there is misfit between the environment and the individual. In both models a challenging environment is seen as a threat or as an opportunity to maintain functional capacity.

Although the two theories share similar content, there are a few differences between them. The disablement process model shows the pathway from pathology to disability, seeking to explain the temporal order and conceptual outline of the contributing factors, while the ecological model of ageing shows the interplay between the individual and the environment from a general perspective and sees the relationship as a dynamic process, explaining the mechanisms behind the interaction. In addition, the ecological model of aging has a strong psychological emphasis, while the disablement process model emphasizes the physiological changes. Thus these models support each other and are used as the framework for this study.

Environmental gerontology at present

The ecological model of ageing was introduced in 1973 by Lawton and Nahemow, and has become a landmark in environmental gerontology (Wahl & Weisman 2003). Since then, three basic domains of research in environmental gerontology have emerged: private home environments, planned environments and residential decisions. Research has also focused on three basic functions that the environment offers: maintenance, stimulation and support. Wahl and Weisman (2003), in their review, note that over the last two decades research in environmental gerontology has been focused more on the private home environment and less on the institutional environment. Also, studies of neighborhoods, regions and urban-rural divides are lacking. In addition, causal relations remain relatively unclear as most studies are based on cross-sectional data (Kendig 2003, Wahl & Weisman 2003).

Over the last ten years, interest in the association between neighborhood environments and the health of older people has increased (for reviews, see Wahl et al.2009a, Yen et al. 2009) and the role of the home environment in the disablement process has become an important public health concern (Wahl et al. 2009a). Recently, environments of ageing have been mentioned as one of the research priorities in future aging studies in Europe [http://futurage.group.shef.ac.uk/] [cited 10.1.2011].

2.2 Outdoor mobility in old age

2.2.1 Outdoor mobility and participation in outdoor activities

Mobility is defined as the "ability to move oneself (either independently or by using assistive devices or transportation) within environments that expand from one's home to the neighborhood and to regions beyond" (Webber et al. 2010). This broad definition is related to the definitions issued by the World Health Organization (WHO 2001) and to life-space mobility by taking into account the role of the environment on mobility (Stalvey et al. 1999).

Participation restriction refers to "problems an individual may experience in involvement in life situations"(WHO 2001). Participation restriction in different areas of life is common among older adults and the most common area of participation restriction is mobility outside the home (Wilkie et al. 2006). Restrictions in outdoor mobility increase with age; for example, approximately 40% of women aged 70-79 years, and over 60% of women over 80 years reported restrictions in mobility outside the home (Wilkie et al. 2006). Extreme activity restriction happens when a person is unable to move independently outside the home and becomes homebound. Being homebound is typically connected with severe disability, but it is also more prevalent among those with lower socioeconomic status (SES) and older age (Simonsick et al. 1998). In addition, homebound older people have a very high rate of depressive symptoms compared to community-living people, who are able to participate in out-of-home activities (Choi & McDougall 2007).

Going outdoors is a prerequisite for taking care of daily activities, such as shopping, but also meeting friends and relatives, doing gardening, taking a walk for physical exercise or attending different events. However, physical activity is not the only reason for the health effects of outdoor activity. Contact with nature, which includes passive interaction, such as sitting on a park bench as well as active interaction, such as walking and gardening, has positive effects on mental well-being, which have been studied e.g. among dementia patients (Bossen 2010). Outdoor mobility also offers possibilities to carry out daily activities such as shopping (Jacobs et al. 2008), and to participate in social activities (Kono et al. 2007). On the other hand, close relationships with friends and relatives motivate older people to move outdoors (Mollenkopf et al. 1997). Social support mediates the effect of physical activity on functional disability (Taylor & Lynch 2004, Travis et al. 2004). Older people who are more socially engaged report less disability (Mendes de Leon et al. 2003) and are also more physically active (Tan et al. 2009), while less frequent social activity predicts decline in motor functions among older people (Buchman et al. 2009).

2.2.2 Mobility decline with aging

There are differences in the pace of the disability process between persons. The onset of disability may be sudden and catastrophic for some and slowly progressive for others. Sudden disability is usually a result of a traumatic event, such as a hip fracture or a stroke, while slow progressive functional decline is a consequence of worsening health conditions, such as arthritis (Guralnik et al. 2001). If disability develops slowly, prior to mobility disability the older person may have adapted the way of doing a particular task. For example, there might be changes in task frequency or the time used, or pauses for rest introduced during task performance. This kind of adaptation is called preclinical mobility limitation, and it has been found to predict incident mobility limitation and falls among older people (Fried et al. 2000, Fried et al. 2001, Mänty et al. 2010). It has also been shown that mobility limitation is a dynamic process with possible transitions between states of independence and dependency (Hardy & Gill 2005, Gill et al. 2006, Gill et al. 2010).

Frequency of going outdoors is a good indicator of functional and psychosocial functioning among community-dwelling older people (Kono et al. 2004). People who go outdoors more often are also more likely to maintain better physical and mental functioning in later life (Kono et al. 2004, Kono et al. 2007). Those who go out daily, report significantly less musculoskeletal pain, sleeping problems, urinary incontinence and difficulties in activities of daily living (ADL) functions (Kono et al. 2007, Jacobs et al. 2008). Walking outdoors has also been suggested to be protective for cognitive health (Abbott et al. 2004, Barnes et al. 2007, Prohaska et al. 2009, Suzuki & Murase 2010). Lower frequency of going outdoors is associated with depressive mood, poor subjective health and low cognition (Fujita et al. 2006, Kono et al. 2007). Additionally, it may also lead to institutionalization (Fujita et al. 2006) and increase the risk for mortality (Inoue et al. 2006). Some studies have suggested that even a small amount of outdoor activities, e.g. at least once a week, is beneficial for maintaining physical functioning (Shimada et al. 2009), especially among those who already have mobility limitations (Simonsick et al. 2005). In addition, low intensity physical activity, such as taking a short walk or spending time outdoors have been found to improve quality of life among older people who suffer from dizziness (Ekwall et al. 2009).

When people get older, they have more mobility limitations and due to increasing mobility limitations, outdoor walking decreases (Simonsick et al. 2005). According to the Finnish Health 2000 Survey, 82% of men and 77% of women aged 65 to 74 years reported being able to walk 0.5 km without difficulties. Among people aged 75 to 84 years the corresponding percentages were 59% and 47%, while among people over 85 years only 17% of men and of women 18% reported no difficulties in walking 0.5 km (Koskinen et al. 2004). However, it has been established that almost one-third of the older women who report mobility limitations also walk regularly outdoors (Simonsick et al. 1999). A recent study in Finland showed that 70% of community-dwelling men and 40% of

community-dwelling women aged 81 to 90 years reported walking outdoors for exercise 2-3 times a week (Mäkilä et al. 2010), while in another study 11% of the community-dwelling older people aged 65 to 74-years had not participated in recreational outdoor activities during the last year. The most important constraint on outdoor activities was difficulties in moving around in the natural environment, which was reported by almost half of the men and over 60% of the women. For older women, lack of company was also an important reason for not going outdoors (Neuvonen et al. 2004).

Although mobility limitations increase with age, the prevalence of perceived difficulties in mobility has declined at the population level over the last few decades. In Finland, a comparison between the Mini-Finland Health Survey (in 1978-1980) and Health 2000 Survey (2000-2001) showed that among people over 65 years of age, the proportion of those reporting difficulties in walking 0.5 km had decreased from 44% to 28% among men and from 45% to 35% among women (Aromaa et al. 2004). Also, self-reported ability to move outdoors has improved, especially among people over age 85 (Pitkälä et al. 2001). These improvements in mobility may partly be explained by the improvements in overall health and SES. Heikkinen et al. (2010) conducted a repeated population-based cross-sectional study to determine trends in health, functioning and physical activity in the Finnish population aged 65 to 69 years (Heikkinen et al. 2010). They found that over the last two decades, significant improvements had taken place in socio-economic status, self-rated health, memory problems, functioning and physical activity. Increased levels of physical activity have also been noted in other countries. According to the Australian Health Survey, everyday walking activity has increased over the last decade, especially among people over 75 years of age (Merom et al. 2009).

2.2.3 Assessment of outdoor mobility decline

The most common form of outdoor mobility among older people is walking (Mäkilä et al. 2010). Walking ability can be assessed either by self-reports or by performance-based measures (Guralnik & Ferrucci 2003). Interviews on self-reports are easy to carry out e.g. in the home environment or over the telephone, while performance-based measures are usually carried out under controlled circumstances. It has been argued that self-reports may lack sensitivity to change in physical function (Kivinen et al. 1998). Recently no differences have been found in self-reported versus performance-based measures of physical functioning, showing that self-reports are as sensitive to change as performance-based measures (Latham et al. 2008). In fact, self-reports can be even more sensitive to functional change than performance-based measures (Fried et al. 2000, Latham et al. 2008). Self-reports reflect the actual activities that people engage in their daily life ("do do"), while performance-based measures target how well people can perform a given task under controlled conditions ("can do"). Latham and colleagues (2008) suggest that people may be able to ignore their pain or fatigue during a short-term performance assessment, whereas self-report captures the effects of pain or fatigue on routine activities (Latham et al.

2008). Short-term performance tests assess the upper limit of the person's functioning while self-reports may be viewed as representative of the usual level of functioning. Thus performance-based and self-report measures of functioning complement each other in providing information on functional limitations (Kempen et al. 1996).

Self-report measures

Self-reports of mobility limitations are often collected using questionnaires or interviews on the respondent's ability to walk or difficulty in walking certain distances, such as a quarter of a mile (400 meters), 0.5 km or 2 km (Fried et al. 2001, Guralnik & Ferrucci 2003, Hardy et al. 2010). Additionally, questions about task modifications may be included to capture early signs of mobility limitation (Fried et al. 2000, Fried et al. 2001, Mänty et al. 2007).

Frequency of going outdoors can be used as an indicator of health and functional status among older people (Kono et al. 2004). Frequency of going outdoors takes into account all the activities performed out of the home, such as shopping, taking a walk or visiting friends, which gives a broad picture of the respondent's ability to maintain his or her independence in the community (Kono et al. 2004, Kono et al. 2007, Jacobs et al. 2008).

To combine assessments of outdoor mobility and the environment, researchers have focused on the concept of life-space mobility (Stalvey et al. 1999, Baker et al. 2003, Peel et al. 2005). Life-space can be defined as "the size of the spatial area a person purposely moves through in his/her daily life, as well as the frequency of travel within a specific time frame" (Xue et al. 2008). Life-space has proven to be a valid measure of mobility and it can be used to evaluate transitions in individuals' abilities to live independently (Stalvey et al. 1999, Baker et al. 2003). Life-space mobility takes into account individual functional capabilities as well as environmental demands, thus reflecting actual mobility performance (Stalvey et al. 1999). It also includes compensatory strategies, as older persons with mobility limitations may not necessarily restrict their life-space if they find ways to compensate for difficulties, e.g. by using mobility devices.

Performance-based measures

A commonly used performance-based objective measure of mobility is walking speed, which has been shown to be a reliable and valid measurement of functional performance in older people (Guralnik et al. 2000, Guralnik & Ferrucci 2003). Walking speed can be measured by maximal walking speed (Aniansson et al. 1980, Latham et al. 2008,) or by habitual walking speed (Cesari et al. 2005) over different distances, usually 6 or 10 meters. Habitual walking speed shows the normal performance level in daily life while maximal walking speed shows the individual's ability to react in more demanding tasks, such as crossing a street. Longer distance walking tests, such as the 6-minute walking test and the long corridor walk, provide information on aerobic capacity (Simonsick et al. 2001, Simonsick et al. 2008). Studenski et al. (2011) showed recently that walk-

ing speed over 4 meters is informative and easily implemented in practice and can be used to identify older adults with increased mortality risk. They also suggested that gait speed is more informative among older people who do not have mobility limitations and less informative among those who already have difficulties in mobility (Studenski et al. 2011). During recent years, more interest has been paid to habitual walking speed, which has been found to be sensitive in discriminating mobility limitation levels among older people (Kim et al. 2009).

In addition to measurement of walking speed, observation of gait patterns provides information about walking ability and also an opportunity to evaluate different components of impaired walking. There are several known age-related changes in gait patterns, such as decrease in walking speed, step length and foot elevation, and increase in double-support time (Bock & Beurskens 2010, Ko et al. 2010). It has been found that gait patterns differ according to the walking environment. For example, when walking in a laboratory, step duration is longer than when walking outdoors in the park (Bock & Beurskens 2010).

2.2.4 Assessment of environmental barriers to and facilitators of outdoor mobility

WHO defines an environmental barrier as an environmental factor with a negative influence on activity and an environmental facilitator as an environmental factor with a positive influence on activity (WHO 2001). These definitions include perceived as well as objective factors. Environmental barriers are often connected to accessibility, which refers to an "encounter between the person's or group's functional capacity and the design and demands of the physical environment"(Iwarsson & Ståhl 2003, p.61). An accessible environment is an environment in which an individual with any impairment can function independently. The term usability is often used interchangeably with accessibility. However, while accessibility includes both the individual and environmental domains, usability adds the component of activity, and takes into account user evaluation of the possibilities to use the environment. Thus accessibility may be seen as a precondition for usability. A broader term, including the idea of accessibility, is Design for All (DfA) (also known as universal design), which means designing environments, products and services so that they are accessible to all people, irrespective of age, gender or functional ability. When focusing on the design of environments, design for all means the best approximation of the environmental aspects that meet the needs of the maximum amount of people. DfA is mostly about changing attitudes throughout society and describes a process more than a definite result (Iwarsson & Ståhl 2003).

To investigate environmental barriers to and facilitators of outdoor mobility, self-reports and objective measures of environment have been used. No single instrument of environmental measurement exists that could be consistently applied in all situations. Self-reports on the environment include perceptions of barriers or supportive features in the nearby environment. The benefit of self-reports is that they reflect the physical environment which the respondent uses.

Only a few self-report questionnaires are, however, specifically targeted at older people. The self-report assessment tool called the 'Environmental Analysis of Mobility Questionnaire' (EAMQ) (Shumway-Cook et al. 2003) has been found to be a reliable and valid measure of environmentally determined mobility disability among older people (Shumway-Cook et al. 2005). Another self-report instrument, 'Home and Community Environment' (HACE), designed to assess barriers and facilitators in discrete environmental domains, has been tested for construct validity among older community-living people (Keysor et al. 2005). So far, neither of these measurement tools has been used in Finland.

Objective measures of the environment give accurate information on e.g. residential density, street connectivity and distances to services and other public facilities. One of the most popular objective environment assessment method, or tool, is the 'Geographic Information System' (GIS) (Chang 2008). The GIS is a computer system that captures, stores, analyzes and displays geographically referenced data that describes the location and characteristics of spatial features. The GIS has been used, for example, in transportation planning and increasingly also in health studies (Chang 2008). A simpler, objective measurement tool is direct neighborhood observation, which involves systematic documentation of neighborhood characteristics that may have positive or negative implications for residents' health. Assessment can be conducted by using a 'Neighborhood Observational Checklist' (NOC) in which the observer indicates whether certain environment items are present or absent (Zenk et al. 2007). This method is easy to translate for use in different countries. The problem with objective measures has been that they give accurate data on the environment but do not take into account the person who is using the environment. Thus they do not give an exact picture of the environment that is meaningful for and used by the resident.

The 'Housing Enabler' is an observational assessment instrument that was designed to assess problems in housing accessibility, and it offers a possibility to study the relationship between environmental barriers and individual capabilities (Iwarsson 1999). The Housing Enabler focuses on the home environment and does not assess outdoor environments besides the immediate surroundings of the home. As a result, the Housing Enabler gives a total accessibility score, which reflects the P-E fit. The Housing Enabler has been used in several European countries and has been translated into English, German, Hungarian, and Latvian. Recently, a cross-Nordic version was collaboratively developed by Sweden, Finland, Denmark and Iceland (Helle et al. 2010). However, the use of the Housing Enabler requires careful rater training and conducting the assessments take a long time. Instrument-specific software is available, which speeds up the assessment process.

In spite of the growing body of literature on environmental features, knowledge about the validity of self-reported environmental barriers as compared to objective assessments is limited. A few studies have shown, however, that differences between measures may be due to individual differences, as people without recent experiences of their environment, as well as those who are physically inactive, overweight and have lower SES, more often have mis-

match between the perceived and objectively measured environment (Fänge & Iwarsson 2003, Gebel et al. 2009), whereas perceived and objectively measured environmental barriers resemble each other if the respondent has recent experiences of the environment under study (Fänge & Iwarsson 2003).

2.2.5 Individual predictors of outdoor mobility decline

In the disablement process model (see page 15), Verbrugge and Jette outline intra-individual and extra-individual factors that can either reduce or increase functional limitations. While the main pathway emphasizes the physiological process, intra-individual factors focus on lifestyle and behavioral changes, psychosocial attributes and coping, and activity accommodations. In addition, predisposing characteristics, such as demographic, social, lifestyle, behavioral and psychological characteristics, can affect the severity of functional limitation (Verbrugge & Jette 1994). Depression, SES and fear may be viewed as examples of the intra-individual factors affecting functioning.

Depressive symptoms

Depressive symptoms include emotions such as depressive mood, feelings of guilt and worthlessness, feelings of helplessness and hopelessness, but also loss of appetite and sleeping disturbances (Radloff 1977), and can be seen as an example of the psychosocial attributes and coping posited in the disablement process model (Verbrugge & Jette 1994). The prevalence of depressive symptoms among community-dwelling older people range from 8% to 16%, but major depression, also called clinical depression, among older people is relatively rare, ranging from 1% to 4% (Blazer 2003). Major depression can be diagnosed, if the symptoms are long lasting and if many of the depressive symptoms occur simultaneously. Depressive symptoms are more frequent among the oldest old, but the relationship between depression and age can be explained by the higher proportion of women, and by the presence of physical disability, more cognitive impairments and lower SES (Blazer 2003).

Penninx et al. (1998) studied the impact of depressive symptoms on change in physical performance in community-dwelling older people over 4 years. They found that depressive symptoms were predictive of subsequent decline in physical performance. One possible explanation for this association was that people with depressive symptoms are less engaged in walking, gardening, or vigorous exercise (Penninx et al. 1998). Other studies have also shown that depressive symptoms increase the risk for outdoor activity restriction (Wilkie et al. 2007, Rosqvist et al. 2008); however, it is also the case that activity restrictions increase depression (Lampinen et al. 2000, Choi & McDougall 2007). For example, it was found recently that daily walking was associated with a lower risk for 8-year incident depressive symptoms among Japanese-American men (Smith et al. 2010), that a high level of depressive symptoms prevailed among stroke survivors who had given up traveling by public transport (Wendel et al. 2008), and that depression increased in older people who had given up other meaningful activities (Duke et al. 2002, Benyamini & Lo-

mranz 2004). People with mobility limitations report more depressive symptoms than persons with only mild or no mobility limitations (Hirvensalo et al. 2007). Negative experiences of the environment as well as sociodemographic characteristics may also predispose older people to depression (Hybels et al. 2006, Beard et al. 2009b).

Socioeconomic status

Socioeconomic status is a combined term which has been used to describe a person's income, occupation and education level and can either reduce or increase functional limitations, thus reflecting the intra-individual factors posited in the disablement process model (Verbrugge & Jette 1994). A number of studies have reported that people with low SES, that is, people who have less education and a poor financial situation, have more mobility limitations than people with higher SES (Avlund et al. 2004, Nordstrom et al. 2007, Sainio et al. 2007, Lang et al. 2008a, Nilsson et al. 2010). Additionally, people with lower SES are less physically active and give lower self-ratings of their health than people with higher SES (Wilson et al. 2004, Borodulin et al. 2008).

A recent Danish study showed that financial assets are associated with onset of mobility disability (Nilsson et al. 2010). The researchers suggest that psychosocial and behavioral factors (e.g. smoking, physical inactivity, obesity) as well as work history and chronic conditions may explain the association (Nilsson et al. 2010). A Finnish study found that morbidity, obesity, smoking and physical workload are on the pathway from low education to mobility limitation (Sainio et al. 2007).

It has been suggested that home ownership and financial assets are the best indicators of SES in predicting functional ability (Robert & House 1996, Grundy & Glaser 2000, Avlund et al. 2004). Those who live in rented apartments are more likely to have problems with the activities of daily living (Rautio et al. 2006) and also have higher risk for institutionalization (Wang et al. 2001) than those living in their own apartment. Home ownership has in many cases been used as a social indicator (Grundy & Glaser 2000, Rautio et al. 2006), but it is informative, among other things, about life control, and seems to be a more important factor than current income (Grundy & Glaser 2000).

Besides the individual's SES, the sociodemographic and housing characteristics of their neighbourhood have an effect on residents' wellbeing. Neighbourhood SES can be defined on the basis of mean household income, percentage of post-secondary education graduates and percentage of low income households in certain neighbourhoods (Grant et al. 2010). Kamphuis et al (2009) found in their study that unfavourable neighbourhood conditions (i.e. poor aesthetics) explained the association between individual SES and less outdoor walking. Low income, poor housing stock and residential instability increase the number of neighbourhood problems (Balfour & Kaplan 2002). Those who live in disadvantaged neighbourhoods, report significantly worse health status, and are physically less active, than those in advantaged areas (Ross & Mirowsky 2001). Low SES neighbourhoods have greater distances to services

and more traffic noise, while higher SES neighbourhoods have more possibilities for walking, for example better walking routes and more parks, which affects the outdoor walking activity among older people (Grant et al. 2010). This might help to explain why neighbourhood deprivation has a significant effect on the development of mobility difficulties in older people (Lang et al. 2008b, Beard et al. 2009a).

Fear

Fear is a distressing emotion, usually aroused by impending danger, whether the threat is real or imagined. Fear is an example of negative affect resulting from mismatch between environmental press and individual competence (Lawton & Nahemow 1973). Among older people, one major feature that leads to avoidance of outdoor activities is fear. Most commonly reported fears among older people are fear of falling and fear of crime (Murphy et al. 2002, Delbaere et al. 2004, Martin et al. 2005, Stafford et al. 2007, Zijlstra et al. 2007, Foster & Giles-Corti 2008, Roman & Chalfin 2008). Previous studies have shown that fear is common, especially among older women, and that fear correlates with factors such as low SES and poor health (Murphy et al. 2002, Delbaere et al. 2004, Zijlstra et al. 2007, Scheffer et al. 2008).

Fear of falling has been defined as a lasting concern about falling that leads to avoidance of activities that the person is capable of performing (Tinetti & Powell 1993). For example, fear may restrict participation in physical activity (Murphy et al. 2002, Martin et al. 2005, Wijlhuizen et al. 2007, Zijlstra et al. 2007) and thus lead to decline in physical capabilities (Cumming et al. 2000, Delbaere et al. 2004). This can be explained by the self-efficacy theory, which suggests that people tend to avoid situations that they believe exceed their coping skills (Bandura 1977). Self-efficacy, which is seen as central in explaining fearful and avoidant behavior (Bandura 1977), is also very important internal characteristic for outdoor mobility (Booth et al. 2000, Kono et al. 2004, Lord et al. 2010).

