MOBILITY skills are important for older people, supporting the maintenance of autonomy, independence in daily activities, and living in the community. Good mobility necessitates at least adequate walking speed, muscle strength, and balance. The maintenance of outdoor physical activity, walking in particular, plays an important role in functional independence in old age (1). Grip strength is a significant determinant of functional performance (2), but good balance reduces the risk of fall-related injuries in older people (3). Conversely, an inactive lifestyle is linked to an increased risk of death and disability (4).

Mobility in older age has been studied in connection with genetic background (5,6), health habits (7), present physical activity (8), and physical activity in midlife (9,10). Previous studies have shown that there is an association between physical activity in midlife and functional and health status in old age. The physical activity in midlife was related to better physical health and functioning and lower mortality risk (7,8,10–13). Furthermore, better cognitive status (14), lower risk of dementia and Alzheimer’s disease (15), and lower risk of institutionalization (16) were linked to physical activity during midlife.

To date, relatively few studies (9,10,17) have investigated the effects of midlife physical activity on different components of mobility. In addition, the relationship between physical activity during midlife and mobility in older age has rarely been evaluated in community-based settings. The aim of the present study was to evaluate whether physical activity at age of 20–64 years was associated with mobility and muscle strength in old age.
Methods

Study Population

This study utilized baseline data from the Geriatric Multidisciplinary Strategy for the Good Care of the Elderly (GeMS) study (18). GeMS is a population-based randomized comparative study conducted in the city of Kuopio, Finland, from 2004 to 2007. The purpose of the GeMS study was to evaluate the effects of geriatric assessment, care, and rehabilitation. A random sample of 1,000 persons was extracted from all the ≥75-year-old people living in the city of Kuopio (n = 5,615). Of the 1,000 persons, 162 refused to participate, 2 moved to another city, and 55 died before the baseline examination. In total, 781 (78%) attended the baseline examination. For the purpose of this analysis, we excluded those participants who lived in institutional care facilities (n = 81) and participants who did not report their physical activity level at age of 20–64 years (n = 21). Thus, 679 community-dwelling participants were included in the present analysis. All participants or their proxies gave written informed consent to participate in the study. The study protocol was approved by the Research Ethics Committee of the Northern Savo Hospital District, Kuopio, Finland.

Assessment of Health Status

Two trained nurses and two physiotherapists interviewed and examined all the participants. Each participant’s medical records from the Kuopio University Hospital and Primary Health Care were available. Data collection was supplemented by caregiver interview if a participant was unable to answer reliably, mainly because of cognitive impairment. Self-rated health was determined using a 5-point scale (very good, good, moderate, poor, and very poor) and collected by questionnaire. The question was “What kind of health situation do you have in your own opinion?” Self-rated health was determined using a 5-point scale and categories 0–1 (unable to walk outside) and 2–3 (able to walk independently) were combined for the analyses.

Comorbidity was computed using a modified version of Functional Comorbidity Index (FCI). The FCI is a validated scale that predicts physical function in older people (19). In this study, data on the following medical conditions were available: rheumatoid arthritis and other inflammatory connective tissue diseases, osteoporosis, diabetes, chronic asthma or chronic obstructive pulmonary disease, coronary artery disease, heart failure, myocardial infarction, stroke, depression, visual impairment, hearing impairment, Parkinson’s disease or multiple sclerosis, and obesity (body mass index > 30). Patient diagnoses obtained from the Finnish National Prescription and Special Reimbursement Registers maintained by the Social Insurance Institution of Finland were used to screen for the presence of rheumatoid arthritis and other inflammatory connective tissue diseases (the data did not include osteoarthritis), chronic asthma or chronic obstructive pulmonary disease, Parkinson’s disease, or multiple sclerosis. Other conditions of the FCI were ascertained via participant self-report and medical records. Depressive symptoms were assessed by the 15-item Geriatric Depression Scale. Scores of 5 or more were considered indicative of depression (20). The presence of each of the 13 conditions listed previously included in the FCI gave one score and a higher FCI sum score represented greater comorbidity.

