Determinants of Reduced Walking Speed in People with Musculoskeletal Pain

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ABSTRACT. ***Objective.*** Maintenance of good walking speed is essential to independent living. People with musculoskeletal disease often have reduced walking speed. We investigated determinants of slower walking, other than musculoskeletal disease, that might provide valuable additional targets for therapy.

Methods. We analyzed data from the Somerset and Avon Survey of Health, a community based survey of people aged over 35 years. A total of 2703 participants who reported hip or knee pain at baseline (1994/1995) were studied, and reassessed in 2002-2003; 1696 were available for followup, and walking speed was tested in 1074. Walking speed (m/s) was used as outcome measure. Baseline characteristics, including comorbidities and socioeconomic factors, were tested for their ability to predict reduced walking speed using multiple linear regression analysis.

Results. Age, female sex, and immobility at baseline were predictive of slower walking speed. Other independent risk factors included the presence of cataract, low socioeconomic status, intermittent claudication, and other cardiovascular conditions. Having a cataract was associated with a decrease of 0.10 m/s (95% CI 0.03, 0.16). Those in social class V had a walking speed 0.22 m/s (95% CI 0.12, 0.31) slower than those in social class I.

Conclusion. Comorbidities, age, female sex, and lower socioeconomic position determine walking speed in people with joint pain. Issues such as poor vision and social-economic disadvantage may add to the effect of musculoskeletal disease, suggesting the need for a holistic approach to management of these patients. (First Release August 1 2007; J Rheumatol 2007;34:1905–12)

Key Indexing Terms:
WALKING SPEED — LIMITATIONS — LONGITUDINAL
MUSCULOSKELETAL PAIN — COMORBIDITIES — INDEPENDENT LIVING

Maintaining an adequate walking speed is fundamental for the ability to safely and independently perform ordinary daily activities such as crossing the road, going shopping, and doing household tasks. Usual and maximum walking speed are indicators of mobility and are central to independence[1]. In older adults, mobility disability, defined as an individuals' relative ability to move about effectively in their surroundings, predicts the onset of disability in tasks required for independent living[2-4]. Good walking ability is essential to a physically and socially active life[5,6] and to the retention of emotional vitality[7,8], each of which are major determinants of quality of life in old age[9-11]. Walking speed is also promoted as a simple means of assessing "frailty" in older people, owing to its strong and independent associations with many chronic diseases, and with the risk of mortality[12,13]. Walking speed in healthy older people also reflects their physical capacity: the Established Population for Epidemiologic Studies of the Elderly (EPESE)[14] found functional impairment to be determined by walking difficulty, vision, mental status score, and independence in activities of daily living.

Assessing a specific functional limitation, such as walking speed, should help us understand the onset and progression of physical disability. The path from disease to disability, conceptualized by theoretical models such as Nagi's pathway[15] and the disablement process of Verbrugge and Jette[16], is known to be complex. The interaction of several domains was recognized in the World Health Organization's revised model of functioning and disability[17], in which the roles of intraindividual factors such as personality and extraneous factors such as the physical and social environment were expressed.

Osteoarthritis (OA) is a common joint disorder in all populations, and is one of the main conditions responsible for disability and activity limitations[18]. The condition usually pres-

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ents with joint pain, and persistent knee and hip pain in older people is generally due to OA. The prevalence of the disease is increasing with the aging population and it has a significant influence on health services provision and planning[19,20].

Assessing other determinants of walking speed in people with OA or lower limb musculoskeletal pain should help identify potentially modifiable risk factors and might also be useful in identifying a subgroup who are likely to lose their independence, in whom earlier rehabilitation interventions could be tested. We examined the relationships between a range of potential risk factors and walking speed in a prospective study of people with lower limb musculoskeletal pain drawn from a large population based sample.