Some studies of fear of falling have proposed that this particular fear might be part of a more generalized psychological disorder (Murphy et al. 2002) or generalized fearfulness (Lawrence et al. 1998), which suggests that fear-related avoidance of activities should be examined from a more general point of view, rather than focusing on either fear of falling or fear of crime. Thus far, a general fear or avoidance of walking outdoors has been suggested to be a consequence of crime and disorders in the neighborhood (Roman & Chalfin 2008), with the result that features of the physical environment have been neglected, despite the fact that environmental barriers may cause insecurity when moving outdoors and so predispose older people to avoid outdoor activities.

2.2.6 Physical activity – a basic need

Physical activity is defined in a broad sense as "any bodily movement produced by the skeletal muscles that results in an expenditure of energy" (Caspersen et al. 1985). The American College of Sport Medicine and the American Heart Association produced recommendations for physical activity for older people

(Nelson et al. 2007) which were formulated with the aim of promoting or maintaining health by reducing the risk of chronic conditions, functional limitations and disability. However, these recommendations do not take into account personal experience of the adequacy of the physical activity engaged in. The majority of older community-dwelling people wish to increase their level of physical activity, especially if they have mobility limitations (Leinonen et al. 2007, Rasinaho et al. 2007). However, a substantial proportion of them also feel that they lack the opportunity to do so. This situation leads to unmet need for physical activity, which is the feeling that one's level of physical activity is inadequate, and is therefore distinct from the amount of physical activity recommended as sufficient for good health.

Physical activity can be considered as a basic human need for human. A basic need, in general, may be defined as "an energizing state that, if satisfied, conduces toward health and well-being but, if not satisfied, contributes to ill-being" (Ryan & Deci 2000) . Inadequately met basic needs predict depression (Blazer et al. 2007), problems in physical functioning (Sachs-Ericsson et al. 2006) and mortality (Blazer et al. 2005). Studies have shown the prevalence of different disturbing behaviors among institutionalized people who are not able freely to move outdoors, and who are probably experiencing unmet need for physical activity. For example, a common behavioral disorder among institutionalized dementia patients is agitation, which is a generalized term for disruptive behaviors such as wandering and repeated vocalization. Many studies have found that access to outdoor environments decrease agitation (Cohen-Mansfield 2007, Connell et al. 2007, Detweiler et al. 2008), while physical inactivity increases stress and agitation (Scherder et al. 2010) among institutionalized older people with dementia.

Previous research in the field of unmet needs among older people has been limited almost entirely to the needs of care, health services, personal assistance and economic security (Desai et al. 2001, Iliffe et al. 2004, Blazer et al. 2005, Sachs-Ericsson et al. 2006, Blazer et al. 2007, Lee 2007). Some earlier research exists on unmet need of physical activity but it is focused on children and examines whether children meet recommendations laid down for physical activity. Unmet need for physical activity as a personal experience among older people has been ignored in research.

2.3 Environmental factors and outdoor mobility decline

Environment and physical activity

In this study the focus is on the outdoor physical environment, which refers to the neighbourhood area inclusive of the natural and built environment. Previously it has been stated that environmental features can either facilitate or restrict participation in outdoor activities (WHO 2001) and that environmental conditions affect outdoor physical activity, especially in older adults (Shumway-Cook et al. 2003). Sugiyama and Ward Thompson (2007) studied the me-

chanisms underlying the association between environment and health among people over 65 years of age. They found that neighborhood environments contribute to health in two ways: by providing opportunities to be physically active and by providing possibilities for social interaction (Sugiyama & Ward Thompson 2007).

It has been found previously that safe footpaths for walking (Booth et al. 2000, Li et al. 2005), presence of sidewalks (Brownson et al. 2001, Spence et al. 2006, Christensen et al. 2010,) and living within walking distance of accessible facilities are positively associated with physical activity (Booth et al. 2000, King et al. 2005, Li et al. 2005, King 2008, Nagel et al. 2008, Grant et al. 2010). On the other hand, it has also been found that barriers in the outdoor environment, such as poor street conditions and inadequate lighting, correlate with a lower level of physical activity and walking and a higher prevalence of outdoor mobility restriction (Booth et al. 2000, Brownson et al. 2001, Hooker et al. 2005, Mota et al. 2007).

A recent American study of people aged 18-64 with and without disabilities showed that people with disabilities engage less in physical activity than people without disabilities, but that positive perceptions of the environment have similar effects on physical activity participation for both. The most meaningful feature in the environment, in terms of physical activity participation, for people with disabilities was the presence of sidewalks. For people without disabilities, recreation facilities, trails and parks were most meaningful (Christensen et al. 2010). Enjoyable scenery and walkable green and open spaces near the homes are positively associated with walking activity among older people (Brownson et al. 2001, Li et al. 2005, Spence et al. 2006), although among middle-aged people, such an association was not found (Hillsdon et al. 2006, Maas et al. 2008). In addition, a recent review showed that physical activity in natural environments has more health effects than physical activity in a built indoor or outdoor environment (Bowler et al. 2010). However, the studies in question comprised people under age 65, and consequently the results cannot be generalized to the older population.

Environment and functional capacity

Previous studies have shown an association between environmental features and functional capacity, but most of these studies are cross-sectional and only a few are prospective. However, in cross-sectional studies it has been shown that people with mobility limitations report more barriers in their environment than people without limitations (Shumway-Cook et al. 2003). This topic has been studied in particular in different patient groups, such as people with osteoarthritis (Keysor et al. 2010, White et al. 2010), spinal cord injury (Whiteneck et al. 2004b), and stroke (Rochette et al. 2001). Shumway-Cook et al. (2002) studied environmental demands associated with community mobility among older people with and without mobility limitations. They found no differences in encountering challenges of distances, traffic density, light levels and weather conditions between those with and those without mobility limitations. However,

those with mobility limitations encountered more challenges with e.g. manual doors, carrying packages, and terrain, such as stairs or uneven surfaces (Shumway-Cook et al. 2002). Clarke and George (2005) studied the role of the built environment in the pathway from functional limitation to disability among older Americans, focusing on lower extremity functions. They found that despite declining physical function, older adults reported greater independence in IADL functions if they lived in an environment with more land-use diversity, which was suggested to support active living (Clarke & George 2005).

Some studies have shown that environmental barriers per se are not associated with ADL dependence; instead, person-environment interaction, P-E fit, is the important feature linking them and its importance grows stronger with advancing age (Werngren-Elgstrom et al. 2008). Clarke and colleagues (2009) studied long-term trajectories of mobility disability over 15 years and found that pedestrian-friendly environments are associated with lower risk for having mobility limitations in old age (Clarke et al. 2009). Balfour and Kaplan (2002) studied development of overall functional loss among people over 55 years of age over one year. They found that barriers in the outdoor environment, such as poor street conditions, poor lighting and heavy traffic increased the risk of functional loss, especially in the lower extremities (Balfour & Kaplan 2002). Similar results were found among middle-aged African Americans (Schootman et al. 2006).

2.4 Outdoor environment and quality of life in old age

For over three decades, quality of life (QoL) has been used as a broad outcome measure in health studies (Gill & Feinstein 1994, Halvorsrud & Kalfoss 2007). Although widely studied, there is no universally accepted definition of QoL. Many studies have referred to the definition of QoL as "individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" given by the World Health Organization (WHO Quality of Life group 1995). In the recent literature, QoL is typically seen as a multidimensional entity which includes domains such as health and symptoms, mood, functioning, life satisfaction and participation (Netuveli et al. 2006, Levasseur et al. 2008b). Lawton (Lawton 1991) defined QoL as "the multidimensional evaluation, by both intrapersonal and social-normative criteria, of the person-environment system of an individual in time past, current, and anticipated". The present study is guided by this definition.

Social relationships, independence and autonomy, health, and financial issues are frequently mentioned as determinants of QoL in older people. Additionally, ability to move around, sensory abilities, and home environment are mentioned as very important for QoL (Kalfoss & Halvorsrud 2009). The importance of the environment for QoL has been acknowledged, even if not yet widely studied (Sugiyama & Ward Thompson 2005, Cutler 2007, Wahl et al.

2009b). Thus far, studies have been limited to comparing differences in QoL according to types of housing, such as those living in institutions and those living at home. These studies have shown lower QoL scores among those living in assisted living facilities or nursing homes than those living in ordinary housing (Cutler 2007, Bodur & Dayanir Cingil 2009, Karakaya et al. 2009). Less is known about the association between specific features of the outdoor environment and QoL in older community-dwelling people in general. One recent study showed that fewer barriers in the physical environment predicted good QoL, but did not specify the most severe environmental barriers (Levasseur et al. 2008b). A study among people with spinal cord injuries showed that negative environmental factors decreased their possibilities to move outdoors, thus having negative effects on life satisfaction (Whiteneck et al. 2004a). However, similar studies have not been carried out among older people.

Although the association between the environment and QoL has not been widely studied, knowledge of the benefits of moving outdoors for overall well-being in older people has increased (Kono et al. 2004, Simonsick et al. 2005). For example, restrictions on participation in out-of-home activities and having to give up meaningful activities reduce QoL (Clarke et al. 2000, Ekstrom et al. 2008, Levasseur et al. 2008a). In their recent literature review, Abraham and colleagues (2010) suggest, that to promote health, the most important environmental aspects are easy access to natural environments and the availability of green areas. Additionally, perceptions of the environment as pleasant, attractive and safe are important for general well-being (Abraham et al. 2010).

Natural environments offer multisensory stimulation for the physical, emotional, psychological and cognitive domains. To have experiences of natural environments, people do not necessarily have to walk in those environments, as even passive interaction with the environment has positive health effects, especially for older people with dementia (Bossen 2010). Relaxing and restorative effects of natural environments have been observed in many studies among adult populations. Recovery from the stress is faster and more complete when the subject is exposed to natural rather than urban environments (Ulrich et al. 1991).

2.5 Summary and study concepts

2.5.1 Summary of the literature review

Moving outdoors is a prerequisite for taking care of daily activities, such as shopping, but also for meeting friends and relatives, doing gardening and taking a walk for physical exercise or attending different events. Outdoor mobility limitation is common among older people and increases with advancing age (Simonsick et al. 2005, Wilkie et al. 2006). Individual features related to outdoor mobility have been widely studied, but knowledge of the environmental effects on the development of mobility decline and quality of life in older people is in-

sufficient. Commonly reported barriers to mobility in the outdoor environment include e.g. poor lighting, uneven sidewalks, busy traffic and lack of benches (e.g. Balfour & Kaplan 2002, Ståhl et al. 2008). Although there is some evidence that barriers in the outdoor environment have an effect on participation in physical activities (Booth et al. 2000), mobility decline (Balfour & Kaplan 2002) and quality of life (Levasseur et al. 2008b) in older people, most studies have focused on people under age 65 or have only carried out cross-sectional analyses, thus being unable to confirm the temporal order of the associations. More prospective studies are needed to evaluate the role of the environment in the disablement process.

A common cause for avoiding outdoor mobility in old age is fear. The most commonly studied fear is that of falling. Fear may decrease the perceived opportunities for moving outdoors, potentially leading to unmet physical activity need. Physical activity can be seen as a basic need, which, if not met, may lead to adverse health events. The inability to perform desired activities may also affect the individual's quality of life.

2.5.2 Study concepts

In the present study, perceived barriers to outdoor mobility represent "the environmental press", which in the disablement process model are seen as the extra-individual factors that are threats to functional capacity. Personal competence is studied in terms of walking ability, health status and mood. The imbalance between the environment and the individual, which Lawton and Nahemow (1973) referred to as maladaptation, are shown in the present study as fear of moving outdoors and unmet physical activity need.

In the present study, outdoor mobility refers to walking that takes place outside of the home, thus leaving transportation and wheelchairs outside the study. Outdoor mobility decline refers to increase in perceived walking difficulties or loss of walking ability, which in the disablement process model are seen as functional limitations. Two outdoor mobility tasks, walking 2 km and 0.5 km which express different stages of mobility decline, are examined.

Quality of life is used as a global outcome of the relationships between barriers in the outdoor environment and outdoor mobility decline, fear of moving outdoors and unmet physical activity need.

Table 1 shows the definitions of the central concepts used in the study grouped according to the ecological model of ageing.

TABLE 1 Definitions of the central concepts of the thesis grouped according to the ecological model of ageing

Concept	Definition and reference
Environmental demand	
Perceived barriers in the outdoor environment (I, II, III, IV)	In this thesis physical environment refers to the natural and built environment near the participant's home. Perceived barriers in the outdoor environment are features in the physical environment with a negative influence on activity (WHO 2001)
Individual Capabilities	
Outdoor mobility (I, II, III)	Ability to move oneself within environments that expand from one's home to the neighborhood and to regions beyond (Webber et al. 2010)
Outdoor mobility decline (I, II)	In this thesis outdoor mobility decline refers to increase in perceived walking difficulties or loss of walking ability
Interaction between environment and individual	
Physical activity (I, III)	Any bodily movement produced by skeletal muscles that result in an expenditure of energy (Caspersen et al. 1985)
Unmet physical activity need (III, IV)	Unmet physical activity need is a feeling that one's level of physical activity is inadequate. Basic need is an energizing state that, if satisfied, conduces toward health and well-being but, if not satisfied, contributes to ill-being (Ryan & Deci 2000)
Fear of moving outdoors (II, III, IV)	An emotional condition that can lead to avoidance of outdoor activities that are well within a person's functional health capacity
Outcome	
Quality of Life (IV)	The multidimensional evaluation, by both intrapersonal and social-normative criteria, of the person-environment system of an individual in time past, current, and anticipated (Lawton 1991)

3 AIM OF THE STUDY

The purpose of the study was to examine effects of barriers in the outdoor environment on outdoor mobility decline and quality of life among older people. Specifically, the purpose was to examine:

1. Is there an association between perceived barriers in the outdoor environment and development of walking difficulty? (I)

2. What individual and environmental factors are associated with fear of moving outdoors and does fear of moving outdoors predict incident outdoor walking decline? (II)

3. What individual and environmental factors are associated with unmet physical activity need and does fear of moving outdoors and barriers in the outdoor environment predict development of unmet physical activity need? (III)

4. How are barriers in the outdoor environment associated with quality of life among older people and do fear of moving outdoors and unmet physical activity need play a role in this association? (IV)

4 DATA AND METHODS

4.1 Study design and participants

The data for the study come from the Screening and Counseling for Physical Activity and Mobility in Older People (SCAMOB) project. The SCAMOB project investigates the effects of physical activity counseling among community-dwelling older people in the city of Jyväskylä. Jyväskylä is a city in Central Finland with a population of almost 130 000. The city's landscape is characterized by extensive areas of lakes, high hills covered with forests and high ridge in the middle of the city.

The target population of the study comprised all community-dwelling 75- to 81-year-old residents living in the city centre area of Jyväskylä, Finland (N=1310) in March 2003. The contact information was gathered from the Finnish population register. A letter informing about the study was sent to all potential participants and soon after receipt of the letter they received a brief phone call from the study centre, in which they were asked about their health, physical activity and mobility as well as their willingness to participate in the study. 1100 persons were reached and 17% of them were excluded because they were either too physically active or had excessively impaired mobility. In addition, some refused to continue at this point. A total of 727 people (188 men and 539 women, mean age 77.6 (standard deviation, SD=2.0) years) were willing to participate in study and were interviewed in their homes. To be eligible for the study, participants had to be able to walk 500 meters without help from another person, be only moderately physically active or sedentary (at most 4 hours of walking or 2 hours of other exercise weekly), have a Mini-Mental State Examination (MMSE) score > 21 and have no medical contraindications for physical activity (Leinonen et al. 2007). Of the 727 participants who were interviewed at home, 657 participated in physical assessments and interviews conducted by a nurse examiner in the study centre. After the baseline interviews and examinations, 632 people agreed to take part in a randomized controlled trial and were randomized into an intervention and a control groups.

In the present study, baseline interview data (n=727) were used for the cross-sectional analyses and data from the control group (n=314) were used to follow up the naturally occurring changes in mobility. After the baseline face-to-face interviews, telephone interviews on mobility were carried out 3 times at 6-month intervals. Face-to-face interviews were conducted again at the 2-year follow-up point and telephone interviews again 3 times at 6-month intervals. Thus, the overall follow-up period was 3.5 years.

For prospective analyses on the development of perceived difficulty in walking 2 km or 0.5 km, those participants who reported no difficulty in these tasks at baseline (walking 2 km, n=214; walking 0.5 km, n=266) were included. The drop-out rate in the control group over the 3.5 years was 14% (45 persons). Of these, 18 died, 16 declined, 8 dropped out because of poor health, 1 moved and 2 persons were not reached.

4.2 Ethics

The SCAMOB project was approved by the Ethical Committee of the Central Finland Health Care District. The participants were informed about the research and signed an informed consent. The study was conducted according to the guidelines for good scientific and clinical practice laid down by the Declaration of Helsinki.

4.3 Measurements

4.3.1 Barriers in the outdoor environment

Barriers in the outdoor environment were examined as perceived by the participants by using standardized questions. That is, the participants were asked whether certain environmental features impacted negatively on their possibilities for moving independently outdoors, with the answer options yes/no. This provided a subjective view of the outdoor environment and features of the walking routes the participants used. The environmental features asked about were poor street conditions, hills in the immediate environment, long distances to everyday services (e.g. shops, banks), lack of resting places, noisy traffic and dangerous crossroads.

In the analyses environmental barriers were used one at a time (Papers II-III) or combined (Papers I and IV). For the combined variables, the information on lack of resting places and long distances was merged and recoded to form the variable *Distances*; noisy traffic and dangerous crossroads were recoded as *Traffic*; and hilly terrain and streets in poor condition were recoded as *Terrain*. For the purpose of Paper I, these three new variables were dichotomized. For each of the three constructed variables, 0 indicates that neither of the barriers

were reported, and 1 that one or both of the barriers in the respective variable were present.

In Paper IV, the range of each variable was set to 0, 1 or 2. For each of the variables (Distances, Traffic and Terrain) 2 indicates that both barriers were reported, and 0 that neither and 1 that one of the barriers in the respective variable was present.

4.3.2 Walking difficulty

Walking difficulty was studied using a structured interview on perceived difficulties in walking 2 km and 0.5 km. The questions were formulated as follows: "Do you have difficulty in walking 2 km?" and "Do you have difficulty in walking 0.5 km?", with the following response options: (1) I am able to manage without difficulty, (2) I am able to manage with some difficulty, (3) I am able to manage with great deal of difficulty, (4) I am able to manage only with the help of another person, and (5) I am unable to manage even with help. For the analyses, perceived difficulties in walking was dichotomized into "no difficulties" (1) and "difficulties" (2-5). Difficulties in walking 2 km and 0.5 km express different stages of mobility decline, thus allowing the influence of the environment on the progression of early and advanced mobility limitation to be studied.

4.3.3 Fear of moving outdoors

We created a variable to describe fear of moving outdoors. This variable was based on two questions included in a larger questionnaire on outdoor mobility. In the first question, participants were asked to choose from a list of items all those which described their situation. Participants who agreed with the statement "I have feelings of insecurity when moving outdoors" were considered to have fear of moving outdoors. In addition, participants were asked if they avoid moving outdoors and, if so, to write down their reasons for avoiding going outdoors. Those who reported that they avoid moving outdoors for reasons that could be categorized as perceived elements of danger, insecurity due to other pedestrians or fear were also considered to have fear of moving outdoors. People reporting other reasons for not going outdoors, such as poor vision, were not categorized as having fear of moving outdoors. To be categorized as having fear of moving outdoors, the participant had to report either feelings of insecurity when moving outdoors, or avoid moving outdoors because of perceived elements of danger, insecurity due to other pedestrians or fear, or both.

4.3.4 Unmet physical activity need

Unmet physical activity need was studied by the question "Do you feel that you would have the opportunity to increase your level of physical activity level if someone recommended you do so?" and "Would you like to increase your level of physical activity?", with the response options yes/no. Persons who felt that they had no opportunity to engage in physical activity despite being willing to

increase their physical activity level were defined as experiencing unmet physical activity need.

4.3.5 Quality of life

Perceived quality of life (QoL) was assessed using the LEIPAD questionnaire (De Leo et al. 1998). The questionnaire was left with the participants during an at-home interview, where they were given instructions on how to fill it in. They were asked to bring the completed questionnaire along to the study centre, where the nurse examiner checked it. The LEIPAD was constructed for use with older people, and comprised 31 items related to seven subscales: physical function (5 items), self-care (6 items), depression and anxiety (4 items), cognitive functioning (5 items), social relations (3 items), sexual functioning (2 items), and life satisfaction (6 items). Each item was scored from 0 to 3, with 0 indicating the best condition and 3 the worst. Each subscale can be used to represent different dimensions of QoL, but also a summed index of all items can be used as an indicator of overall QoL. Higher scores indicate worse QoL (range 0-93) (De Leo et al. 1998). In the present study the summed index was used, and ancillary analyses were performed for each of the subscales.

4.3.6 Physical activity

Habitual physical activity was assessed using a previously validated 7-category scale (Grimby 1986): (a) mainly resting, (b) most activities performed sitting down, (c) light physical activity 1–2 h/wk, (d) moderate physical activity 3 h/wk, (e) moderate physical activity at least 4 h/wk, (f) strenuous physical exercise several times a week, and (g) competitive sports several times a week. Persons who belonged to the two highest categories had been excluded from the study before randomization, as they were considered to be too physically active and thus would not have benefited from the physical activity counseling intervention, which was the primary research question of the SCAMOB project.

4.3.7 Chronic conditions

Information on chronic conditions was elicited as self-reported physician-diagnosed chronic conditions by the question: “Do you have any disease or defect diagnosed by a doctor that has lasted over 3 months?” and the response was written down by the interviewer during the at-home interview. All chronic conditions reported were later confirmed by a nurse examiner in the clinical examination held in the study centre. A condition was considered chronic if it had lasted more than three months. For the purpose of the analyses, the number of chronic conditions was calculated as the number of different physician-diagnosed diseases the participants reported. Subsequently, chronic conditions were divided into the categories of cardiovascular, musculoskeletal and lung diseases (Leinonen et al. 2007).

4.3.8 Maximal walking speed

Maximal walking speed was measured in the study centre corridor over a distance of 10 meters (Aniansson et al. 1980). The participants were allowed 2 to 3 meters for acceleration before the start-line and they were encouraged to walk as fast as possible without risking their health. Timing was done using a stopwatch. The participants wore sneakers or walking shoes and use of a walking aid was allowed if needed.

4.3.9 Potential confounders

Variables reported in previous studies as correlating with environmental factors and mobility decline were considered as potential confounders. Sociodemographic indicators included age, living arrangements (alone or with someone), years of education and perceived financial position (very bad, bad, or moderate vs. good or very good). Use of mobility devices indoors and outdoors was self-reported. Cognitive impairment was assessed with the Mini-Mental State Examination (MMSE) (Folstein et al. 1975) and depressive symptoms with the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff 1977).

4.4 Statistical analysis

4.4.1 Descriptive statistics

Descriptive statistics were obtained by using SPSS software program (SPSS inc. Chicago, IL, versions 14.0, 15.0 and 18.0). Baseline characteristics were described by using means and standard deviations or percentages. To test for the statistical significance of group differences, chi-square tests for the categorized variables and *t* tests for the continuous variables were used.