Cognitive function was assessed using the Mini-Mental State Examination (MMSE). The MMSE sum scores were categorized as normal (30–25) or impaired (24–0) (21).

Assessment of Physical Activity

Information concerning physical activity level at age of 20–64 years was collected by a questionnaire. The question was “How much physical activity did you have when you were 20–64 years old?” There were three response categories: no regular physical activity (0), regular physical activity (1), and sports at the age of 20–64 years (2). Categories 1–2 (active) were combined for the analyses.

Data on current physical activity were collected using a modified version of the Grimby Scale (22). The participants were asked “Which of the following options describes best your present physical activity?” On the basis of their reports, the participants were categorized into an inactive group (0–1, no physical activity or no other physical activity but light walking one to two times a week at the most), light activity group (2, light walking or other light exercise several times a week), moderate activity group (3, moderate physical activity one to two times a week), or into an intensive activity group (4, moderate or vigorous physical activity several times a week).

Assessment of Mobility

Ability to walk outside and ability to walk at least 400 m were assessed by asking the participants “Are you able to walk outside? Can you walk at least 400 m?” Both questions contained four response categories from dependent (0) to totally independent (3). Categories 0–1 (unable to walk independently) and 2–3 (able to walk independently) were combined for the analyses.

Maximum walking speed was measured with a stopwatch (0.1 s accuracy) during a 10 m walk. The participants started walking a few m meters before the start line to achieve maximum speed and were timed from the moment their lead foot crossed the start line until the front foot crossed the 10-m line. The results were expressed as meters per second (m/s). The data on walking speed were missing in 91 women and 37 men.

Assessment of Maximal Voluntary Muscle Strength

Grip force of both hands was measured using a Saehan dynamometer (Saehan Corporation, South Korea) in sitting
position and with elbow in 90° flexion close to the body. Participants were allowed two maximal efforts for both hands, and the highest value was accepted as the result. The data on grip strength were missing in 33 women and 19 men.

Maximal isometric knee extension strength was measured on both sides in sitting position using an adjustable dynamometer chair (Good Strength; Metitur Oy, Palokka, Finland). The measurements were performed at a knee angle of 60°. Participants were allowed three maximal efforts for both legs, and the best performance with the highest value was accepted as the result. The results were expressed as kilograms (kg), and the result of the better leg was used in the analyses. The data on knee extension strength were missing in 124 women and 44 men.

Statistical Analysis

The characteristics of the sample were summarized using proportions and means with SD. Statistical comparisons between the physical activity groups (active or inactive at age of 20–64 years) were made using chi-square test or t test for independent samples. Analysis of covariance was used for adjusted comparisons of continuous physical outcome variables (grip strength, walking speed, and knee extension strength); these analyses were conducted separately for men and women. Age, MMSE, and FCI were used as covariates in the analyses. To assess the association between the level of physical activity at age of 20–64 years and old-age mobility, logistic regression analysis with crude and adjusted (for age, sex, MMSE, and FCI) odds ratios (OR) was used. Data were analyzed using STATA 11.1 (Stata Corporation, College Station, TX) software.

RESULTS

The mean age of the 679 community-dwelling participants was 80.8 (SD 4.6) years, 69.5% (n = 472) of them were women. A total of 399 (58.8%) participants had been physically active at age of 20–64 years. The participants’ sociodemographic characteristics, health status, and results of the mobility and strength measures are summarized in Table 1. The results show statistically significantly that those who had been active at age of 20–64 years had longer education, their frequency of obesity was lower, their MMSE score was higher, and there were more persons able to walk outside or at least 400 m independently compared with the participants who had been inactive during that age. Furthermore, men who had been physically active at age of 20–64 years had significantly greater grip strength and faster walking speed than those who had been inactive during that age.