MATERIALS AND METHODS

Sample. The Somerset and Avon Survey of Health Study (SASH) is a community based, age-sex stratified survey. The sample included 28,080 individuals aged 35 years or over randomly selected from 40 general practices in the Southwest of England. Sampled individuals were first screened using a postal questionnaire that included specific questions on hip and knee pain. At first-stage screening 22,376 responded, as reported[21]. Pain in the hip or knee or both was reported by 6416, of whom 4304 were invited for further examination and 2703 (63%) attended for a baseline examination, which took place between January 1994 and October 1995. As shown in Figure 1, of the 2703 examined at baseline, 439 had died before the followup examination (between April 2002 and April 2003). A further 60 people were excluded from being asked to take part in the followup study because their general practitioner had advised against this, or because they had previously indicated that they wanted to take no further part in the study. A further 450 could not be contacted. Of the remaining 1696 individuals who were contacted, 270 did not wish to take part, 129 were excluded, mostly due to severe health conditions, and 2 had emigrated; 1295 (76.4%) completed the followup questionnaires and 1117 were clinically examined.

Data reported here are from an analysis of the 1074 individuals who completed the followup questionnaire and were deemed fit enough to undertake the walking speed test.

Outcome measure. A walking speed test, performed at followup in 2003/2004, was used as the outcome measure. Individuals had to consent to the test and be deemed fit to undertake it, by both themselves and the independent assessors, who were advised to exclude people at risk of falling. A 6-meter walking test was performed twice; participants were asked to walk a marked 6-meter distance as fast but as safely as they could from an assigned starting point. Time was measured using a stopwatch and the faster of 2 attempts was used for the analysis when 2 measures were available; where only one test was performed (51 people) this was used.

Explanatory variables. Data collected at baseline in 1994/1995 were used to determine potential predictors of walking speed measured 8 years later. At baseline, participants were assessed for their self-reported health conditions, pain, and walking ability, and extensive socioeconomic and demographic data were also collected.

Age was grouped into 10-year bands between 35 to 84 years at baseline. Body mass index (BMI) was classified into 4 categories: underweight (BMI < 18.5 kg/m^2), normal weight (18.5–24.9, used as reference category), overweight ($\geq$ 25–29.9), and obese ($\geq$ 30). Smoking was categorized into current smoker, ex-smoker (any history of smoking), and nonsmoker; the latter 2 categories were used as a reference, as no difference was found between them. Townsend deprivation scores[22] derived from a 1991 census were used, with each participant assigned to one of 5 categories derived from their area postal code as described[23]. Employment status was split into 4 groups: paid employment, retired, sick and disabled, and in unpaid employment. Self-reported comorbidities were grouped as follows: (1) Arthritis (rheumatoid arthritis,

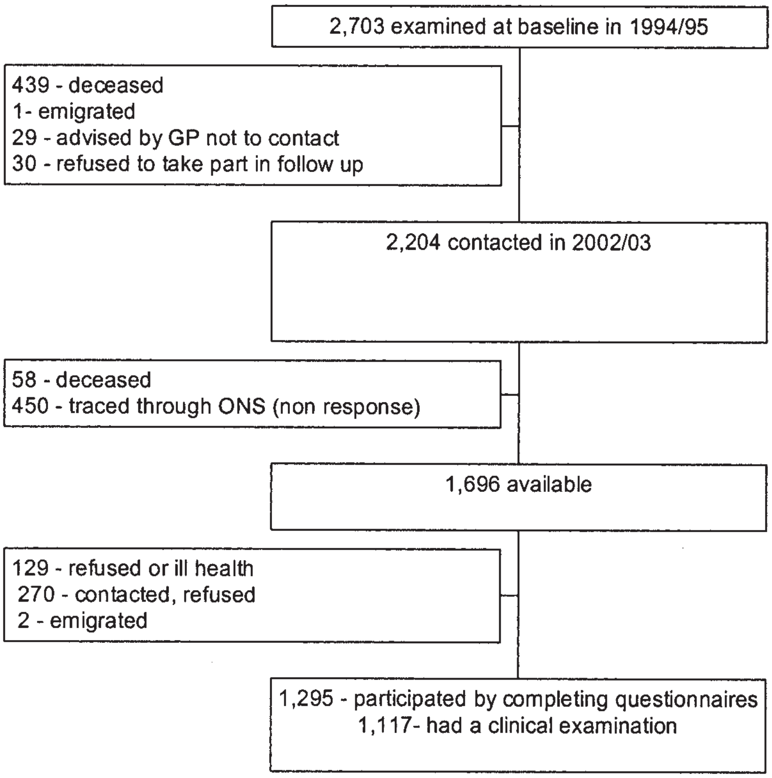

Figure 1. Status of subjects at followup. ONS: Office for National Statistics, UK.