The incidence of walking difficulty (Paper I) was calculated for each environmental barrier and expressed as the number of cases per 10 person years. Time to walking difficulty was calculated as days from the beginning of the study until the day of the interview when the participant first reported difficulty. The cumulative incidence was calculated by the number of new cases during the 6-month period divided by the number of subjects at risk at the beginning of the study.

Analysis of variance (ANOVA) (Paper IV) was used to test differences in the mean QoL scores between groups according to gender, those afraid and not afraid of moving outdoors, those with and those without perceived unmet physical activity need and those who reported 0-2 difficulties in outdoor environment. Additionally, the correlations between each subscale of the LEIPAD questionnaire and each environmental variable were calculated to investigate if the associations were similar to the overall score of the LEIPAD questionnaire.

All the analyses in each Paper (I-IV) were performed first separately for women and men. As the associations were practically identical for both sexes, for the final reports men and women were included in the same analyses adjusted for gender.

4.4.2 Multivariate models

Logistic regression analyses
Logistic regression analyses were used to identify the factors associated with fear of moving outdoors and unmet physical activity need at baseline (Papers II and III). Age- and gender-adjusted as well as fully adjusted cross-sectional associations were studied. Additionally, the participants were stratified according to whether or not they experienced difficulties in walking 2 km to examine whether the relationship between environmental factors and unmet physical activity need differed between these groups (Paper III).

In the longitudinal setting, individual and environmental factors as predictors of unmet physical activity need were studied by using logistic regression analyses (Paper III). Those reporting unmet physical activity need at baseline were excluded from these analyses. Separate models were created for the individual and environmental factors. The first model was adjusted for age and gender and the second model was a multivariate model in which all the variables were included simultaneously.

Cox regression models
Cox regression models (Cox & Oakes 1984) were used to assess the association between each environmental barrier and incident walking difficulty in the longitudinal setting (Paper I). Time to walking difficulty was calculated as days from the beginning of the study until the day of the interview when the participant first reported difficulty. Participants were censored when they first reported walking difficulty, at their day of death or at the end of the follow-up, whichever occurred first. All the analyses were performed separately for perceived difficulty in walking 2 km and 0.5 km, and two models were created for each environmental variable. In the base model, age and gender were included as covariates. In the adjusted model, age, gender, physical activity, education in years, perceived financial situation, cardiovascular, lung, and musculoskeletal disease, cognitive status and depressive symptoms were included as covariates.

Generalized Estimating Equations model
Fear of moving outdoors as a predictor of perceived walking difficulty was studied by constructing generalized estimating equations models (GEE) (Liang & Zeger 1986) (Paper II). This approach was chosen, because it was anticipated that after first reporting walking difficulty some people may also recover from it. Prevalence at each data collection round, as shown in Figure 4, is a function of the incidence of, and recovery from, the difficulty state. The exception is the first follow-up, when prevalence and incidence coincided, as we excluded from these analyses people who reported walking difficulty at baseline. In the GEE

models, changes between states from 'no difficulty' to 'difficulty', and from 'difficulty' to 'no difficulty', were compared between groups formed according to presence of fear of moving outdoors at baseline. The interaction effects, expressed as odds ratios (OR), indicate whether the changes differed between those with fear of moving outdoors compared to those with no fear. Calculating the ORs for each 6-month follow-up separately was chosen, as it was not possible to anticipate when the changes would take place and how long they would last due to lack of earlier studies. Each OR indicates whether changes to and from the state of difficulty differed statistically significantly between the fear and no-fear groups over each sequential six-month period with the beginning of that period as the baseline. In addition, GEE modeling was used to analyze whether prevalence of perceived walking difficulty over the entire 3.5-year period differed significantly between those with fear compared to those with no fear. All the analyses were performed separately for perceived difficulty in walking 0.5 km and walking 2 km. Two separate GEE models were constructed for each distance. The first model was adjusted for age and gender. In the second model, age, gender, education in years, musculoskeletal diseases, depressive symptoms, walking speed and environmental factors were included as covariates. The analyses were performed with SAS software program version 9.1 (SAS Institute, Inc., Cary, NC) using the GENMOD procedure.

Path analyses

A path analysis model, which is one of the techniques included in structural equation methods using LISREL (Jöreskog & Sörebom 1993), was used for the analyses of the determinants of QoL (Paper IV). A path analysis made it possible to study simultaneous associations of the factors influencing QoL as well as their interrelations. To create the path analysis model, correlation coefficients were computed for the number of chronic conditions, maximal walking speed, environmental barriers, unmet physical activity need and fear of moving outdoors. To carry out model testing, this model requires complete data with no missing values on any variable. Complete data for the path analysis were available from 589 participants.

Indicators of model fit were χ^2, goodness-of-fit index (GFI) (≥ 0.9 indicates a good fit), adjusted goodness-of-fit index (AGFI) and root mean square residual (RMR). The multivariate procedure was accomplished using the LISREL 8.72 program (Scientific Software International, Inc, Lincolnwood, IL).

In all the analyses, when the 95% confidence intervals (CIs) did not include the value 1, or when $p<.05$, the results were regarded as statistically significant.

Data imputation

For cases with missing values in mobility limitation at some point over the 3.5-year follow-up, data were imputed with the multiple imputation procedure implemented in SAS by using information on other mobility tasks and baseline information on number of long-term diseases, body mass index and MMSE and

CES-D score (Papers I-III). The sensitivity analyses performed suggested no substantial differences in effects due to imputation. Subjects who died (n=18) during the follow-up were censored at the date of death and missing values were not imputed.

5 RESULTS

5.1 Characteristics of the participants

Table 2 summarizes the baseline characteristics of the participants in the SCA-MOB project.

TABLE 2 Baseline characteristics of the participants in the SCAMOB project (n=727).

	Mean	(SD)
Age	77.6	(2.0)
Education (years)	9.1	(4.2)
Chronic conditions (number)	3.1	(2.0)
Walking speed (m/s)	1.4	(0.4)
CES-D (score)	10.2	(7.6)
MMSE (score)	26.8	(2.5)
QoL (score)	26.1	(8.9)
	%	
Women	75	
Living alone	58	
Financial situation		
Good or very good	42	
Bad or very bad	58	
Lung disease	16	
Musculoskeletal disease	50	
Cardiovascular disease	67	
Difficulties in walking 2 km	33	
Difficulties in walking 0.5 km	14	
Fear of moving outdoors	56	
Unmet physical activity need	14	

SD=Standard Deviation

5.2 Barriers in the outdoor environment

Table 3 summarizes the barriers in the outdoor environment reported by the participants. The most commonly reported barrier in the outdoor environment was hills in the immediate vicinity, which was reported by 23% of the participants. At baseline, people with walking difficulties reported more barriers in their outdoor environment than those without walking difficulties. In particular, poor street conditions, hills in the nearby environment, long distances to everyday services and lack of resting places were more prevalent among people with walking difficulties. There were no major differences between women and men in reporting barriers in the outdoor environment.

TABLE 3 Barriers in the outdoor environment at baseline according to gender and difficulties in walking 2 km at baseline among 75- to 81-year-old community-dwelling people.

Barriers in the outdoor environment	Total n=727	Women n=539	Men n=188	p-value*	Walking difficulty n=256	No walking difficulties n=467	p-value*
	%	%	%		%	%	
Poor street condition	19	21	13	.014	23	17	.035
Hills	23	26	16	.005	38	16	<.001
Long distances	10	11	7	.088	15	7	<.001
Lack of resting places	12	13	10	.403	22	5	<.001
Noisy traffic	12	12	11	.701	14	12	.769
Dangerous crossroads	13	14	13	.799	13	13	.866

* Statistical significance calculated with Chi-square test

5.3 Barriers in the outdoor environment and mobility decline

5.3.1 Barriers in the outdoor environment and development of walking difficulties (I)

The baseline characteristics of the participants according to the development of walking difficulty in walking 2 km during the 3.5-year follow-up are shown in Table 4. Those who developed walking difficulty during the follow-up reported Distances and Terrain as environmental barriers to outdoor mobility more often compared to those who did not develop walking difficulty. Additionally, they were older, had more depressive symptoms and were less physically active than persons who did not develop walking difficulty during the follow-up (Table 4).

TABLE 4 The baseline characteristics of the 75- to 81-year-old participants (n=214) who had no walking difficulty at baseline, according to development of difficulty in walking 2 km during the 3.5-year follow-up (Paper I).

	Developed Difficulty n=124		No Difficulty n=90		p-value*
	Mean	(SD)	Mean	(SD)	
Age	77.7	(1.7)	77.1	(2.0)	.019
Education in years	9.0	(5.0)	9.9	(4.4)	.181
CES-D	9.7	(6.0)	7.0	(5.7)	.002
MMSE	27.0	(2.2)	27.3	(2.3)	.312
	%		%		
Women	73		70		.566
Financial situation					.671
Bad or moderate	57		53		
Good or very good	43		47		
Cardiovascular disease	70		64		.344
Musculoskeletal disease	43		33		.136
Lung disease	15		7		.066
Physical Activity					.003
Mainly resting	0		0		
Most activities performed sitting down	1		0		
Light physical activity, 1-2 h/wk	23		8		
Moderate physical activity, 3 h/wk	52		48		
Moderate physical activity, ≥ 4 h/wk	25		44		
Barriers in the outdoor environment					
Distances	16		4		.004
Terrain	35		17		.006
Traffic	21		21		.971

* Chi-square test and *t* test

CES-D= Center for Epidemiologic Studies Depression Scale

MMSE= Mini-Mental State Examination

SD= Standard Deviation

NOTE: Barriers in the outdoor environment studied were lack of resting places and long distances (Distances), hilly terrain and poor street conditions (Terrain) and noisy traffic and dangerous crossroads (Traffic).

Cumulative incidence for difficulty in walking 2 km and 0.5 km at each six-month follow-up are shown in Table 5. Cumulative incidence for difficulties in walking 2 km was 59% and in walking 0.5 km 45%.

TABLE 5 Cumulative incidence of 0.5 km and 2 km walking difficulty at semi-annual follow-ups among people without walking difficulty at baseline (0.5 km, n=266; 2 km, n=214) according to whether certain barriers in the outdoor environment are present or absent.

2 km walking		6 Months	12 Months	18 Months	24 Months	30 Months	36 Months	42 Months
Distances (%)	Yes (n=24)	50	58	63	71	75	83	83
	No (n=190)	20	30	36	41	47	51	55
Terrain (%)	Yes (n=61)	33	48	54	57	66	66	70
	No (n=153)	20	27	33	39	44	48	53
Traffic (%)	Yes (n=45)	31	42	44	51	56	56	58
	No (n=168)	21	31	38	42	49	55	58
0.5 km walking								
Distances (%)	Yes (n=40)	33	35	45	53	63	65	68
	No (n=226)	10	19	25	28	33	36	39
Terrain (%)	Yes (n=84)	23	30	35	39	46	49	52
	No (n=182)	9	18	25	29	34	37	41
Traffic (%)	Yes (n=58)	17	28	36	41	45	48	50
	No (n=208)	12	20	25	29	35	38	42

NOTE: Barriers in the outdoor environment studied were lack of resting places and long distances (Distances), hilly terrain and poor street conditions (Terrain) and noisy traffic and dangerous crossroads (Traffic).

The rate of walking difficulty ranged from 1.4 to 5.4 per 10 person years according to the presence of barriers in the outdoor environment and the mobility task in question. For example, in the group reporting Distances as a barrier in the outdoor environment, the rate of incident difficulty in walking 2 km was 5.41/10 person years, while among those who did not report that particular environmental feature, the rate was 2.33/10 person years. For walking 0.5 km, the corresponding numbers were 3.35/10 person years and 1.46/10 person years, respectively (Figure 3).

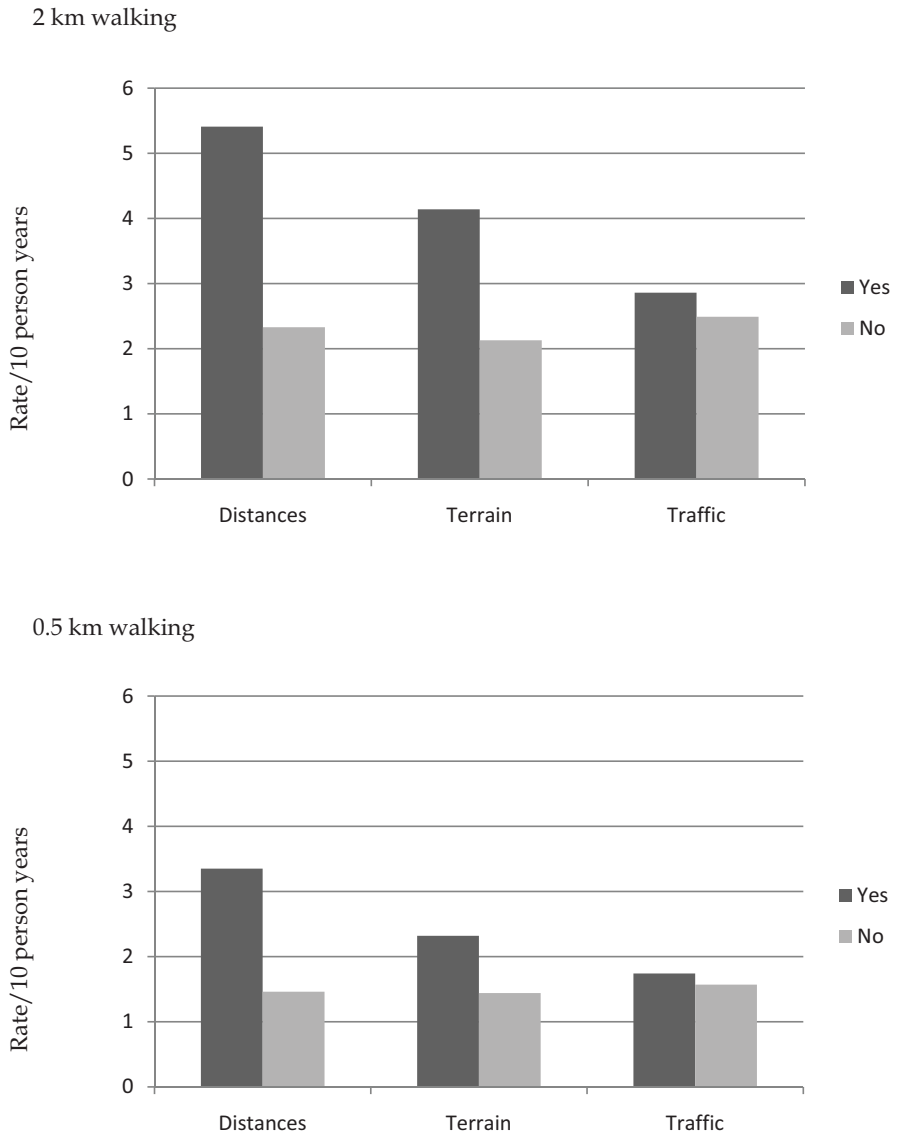

FIGURE 3 The rates of incident walking difficulty in groups based on the perceived barriers in the outdoor environment among community-living people aged 75- to 81-years without difficulties in walking at baseline. Follow-up time was 3.5 years with examinations taking place every 6 months. Barriers in the outdoor environment studied were lack of resting places and long distances (Distances), hilly terrain and poor street conditions (Terrain) and noisy traffic and dangerous crossroads (Traffic) (Paper I).

Cox regression analysis was used to assess the association between each barrier in the outdoor environment and incident walking difficulty. After adjusting the models for potential confounders, people who reported Distances as a barrier in the outdoor environment had approximately twofold risk for incident difficulty in 2 km and 0.5 km walking (Table 6).

TABLE 6 Cox regression model of the effects of barriers in the outdoor environment on the development of perceived difficulties in walking 2 km (n=214) and 0.5 km (n=266) among 75- to 81-year-old community-dwelling people without walking difficulties at baseline in the 3.5-year follow-up (Paper I).

	Difficulties in walking 2 km			
	Base Model*		Adjusted Model†	
Environmental barrier	HR	95% CI	HR	95% CI
Distances	2.66	1.62-4.37	2.19	1.31-3.64
Terrain	2.00	1.37-2.90	1.44	0.96-2.18
Traffic	1.32	0.84-2.06	1.28	0.80-2.05
	Difficulties in walking 0.5 km			
	Base Model*		Adjusted Model†	
Environmental barrier	HR	95% CI	HR	95% CI
Distances	2.43	1.04-3.77	1.90	1.18-3.03
Terrain	1.62	1.11-2.36	1.15	0.76-1.74
Traffic	1.57	1.02-2.42	1.51	0.96-2.38

* Bivariate associations, adjusted for age and gender
† Adjusted for age, gender, physical activity, education in years, financial situation, cardiovascular-, lung- and musculoskeletal diseases, cognitive status and depressive symptoms.
HR= Hazard Ratio
95% CI= 95% Confidence Interval
NOTE: Barriers in the outdoor environment studied were lack of resting places and long distances (Distances), hilly terrain and poor street condition (Terrain) and noisy traffic and dangerous crossroads (Traffic).

5.3.2 Fear of moving outdoors and walking difficulties (II)

At baseline, 8% of men and 11% of women reported feelings of insecurity when moving outdoors and 26% of men and 62% of women avoided moving outdoors because of fear, insecurity due to other pedestrians or other perceived elements of danger. In total, 65% of women and 29% of men reported one or the other and were categorized as having fear of moving outdoors.

People who reported fear of moving outdoors were more likely to be women, have shorter education, have a poor financial situation, live alone, have musculoskeletal diseases and slower walking speed and report poor street conditions, noisy traffic and hills as barriers in the outdoor environment. Women were over four times more likely to report fear of moving outdoors than men (OR 4.47, 95% CI 3.11-6.41). Each additional year of age increased the odds for reporting fear of moving outdoors by 7% (OR 1.07, 95% CI 0.99-1.15) (Table 7).

TABLE 7 Factors associated with fear of moving outdoors in logistic regression analysis at baseline among 75-to 81-year-old people (n=654-727) (Paper II).

	Bivariate*		Multivariate†	
	OR	**95% CI**	**OR**	**95% CI**
Living alone	0.94	0.67-1.32	0.77	0.52-1.14
Education in years	0.94	0.90-0.98	0.96	0.91-1.01
Financial situation				
Bad or moderate vs. good or very good	1.49	1.09-2.04	1.13	0.77-1.65
Cardiovascular disease	1.21	0.87-1.68	1.19	0.83-1.72
Lung disease	0.99	0.65-1.49	0.83	0.51-1.35
Musculoskeletal disease	1.94	1.42-2.66	1.90	1.33-2.73
CES-D	1.02	0.99-1.04	1.00	0.98-1.03
MMSE	0.96	0.90-1.02	0.93	0.85-1.02
10m walking speed, m/s	0.58	0.36-0.94	0.87	0.48-1.56
Difficulty walking 0.5 km	1.01	0.48-2.15	0.84	0.29-2.38
Difficulty walking 2 km	1.19	0.75-1.82	0.91	0.50-1.67
Barriers in the outdoor environment				
Poor street condition	1.71	1.13-2.58	1.31	0.80-2.12
Hills	1.59	1.08-2.32	1.28	0.81-2.04
Long distances	1.36	0.81-2.31	1.14	0.62-2.11
Lack of resting places	1.36	0.84-2.22	1.04	0.56-1.90
Noisy traffic	2.67	1.57-4.56	2.40	1.32-4.39
Dangerous crossroads	1.43	0.90-2.29	1.12	0.65-1.95

* Age- and gender-adjusted bivariate odds ratios
† Age- and gender-adjusted multivariate full model with all variables included in the model simultaneously
CES-D= Center for Epidemiologic Studies Depression Scale
MMSE= Mini-Mental State Examination
OR= Odds Ratio
95% CI= 95% Confidence Interval

The prevalence of mobility difficulty at each semi-annual interview during the 3.5-year follow-up among those with and without self-reported difficulty at baseline in walking 0.5 km or 2 km are shown in Figure 4. The results of the related GEE models are shown in Table 8. People who reported fear of moving outdoors but no difficulty walking 0.5 km or 2 km at baseline were three to almost five times more likely to develop difficulty during the following six months. From six months onwards, the changes to and from the difficulty state were similar between the fear and no-fear groups, making the further ORs non-

significant and the changes in prevalence parallel. The difference in the prevalence of perceived difficulty in walking remained statistically significant throughout the 3.5 -year follow-up for both walking 0.5 km and 2 km (see Table 8, Figure 4.)

TABLE 8 Effect of fear of moving outdoors on the development of perceived difficulties in walking 0.5 km and 2 km among 75- to 81-year-old people afraid of moving outdoors vs. not afraid of moving outdoors. Interaction effect, expressed as Odds ratios (OR), indicates the difference between the groups over time (Paper II).

Difficulties in walking 0.5 km				
	Base Model*		Adjusted Model†	
Months	OR	95% CI	OR	95% CI
0-6	2.56	1.39-4.72	4.60	1.92-11.00
7-12	0.71	0.41-1.23	0.52	0.26-1.06
13-18	0.94	0.56-1.59	0.98	0.46-2.08
19-24	0.93	0.54-1.61	0.93	0.40-2.15
25-30	1.05	0.62-1.78	0.87	0.41-1.85
31-36	0.62	0.35-1.08	0.67	0.31-1.44
37-42	1.22	0.70-2.11	1.15	0.54-2.46
Over time		p=.063		p=.024
Difficulties in walking 2 km				
	Base Model*		Adjusted Model†	
Months	OR	95% CI	OR	95% CI
0-6	2.02	1.27-3.22	3.10	1.49-6.46
7-12	0.81	0.54-1.21	0.83	0.47-1.48
13-18	1.04	0.67-1.62	1.07	0.56-2.03
19-24	1.17	0.73-1.87	1.26	0.59-2.68
25-30	0.63	0.39-1.01	0.46	0.22-0.93
31-36	1.16	0.75-1.78	1.43	0.78-2.61
37-42	1.68	1.10-2.55	1.69	0.96-2.96
Over time		p=.008		p=.009

* Adjusted for age and gender

† Adjusted for age, gender, education, musculoskeletal disease, depressive symptoms, walking speed and presence of poor street conditions, hills, long distances, lack of resting places, noisy traffic and dangerous crossroads.