Physical activity at age of 20–64 years and present (old age) physical activity levels were compared as well. Of the participants who had been inactive at age of 20–64 years, 21% reported their present physical activity as inactive, 29% as light, 40% as moderate, and 11% as intensive. The corresponding percentages for those who had been active at age of 20–64 years were 10%, 24%, 50%, and 15%. The distributions differed statistically significantly between the groups, p < .01.
The age, MMSE, and FCI-adjusted analysis of covariance showed that grip strength \( (p = .77) \), walking speed \( (p = .22) \), or maximal knee extension strength \( (p = .26) \) did not differ statistically significantly between the early adulthood through midlife physical activity groups in women (Figure 1). In men, the adjusted analyses showed a statistically significant difference in grip strength \( (p = .02) \) and walking speed \( (p = .01) \) but not in knee extension strength \( (p = .11) \). Men who had exercised regularly at age of 20–64 years had an average of 3.0 kg (95% confidence intervals [CI]: 3.47–2.48) higher grip strength and 0.20 m/s (95% CI: 0.23–0.16) greater walking speed than men who had been inactive during that age.

In the unadjusted logistic regression analysis, physical activity at age of 20–64 years was positively associated with the ability to walk outside in old age \( (OR = 1.96 [95\% CI: 1.21–3.18]) \). The association did not remain significant after adjustment for age, sex, MMSE, and FCI \( (OR = 1.49 [95\% CI: 0.85–2.61]) \). Between the physical activity at age of 20–64 years and ability to walk 400 m independently in old age, the association was significant both in unadjusted \( (OR = 2.60 [95\% CI: 1.58–4.28]) \) and adjusted \( (OR = 2.17 [95\% CI: 1.25–3.77]) \) analyses.

**Discussion**

This community-based study among older Finns showed that physical activity at age of 20–64 years was associated with better mobility in old age. To our knowledge, only three studies \( (9,10,17) \) have investigated the association between midlife physical activity and mobility in old age among community-dwelling elderly participants. This study adds to information on the effects of early adulthood through midlife physical activity on different components of later mobility. We found that those who had been physically active at age of 20–64 years were more likely to be able to walk 400 m independently at aged 75 and older. Early adulthood through midlife physical activity was also linked to better grip strength and walking speed in older men but not in women. These findings are consistent with previous studies reporting that greater physical activity in midlife may have an independent impact on prevention of disability \( (4,13,23) \) and maintenance of health \( (11,13–16) \), mobility \( (9,24) \), and muscle strength \( (17,25) \) in old age.

This study showed that community-dwelling older persons’ ability to walk outdoors did not discriminate those who had been active at age of 20–64 years from those who had been inactive at that age. However, the length of walk brought out a significant association between physical activity level at age of 20–64 years and probability of walking 400 m independently in old age. This finding is consistent with a previous study \( (9) \). The inability to walk 400 m has also been associated with mobility limitations, disability, and increased all-cause mortality \( (26,27) \).

In a previous study, walking speed was found to be an important indicator of current and future functional status in older adults \( (28) \). Higher levels of physical activity in midlife were significantly associated with better walking speed in old age in both genders \( (9) \). In the present study, old-age walking speed was statistically significantly better among the male participants who had been physically active in early adulthood through midlife. In previous studies, this kind of improvement in walking speed was gained through 3–12 months of exercise training \( (28,29) \), and a change of 0.24 m/s in walking speed was considered as clinically meaningful in a recent study \( (30) \). Our study design,
however, does not allow drawing conclusions on whether the difference in walking speed was clinically significant. One study showed that more active women in midlife walked faster in old age (10), but we did not find such an association in our study. Older people with a walking speed slower than 1 m/s should be considered at high risk of adverse health outcomes (24). In this study and a previous study of Takata and colleagues (31), only men active in midlife had a mean walking speed greater than 1 m/s.