95% CI= 95% Confidence Interval

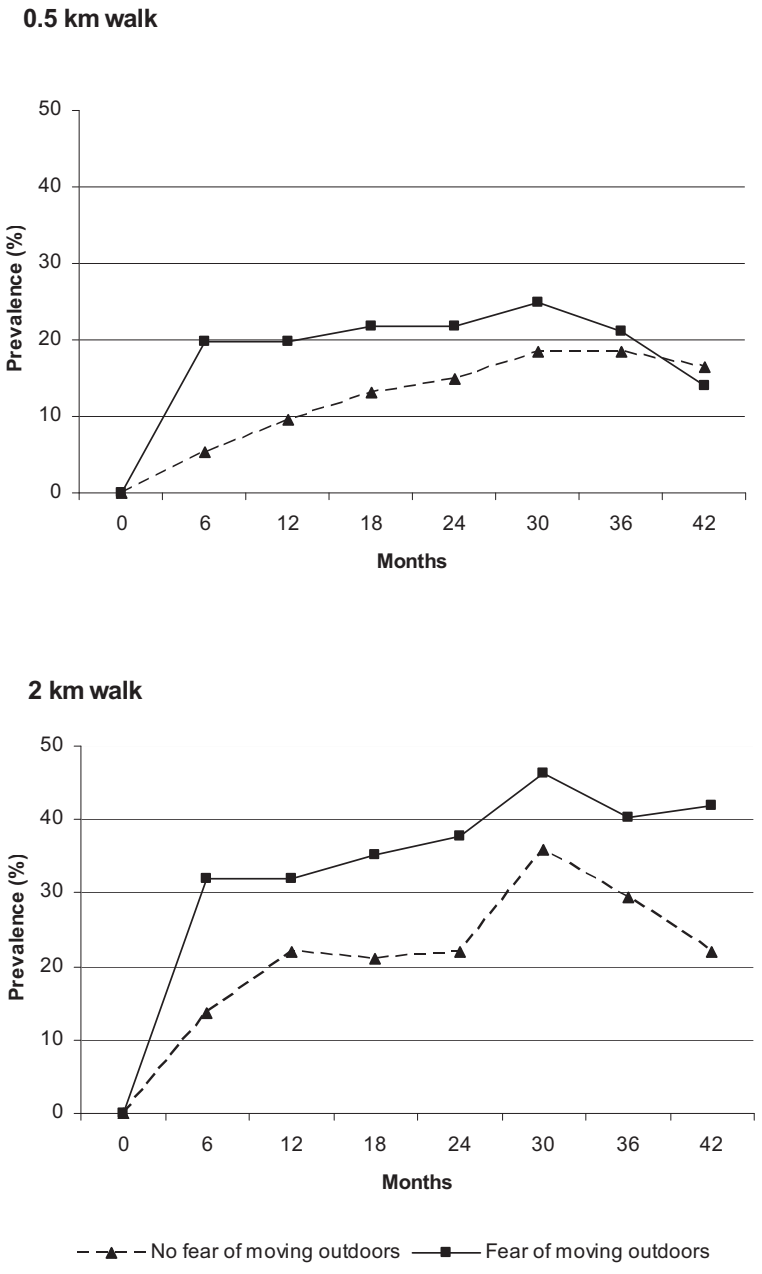

FIGURE 4 Unadjusted prevalence of perceived difficulty in walking 0.5 km (n=266) and 2km (n=214) among 75- to 81-year-old people without difficulty at baseline who were followed up every six months for 3.5 years (Paper II).

5.3.3 Unmet physical activity need (III)

People with unmet physical activity need lived more often with someone and had more depressive symptoms, better cognitive functioning, slower walking speed, and more musculoskeletal diseases and perceived walking difficulties than people who did not report unmet physical activity need. A greater proportion of those reporting unmet physical activity need also reported reduced physical activity level during the past few years than those without unmet physical activity need. Of the environmental factors, hills in the immediate environment, lack of resting places and dangerous crossroads were associated with unmet physical activity need at baseline (Table 9). In the model in which the individual and environmental variables were included simultaneously, good cognitive status (OR 1.25, 95% CI 1.09-1.44), reduction in physical activity (OR 3.33, 95% CI 1.65-6.74) and presence of dangerous crossroads (OR 2.02, 95% CI 1.02-4.02) increased and living alone (OR 0.32, 95% CI 0.18-0.57) and good walking speed (OR 0.26, 95% CI 0.10-0.62) decreased the probability of unmet physical activity need *(not shown in the table)*.

TABLE 9 Association of baseline characteristics with unmet physical activity need among 75- to 81-year-old community-living people (n=643) (Paper III).

	Unmet need						
	Yes (n=90)		No (n=553)		p-value*	OR†	95% CI
	Mean	(SD)	Mean	(SD)			
Age	77.8	(1.9)	77.6	(1.9)	.249	1.07	0.95-1.20
Education, years	8.8	(3.8)	9.2	(4.3)	.399	0.98	0.93-1.04
CES-D score	12.9	(8.0)	9.7	(7.4)	<.001	1.05	1.02-1.08
MMSE score	27.5	(1.9)	27.0	(2.1)	.031	1.14	1.02-1.28
10-m walking speed, m/s	1.2	(0.4)	1.4	(0.4)	<.001	0.15	0.08-0.31
	%		%				
Fear of moving outdoors	58		56		.809	0.97	0.61-1.56
Women	79		75		.372	1.27	0.74-2.19
Living alone	49		59		.063	0.53	0.33-0.86
Financial situation					.199	1.34	0.84-2.14
Bad or moderate	64		57				
Good or very good	36		43				
Cardiovascular disease	72		66		.258	1.35	0.82-2.21
Lung disease	23		15		.093	1.58	0.91-2.75
Musculoskeletal disease	65		50		.006	1.86	1.16-2.99
Difficulty in walking 2 km	60		30		<.001	3.48	2.19-5.53
Reduced physical activity	85		61		<.001	3.76	2.04-6.95
Barriers in the outdoor environment							
Poor street conditions	24		18		.141	1.47	0.87-2.51
Hills	34		21		.006	1.87	1.14-3.02
Long distances	13		9		.224	1.47	0.75-2.89
Lack of resting places	22		9		<.001	2.94	1.65-5.25
Noisy traffic	13		12		.673	1.18	0.61-2.28
Dangerous crossroads	21		12		.012	2.06	1.16-3.64

* Chi-square test and *t*-test
†Age- and gender-adjusted logistic regression analysis
CES-D =Center for Epidemiologic Studies Depression Scale
MMSE=Mini-Mental State Examination
SD= Standard Deviation
OR= Odds Ratio
95% CI= 95% Confidence Interval

Almost all the barriers in the outdoor environment increased the probability of unmet physical activity need, especially among those with difficulties in walking 2 km (Table 10). In particular, lack of resting places and dangerous crossroads were strongly associated with risk for unmet physical activity need among those with difficulties in walking. Poor street conditions and hills in the nearby

environment increased the probability of unmet physical activity need also among those without difficulties in walking.

TABLE 10 Barriers in the outdoor environment associated with unmet physical activity need among those with and without perceived difficulties in walking 2km at baseline (n=640) (Paper III).

	Difficulties in walking (n=215)		No difficulties in walking (n=425)	
	OR	95% CI	OR	95%CI
Poor street conditions				
Yes	3.74	1.70-8.25	2.35	1.10-5.03
No	4.36	2.54-7.48	1.00	
Hills				
Yes	4.04	2.07-7.88	3.05	1.44-6.48
No	4.79	2.71-8.49	1.00	
Long distances				
Yes	1.52	0.66-3.50	2.30	0.94-5.61
No	3.68	2.24-6.03	1.00	
Lack of resting places				
Yes	5.71	2.82-11.54	2.80	0.89-8.8
No	3.24	1.93-5.44	1.00	
Noisy traffic				
Yes	2.82	1.07-7.46	1.73	0.68-4.43
No	3.87	2.34-6.39	1.00	
Dangerous crossroads				
Yes	7.72	3.28-18.13	2.09	0.90-4.87
No	3.48	2.07-5.84	1.00	

Odds ratios (OR) adjusted for age and gender
95% CI = 95% Confidence Interval

Of those who did not report unmet physical activity need at baseline, 15% (17% of women and 10% of men) developed unmet physical activity need over the two-year follow-up. In the prospective analyses, fear of moving outdoors increased the risk for developing unmet physical activity need three fold compared to those not afraid (Table 11). Also, those reporting hills in their immediate environment and noisy traffic were over two to over four times more likely to develop unmet physical activity need. In the multivariate model studying individual factors, fear of moving outdoors was an independent predictor of unmet physical activity need. In the multivariate model studying environmental factors, only noisy traffic predicted unmet need for physical activity when all the environmental factors were included simultaneously in the model adjusted for age and gender. In the model in which all the individual and environmental variables were included, the results remained practically unchanged, but the

statistical power decreased due to the greater number of variables in the model (*data not shown*).

TABLE 11 Predictors of unmet physical activity need among 75- to 81-year-old community-dwelling people (n=214) over two-year follow-up (Paper III).

	Bivariate*		Multivariate†	
	OR	95% CI	OR	95% CI
Individual factors				
Living alone	1.21	0.52-2.82	1.17	0.47-2.86
CES-D	1.03	0.98-1.09	1.03	0.97-1.09
MMSE	0.89	0.75-1.06	0.85	0.69-1.04
Fear of moving outdoors	3.07	1.21-7.81	2.82	1.02-7.75
Education in years	1.01	0.93-1.09	1.04	0.95-1.13
Financial situation				
Bad or moderate vs.				
Good or very good	1.12	0.51-2.45	1.38	0.55-3.50
Musculoskeletal disease	2.01	0.91-4.46	1.38	0.56-3.39
Difficulties in walking 2 km	1.42	0.63-3.21	1.22	0.48-3.09
Barriers in the outdoor environment				
Poor street conditions	0.98	0.31-3.10	0.52	0.13-2.03
Hills	2.30	1.00-5.27	2.49	0.95-6.54
Long distances	1.28	0.34-4.87	1.50	0.35-6.50
Lack of resting places	0.66	0.14-3.06	0.25	0.04-1.57
Noisy traffic	4.48	1.65-12.16	4.61	1.49-14.33
Dangerous crossroads	1.35	0.46-3.96	1.08	0.34-3.47

* age- and gender-adjusted bivariate associations
† age- and gender-adjusted multivariate model, individual and environment factors analyzed separately
CES-D =Center for Epidemiologic Studies Depression Scale
MMSE=Mini-Mental State Examination
OR=Odds ratio
95% CI=95% Confidence Interval

5.4 Barriers in the outdoor environment and quality of life (IV)

QoL was worse among those who reported more barriers in their outdoor environment and those who experienced fear of moving outdoors and unmet physical activity need (Figure 5). Those who had slower walking speed and more chronic diseases also reported worse QoL ($r=-.48$, $p<.001$; $r= .35$, $p<.001$, respectively) (not shown in the figure). All the subscales of QoL showed associations with perceived barriers in the outdoor environment similar to that of the overall sum score (*data not shown*).

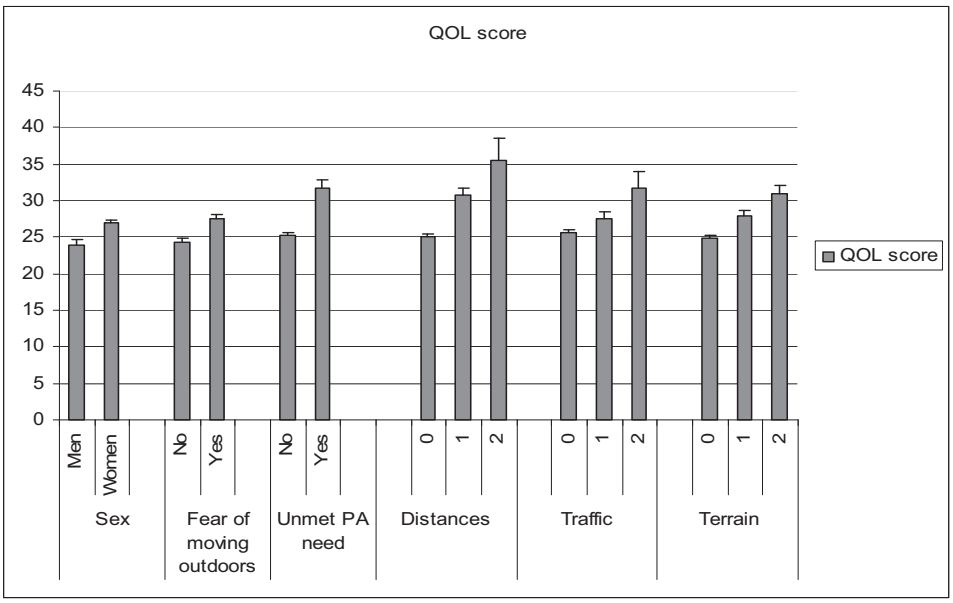

FIGURE 5 Mean QoL score in community-dwelling 75- to 81-year-old people (n=600) according to gender, fear of moving outdoors, unmet physical activity (PA) need and barriers in the outdoor environment. Higher scores indicate worse QoL (range 0-93).
NOTE: Environmental barriers studied were lack of resting places and long distances (Distances), noisy traffic and dangerous crossroads (Traffic) and hilly terrain and poor street conditions (Terrain); (0) no perceived difficulties related to either of the environmental barriers, (1) perceived difficulties related to one barrier (2) perceived difficulties related to two barriers. All differences between groups were statistically significant (p<.001) (Paper IV).

The constructed path analysis model fitted well to the data (χ^2 (7)=12.66; *p*=.08; GFI=0.99, AGFI =0.97, RMR=0.02). By adding number of chronic conditions, maximal walking speed, barriers in the outdoor environment, unmet physical activity need and fear of moving outdoors into the path model, 36% of the variation in QoL was explained. The variables Terrain, Traffic and Distances influenced QoL through either fear of moving outdoors or through unmet physical activity need, while Distances also had a direct association with QoL. The lower a person's walking speed, the more problems reported in the outdoor environment and outdoor mobility and the poorer the QoL. Details are shown in Figure 6. Significant indirect associations were found between walking speed and fear of moving outdoors (β=-0.15, standard error (s.e.)=.03), walking speed and QoL (β=-0.11, s.e.=.02), number of chronic conditions and QoL (β=0.18, s.e.=.02) and Traffic and QoL (β=.14, s.e.=.03). *(Indirect associations not shown in the Table*)

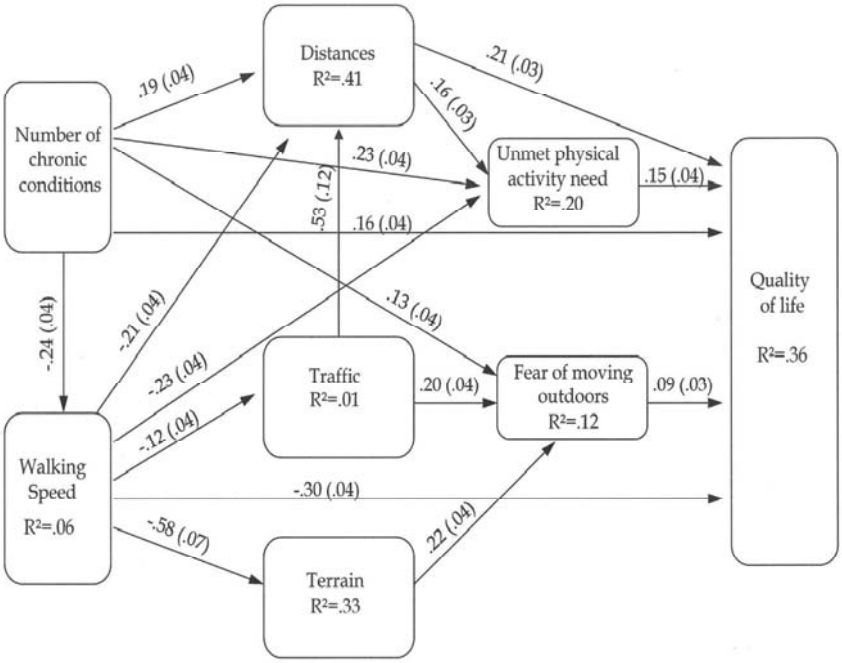

FIGURE 6 The path analyses model of the relationships between perceived barriers in the outdoor environment, unmet physical activity need and fear of moving outdoors to quality of life among 75- to 81-year-old community-dwelling people (n=589). The model includes three layers: individual, environmental and interaction between individual and environment, all of which together were associated with QoL (Paper IV).
NOTE: In the model, slow walking speed increases perceived barriers in the outdoor environment, which affect QoL through fear of moving outdoors and unmet physical activity need. Arrows indicate significant associations and their directions between variables. The numbers show the maximum likelihood estimates of the path coefficients, standard errors are given in parenthesis. The coefficients are significant if they are greater than two times the standard errors. The R^2 values indicate the amount of variation in the dependent variables explained by the other shown variables.

6 DISCUSSION

This study investigated the effects of barriers in the outdoor environment on outdoor mobility decline and quality of life among older community-dwelling people. Further, the effects of fear of moving outdoors on development of walking difficulty and unmet physical activity need were examined.

In this study, perceived barriers in the outdoor environment preceded development of walking difficulty over a 3.5-year follow-up. Barriers in the environment also underlay fear of moving outdoors, which predicted development of walking difficulty and unmet physical activity need. However, fear of moving outdoors predicted walking difficulties independently of the environmental factors. Unmet physical activity need was found to be more common among ambulatory community-dwelling older people who have health and mobility problems and report negative environmental features in their neighborhood. Barriers in the outdoor environment which encumbered outdoor mobility increased fear of moving outdoors and unmet physical activity need and resulted in poor QoL among older community-dwelling people.

6.1 Barriers in the outdoor environment and mobility decline

Barriers in the outdoor environment and walking difficulties

This study showed that perceived barriers to mobility in the outdoor environment precede onset of difficulty in walking 2 km and 0.5 km among community-dwelling older people. A few prospective studies have shown previously that self-reported barriers in the neighbourhood predict loss of physical function, but in these studies the participants have been middle aged (Schootman et al. 2006) or "young-old" people over 55 years of age (Balfour & Kaplan 2002). Other studies have shown an association between environmental barriers and mobility limitation (Clarke et al. 2008, Wahl et al. 2009a, Keysor et al. 2010, White et al. 2010), but have been limited to cross-sectional analyses and have thus been unable to reveal the temporal order in the association.

There are plausible explanations for the association between environmental barriers and the development of walking difficulty. A demanding environment may restrict out-of-home activities in older people, leading to physical inactivity (Booth et al. 2000) and eventually further decline in functional capacity (Buchner 2003, Gill et al. 2003, Boyle et al. 2007). The results of the present study showed that physical activity is one of the underlying mechanisms explaining the association between environmental barriers and walking difficulties. In Finland, seasonal variation should also be kept in mind when interpreting the results. Time of the year may also have an influence on perceived barriers in the environment or perceived walking difficulties, as well as on physical activity. For example, in winter time snow and ice may render pedestrian areas unusable (Wennberg et al. 2009), thus affecting willingness to go out (Shumway-Cook et al. 2003). In Finland, snowy conditions last from approximately December till March. In the present study all the baseline interviews took place during a 3-month period in spring (between April and June) and thereafter at 6-month intervals during either autumn or spring. Thus seasonal variation is not likely to add further explanation to the present results.

It is also possible that starting to perceive barriers in the outdoor environment may reflect early decline in mobility, as a "pre-stage" which has not yet developed into manifest mobility limitation. In the earlier studies it was observed that persons who did not report difficulties in walking, but who had changed their way of doing task (e.g. reported walking more slowly, doing the task less often, getting tired or needing to rest) had an increased risk for manifest mobility limitation (Fried et al. 2000, Fried et al. 2001, Mänty et al. 2007). It is possible that among older people modifying walking habits (Fried et al. 2000) and perceiving the environment as more demanding coincide because the environment no longer supports their level of functional capacity (Lawton & Nahemow 1973). In this case, reporting perceived barriers in the outdoor environment may be an early sign of mobility decline. In the present study, crossroads perceived as dangerous and traffic noise preceded development of limitation in basic but not advanced mobility. It is possible that sensory losses underlie the association between perceiving heavy traffic as a barrier to outdoor mobility and development of limitation in basic mobility. Age-related deterioration in hearing and vision make it difficult to orient oneself in the environment (Viljanen et al. 2009a, Viljanen et al. 2009b) and excessive traffic noise and auditory and visual signals at intersections may become confusing and lead to concerns for personal safety and avoidance of such situations (Ståhl et al. 2008), thus leading to physical inactivity and mobility decline.

Fear of moving outdoors

Fear of moving outdoors was common among community-living older people and predicted mobility decline over the 3.5-year follow-up. The incidence of new mobility limitation was much higher among those experiencing fear of moving outdoors during the first 6 months after the baseline, and this remained significant over the entire 3.5-year follow-up. The results showed that the

higher risk of developing perceived difficulty in walking 2 km or 0.5 km among people reporting fear of moving outdoors was not explained by the environmental barriers or health-related factors, but that fear increased the risk of mobility decline independent of these.

Fear of moving outdoors in old age has not been studied before, but previous studies on fear of falling and fear of crime have yielded similar results on the underlying factors (Green et al. 2002, Austin et al. 2007, Barnett et al. 2007, Scheffer et al. 2008). Fear was more common among women than men, which has also been found in previous studies (Green et al. 2002, Suzuki et al. 2002, Delbaere et al. 2004, Wood et al. 2008), and good SES decreased the probability of fear of moving outdoors. In previous studies, a correlation between high SES and more favorable neighborhood characteristics has been found (Ross & Jang 2000, Balfour & Kaplan 2002, Feldman & Steptoe 2004, Franzini et al. 2005, Wood et al. 2008). However, in the present study, almost all of the participants were living in the same urban area, most of them in condominiums and some in detached houses, and therefore there were only minor differences in neighborhood characteristics across the sample. More years of education and good perceived financial situation may thus be indicators of general resources in life and thus have a positive influence on the self-reliance of the individual.

It is possible that fear of moving outdoors is a subjective sign of impending task difficulties. This is in line with the finding that a difference in perceived difficulties in walking 0.5 km and 2 km emerged during the first six months of the follow-up. It is also possible that fear-related avoidance of activities accelerates the disablement process because of the consequences of physical inactivity and reduced participation in social and other out-of-home activities. The possibility, that perceived fear of moving outdoors may have a direct effect on perceived difficulty in walking cannot be ruled out. Fear of moving outdoors may cause feelings of discomfort and thus directly influence perceived difficulty in outdoor mobility. However, all those with perceived difficulty at baseline were excluded from the prospective analyses. Thus it is unlikely that overlap in people's minds of the concepts of fear of moving outdoors and perceived difficulty walking specific distances would explain the results.

As fear of moving outdoors was defined as an emotional condition, it may also reflect other emotional conditions, such as depression. Depressive symptoms also increase the risk of outdoor activity restriction (Wilkie et al. 2007) and predict incident mobility decline (Penninx et al. 1998). However, in the age- and gender-adjusted analysis only a weak association between fear of moving outdoors and depressed mood was observed. The association disappeared in the multivariate analyses, suggesting that fear of moving outdoors is a phenomenon independent of depressed mood.

Reporting barriers in the outdoor environment, especially poor street conditions, hills in the nearby environment and noisy traffic, increased the probability of fear of moving outdoors. Previous studies have found associations between physical activity and environmental characteristics such as safety (Booth et al. 2000, Brownson et al. 2001, Foster et al. 2004, Shenassa et al. 2006, Mota et

al. 2007). It is possible that an environment perceived as too demanding may accentuate the unwillingness to go outdoors, particularly among people with mobility limitations (Bruce et al. 2002, Delbaere et al. 2004, Fletcher & Hirdes 2004). Fear of moving outdoor may also be a result of poor self-efficacy. According to the self-efficacy theory, people fear and avoid situations they believe exceed their coping skills (Bandura 1977) and self-efficacy has been found to be a very important factor in outdoor mobility (Booth et al. 2000, Kono et al. 2004, Lord et al. 2010).

Recently, it was suggested that falls are a result of person-environment mismatch rather than solely environmental hazards (Iwarsson et al. 2009), and that fear of falling is environmentally determined and should be classified according to environment, whether it concerns indoor or outdoor environment (Deshpande et al. 2009). These findings suggest the existence of fear that is related to environmental factors, thus supporting the results of the present study.

Unmet physical activity need

This study demonstrated that a fair proportion of those aged 75 to 81 years feel that they do not have enough opportunities to increase their physical activity level despite their willingness to do so. Unmet physical activity need was defined in this study as the feeling that one's level of physical activity is inadequate. The results showed that perceived barriers in the outdoor environment magnified the risk for unmet physical activity need especially among those whose mobility had started to decline. Mismatch between environmental demand and individual capabilities reduce possibilities for participation, which in turn may have effects on several other health outcomes and quality of life.

While the present study sheds some light on the development of unmet physical activity need, in part the dynamics underlying this development remain unrevealed and thus warrant further study. Fear of moving outdoors and reduction in physical activity preceded the development of unmet physical activity need together with barriers in the outdoor environment near the home. Depressive symptoms were observed simultaneously with unmet physical activity need, and thus it is possible that depressive symptoms are a consequence rather than a cause of unmet physical activity need. These findings are in line with those of previous studies, where high levels of depressive symptoms have been found among stroke survivors who have given up traveling by public transport (Wendel et al. 2008) and an increase in depression in older people who have given up other meaningful activities (Duke et al. 2002, Benyamini & Lomranz 2004) .

The stability of unmet physical activity need is currently unclear. Almost half of those with unmet physical activity need at baseline did not report it at follow-up, which indicates that unmet physical activity need may be transient. In addition, those who reported that they had reduced their physical activity level over the past few years were almost four times more likely to report unmet physical activity need. It seems likely that unmet physical activity need becomes evident relatively soon after the occurrence of events causing changes in

physical activity, such as the need to attend to a sick spouse or a disease or injury leading to mobility decline. Later on, people may adapt to their current situation and the desire to be more physically active disappears.

Turning to the environmental factors studied, hills in the immediate environment and noisy traffic predicted development of unmet physical activity need in the two-year follow-up. Noisy traffic was an independent predictor of unmet physical activity need even when adjusted for walking difficulties. It is possible that traffic noise indicates the existence of busy roads, which are perceived as dangerous by older people (Ståhl et al. 2008). Thus it is worries about personal safety rather than the noise itself that may lead to the perception that one's opportunities for physical activity have become restricted, leading further to the development of unmet physical activity need.

6.2 Barriers in the outdoor environment and quality of life

This study showed that individual capabilities, a demanding outdoor environment and their interaction explained 36% of the variance in QoL. This finding can be considered as a sizeable proportion, since important factors known to affect QoL in old age, such as social relationships and financial situation, were not included in the analyses. The fact that perceived barriers in the outdoor environment correlated with all the QoL subscales suggests that the outdoor environment may have a broader influence on QoL than has hitherto been acknowledged. While others have reported the importance of the outdoor environment for the quality of life of older people (Levasseur et al. 2008a), the results of the present study deepen the existing knowledge on the factors influencing QoL.

In the present study, people with poor functional capacity, defined as slower walking speed and more chronic conditions, reported their outdoor environment to be more demanding and had lower QoL than those who were healthier. This finding coheres with the ecological model of ageing (Lawton & Nahemow 1973). The fact that fear of moving outdoors and unmet physical activity need play a role in the interplay between the outdoor environment and QoL, is a novel finding. Previously, Levasseur and colleagues (Levasseur et al. 2008b) emphasized that satisfaction with participation is a better predictor of QoL than the level of participation itself, which is in line with the present findings.

It has been found that natural and green spaces in the neighbourhood have an effect on well-being (Pretty et al. 2005). Green exercise, that is exercise in natural outdoor environments, may improve self-esteem and mood (Barton & Pretty 2010). Spending time in outdoor areas and in natural settings also promotes restorative experiences such as relaxation and calmness, according to a study of a Finnish population aged 15-75-years (Korpela et al. 2010). This may partly explain the results of the present study. People who perceive no opportunities for moving outdoors either because of the barriers in the outdoor environment or because of fear, may also have feelings of depressed mood, with

negative effects on QoL. Recently, it was also shown that access to clean and high quality natural environments increases life satisfaction (Vemuri et al. 2011).

For older people, mobility means independence and personal freedom, both of which are crucial for quality of life (Bourret et al. 2002). Therefore, improving possibilities for outdoor mobility among older people may help enhance their QoL by reducing their fear of moving outdoors and alleviating their unmet need for physical activity.

6.3 Methodological considerations

This study is based on the data from the SCAMOB project, which utilized a large sample of ambulatory, community-dwelling 75- to 81-year old people of whom approximately half were included in the present 3.5-year follow-up study.

First of all, this study used a data set previously collected for the randomized controlled study. Using a previously collected data set can be regarded as an effective alternative because material that has already been collected can be fully utilized. However, it also presents certain challenges for the study, which in the present instance mainly concern the study sample. The inclusion criteria of the study were set according to the primary research question addressed by the SCAMOB project. Thus the participants in the present study were a truncated sample of community-dwelling older people, as the most disabled and most vigorous people had already been excluded from the sample. This might explain the overall low rate of perceived barriers in the environment, since, according to previous studies, older people who have severe mobility limitations also report more barriers in their environment. Thus the results of the present study may underestimate the effects of barriers in the outdoor environment on outdoor mobility decline. However, the study design of the SCAMOB project enabled cross-sectional and prospective analyses on topics that have not been widely studied before.

To examine perceived barriers in the outdoor environment, standardized questionnaires were used. A validated tool for environmental evaluation was not available in the present research, a factor which should be taken into account when interpreting the results. The environmental factors studied were considered to be relevant for the mobility in this age group on the basis of earlier research conducted in a Finnish context (Heikkinen 1998). It is possible that some other important features in the environment that older people consider meaningful for their mobility have not been taken into account in our analyses. In addition, self-reported barriers in the environment instead of objective measures were used. However, according to a Swedish study on housing accessibility, there seem to be more marked differences between self-reports and professional assessments in samples of persons without current experiences of moving about in the environment under study. Self-reports of persons with recent experiences resemble professional assessments (Fänge & Iwarsson 2003). In the

present study, at baseline, all the participants were able to move independently outdoors and most likely had current experiences of their environments, suggesting that their reports were most probably quite accurate. Moreover, self-reports on the environment reflect the individual's customary walking routes and thus give a more reliable picture of the barriers in the environment than that conveyed by objective measures (Gebel et al. 2009); thus the method used to evaluate the environment had relevance for the study and the information collected was able to answer the study questions.

The concept of fear of moving outdoors integrated information about general insecurity when moving outdoors and avoidance of outdoor activities because of fear, insecurity due to other pedestrians, or elements of danger. It should be noted that there is no widely accepted instrument to measure fear of moving outdoors and the data collection was not designed specifically to examine fear of moving outdoors. Nevertheless, even with the crude measure used, the results showed that fear may lead to deterioration in functional ability in old age.

It should also be noted that our definition of unmet physical activity need concerned physical activity in general, while the environmental features studied were rather specific for outdoor walking. However, walking outdoors is the most popular form of physical activity among community-dwelling older people in Finland (Mäkilä et al. 2010) and often a prerequisite for attending other physical activities. Thus it is not likely that this discrepancy has materially affected the results.

In the present study, self-reported walking difficulty was used as an outcome measure in Papers I and II to study the effects of barriers in the outdoor environment and fear of moving outdoors on mobility decline over a 3.5 -year follow-up. Although it has been argued that self-reports may not be sensitive enough to detect changes in functioning over time (Kivinen et al. 1998), among highly functioning older people self-reports of mobility decline may be even more sensitive to the changes in functional capacity than objective measures (Fried et al. 2000, Latham et al. 2008).

To study the development of walking difficulties, two different statistical methods were used. The effects of the barriers in the outdoor environment on incident walking difficulty were analyzed with Cox regression analysis. Cox regression analysis can be used to investigate the association of one or more explanatory variables from the beginning of the study until the event occurs (Cox & Oakes 1984). In the present study, data were collected at six-month intervals and thus we do not know at exactly what time points walking difficulty emerged. This leads to a situation where we have a large group of people who report a new difficulty at the same measurement point. Cox regression models were chosen as analytical methods for Paper I, since excluding participants with walking difficulty at baseline reduced the proportion of participants reporting barriers in their environment, and hence conducting adequate GEE models for the 3.5-year follow-up was not possible.

GEE models were used to study fear of moving outdoors as a predictor of walking difficulties (Paper II). With GEE models it is possible to take into account transitions in the states of difficulty reported over the follow-up and compare the prevalence of walking difficulty in each data collection wave. Each six-month interval for which data were available during the follow-up, with the beginning of each period as the reference, i.e. 6 months vs. beginning of study, 12 months vs. 6 months, continuing up to 42 months vs. 36 months, was studied. With this method it was possible to estimate when the possible decline in mobility occurs, what kinds of transitions happen over time and how long the possible effect lasts.

GEE models take into account that some people may also recover from a reported difficulty, while in the Cox regression analyses the participant is censored when she/he first reports difficulties. However, with both of these methods it is possible to investigate the temporal order of the associations, which was the main study question.

In the present study, QoL was assessed with the multidimensional LEIPAD questionnaire. With a scale consisting of several subscales, there is a risk of tautological effects in the analyses. Therefore, to avoid overlap, it is necessary to carefully compare the dimensions of the scale with the predictors of the model. The LEIPAD questionnaire includes items where the participants are asked to evaluate their physical functioning in terms of their perceived abilities to perform daily activities. In the path modeling applied in the present study, maximal walking speed was chosen as an indicator of physical performance because it is conceptually separate from the items in the physical function and self-care subscales of the LEIPAD. Although our analysis of the association between the environment and quality of life are cross-sectional and causality cannot be confirmed, path analysis allows us to draw inferences about the direction of the associations. Even then, the existence of a circular decline where environmental barriers lead to mobility loss, in turn leading to perception of the environment as more challenging than before, is also a possibility.

Two theoretical frameworks were used to guide the analyses. The disablement process model (Verbrugge & Jette 1994) guided the longitudinal analyses, while the ecological model of ageing (Lawton & Nahemow 1973) supported the cross-sectional analyses and helped to explain the associations between the variables and created a basis for constructing the path analyses model in Paper IV. The measurements and the associations that were examined in the present study were based on these theoretical models. The ecological model of ageing shows the association between the environment and the individual in a dynamic way. This is a difficulty in epidemiological studies, which aim at providing evidence for causality and find risk factors for different outcomes. However, there are many similarities between the models, and thus these two models created a good foundation for the analyses by supporting each other.

This study was conducted in an urban area of central Finland, and thus the results may not be valid in rural areas or in the bigger cities, a factor which should be kept in mind when interpreting the results. There might also be some

national differences in personal as well as environmental characteristics between Finland and other western countries, as was shown in the MOBILATE project (Mollenkopf et al. 2004).

The long follow-up time and semi-annual follow-up points allow us to make inferences on the temporal order of events leading to the development of walking difficulties and unmet physical activity need, and thus identify individuals who are at risk for outdoor mobility decline. The strengths of the present study are the large, population-based sample and the application of both cross-sectional and longitudinal data analysis on topics related to barriers in the outdoor environment and outdoor mobility that have not been widely studied before. The present study offers new knowledge about the barriers in the outdoor environment affecting outdoor mobility and QoL among older people and emphasizes the importance of the environment in the disablement process.

6.4 Future directions

The results of this research suggest several new study hypotheses and directions. Since the relationship between environmental barriers and individual capabilities seem to have important effects on outdoor mobility, it would be beneficial to target more research on life-space mobility, which reflects the ability to move outdoors in a specific environment (Stalvey et al. 1999, Baker et al. 2003). Studying life-space mobility offers possibilities to identify the factors that are crucial for the ability to maintain community mobility.

Modifications of the environment, but also modifications on the individual level, such as strength training, may improve P-E fit, offering better possibilities for adaptive behavior. This leaves the question, how can the environment be modified to support functioning, to prevent mobility limitations and to reduce fear of moving outdoors and unmet physical activity need? Although this study shed some light on these questions, the need remains for more knowledge on the associations between the environment and people's possibilities to participate in out-of-home activities. This would help to prevent marginalization with respect to physical activity and increase possibilities for physical activity, thus improving functional ability and quality of life.

The concepts of unmet physical activity need and of fear of moving outdoors are new, and therefore more studies related to these concepts is needed to confirm the present results. In particular, a study for addressing the differences between fear of moving outdoors, fear of falling and fear of crime would be important to distinguish these concepts from each other. Replication studies are needed both in different environments - urban, suburban and rural - and among different populations, from the most severely disabled to active seniors.

This study showed that fear of moving outdoors is very common among community-dwelling older people; however we still do not know whether there are different levels of severity in fear, whether there are differences in the level

of avoidance of activities and what kinds of behavioral changes fear causes. The development of in-depth methods to assess fear of moving outdoors is needed to clarify these questions. Since the present study applied a purely quantitative approach, qualitative or mixed methods could be useful in seeking to understand how these phenomena are experienced by older people themselves. In addition, the consequences of unmet physical activity need remain unclear.

People who experience unmet physical activity need form a fruitful target group for physical activity promotion, because they have the willingness to participate in physical activities. However, traditional physical activity promotion programs are likely to be ineffective among them as they may need more support. For example, volunteer walking buddies may be used to encourage them to exercise, by alleviating their fear of moving outdoors and to support them in facing barriers in the outdoor environment. This topic merits further research.

Homeboundness is an extreme form of participation restriction and it is known to be associated with severe disability (Simonsick et al. 1998). It is not well known how barriers in the outdoor environment affect the development of homeboundness, and how these possible environmental barriers can be modified. This could usefully be studied, since current health care policy in Finland favors home care instead of institutional care. This policy change leads to a situation where even more severely disabled people are living at home and are at risk of becoming homebound.

The findings of the present study show that barriers in the outdoor environment predict the development of walking difficulties and that physical activity explains part of this association. However, the mechanisms underlying the association remain unknown and call for further studies. A better understanding of the mechanisms behind P-E fit and its effects on health outcomes in old age is needed, as this would help in planning interventions and environments that promote outdoor mobility and well-being in community-dwelling older people.

7 MAIN FINDINGS AND CONCLUSIONS

The main findings and conclusions can be summarized as follows:

1. Perceived barriers in the outdoor environment, especially long distances to everyday services and lack of resting places, preceded development of walking difficulties among older people.

2. Fear of moving outdoors was common among older people. Poor socio-economic status, musculoskeletal diseases, slow walking speed and the presence of poor street conditions, hills in the nearby environment and noisy traffic were associated with fear of moving outdoors at baseline.

3. Fear of moving outdoors increased the risk of developing walking difficulties independently of the barriers in the outdoor environment.

4. Unmet physical activity need was more prevalent among those with musculoskeletal diseases, depressive symptoms and mobility limitations. Hills in the nearby environment, lack of resting places and dangerous crossroads were associated with unmet physical activity need at baseline, and the association was especially strong among those with walking difficulties.

5. Fear of moving outdoors and noisy traffic predicted development of unmet physical activity need over a two-year follow-up.

6. Older people with more barriers in their outdoor environment, fear of moving outdoors and unmet physical activity need reported worse QoL.

7. Barriers in the outdoor environment which encumbered outdoor mobility, increased perceptions of fear of moving outdoors and unmet physical activity need, and were associated with poor QoL in older people.

YHTEENVETO (FINNISH SUMMARY)

Ulkoympäristötekijät, ulkona liikkumisen heikkeneminen ja elämänlaatu iäkkäillä ihmisillä

Ulkona liikkuminen on perusedellytys itsenäiselle suoriutumiselle päivittäisistä toiminnoista, kuten kaupassa käynnille, mutta se myös kohentaa mielialaa, terveyttä ja toimintakykyä sekä vahvistaa autonomiaa. Kävelylenkkeily on yksi suosituimmista ikääntyneiden ihmisten liikuntamuodoista, ja jo sangen lyhyidenkin matkojen liikkuminen ulkona edistää ja ylläpitää toimintakykyä. Ympäristötekijät voivat kuitenkin luoda esteitä ulkona liikkumiselle, erityisesti silloin kun liikkumiskyky on heikentynyt ja aistitoiminnoissa on puutteita. Yksilön kykyjen ja ympäristön asettamien vaatimusten on oltava tasapainossa, jotta toiminta olisi optimaalista, ylläpitäen toimintakykyä sekä mahdollistaen osallistumisen haluttuihin aktiviteetteihin. Kykyihin nähden liian haasteellinen ympäristö johtaa toiminnan vähenemiseen ja siten myös toimintakyvyn heikkeneminen nopeutuu. Vaikka ympäristön merkitys iäkkäiden ihmisten toimintakykyyn on usein todettu, tieteellinen tutkimus aiheesta on pinnallista ja rajoittuu usein vain poikittaisanalyyseihin todeten ympäristön ja toimintakyvyn välillä olevan yhteyttä.

Ulkona liikkumista rajoittavista peloista tutkituimpia ovat kaatumisen pelko sekä rikoksen pelko. Henkilöt, jotka kokevat esimerkiksi kaatumisen pelkoa, saattavat välttää liikkumista, jotta eivät altistuisi kaatumisille. Ulkona liikkumiseen saattaa myös vaikuttaa yleisempi pelkotila, joka syntyy tunteesta, ettei selviydy ulkona liikkumisesta esimerkiksi haasteellisen ympäristön takia. Tällaista yleistä ympäristötekijöistä johtuvaa ulkona liikkumisen pelkoa ei kuitenkaan ole aiemmin määritelty eikä tutkittu. Tämäntyyppinen pelkotila saattaa johtaa ulkona liikkumisen välttämiseen myös sellaisilla henkilöillä, jotka fyysisen kykynsä puolesta pystyisivät liikkumaan ulkona. Pelko ei kuitenkaan poista halukkuutta liikkumiseen. Tällöin on seurauksena kokemus siitä, ettei pääse liikkumaan niin paljon kuin haluaisi, joka tässä tutkimuksessa määriteltiin tyydyttämättömäksi liikunnantarpeeksi. Tyydyttämätön liikunnantarve on aiemmassa kirjallisuudessa tuotu esiin lähinnä lasten ja nuorten liikuntakäyttäytymisen yhteydessä, jolloin sillä on tarkoitettu liikuntasuositusten täyttymistä. Iäkkäiden kohdalla ei tästä ole kyse, vaan tyydyttämättömällä liikunnantarpeella tarkoitetaan henkilökohtaista kokemusta liikkumisen riittämättömyydestä.

Elämänlaatu on yksi tutkituimmista osa-alueista ikääntymistutkimuksessa. Elämänlaadun määrittäjinä on yleensä tuotu esiin sosiaaliset suhteet, terveys ja taloudellinen tilanne. Myös ympäristön ja ulkona liikkumisen merkitys on todettu, mutta siihen kohdistuva tutkimus on ollut vähäistä. Kun ulkona liikkuminen rajoittuu ja ihmisen elinpiiri pienenee, sillä on vaikutusta myös elämänlaatuun.

Tässä tutkimuksessa selvitettiin koettujen ulkoympäristön esteiden vaikutusta itseraportoitujen liikkumisvaikeuksien syntymiseen sekä elämänlaatuun kotona asuvilla 75-81-vuotiailla henkilöillä. Lisäksi tarkasteltiin kahta uutta

ulkona liikkumiseen liittyvää käsitettä, ulkona liikkumisen pelkoa ja sen seurauksia, sekä tyydyttämätöntä liikunnan tarvetta ja siihen johtavia tekijöitä. Tutkimuksessa käytettiin Screening and Counselling for Physical Activity and Mobility in Older People (SCAMOB) - projektin aineistoa. Alkuhaastatteluihin osallistui 727 Jyväskylän kaupungin keskusta-alueella kotona asuvaa 75-81-vuotiasta henkilöä. Alkuhaastattelujen jälkeen osallistujat satunnaistettiin koetai kontrolliryhmään. Tässä tutkimuksessa käytettiin SCAMOB-projektin alkumittausaineistoa (n=727) poikittaisanalyyseihin sekä 3.5-vuoden seurantaaineistoa kontrolliryhmästä pitkittäisanalyyseihin (n=314).

Tutkimuksen tulokset osoittavat, että koetut ympäristön esteet lisäävät riskiä uusien kävelyvaikeuksien syntymiseen. Fyysinen aktiivisuus selitti osan tästä yhteydestä, mutta ympäristön vaikutus säilyi silti merkittävänä. Erityisesti pitkät etäisyydet palveluihin ja levähdyspaikkojen puute lisäävät riskiä kävelyvaikeuksien syntymiseen yli kaksinkertaisesti verrattuna henkilöihin jotka eivät kyseisiä ympäristön esteitä raportoineet.

Koetut ympäristön esteet myös lisäsivät ulkona liikkumisen pelkoa hyväkuntoisilla ikääntyneillä. Yli puolet tutkimukseen osallistuneista pelkäsi liikkua ulkona. Erityisesti liikenteen melu lisäsi ulkona liikkumisen pelkoa, mutta myös katujen huono kunto ja mäkinen maasto olivat turvattomuuden taustalla. Pelko oli yleisempää naisilla, niillä jotka asuivat yksin, niillä jotka kokivat taloudellisen tilanteensa heikoksi sekä joilla oli tuki- ja liikuntaelinsairauksia. Ulkona liikkumisen pelolla oli suuri vaikutus myös liikkumisvaikeuksien syntymiseen. Ne henkilöt, jotka raportoivat ulkona liikkumisen pelkoa, mutta joilla ei ollut liikkumisvaikeuksia alkutilanteessa, oli yli kolminkertainen riski saada uusi kävelyvaikeus ensimmäisen puolen vuoden seurannan aikana verrattuna niihin jotka eivät pelänneet ulkona liikkumista.

Ulkona liikkumisen pelko sekä liikenteen melu ennustivat tyydyttämättömän liikunnantarpeen syntymistä. Tyydyttämätön liikunnantarve on melko yleinen ilmiö itsenäisesti kotona asuvilla ikääntyneillä. Erityisesti tyydyttämätöntä liikunnantarvetta kokivat henkilöt, joilla oli haasteellinen kodin lähiympäristö ja liikkumisvaikeuksia.

Elämänlaatunsa kokivat heikommaksi ne henkilöt, joilla on useita esteitä ympäristössään, sekä ne, jotka kokivat ulkona liikkumisen pelkoa ja tyydyttämätöntä liikunnantarvetta. Polkumallianalyysi osoitti, että ympäristön esteet heikensivät elämänlaatua ulkona liikkumisen pelon ja tyydyttämättömän liikunnantarpeen kautta. Kuitenkin pitkät etäisyydet palveluihin sekä levähdyspaikkojen puute vaikuttivat myös suoraan heikkoon elämänlaatuun.