Muscle strength has been shown to have a mediating role between physical activity and disability (32). Weak grip strength is associated with the risk of future disability and difficulties in daily activities (25,33,34). On the other hand, good grip strength predicts longer survival (17). In this study, men who had been physically active at age of 20–64 years had an average of 3 kg better grip strength compared with men who had been physically inactive at that age. This difference can be considered clinically significant (35). The average loss of grip strength in men is about 3.4 kg over a 5-year period (36). In terms of grip strength, the men in our study who had been active at age of 20–64 years and could thus be considered “5 years younger” than those who had been inactive at that age.

Grip and knee extension strengths were significantly lower in women than in men regardless of the physical activity level at age of 20–64. This is consistent with previous reports (31,37). One explanation may be that in all age groups, women have lower muscle mass than men (37). For this reason, analyses of muscle strength should be done separately for men and women.

Comparing the mean values of mobility tests, our results were quite similar to previous studies (31,38,39) and differed from one study (40). The walking speed values of both genders in our study were comparable with earlier studies in which the genders were analyzed together (38,39) and slower than in one Japanese study (31) or in a recent Italian study (30), which analyzed genders separately. In our study, the grip strength of both genders was at the same level (31) or worse (30,40) when compared with earlier studies. The average knee extension strength of both genders was greater than reported in earlier studies (30,31,40), probably because of age or the number of missing cases in the present study.

The main strengths to our study were the community-based setting and the high participation rate. This adds to the generalizability of the results. The main limitations of the study were that the information on the early adulthood through midlife physical activity was based on participants’ recall, and the data covered only persons who had survived to old age. The physical activity assessment covered a long period, from 20 to 64 years of age, and physical activity patterns might have changed over the period. The participants have been living in a rapidly changing world and have had different time periods during their life, including World War II. Many of them may have had plenty of physical activity related to their work and everyday life, but this was not specified in our study. Furthermore, the structured question about physical activity at age of 20–64 years included only three answer options. In regard to the finding that the association between physical activity at age of 20–64 years and grip strength or walking speed in old age was statistically significant in men but not in women, some aspects need to be discussed. First, we cannot exclude whether the physical activity was reported differently between genders. Second, there were differences in comorbidity between early adulthood through midlife physical activity groups among men and women. The FCI and MMSE sum scores differed statistically significantly between inactive and active women but not in men. Thus, in terms of health, women might have benefited from early adulthood through midlife physical activity more than men did. In the comorbidity-adjusted analyses, however, this positive interaction may diminish the association between earlier physical activity and present physical performance.

There have also been contradictory opinions as to whether data on physical performance should be based on self-reports (2) or performance tests (41). Present data on mobility were partly based on self-reports, but walking speed, knee extension strength, and grip strength were also tested. Objective measures are often prioritized, even though missing cases may be more common, as in the present study. Participants who did not complete physical performance tests were mainly unable to come to the research site and they were tested at home. If the knee extension strength test alone was missing, this was most often due to participant’s inability to rise to the high test-chair.

In conclusion, this study revealed the association between physical activity at age of 20–64 years and better mobility in old age. Physical activity was also linked to better grip strength and walking speed in older men but not in women.

**Funding**

The Geriatric Multidisciplinary Strategy for the Good Care of the Elderly (GeMS) Study was supported by grants from the Social Insurance Institution of Finland and City of Kuopio. The sponsors had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; or preparation, review, or approval of the manuscript.

**Conflict of Interest**

None declared.

**Acknowledgments**

We thank the staff of the GeMS study for their contribution to the data collection and participants for their commitment to the study. Author contributions: P.T. had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis; study concept and design: All the authors; analysis and interpretation of data: P.T., E.L., I.N., and S.H.; drafting of the manuscript: P.T. and E.L.; critical revision of the manuscript for important intellectual content: All the authors; statistical analysis: P.T., I.N., and E.L.; study supervision: E.L., S.S., and S.H.

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