Yhteenvetona voidaan todeta, että koetut ympäristön esteet lisäävät riskiä itseraportoitujen liikkumisvaikeuksien syntymiseen ja heikentävät mahdollisuuksia ulkona liikkumiseen, siten heikentäen elämänlaatua hyväkuntoisilla, itsenäisesti kotona asuvilla iäkkäillä ihmisillä. Tämä tutkimus osoittaa, että ympäristön merkitys iäkkäiden ihmisten toimintakyvyn ylläpitämisessä on suurempi kuin on aikaisemmin huomattu. Ulkona liikkumisen pelkoa sekä tyydyttämätöntä liikunnantarvetta kokevat ikääntyneet ihmiset on tärkeä tunnistaa ajoissa, koska he ovat edelleen halukkaita liikkumaan mutta tarvitsevat siihen

erilaista tukea ja ohjausta kuin nuoremmat. Lisäksi liikkumisen esteiden ratkaiseminen on tärkeää, jotta voitaisiin edistää tasavertaisia mahdollisuuksia liikuntaan osallistumiseen, ja siten estää uusien toiminnanvajauksien syntymistä.

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II

FEAR OF MOVING OUTDOORS AND DEVELOPMENT OF OUTDOOR WALKING DIFFICULTY IN OLDER PEOPLE

By

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Fear of Moving Outdoors and Development of Outdoor Walking Difficulty in Older People

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OBJECTIVES: To study which individual characteristics and environmental factors correlate with fear of moving outdoors and whether fear of moving outdoors predicts development of mobility limitation.

DESIGN: Observational prospective cohort study and cross-sectional analyses.

SETTING: Community and research center.

PARTICIPANTS: Seven hundred twenty-seven community-living people aged 75 to 81 were interviewed at baseline, of whom 314 took part in a 3.5-year follow-up.

MEASUREMENTS: Fear of moving outdoors and its potential individual and environmental correlates were assessed at baseline. Perceived difficulties in walking 0.5 km and 2 km were assessed twice a year over a 3.5-year period.

RESULTS: At baseline, 65% of the women and 29% of the men reported fear of moving outdoors. Poor socioeconomic status; musculoskeletal diseases; slow walking speed; and the presence of poor street conditions, hills in the nearby environment, and noisy traffic correlated with fear of moving outdoors. At the first 6-month follow-up, participants with fear of moving outdoors had more than four times the adjusted risk (odds ratio (OR) = 4.6, 95% confidence interval (CI) = 1.92–11.00) of developing difficulties in walking 0.5 km and a three times greater adjusted risk (OR = 3.10, 95% CI = 1.49–6.46) for developing difficulty in walking 2 km compared with those without fear. The difference in the prevalence of walking difficulties remained statistically significant over the 3.5-year follow-up ($P = .02$ and $P = .009$, respectively).

CONCLUSION: Fear of moving outdoors is common in older adults and increases the risk of developing self-reported difficulties in walking 0.5 km and 2 km. Knowledge about individual and environmental factors underlying fear of moving outdoors and finding ways to alleviate fear of moving outdoors are important for community planning and prevention of disability. **J Am Geriatr Soc 57:634–640, 2009.**

Key words: fear of moving outdoors; walking difficulty; environment; aging

In older people, loss of the ability to move outdoors may threaten independent living in the community and participation in social and physical activities. Outdoor physical activity, particularly walking, plays a key role in the maintenance of functional independence in old age.[1]

One model of the disablement process indicates that "disability is not a personal characteristic, but is instead a gap between personal capability and environmental demand."[2] Health-related factors, together with environmental features, may restrict outdoor activities, and changes in one may affect the other.[3,4] Previous studies have shown that environmental features, such as poor street conditions and lighting, correlate with a lower level of physical activity and walking and a higher prevalence of outdoor mobility restriction.[5–10] Of individual characteristics, physical inactivity, low socioeconomic status, depression, and illnesses have been observed to predict incident mobility limitation.[11–14]

Understanding the factors affecting outdoor mobility in older adults helps to find ways to facilitate and motivate older adults to move outdoors, thus potentially preventing the development of disabilities.[2] Fear of moving outdoors may be a factor contributing to the risk of developing mobility limitation. The definition used in the current study is an adaptation of a previously developed definition of fear of falling: "a lasting concern about falling that leads to an individual avoiding activities that he/she remains capable of performing."[15] That is, fear of moving outdoors was defined for the current study as an emotional condition that can lead to avoidance of outdoor activities that are well

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within a person's functional health capacity. This study asked whether people were having feelings of insecurity when moving outdoors and, if they avoided going outdoors, whether that was because of fear.

To the authors' knowledge, fear of moving outdoors has not been studied before. Studies of fear in older adults have mostly concerned fear of crime[16–19] or health concerns (e.g., fear of falling in general).[18,20–24] These studies have shown that fear is common, especially in older women, and that fear correlates with factors such as low socioeconomic status and poor health.[4,17,25–27] Studies on fear of falling and fear of crime give support to the suggestion that fear may restrict physical activity[4,22,25,28,29] and thus lead to decline in physical capabilities.[26,30]

The "Screening and Counseling for Physical Activity and Mobility" project (SCAMOB) provided an opportunity to study fear of moving outdoors in community-living older persons who were able to walk independently outdoors but still could perceive difficulty in walking. The aim was to study which individual characteristics and environmental factors correlate with fear of moving outdoors and to examine whether fear of moving outdoors predicts development of mobility limitation over a 3.5-year follow-up.

METHODS

Design

This observational study was based on cross-sectional analyses of baseline data and prospective twice-annual follow-up data over a 3.5-year period on the control group recruited for SCAMOB, a randomized controlled trial (ISRCTN 07330512). The SCAMOB project investigates the effects of physical activity counseling in community-living older people. The study design and methods are described in detail elsewhere.[31]

Study Population

The target population of the study comprised community-living residents of the City of Jyväskylä, Finland, aged 75 to 81. In 2003, 727 people (188 men and 539 women, mean age 77.6 ± 2.0) were interviewed in their homes. Of these, 657 participated in physical assessments and interviews conducted by a nurse examiner in the study center.

To be eligible for the follow-up of this study, participants had to have a Mini-Mental State Examination (MMSE) score greater than 21, be able to walk 500 m without help from another person, be only moderately physically active or sedentary (at most 4 hours of walking or 2 hours of other exercise weekly), and have no medical contraindications for physical activity.[31] Telephone interviews on mobility were conducted three times at 6-month intervals after baseline, face-to-face interviews were conducted at the 2-year follow-up point, and telephone interviews were conducted again three times at 6-month intervals after that for an overall follow-up period of 3.5-years.

Baseline interview data (N = 727) were used for the cross-sectional analyses, and data from the SCAMOB control group (n = 314) were used to follow up the naturally occurring changes in mobility. The dropout rate in the control group over 3.5 years was 14% (45 persons); 18 died, 16 declined, eight dropped out because of poor health, one moved, and two could not be reached.

For prospective analyses on the development of perceived difficulty in walking 2 km or 0.5 km, control group members who reported no difficulty in these tasks at baseline were included (walking 2 km, n = 214; walking 0.5 km, n = 266).

The ethical committee of the Central Finland Central Hospital approved the SCAMOB project. Participants were informed about the research and signed an informed consent.

Measurements

Background Characteristics

Sociodemographic indicators included age, living arrangements (alone or with someone), years of education, and perceived financial position (very bad, bad, or moderate vs good or very good). Information on chronic conditions was elicited as self-reported physician-diagnosed chronic conditions that the nurse examiner confirmed in the clinical examination. A condition was considered chronic if it had lasted longer than 3 months. Chronic conditions were then divided into the categories of cardiovascular, musculoskeletal, and lung diseases. Use of mobility devices indoors and outdoors was self-reported. At baseline, 10% of the participants used a cane, and none used a walker or wheelchair when moving outdoors. Cognitive impairment was assessed using the MMSE[32] and depressive symptoms using the Center for the Epidemiologic Studies Depression Scale (CES-D).[33]

Fear of Moving Outdoors

A variable was created to describe fear of moving outdoors based on two questions included in a larger questionnaire on health, lifestyle, and outdoor mobility.[31,34] In the first question, participants were asked to choose from a list of items all those that described their situation. Participants who agreed with the following statement, "I have feelings of insecurity when moving outdoors," were considered to have fear of moving outdoors. In addition, participants were asked whether they avoided moving outdoors and, if so, to write down their reasons for avoiding going outdoors. Those who reported that they avoided moving outdoors because of reasons that could be categorized as perceived elements of danger, insecurity due to other pedestrians, or fear were also considered to have fear of moving outdoors. People reporting other reasons for not going outdoors, such as poor vision, were not categorized as having fear of moving outdoors. To be categorized as having fear of moving outdoors, participants had to report feelings of insecurity when moving outdoors; or avoiding moving outdoors because of perceived elements of danger, insecurity due to other pedestrians or fear; or both.

Maximal Walking Speed

Maximal walking speed was measured in the study center corridor over a distance of 10 m. Participants were allowed 2 m to 3 m for acceleration before the start line and were encouraged to walk as fast as possible without risking their health. Timing was done using a stopwatch. Participants wore sneakers or walking shoes, and use of a walking aid was allowed if needed. Walking speed has previously been

shown to be a reliable and valid measurement of functional performance in older people.[35]

Mobility

Perceived difficulties in walking 2 km and 0.5 km were studied twice a year over the 3.5-year follow-up period. The questions were formulated as follows: "Do you have difficulty in walking 0.5 km?" and "Do you have difficulty in walking 2 km?" with response options: I am able to manage without difficulty, I am able to manage with some difficulty, I am able to manage with great deal of difficulty, I am able to manage only with the help of another person, and I am unable to manage even with help. For the analyses, options were dichotomized as "no difficulty" (1) and "difficulty" (2–5).

Environmental Factors

Environmental factors were examined as perceived by the participants, using standardized questionnaires, providing a subjective view of the participants' environment and features of the walking routes they used. Participants were asked whether certain environmental features weakened their possibilities for physical activity, with yes or no responses. The perceived environmental features studied were poor street conditions, hills in the nearby environment, long distances to everyday services (e.g., shops, banks), lack of resting places, noisy traffic, and dangerous crossroads.

Statistical Analysis

Background characteristics, fear of moving outdoors, environmental factors, and walking speed were assessed at baseline, and perceived difficulty in mobility was studied twice a year over the 3.5-year follow-up period. Baseline characteristics were described using means and standard deviations or percentages. Differences between the fear and no-fear groups were assessed using chi-square tests for categorized variables and *t*-tests for continuous variables. Logistic regression models were used to study factors associated with fear of moving outdoors. First only age and sex were adjusted for. Thereafter, all variables suspected of correlating with fear of moving outdoors were included in the model. When the 95% confidence intervals (CIs) did not include 1, or $P < .05$, the differences were regarded as statistically significant. SPSS version 14.0 (SPSS Inc., Chicago, IL) was used for the statistical analyses in the present cross-sectional setting.

Fear of moving outdoors as a predictor of perceived walking difficulty was studied by constructing generalized estimating equation (GEE) models.[36] This approach was chosen, because it was anticipated that, after first reporting walking difficulty, some people may recover from it. Prevalence at each data collection round, as shown in Figure 1, is a function of incidence of and recovery from the difficulty state. The exception is the first follow-up when prevalence and incidence coincided, because people who reported walking difficulty at baseline were excluded from these analyses. In the GEE models, changes between states from no difficulty to difficulty and from difficulty to no difficulty were compared between groups formed according to presence of fear of moving outdoors at baseline. The interaction effects, expressed as odds ratios (ORs), indicate whether changes differed between those with fear of moving outdoors and those with no fear. It was decided to calculate the ORs for each 6-month follow-up separately, because when the changes would take place and how long they would last could not be anticipated because of lack of earlier studies. Each OR indicates whether changes to and from the state of difficulty differed statistically significantly between the fear and no-fear groups over each sequential 6-month period, with the beginning of that period as the baseline. In addition, GEE modeling was used to analyze whether prevalence of perceived walking difficulty over the entire 3.5-year period differed statistically significantly between those with fear and those with no fear. All analyses were performed separately for perceived difficulty in walking 0.5 km and 2 km. Two separate GEE models were constructed for each distance. In the base model, age and sex were included as covariates. In the adjusted model, age, sex, education in years, musculoskeletal diseases, depressive symptoms, walking speed, and environmental factors were included as covariates. For cases with missing values at some point over the 3.5-year follow-up, data were imputed with the multiple imputation procedure implemented in SAS by using information on other mobility tasks and baseline information, such as number of long-term diseases, body mass index, and MMSE and CES-D score. The sensitivity analyses performed suggested no substantial differences in effects due to imputation. Subjects who died (n = 18) during follow-up were censored at the date of death, and

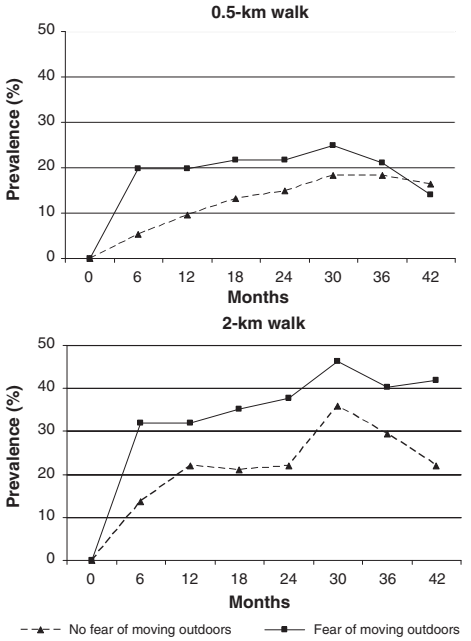

Figure 1. Unadjusted prevalences of perceived difficulty in walking 0.5 km (n = 266) and 2 km (n = 214) in subjects aged 75 to 81 without difficulty at baseline who were followed up every 6 months for 3.5 years.

missing values were not imputed. The analyses were performed with SAS version 9.1 (SAS Institute, Inc., Cary, NC) using the GENMOD procedure.

RESULTS

At baseline, the mean age ± standard deviation of the participants (n = 727) was 77.6 ± 1.9 (range 75–81), and 75% were women. At baseline, 8% of men and 11% of women reported feelings of insecurity when moving outdoors, and 26% of men and 62% of women avoided moving outdoors because of fear, insecurity because of other pedestrians, or other perceived elements of danger. In total, 65% of women and 29% of men reported one or the other and were categorized as having fear of moving outdoors.

Baseline individual and environmental characteristics are shown in Table 1 categorized according to presence or absence of fear of moving outdoors. People who reported fear of moving outdoors were more likely to be female, to have less education, to have a poorer financial situation, to live alone, to have musculoskeletal diseases and slower walking speed, and to report poor street condition, noisy traffic, and hills in their environment. Older age correlated with fear of moving outdoors with borderline significance ($P = .08$). The results are shown with men and women combined in the same analyses because the associations were almost identical for both sexes. Women were more than four times as likely to report fear of moving outdoors as men (OR = 4.47, 95% CI = 3.11–6.41). Each additional year of age increased the odds of reporting fear of moving outdoors by 7% (OR = 1.07, 95% CI = 0.99–1.15). The associations were further inspected using logistic regression models with presence of fear of moving outdoors as the outcome. The models adjusted for age and sex, as well as the full model with all covariates included, were mostly in agreement with the crude analyses (Table 2). Further analyses were performed stratifying data according to presence of difficulties in walking 2 km at baseline, and it was observed that poor street conditions, noisy traffic, and hills increased the probability of having fear of moving outdoors, particularly in those who reported difficulty walking 2 km and much less so in those without perceived difficulty (data not shown).

Table 1. Association Between Baseline Characteristics and Fear of Moving Outdoors in Community-Living People Aged 75 to 81

Characteristic	Fear (n = 405)	No Fear (n = 322)	*P*-Value*
Age, mean ± SD	77.7 ± 2.0	77.4 ± 2.0	.08
Education, years, mean ± SD	8.5 ± 3.5	9.7 ± 4.8	<.001
Center for Epidemiologic Studies Depression Scale score, mean ± SD	10.7 ± 7.8	9.5 ± 7.3	.037
Mini-Mental State Examination score, mean ± SD	26.6 ± 2.4	26.9 ± 2.6	.102
10-m walking speed, m/s, mean ± SD	1.30 ± 0.4	1.42 ± 0.4	<.001
Female, %	86	59	<.001
Living alone, %	63	51	.001
Financial situation, %			.003
Bad or moderate	63	53	
Good or very good	37	47	
Cardiovascular disease, %	68	65	.46
Lung disease, %	17	16	.72
Musculoskeletal disease, %	59	40	<.001
Use of cane, %	10	10	.95
Walking 0.5 km, %			.48
No difficulties	84	85	
Difficulties	16	15	
Walking 2 km, %			.06
No difficulties	62	68	
Difficulties	38	32	
Environmental factors, %			
Poor street condition	23	14	.002
Hills	27	17	.001
Long distances	12	8	.10
Lack of resting places	13	10	.17
Noisy traffic	16	7	<.001
Dangerous crossroads	15	11	.13

* Chi-square test and *t*-test.
SD = standard deviation.

Table 2. Factors Associated with Fear of Moving Outdoors in Logistic Regression Analysis at Baseline in People Aged 75 to 81 (N = 654–727)

Factor	Bivariate* Odds Ratio (95% Confidence Interval)	Multivariate† Odds Ratio (95% Confidence Interval)
Living alone	0.94 (0.67–1.32)	0.77 (0.52–1.14)
Education in years	0.94 (0.90–0.98)	0.96 (0.91–1.01)
Financial situation bad or moderate versus good or very good	1.49 (1.09–2.04)	1.13 (0.77–1.65)
Cardiovascular disease	1.21 (0.87–1.68)	1.19 (0.83–1.72)
Lung disease	0.99 (0.65–1.49)	0.83 (0.51–1.35)
Musculoskeletal disease	1.94 (1.42–2.66)	1.90 (1.33–2.73)
Center for Epidemiologic Studies Depression Scale score	1.02 (0.99–1.04)	1.00 (0.98–1.03)
Mini-Mental State Examination score	0.96 (0.90–1.02)	0.93 (0.85–1.02)
10 m walking speed, m/s	0.58 (0.36–0.94)	0.87 (0.48–1.56)
Difficulties versus no difficulties walking 0.5 km	1.01 (0.48–2.15)	0.84 (0.29–2.38)
Difficulties versus no difficulties walking 2 km	1.19 (0.75–1.82)	0.91 (0.50–1.67)
Environmental factors		
Poor street condition	1.71 (1.13–2.58)	1.31 (0.80–2.12)
Hills	1.59 (1.08–2.32)	1.28 (0.81–2.04)
Long distances	1.36 (0.81–2.31)	1.14 (0.62–2.11)
Lack of resting places	1.36 (0.84–2.22)	1.04 (0.56–1.90)
Noisy traffic	2.67 (1.57–4.56)	2.40 (1.32–4.39)
Dangerous crossroads	1.43 (0.90–2.29)	1.12 (0.65–1.95)

* Age- and sex-adjusted bivariate odds ratios.
† Age- and sex-adjusted multivariate full model with all variables included in the model simultaneously.

Table 3. Effect of Fear of Moving Outdoors on the Development of Perceived Difficulty Walking 0.5 km and 2 km in People Aged 75 to 81 Afraid of Moving Outdoors Versus Not Afraid of Moving Outdoors

	Base Model*	Adjusted Model†
Months	OR (95% Confidence Interval)	
Difficulty walking 0.5 km		
0–6	2.56 (1.39–4.72)	4.60 (1.92–11.00)
7–12	0.71 (0.41–1.23)	0.52 (0.26–1.06)
13–18	0.94 (0.56–1.59)	0.98 (0.46–2.08)
19–24	0.93 (0.54–1.61)	0.93 (0.40–2.15)
25–30	1.05 (0.62–1.78)	0.87 (0.41–1.85)
31–36	0.62 (0.35–1.08)	0.67 (0.31–1.44)
37–42	1.22 (0.70–2.11)	1.15 (0.54–2.46)
Over time	$P = .06$	$P = .02$
Difficulty walking 2 km		
0–6	2.02 (1.27–3.22)	3.10 (1.49–6.46)
7–12	0.81 (0.54–1.21)	0.83 (0.47–1.48)
13–18	1.04 (0.67–1.62)	1.07 (0.56–2.03)
19–24	1.17 (0.73–1.87)	1.26 (0.59–2.68)
25–30	0.63 (0.39–1.01)	0.46 (0.22–0.93)
31–36	1.16 (0.75–1.78)	1.43 (0.78–2.61)
37–42	1.68 (1.10–2.55)	1.69 (0.96–2.96)
Over time	$P = .008$	$P = .009$

Note: Interaction effect expressed as odds ratio (OR) indicates the difference between the groups over time.

*Adjusted for age and sex.

†Adjusted for age, sex, education, musculoskeletal disease, depressive symptoms, walking speed and presence of poor street conditions, hills, long distances, lack of resting places, noisy traffic, and dangerous crossroads.

The prevalence of mobility difficulty at each 6-month interview during the 3.5-year follow-up in those without self-reported difficulty at baseline in the 0.5 km or 2 km walking are shown in Figure 1. The results of the related GEE models are shown in Table 3. People who reported fear of moving outdoors but no difficulty walking 0.5 km or 2 km at baseline were three to almost five times as likely to develop perceived difficulty during the following 6 months. From 6 months onward, the changes to and from the perceived difficulty state were similar between the fear and no-fear groups, making the further ORs nonsignificant and the changes in prevalence parallel. The difference in the prevalence of perceived difficulty in walking remained statistically significant throughout the 3.5-year follow-up for walking 0.5 km and 2 km (Table 3 and Figure 1).

DISCUSSION

In the present study, fear of moving outdoors predicted greater risk of developing self-reported difficulties in walking 0.5 km and 2 km during the first 6 months after baseline. The resulting difference in prevalence remained significant over the entire 3.5-year follow-up. It was observed that fear of moving outdoors is common in older people, especially in women, and that poor socioeconomic status, musculoskeletal diseases, slow walking speed, and the presence of negative environmental features underlay fear of moving outdoors but do not explain the greater risk of incident mobility limitation of those with fear of moving outdoors.

In the previously developed disablement process model[2] and an ecological model of aging,[3] disability is seen as a gap between personal capability and environmental demand, suggesting that personal and environmental components have to be in balance to support adaptive behavior. Fear of moving outdoors may be a consequence of perceived imbalance between environmental demand (or threat) and personal capability, and it was anticipated that fear of moving outdoors would contribute to the pathway from environmental and individual risks to outdoor mobility limitation. The results showed that the presence of other risk factors for mobility decline did not explain the higher risk of developing perceived difficulty walking 2 km or 0.5 km in people reporting fear of moving outdoors but that fear increased the risk of mobility decline independent of these risk factors. Adjusting the GEE models for potential confounders did not attenuate the ORs but instead increased them.

It is possible that fear of moving outdoors is a subjective sign of impending task difficulties. This is consistent with the finding that differences in perceived walking difficulties in 0.5 km and 2 km emerged during the first 6 months of follow-up. It is also possible that fear-related avoidance of activities accelerates the disablement process because of the consequences of physical inactivity and reduced participation in social and other out-of-home activities. Earlier studies have shown that outdoor physical activity mediates the association between fear of falling and falls.[28] The possibility that perceived fear of moving outdoors may have a direct effect on perceived difficulty in walking cannot be excluded. Fear of moving outdoors may cause feelings of discomfort and thus directly influence perceived difficulty in outdoor mobility, although all potential subjects with perceived difficulty at baseline were excluded from the prospective analyses. It is unlikely that overlap in people's minds in the concepts of fear of moving outdoors and perceived difficulty walking specific distances would explain the results. Furthermore, it cannot be excluded that time of year may influence fear of moving outdoors or perceived walking difficulties, although all baseline interviews took place during a 3-month period in spring and thereafter at 6-month intervals during autumn or spring. Because people with and without fear of moving outdoors were always interviewed at the same time of the year, seasonal variations are not likely to add further explanation.

To the best of the authors' knowledge, this is the first study on fear of moving outdoors in old age, but previous studies on fear of falling and fear of crime have yielded similar results about underlying factors.[17,24,29,37] Some studies of fear of falling have recognized that this particular fear might be part of a more generalized psychological disorder[25] or generalized fearfulness,[38] which suggests a need for more broad-based approach to this phenomenon. It is also possible that fear of moving outdoors reflects other emotional conditions, such as depression. Depressive symptoms also increase the risk of outdoor activity restriction,[39] although in the age- and sex-adjusted analysis, only a weak association between fear of moving outdoors and depressed mood was observed, which disappeared in the multivariate analyses, suggesting that fear of moving outdoors is

a phenomenon independent of depressed mood. Unfortunately, data for addressing the associations between fear of falling, fear of crime, and fear of moving outdoors were not available in this study. This topic warrants further study.

Being female, having less education and musculoskeletal diseases, and presence of noisy traffic correlated with fear of moving outdoors. In addition, other studies have found that fear is more common in women that men.[7,17,26,27,40] Furthermore, higher socioeconomic status, indicated by more education and good perceived financial situation, decreased the probability of fear of moving outdoors. In previous studies, correlation between high socioeconomic status and the more favorable neighborhood characteristics has been found,[27,41–44] although in this study, almost all of the participants were living in the same urban area, most of them in condominiums and some in detached houses, and therefore there were only minor differences in neighborhood characteristics across the sample. Years of education and good perceived financial situation may thus be indicators of general resources in life and thus have a positive influence on the self-reliance of the individual.

Reporting that the neighborhood was demanding, in terms of poor street conditions, hills in the nearby environment, and noisy traffic, increased the probability for fear of moving outdoors. According to reports by the Finnish Road Administration[45] and some other previous studies, lighting conditions, snow, and ice affect the willingness of older adults to go out.[46] In a previous study,[44] excessive noise, inadequate lighting, traffic, and limited access to public transportation were connected with greater risk of loss of physical function. Other studies have also found associations between physical activity and environmental characteristics such as safety.[5,6,8,9,47] It is possible that an environment perceived as stressful may accentuate unwillingness to go outdoors, particularly in people with mobility limitations.[21,26,48,49] In contrast, in the data used for the current study, no information on supportive environmental aspects were available, but positive environmental factors should also be taken into account in further studies.

In this study, good walking speed protected from fear of moving outdoors, whereas musculoskeletal diseases increased its risk. The category of musculoskeletal diseases included conditions such as arthritis but also previous fractures and osteoporosis. People with osteoporosis are aware of their risk of fractures[50] and may thus develop fear of moving outdoors. A bone fracture is a dramatic and painful event and will likely lead to fear and avoidance of activities that may predispose the person to report fear of moving outdoors.

The strengths of this study are the large, population-based sample and cross-sectional and longitudinal data analyses of a topic that has not been widely studied. The longitudinal analyses gave us the opportunity to study the temporal connections between fear of moving outdoors and perceived walking difficulties. There is no widely accepted instrument to measure fear of moving outdoors. This study suggests that fear of moving outdoors is an existing and meaningful phenomenon and supports the need to develop a validated self-report measure for this phenomenon. This study was not designed specifically to examine fear of moving outdoors. Nevertheless, even with a crude measure, the results showed that fear may lead to deterioration in functional ability in old age. In addition, because of the sample characteristics of the original study, the community-living sample of older people for the current study was truncated (with a rather narrow age range and the most disabled and the most vigorous individuals excluded). Therefore, the results may be viewed as an underestimation rather than an overestimation of the effects of fear of moving outdoors on perceived walking difficulty.

CONCLUSION

Fear of moving outdoors is common in older adults and increases the risk of developing perceived walking difficulties. Knowledge about the individual and environmental factors underlying fear of moving outdoors and finding ways to alleviate fear of moving outdoors are important for community planning and prevention of disability. The topic warrants further study.

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Author Contributions: Rantakokko had full access to all the data gathered for the study and takes full responsibility for the integrity of the data and the accuracy of the data analyses. Concept and design: Rantakokko, Leinonen, Heikkinen, Rantanen. Acquisition of data: Mänty, Leinonen, Heikkinen, Rantanen. Statistical analysis: Rantakokko, Törmäkangas. Interpretation of data: Rantakokko, Törmäkangas, Rantanen. Drafting the manuscript: Rantakokko, Mänty, Iwarsson, Rantanen. Critical revision of the manuscript for important intellectual content: Rantakokko, Mänty, Iwarsson, Törmäkangas, Leinonen, Heikkinen, Rantanen.

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III

UNMET PHYSICAL ACTIVITY NEED IN OLD AGE

By

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Unmet Physical Activity Need in Old Age

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OBJECTIVES: To examine which individual and environmental factors correlate with unmet physical activity need in old age and predict development of unmet physical activity need (the feeling that one's level of physical activity is inadequate and thus distinct from the recommended amount of physical activity) over a 2-year follow-up.

DESIGN: Observational prospective cohort study and cross-sectional analyses.

SETTING: Community and research center.

PARTICIPANTS: A total of 643 community-living ambulatory people aged 75 to 81 took part in face-to-face interviews and examinations at baseline and 314 at the 2-year follow-up.

MEASUREMENTS: Unmet physical activity need and its potential individual and environmental correlates were assessed at baseline. Development of unmet physical activity need was assessed over the 2-year follow-up period.

RESULTS: At baseline, all participants were able to walk at least 500 m outdoors, but 14% perceived unmet physical activity need. Unmet physical activity need was more prevalent in those with musculoskeletal diseases, depressive symptoms, and mobility limitations. Hills in the nearby environment, lack of resting places, and dangerous crossroads correlated with unmet physical activity need at baseline; the association was especially strong in those with walking difficulties. Significant baseline predictors for incident unmet physical activity need (15%) included fear of moving outdoors, hills in the nearby environment, and noisy traffic.

CONCLUSION: Unmet physical activity need is common in ambulatory community-living older people who have health and mobility problems and report negative environmental features in their neighborhood. Solutions to overcome barriers to physical activity need to be developed to promote equal opportunities for physical activity participation. **J Am Geriatr Soc 58:707–712, 2010.**

Key words: unmet need; physical activity; environment; aging

Physical activity is typically defined as any bodily movement produced by skeletal muscles that result in an expenditure of energy.[1] The need for physical activity is fundamental for human beings of all ages. Because of its health benefits, such as preventing chronic conditions, mobility loss, and maintaining community independence,[2–4] it is now recognized that older people need to be encouraged to maintain and adopt an active life-style (e.g., the Second World Assembly on Ageing in 2002[5]). It is widely recognized that frail older people in residential care facilities are extremely physically inactive, but unmet need for physical activity in community-living, ambulatory people has not been acknowledged.

An earlier study found that the majority of older community-living people wished to increase their level of physical activity,[6] but a substantial proportion of them also felt that they lacked the opportunity to do so. This situation was defined as unmet need for physical activity, because the people in question were less physically active than they wished to be. Unmet physical activity need is, then, the feeling that one's level of physical activity is inadequate and is therefore distinct from the amount of physical activity recommended as sufficient for good health.[7] To the authors' knowledge, the unmet need of physical activity in older people has not been studied before. A basic need, in general, may be defined as "an energizing state that, if satisfied, conduces toward health and well-being but, if not satisfied, contributes to ill-being."[8] Inadequately met basic needs predict depression,[9] problems in physical functioning,[10] and mortality.[11] Previous research in the field of unmet needs of older people has been limited almost entirely to the needs of care, health services, personal assistance, and

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economic security.[9–14] Satisfying physical activity need is unique in the sense that it ranges from physiological functions, such as breathing or muscle activity, to valued social activities, such as doing volunteer work or going to an art event, referring to participation as described in the International Classification of Functioning, Disability and Health.[15] It is currently unclear what factors lead to unmet need for physical activity in ambulatory community-living older people. An earlier study of ambulatory people showed that a greater proportion of those who perceived difficulty in walking were more willing to increase their physical activity than those who perceived no such difficulties.[16] Moreover, negative environmental features may restrict participation in physical activities, especially for those who perceive difficulty in walking, thus leading to severe functional deterioration.[17,18] Loss of personal capabilities together with high environmental demands reduce the opportunity for adaptive behavior[19] and may thus predispose people to perceive unmet need for physical activity.

The aim of this study was to examine which individual characteristics and environmental factors correlate with unmet physical activity need, whether and, if so, how environmental features are related to unmet physical activity need in older people with perceived walking difficulties, and what factors would predict the development of unmet physical activity need over a 2-year follow-up period.

METHODS

Design

This observational study was based on cross-sectional analyses of baseline data and prospective follow-up data over a 2-year period on the control group recruited for a randomized controlled trial entitled "Screening and Counselling for Physical Activity and Mobility" (SCAMOB) (ISRCTN 07330512). The SCAMOB project investigates the effects of physical activity counseling in community-living older people in Finland. The study design and methods have been described in detail elsewhere.[6]

Study Population

The target population of the study comprised community-living residents of the City of Jyväskylä, Finland, aged 75 to 81 (N = 1,310). To be eligible for the study, participants had to have a Mini-Mental State Examination (MMSE) score greater than 21, be able to walk 500 m without help from another person, be only moderately physically active or sedentary (at most 4 hours of walking or 2 hours of other exercise weekly), and have no medical contraindications for physical activity.[6] After screening, there were 643 participants in the cross-sectional analyses and 314 participants in the control group for the follow-up of the development of unmet physical activity need. For the prospective analyses on the development of unmet physical activity need, those control group members who did not have unmet physical activity need at baseline were selected (n = 214). The dropout rate in the follow-up group over 2 years was less than 10%.

The Ethical Committee of the Central Finland Central Hospital approved the SCAMOB project. Participants were informed about the research and signed informed consent.

Measurements

The outcome measure of this study, unmet physical activity need, was studied using the question "Do you feel that you would have the opportunity to increase your level of physical activity level if someone recommended you do so?" and "Would you like to increase your level of physical activity?" with the response options of yes or no. Persons who felt that they had no opportunity to engage in physical activity but were willing to increase their physical activity level were defined as experiencing unmet physical activity need.

Sociodemographic indicators included age, living arrangements (alone or with someone), years of education, and perceived financial position (very bad, bad, or moderate vs good or very good). Information on chronic conditions was elicited as self-reported physician-diagnosed chronic conditions that a nurse examiner confirmed in the clinical examination. A condition was considered chronic if it had lasted longer than 3 months. Chronic conditions were then divided into the categories of cardiovascular, musculoskeletal, and lung diseases. Cognitive impairment was assessed using the MMSE[20] and depressive symptoms with the Center for Epidemiologic Studies Depression Scale.[21]

Fear of moving outdoors was self-reported. People who reported feelings of insecurity when moving outdoors or avoidance of going outdoors because of perceived elements of danger or insecurity due to other pedestrians or fear were categorized as having fear of moving outdoors.[22]

Maximal walking speed was measured in the study center corridor over a distance of 10 m. Participants were allowed 2 to 3 m for acceleration before the start line and were encouraged to walk as fast as possible without risking their health. Time was taken with a stop watch. Participants wore sneakers or walking shoes, and use of a walking device was allowed if needed.

Mobility limitation was studied using a structured interview on perceived difficulties in walking 2 km. The question was formulated as follows: "Do you have difficulty in walking 2 km?" with the following response options: (1) I am able to manage without difficulty, (2) I am able to manage with some difficulty, (3) I am able to manage with great deal of difficulty, (4) I am able to manage only with the help of another person, and (5) I am unable to manage even with help. For the analyses, perceived difficulties in walking was dichotomized as no difficulties (1) and difficulties (2–5).

Self-reported reduction in physical activity was assessed retrospectively at baseline. Participants were asked about changes in their amount of physical activity during the past few years, and five response options were given: (1) reduced a lot, (2) reduced a little, (3) remained as before, (4) increased a little, and (5) increased a lot. For the analyses, self-reported reduction in physical activity was dichotomized as reduced (1–2) and not reduced (3–5).

Environmental factors were examined as perceived by the participants using standardized questions providing a subjective view of the outdoor environment and features of the walking routes they used. That is, the participants were asked whether certain environmental features negatively affected their possibilities for moving independently outdoors (yes or no). The environmental features asked about were poor street conditions, hills in the immediate environment, long distances to everyday services (e.g., shops,

banks), lack of resting places, noisy traffic, and dangerous crossroads.

Statistical Analyses

Baseline characteristics were described using means and standard deviations or percentages. In the cross-sectional setting, differences between those with and without unmet physical activity need were analyzed using chi-square tests for the categorical variables and *t*-tests for the continuous variables. The results are shown with men and women combined in the same analyses, because the sex-stratified analyses showed almost identical results for both sexes. Logistic regression analyses were used to identify the factors associated with unmet physical activity need at baseline. Age-, sex-, and fully adjusted associations were calculated. Finally, the participants were stratified according to whether they experienced difficulties walking 2 km to determine whether the relationship between environmental factors and unmet physical activity need differed between these groups.

In the longitudinal setting, individual and environmental factors as predictors of unmet physical activity need were studied using logistic regression analyses. Those reporting unmet physical activity need at baseline were excluded from these analyses. Two separate models were created for the individual and environmental factors. The first model shows the age- and sex-adjusted bivariate associations, and the second model is a multivariate model in which all of the variables were included simultaneously and adjusted for age and sex.

SPSS version 14.0 (SPSS Inc., Chicago, IL) was used for all of the statistical analyses. When the 95% confidence intervals (CIs) did not include 1, or when P was $<.05$, the results were regarded as statistically significant.

RESULTS

The mean age of the participants (n = 643) was 77.6 ± 1.9; 75% were women.

At baseline, 67% (68% of women and 63% of men) were willing to increase their physical activity level, and 36% (35% of women and 37% of men) felt that they had no opportunities to do so. In total, 14% (15% of women and 12% of men) were categorized as having unmet physical activity need at baseline, because they reported willingness to increase their physical activity while also perceiving no opportunity to do so.

Baseline individual and environmental characteristics are shown in Table 1 according to the presence or absence of unmet physical activity need. People with unmet physical activity need more often lived with someone and had depressive symptoms, good cognitive functioning, slow walking speed, musculoskeletal diseases, and perceived walking

Table 1. Baseline Characteristics of Community-Living People Aged 75 to 81 with and without Unmet Physical Activity Need (n = 643)

Characteristic	With (n = 90)	Without (n = 553)	*P*-Value*	Odds Ratio† (95% Confidence Interval)
Age, mean ± SD	77.8 ± 1.9	77.6 ± 1.9	.25	1.07 (0.95–1.20)
Education, years, mean ± SD	8.8 ± 3.8	9.2 ± 4.3	.40	0.98 (0.93–1.04)
Center for Epidemiologic Studies Depression Scale score, mean ± SD	12.9 ± 8.0	9.7 ± 7.4	<.001	1.05 (1.02–1.08)
Mini-Mental State Examination score, mean ± SD	27.5 ± 1.9	27.0 ± 2.1	.03	1.14 (1.02–1.28)
10-m walking speed, m/s, mean ± SD	1.2 ± 0.4	1.4 ± 0.4	<.001	0.15 (0.08–0.31)
Fear of moving outdoors, %	58	56	.81	0.97 (0.61–1.56)
Female, %	79	75	.37	1.27 (0.74–2.19)
Living alone, %	49	59	.06	0.53 (0.33–0.86)
Financial situation, %			.20	1.34 (0.84–2.14)
Bad or moderate	64	57		
Good or very good	36	43		
Cardiovascular disease, %	72	66	.26	1.35 (0.82–2.21)
Lung disease, %	23	15	.09	1.58 (0.91–2.75)
Musculoskeletal disease, %	65	50	.006	1.86 (1.16–2.99)
Difficulty walking 2 km, %	60	30	<.001	3.48 (2.19–5.53)
Reduced physical activity, %	85	61	<.001	3.76 (2.04–6.95)
Environmental factors, %				
Poor street conditions	24	18	.14	1.47 (0.87–2.51)
Hills	34	21	.006	1.87 (1.14–3.02)
Long distances	13	9	.22	1.47 (0.75–2.89)
Lack of resting places	22	9	<.001	2.94 (1.65–5.25)
Noisy traffic	13	12	.67	1.18 (0.61–2.28)
Dangerous crossroads	21	12	.01	2.06 (1.16–3.64)

* Chi-square test and *t*-test.
† Age- and sex-adjusted logistic regression analysis.
SD = standard deviation.

Table 2. Environmental Factors Associated with Unmet Physical Activity Need in Participants with and without Perceived Difficulties in Walking 2 km at Baseline (n = 640)

	Odds Ratio (95% Confidence Interval)*	
Factor	**Difficulties (n = 215)**	**No Difficulties (n = 425)**
Poor street conditions		
Yes	3.74 (1.70–8.25)	2.35 (1.10–5.03)
No	4.36 (2.54–7.48)	1.00
Hills		
Yes	4.04 (2.07–7.88)	3.05 (1.44–6.48)
No	4.79 (2.71–8.49)	1.00
Long distances		
Yes	1.52 (0.66–3.50)	2.30 (0.94–5.61)
No	3.68 (2.24–6.03)	1.00
Lack of resting places		
Yes	5.71 (2.82–11.54)	2.80 (0.89–8.84)
No	3.24 (1.93–5.44)	1.00
Noisy traffic		
Yes	2.82 (1.07–7.46)	1.73 (0.68–4.43)
No	3.87 (2.34–6.39)	1.00
Dangerous crossroads		
Yes	7.72 (3.28–18.13)	2.09 (0.90–4.87)
No	3.48 (2.07–5.84)	1.00

* Adjusted for age and sex.

difficulties. They had also reduced their physical activity level over the past few years. Of the environmental factors, hills in the immediate environment, lack of resting places, and dangerous crossroads were associated with unmet physical activity need at baseline (Table 1). In the full model, good cognitive status (odds ratio (OR) = 1.25, 95% CI = 1.09–1.44), reduction in physical activity (OR = 3.33, 95% CI = 1.65–6.74), and presence of dangerous crossroads (OR = 2.02, 95% CI = 1.02–4.02) increased and living alone (OR = 0.32, 95% CI = 0.18–0.57) and good walking speed (OR = 0.26, 95% CI = 0.10–0.62) decreased the probability of unmet physical activity need (data not shown in table).

Almost all of the negative environmental factors increased the probability of unmet physical activity need, in particular in those with difficulties in walking 2 km (Table 2). In particular, lack of resting places and dangerous crossroads were strongly associated with risk of unmet physical activity need in those with difficulties walking. Poor street conditions and hills in the nearby environment also increased the probability of unmet physical activity need in those without difficulties in walking.

Of those who did not report unmet physical activity need at baseline, 15% (17% of women and 10% of men) developed unmet physical activity need over the 2-year follow-up. In the prospective analyses, fear of moving outdoors resulted in three times the risk of developing unmet physical activity need compared with not being afraid (Table 3). Participants reporting hills in their immediate environment and noisy traffic were more than two times to more than four times as likely to develop unmet physical activity need. In the multivariate model studying individual factors, fear of moving outdoors was an independent predictor of unmet physical activity need. In the multivariate model studying environmental factors, only noisy traffic predicted unmet need for physical activity when all of the environmental factors were included simultaneously and the model adjusted for age and sex. In the model including all of the individual and environmental variables, the results remained practically unchanged, but the statistical power decreased because of the greater number of variables in the model (data not shown).

DISCUSSION

To the authors' knowledge, this study is the first to target unmet need for physical activity in older people, and it demonstrates that a fair proportion of those aged 75 to 81 feel that they do not have enough opportunities to increase their physical activity level despite a willingness to do so. Unmet physical activity need is the feeling that one's level of physical activity is inadequate and is therefore distinct from the amount of physical activity recommended as sufficient for maintaining good health.[7] The results of the present study suggest that negative environmental features magnify the risk for unmet physical activity need in those whose mobility has started to decline. According to the ecological model of aging,[19] human behavior is the outcome of personal capabilities, environmental demands, and the inter-

Table 3. Predictors of Unmet Physical Activity Need in Community-Living People Aged 75 to 81 (n = 214) over 2 Years of Follow-Up

	Odds Ratio (95% Confidence Interval)	
Predictor	**Bivariate***	**Multivariate†**
Individual factors		
Living alone	1.21 (0.52–2.82)	1.17 (0.47–2.86)
Center for the Epidemiologic Studies Depression Scale	1.03 (0.98–1.09)	1.03 (0.97–1.09)
Mini-Mental State Examination	0.89 (0.75–1.06)	0.85 (0.69–1.04)
Fear of moving outdoors	3.07 (1.21–7.81)	2.82 (1.02–7.75)
Education in years	1.01 (0.93–1.09)	1.04 (0.95–1.13)
Financial situation		
Bad or moderate vs good or very good	1.12 (0.51–2.45)	1.38 (0.55–3.50)
Musculoskeletal disease	2.01 (0.91–4.46)	1.38 (0.56–3.39)
Difficulties vs no difficulties walking 2 km	1.42 (0.63–3.21)	1.22 (0.48–3.09)
Environmental factors		
Poor street conditions	0.98 (0.31–3.10)	0.52 (0.13–2.03)
Hills	2.30 (1.00–5.27)	2.49 (0.95–6.54)
Long distances	1.28 (0.34–4.87)	1.50 (0.35–6.50)
Lack of resting places	0.66 (0.14–3.06)	0.25 (0.04–1.57)
Noisy traffic	4.48 (1.65–12.16)	4.61 (1.49–14.33)
Dangerous crossroads	1.35 (0.46–3.96)	1.08 (0.34–3.47)

* Age- and sex-adjusted bivariate associations

† Age- and sex-adjusted multivariate model, individual and environment factors analyzed separately.

action of these two components. It was anticipated that unmet physical activity need would be a consequence of a mismatch between environmental demands and reduced personal capabilities; these results support this assumption.

Although the present study sheds some light on the development of unmet physical activity need, the dynamics underlying this development remain partially unrevealed and thus warrant further study. Fear of moving outdoors and reduction in physical activity preceded the development of unmet physical activity need, together with negative environmental features near the home. Depressive symptoms were observed simultaneously with unmet physical activity need, and thus it is possible that depressive symptoms are a consequence rather than a cause of unmet physical activity need. These findings are consistent with those of previous studies in which high-level depressive symptoms have been found in stroke survivors who have given up traveling using public transport[23] and an increase in depression in older people who have given up other meaningful activities.[24,25]

Stability of unmet physical activity need is currently unclear, although almost half of those with unmet physical activity need at baseline did not report it at follow-up, which indicates that unmet physical activity need may be transient. It seems likely that unmet physical activity need becomes evident relatively soon after the occurrence of events causing changes in physical activity, such as the need to attend to a sick spouse or a disease or injury leading to mobility decline. Later on, people may adapt to their current situation, and the desire to be more physically active may disappear. This is consistent with the finding that walking difficulties coincided with unmet physical activity need, whereas fear of moving outdoors preceded it. An earlier study showed that fear of moving outdoors predicts the development of new walking difficulties in the near future,[22] possibly leading to the development of unmet physical activity need.

It is also possible that fear of moving outdoors leads to unmet physical activity need because of poor self-efficacy. According to the self-efficacy theory, people fear and avoid situations they believe exceed their coping skills,[26] whereas previous studies of fear of falling and fear of crime suggest that fear restricts participation in outdoor activities.[27–29] Ancillary analyses showed that fear of moving outdoors reduced perceived possibilities for physical activity but did not attenuate willingness to increase physical activity.

Turning to the environmental factors studied, hills in the immediate environment and noisy traffic predicted development of unmet physical activity need in the 2-year follow-up. Noisy traffic was an independent predictor of unmet physical activity need even when adjusted for walking difficulties. Consistent with the finding of a recent study identifying problems in pedestrian environments as perceived by older people,[30] traffic noise may indicate a perception of busy roads that are dangerous, in which case, it is worries about personal safety rather than the noise itself that may lead to the perception that opportunities for physical activity have become restricted and in turn to the development of unmet physical activity need.

The strengths of the present study are the large, population-based sample and the application of cross-sectional and longitudinal analysis of a topic that has not been widely studied before. The longitudinal setting allows inferences to be made on the temporal order of events leading to the development of unmet physical activity need and thus identify individuals who are at risk for marginalization from physical activity. One limitation of this study is that that definition of unmet physical activity need considered physical activity in general, whereas the environmental features studied were rather specific for walking. Nevertheless, walking outdoors is the most popular form of physical activity of community-living older people in Finland and often a prerequisite for attending other physical activities. Thus, it is likely that the results were not substantially weakened. In addition, the population studied was a truncated sample of community-living older people, because the most-disabled and most-vigorous people were excluded.[6] The proportion of those in the general population experiencing unmet physical activity need is probably larger than in the sample. Hence the results probably underestimate the extent of the problem.

CONCLUSION

Unmet physical activity need is relatively common in ambulatory community-living older people, especially for those with health and mobility problems who also report negative environmental features in their neighborhood. These people form a fruitful target group for physical activity promotion, although traditional physical activity promotion programs are likely to be ineffective for them because they may need more support. For example, volunteer walking buddies may be used to encourage them to exercise. This topic merits further research.

ACKNOWLEDGMENTS

Conflict of Interest: The editor in chief has reviewed the conflict of interest checklist provided by the authors and has determined that the authors have no financial or any other kind of personal conflicts with this paper.

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Author Contributions: Rantakokko had full access to all the data gathered for the study and takes full responsibility for the integrity of the data and the accuracy of the data analyses. Concept and design: Rantakokko, Hirvensalo, Leinonen, Heikkinen, Rantanen. Acquisition of data: Hirvensalo, Leinonen, Heikkinen, Rantanen. Statistical analysis: Rantakokko. Interpretation of data: Rantakokko, Rantanen. Drafting the manuscript: Rantakokko, Iwarsson, Rantanen. Critical revision of the manuscript for important intellectual content: Rantakokko, Iwarsson, Hirvensalo, Leinonen, Heikkinen, Rantanen. Obtained funding: Rantakokko, Hirvensalo, Leinonen, Heikkinen, Rantanen.

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IV

QUALITY OF LIFE AND BARRIERS IN THE URBAN OUTDOOR ENVIRONMENT IN OLD AGE

By

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Quality of Life and Barriers in the Urban Outdoor Environment in Old Age

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OBJECTIVES: To examine the association between barriers in the outdoor environment and perceived quality of life (QoL) in old age and to assess whether fear of moving outdoors and unmet physical activity need contribute to this association.

DESIGN: Cross-sectional.

SETTING: Community and research center.

PARTICIPANTS: Five hundred eighty-nine, community-dwelling people aged 75 to 81 took part in face-to-face home-interviews and examinations in the research center.

MEASUREMENTS: QoL was assessed using the LEIPAD questionnaire. Environmental barriers were studied based on self-reports of lack of resting places or long distances (distances), noisy traffic or dangerous crossroads (traffic), and hilly terrain or poor street condition (terrain). Fear of moving outdoors and unmet physical activity need were self-reported, and maximal walking speed was measured over 10 m. A path analyses model using LISREL was used for the statistical analyses.

RESULTS: QoL was worse among those who reported more barriers in their outdoor environment, experienced fear of moving outdoors or unmet physical activity need, and had slower walking speed and more chronic diseases. In the path model, in which 36% of the variation in QoL was explained, terrain, traffic and distances influenced QoL through fear of moving outdoors or unmet physical activity need, whereas distances had a direct association with QoL.

CONCLUSION: An outdoor environment that encumbers outdoor mobility increases perceptions of fear of moving outdoors and unmet physical activity need and is associated with poor QoL in older people. More research is needed to confirm the temporal order and causality of these observations. **J Am Geriatr Soc 58:2154–2159, 2010.**

Key words: quality of life; outdoor environment; outdoor mobility

For more than a decade, quality of life (QoL) has been used as a broad outcome measure in health intervention studies.[1] Although widely studied, there is no universally accepted definition of QoL. Many studies have referred to the definition of QoL as "individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns" given by the World Health Organization Quality of Life group.[2] In the recent literature, QoL is typically seen as a multidimensional entity that includes domains such as health and symptoms, mood, functioning, life satisfaction, and participation.[3,4]

The ecological model of aging[5] considers human behavior and well-being to be strongly related to the environment where a person lives and to her or his capabilities. Lawton[6] defined QoL as "the multidimensional evaluation, by both intrapersonal and social-normative criteria, of the person-environment system of an individual in time past, current, and anticipated." The importance of environment for QoL has been acknowledged, even if not yet widely studied.[7,8] Studies have been limited to comparing differences in QoL according to types of housing, such as institutions and in the community. These studies have shown lower QoL scores for participants living in assisted living facilities or nursing homes than for those living in the community.[8–10] Less is known about the association between specific features of outdoor environment and QoL in older community-dwelling people in general. One recent study showed that fewer barriers in the physical environment predicted good QoL but did not specify the most-severe environmental barriers.[3] A study of people with spinal cord injuries showed that negative environmental factors decrease possibilities of moving outdoors, thus having negative effects on life satisfaction.[11] Similar studies have not been conducted in older people, although there are studies

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showing that barriers in the outdoor environment increase the risk of functional loss[12] and walking difficulties[13] and decrease physical activity participation.[14] A previous analyses of the current data found that perceived barriers in the outdoor environment correlated with experiencing fear of moving outdoors and unmet physical activity need.[15,16]

In recent years, knowledge of the benefits of moving outdoors for physical, psychological, and social well-being in older people has increased.[17,18] For example, restrictions on participation in out-of-home activities and having to give up meaningful activities reduce QoL.[19–21] It is therefore intuitive that the presence of environmental barriers may decrease QoL in older community-dwelling people, but to best of the authors' knowledge, no studies on this topic have been published.

The aim of the study was to examine the associations between perceived barriers in the outdoor environment and QoL in older community-living people who are able to move independently outdoors and to assess whether fear of moving outdoors and unmet physical activity need play a role in this association. The results of this study will increase understanding of the role of the outdoor environment for QoL in ambulatory community-dwelling older people. Such knowledge regarding environmental barriers to outdoor mobility and physical activity is important when planning residential areas for all ages.

METHODS

Design and Study Population

The data for this study are from the baseline measurements of the randomized controlled trial entitled "Screening and Counseling for Physical Activity and Mobility" (SCAMOB). The study design and methods have been described in detail elsewhere.[22]

The target population for the study comprised all community-dwelling residents of the City of Jyväskylä, Finland, aged 75 to 81 (N = 1,310). To be eligible for the study, participants had to have a Mini-Mental State Examination (MMSE) score greater than 21, be able to walk 500 m without help from another person, be only moderately physically active or sedentary (at most 4 hours of walking or 2 hours of other exercise weekly), and have no medical contraindications for physical activity.[22] The SCAMOB project (International Standard Randomised Controlled Trial Number 07330512) investigates the effects of physical activity counseling in community-dwelling older people in Finland. Seven hundred twenty-seven people (539 women, 188 men; mean age 77.6 ± 2.0) were interviewed in their homes, of whom 657 participated in physical assessments and interviews conducted by a nurse examiner in the study center.

The Ethical Committee of the Central Finland Central Hospital approved the SCAMOB project. Participants were informed about the research and signed an informed consent.

Measurements

Quality of Life

Perceived QoL was assessed using the LEIPAD questionnaire.[23] The participants were left the questionnaire during an at-home interview, given instructions on how to fill it in, and asked to bring it to the study center, where the nurse examiner checked it. The LEIPAD is constructed for use with older people and includes 31 items related to seven subscales: physical function (5 items), self-care (6 items), depression and anxiety (4 items), cognitive functioning (5 items), social relations (3 items), sexual functioning (2 items), and life satisfaction (6 items). Each item is scored from 0 to 3, with 0 indicating the best condition and 3 the worst. Each subscale can be used to represent different dimensions of QoL, and a summed index of all items can be used as an indicator of overall QoL. In the present study, the summed index was used. Higher scores indicate worse QoL (range 0–93).[23] Reliability of the questionnaire has been found to be good (0.81), and good or at least acceptable values of internal consistency have been found (Cronbach alpha 0.55–0.79).[23]

Fear of Moving Outdoors

People who reported feelings of insecurity when moving outdoors or avoided going outdoors because of perceived elements of danger or insecurity due to other pedestrians or fear were categorized as having fear of moving outdoors.[15] Fear of moving outdoors has been found to be common in community-dwelling ambulatory people and to predict development of outdoor walking difficulty.[15]

Unmet Physical Activity Need

Unmet physical activity need is the feeling that one's level of physical activity is inadequate and was studied using the questions, "Do you feel that you would have the opportunity to increase your level of physical activity if someone recommended you do so?" and "Would you like to increase your level of physical activity?" with response options of yes or no. Persons who reported that they had no opportunity to engage in physical activity but reported willingness to increase their physical activity level were defined as experiencing unmet physical activity need.[16] It was previously found that people with walking difficulties are more likely to have unmet physical activity need and that reduction in physical activity precedes the development of unmet physical activity need. Additionally, unmet physical activity need may be transient, with almost half of those who reported unmet physical activity need not reporting it after 2 years.[16]

Barriers in the Outdoor Environment

Perceived barriers in the outdoor environment were examined using standardized questions[15] to elicit a subjective view of the outdoor environment and of the walking routes used. Participants were asked whether environmental barriers limited their ability to move independently outdoors (yes/no). The barriers studied were lack of resting places and distances perceived to be long (distances: range 0–2), noisy traffic and dangerous crossroads (traffic: range 0–2), and hilly terrain and streets in poor condition (terrain: range 0–2). For each of the three constructed variables, 2 indicates that both barriers were reported, 1 that one of the barriers was reported, and 0 that neither was reported.

Number of Chronic Conditions

The number of chronic conditions was calculated on the basis of how many different physician-diagnosed diseases

participants reported. A condition was considered chronic if it had lasted longer than 3 months. Information on chronic conditions was elicited using the question: "Do you have any disease or defect diagnosed by a doctor that has lasted longer than 3 months?" The interviewer wrote the response down during the at-home interview. A nurse examiner confirmed chronic conditions later during the clinical examination in the study center, and only confirmed chronic conditions were calculated.[22]

Maximal Walking Speed

Maximal walking speed was measured in the study center corridor over a distance of 10 m. Participants were allowed 2 to 3 m for acceleration before the start line and were encouraged to walk as fast as possible without risking their health. Timing was done using a stopwatch. Participants wore sneakers or walking shoes, and use of a walking aid was allowed if needed.[22] Walking speed has previously been shown to be a reliable and valid measurement of functional performance in older people.[24]

Statistical Methodology

Baseline characteristics were described using means and standard deviations or percentages (Table 1). Analysis of variance (ANOVA) was used to test differences in mean QoL scores between groups according to sex, self-reported fear of moving outdoors, self-reported unmet physical activity need, and self-reported zero to two difficulties in the outdoor environment. Sex-stratified ANOVA analyses were also performed to investigate whether the results were similar in men and women. Correlations between each subscale of the LEIPAD questionnaire and each environmental variable were calculated to determine whether the associations resembled the overall score of the LEIPAD questionnaire. SPSS version 14.0 (SPSS Inc., Chicago, IL) was used for the ANOVAs. When $P < .05$, the results were regarded as statistically significant.

To construct a path analysis model, correlation coefficients were computed for QoL, number of chronic conditions, maximal walking speed, perceived environmental barriers, unmet physical activity need, and fear of moving outdoors. A path analysis model, which is one of the techniques included in structural equation methods using LISREL (Scientific Software International, Inc., Lincolnwood, IL), was used for the analyses of the determinants of QoL. Path analysis makes it possible to study simultaneous associations of the factors influencing QoL, as well as their interrelations. Results of the path analysis are shown with the maximum likelihood estimates of the path coefficients (beta coefficients) and their standard errors (SE). Of the 657 participants, 600 had answered all of the questions on the QoL questionnaire. Most of the missing data concerned sexual life, and another 11 subjects had missing information on unmet physical activity need. Thus, 589 participants had complete data for analysis.

Indicators of fit of the model were chi-square (χ^2), goodness-of-fit index (GFI) ($\geq$0.9 indicates a good fit), adjusted GFI (AGFI), and root mean square residual (RMR). The multivariate procedure was accomplished using the LISREL 8.72 program.

Table 1. Characteristics of the Participants (n = 589)

Characteristic*	Value
Age, mean ± SD	77.6 ± 1.94
Quality of life score, mean ± SD	26.1 ± 8.9
Number of chronic conditions, mean ± SD	3.05 ± 1.98
Walking speed, m/s, mean ± SD	1.36 ± 0.37
Female, %	75
Afraid of moving outdoors, %	56
Unmet physical activity need, %	13
Lack of resting places and long distances to everyday services, %	
0	82
1	15
2	3
Noisy traffic and dangerous crossroads, %	
0	79
1	18
2	3
Poor street condition and hills in the immediate environment, %	
0	67
1	24
2	9

* 0 = no perceived difficulties related to the environmental barriers, 1 = perceived difficulties related to one barrier, 2 = perceived difficulties related to two barriers.
SD = standard deviation.

RESULTS

Baseline individual and environmental characteristics are shown in Table 1. The mean age of the participants was 77.6 (range 75–81), and 75% were women. The QoL sum score ranged from 7 to 66, with higher scores indicting worse QoL. The results are shown with women and men combined in the same analyses, because associations were almost identical for both sexes. QoL correlated statistically significantly with all of the variables. QoL was worse in participants who reported more barriers in their outdoor environment and those who experienced fear of moving outdoors and unmet physical activity need (Figure 1). Those who had slower walking speed and more chronic diseases reported also worse QoL (correlation coefficient $(r) = -0.48$, $P < .001$; $r = 0.35$, $P < .001$, respectively) (not shown in the figure). The associations between all of the subscales of QoL and perceived barriers in the outdoor environment were similar to the associations between the overall sum score and perceived barriers in the outdoor environment (data not shown).

The constructed path analysis model fitted well to the data (χ^2 (7) = 12.66; $P = .08$; GFI = 0.99, AGFI = 0.97, RMR = 0.02). By adding number of chronic conditions, maximal walking speed, perceived environmental barriers, unmet physical activity need, and fear of moving outdoors into the path model, 36% of the variation in QoL was explained. The variables terrain, traffic, and distances influenced QoL through fear of moving outdoors or unmet physical activity need, whereas distances also had a direct association with QoL. The lower a person's walking speed, the more problems reported in the outdoor environment and outdoor mobility and the poorer the QoL. Details are

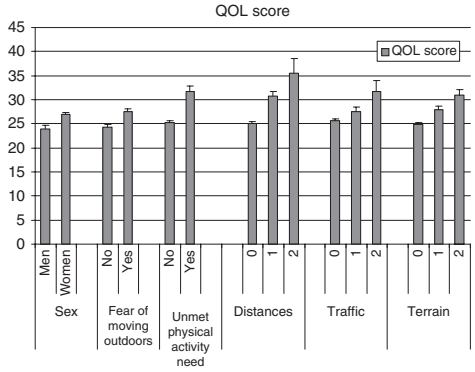

Figure 1. Mean quality of life (QoL) score in community-dwelling people aged 75 to 81 (N = 600) according to sex, fear of moving outdoors, unmet physical activity need, and barriers in the outdoor environment. Higher scores indicate worse QoL (range 0–93). Environmental barriers studied were lack of resting places and long distances (distances), noisy traffic and dangerous crossroads (traffic), and hilly terrain and poor street condition (terrain): 0 = no perceived difficulties related to either of the environmental barriers, 1 = perceived difficulties related to one barrier, 2 = perceived difficulties related to two barriers. All differences between groups were statistically significant ($P < .001$).

shown in Figure 2. Significant indirect associations were found between walking speed and fear of moving outdoors ($\beta = -0.15$ (SE = 0.03)), walking speed and QoL ($\beta = -0.11$ (0.02)), number of chronic conditions and QoL ($\beta = 0.18$ (0.02)) and Traffic and QoL ($\beta = 0.14$ (0.03)) (indirect associations not shown in Figure 2).

DISCUSSION

This study shows that perceived barriers in the outdoor environment reduce QoL in older people and that fear of moving outdoors and unmet physical activity need mediate this association. Although others have reported on the importance of the outdoor environment for the QoL of older people,[21] the current study deepens the existing knowledge on the factors influencing QoL.

The present findings cohere with the ecological model of aging, in which human behavior and well-being are strongly related to the environment in which a person lives and to his or her individual capabilities.[5] In the current study, people who had more chronic conditions and slower walking speed reported more barriers in their outdoor environment and had lower QoL than those who were healthier. The fact that fear of moving outdoors and unmet physical activity need play a role in the interplay between the outdoor environment and QoL is a novel finding. Unmet physical activity need emerges when people are not satisfied with their ability to participate in physical activities. This is in line with previous research[3] that found that satisfaction with participation was a better predictor of QoL than the

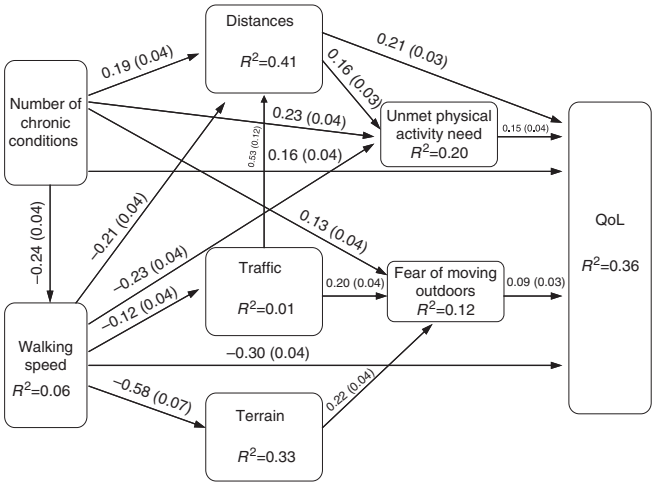

Figure 2. The path analyses model of the relationships between quality of life (QoL) and perceived barriers in the outdoor environment, unmet physical activity need, and fear of moving outdoors in community-dwelling people aged 75 to 81 (n = 589). The model includes three layers (individual, environmental, and an interaction of individual and environment) that together are associated with QoL. In the model, slow walking speed increased perceived barriers in the outdoor environment, which affect QoL through fear of moving outdoors and unmet physical activity need. Arrows indicate significant associations and their directions between variables. The numbers show the maximum likelihood estimates of the path coefficients, standard errors are given in parenthesis. The coefficients are significant if they are greater than two times the standard errors. The coefficient of determination (R^2) values indicate the amount of variation in the dependent variables that the other shown variables explain.

level of participation itself. Some other studies have reported parallel findings. For example, giving up meaningful activities results in a high level of depressive symptoms in older people.[25] Although the association between QoL and fear of moving outdoors had not previously been studied, studies of fear of falling and fear of crime have shown that fear is strongly correlated with poorer QoL.[26,27]

The present study assessed QoL using the multidimensional LEIPAD questionnaire. With a scale consisting of several subscales, there is a risk of tautological effects in the analyses, so to avoid overlap, it is necessary to carefully compare the dimensions of the scale with the predictors of the model. The LEIPAD questionnaire includes items in which the participants are asked to evaluate their physical functioning in terms of their perceived ability to perform daily activities. In the path modeling applied in the present study, maximal walking speed was chosen as an indicator of physical performance because it is conceptually separate from the items in the physical function and self-care subscales of LEIPAD.

Perceived barriers in the outdoor environment and specific problems in outdoor mobility explained 36% of the variance in QoL. This a fair proportion, because significant factors known to affect QoL, such as social relationships and financial situation, were not included in the analyses. The fact that perceived barriers in the outdoor environment correlated with all of the QoL subscales suggests that the outdoor environment may have a broader influence on QoL than has hitherto been acknowledged. This topic warrants further studies.

The strengths of this study were the large, population-based sample and data analyses on a topic that has not been previously widely studied. The findings enhance understanding of the importance of barriers in the outdoor environment for QoL in community-dwelling older people. Additionally, the results of the study are easily implemented in practice and offer possibilities for multidimensional collaboration between community planners and healthcare professionals. This kind of knowledge is needed when planning environments that promote physical activity and well-being in community-dwelling older people.

Although the analyses are cross-sectional, and causality cannot be confirmed, path analysis allows inferences about the direction of the associations to be drawn. Even then, the existence of a circular decline, in which environmental barriers lead to mobility loss, which in turn leads to perception of the environment as more challenging than before, is also a possibility. Future studies should address ways to alleviate this situation.

This study was conducted in an urban area of central Finland, so the results may not be valid in rural areas, a caveat that should be kept in mind when interpreting the findings. There might also be some national differences in personal and environmental characteristics between Finland and other western countries, as was shown in the MOBILATE project,[28] although it seems unlikely that the association between perceived barriers in the outdoor environment and QoL would differ across countries. Nevertheless, more studies in different settings are needed. In addition, the population studied was a truncated sample of community-dwelling older people, because the most disabled and most vigorous people were excluded, and all of the participants were able to move independently outdoors. People with functional limitations often report more environmental barriers and worse QoL than people without functional limitations.[29] Thus, the results may be viewed as an underestimation of the association between perceived barriers in the outdoor environment and QoL.

For older people, mobility means independence and personal freedom, both of which are crucial for QoL.[30] Therefore, improving possibilities for outdoor mobility of older people may help enhance their QoL by reducing their fear of moving outdoors and meeting their need for physical activity.

CONCLUSION

An outdoor environment that encumbers outdoor mobility increases perceptions of fear of moving outdoors and unmet physical activity need and is associated with poor QoL in older people. These results provide insight into how negative features of the outdoor environment influence QoL. More research is needed to confirm the temporal order and causality of these observations.

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