"rheumatism," and other types of arthritis); (2) cardiovascular (angina, myocardial infarction, heart failure, and other heart conditions); (3) respiratory related (asthma, bronchitis, emphysema, and other chest trouble); (4) eye trouble (cataract, diabetic retinopathy, glaucoma, and other eye complaints); and (5) other health problems (including hypertension, depression, blood clot in leg veins, stroke, intermittent claudication, diabetes, cancer, and other health problems). The morbidity data were treated both by groups and by individual health condition where there were sufficient data for meaningful analysis.

Walking ability was assessed at baseline through responses to a question on the time taken before one had to stop when walking on flat ground; the response categories used were: (1) less than 5 minutes, (2) quarter of an hour, (3) half an hour, and (4) 1 hour or more; category 4 was used as the reference.

Missing data. Few data were missing from the 1074 individuals involved, with the exception of BMI data, which were not available for 20% of the sample. There did not appear to be any obvious bias in the pattern of missing data; for people aged 35–44 years, however, the percentage was slightly higher. Sensitivity analyses were conducted with exclusion of people of this age range and revealed no difference to any of the findings. In order to maximize the data available for analysis, those with missing BMI were assigned to a separate category. A similar approach was adopted for other explanatory variables, although the proportion with missing data was less than 5%.

Statistical analysis. The distribution of walking speeds was examined graphically using standard methods in Stata (v.9.0) and found to be fairly normal for the 1074 participants. Linear regression modeling was used with walking speed as an outcome. Initially a simple linear regression model was fitted for each of the potential explanatory variables, and those associated with walking speed at 10% significance level or less were considered as potential predictors, and were included in a multivariable model. For each health condition, interactions were investigated with age, sex, and social class, and walking ability at baseline with age. In the final multivariable model, any variable with association at 10% level or less was retained and others were excluded. Goodness of fit was assessed by R^2 statistic, and normal distribution of residuals was confirmed using standard graphical methods. For all descriptive and analytic estimates the multistage sampling design was taken into account using Stata.

RESULTS

The average walking speed for the sample was 0.86 m/s (SD 0.31), 0.93 m/s (SD 0.30) for men and 0.81 m/s (SD 0.30) for women. Table 1 gives a summary of the mean walking speed recorded in 2002/2003, grouped according to characteristics such as age, sex, and self-reported comorbidities recorded in 1994/1995.

Reduced self-reported walking ability at baseline was one of the strongest predictors of the objective measure of poor walking speed 8 years later. There was a trend for a slower walking speed with increasing age, and for men to walk faster than women. Being underweight, overweight, or obese was found to be associated with slower walking speeds. For underweight individuals, however, the numbers were too small, as indicated by the relatively wide confidence intervals. Walking speed also showed an association with social class, with more advantaged people walking faster than the disadvantaged (Figure 2). Area deprivation showed a similar gradient with walking speed. Those with health problems (in addition to their musculoskeletal pain) walked more slowly.

Table 2 presents beta coefficients (estimated reduction in walking speed) and 95% confidence intervals for each of the variables selected in the final model. All sociodemographic factors associated with slower walking in Table 1 were found

Table 1. Mean walking speed, measured in 2002/2003, related to risk factors assessed in 1994/1995 (total 1074 persons).

Risk Factors	n	Mean (95% CI)
Sociodemographic		
Age group, yrs		
34–44 (reference)	105	1.01 (0.96, 1.06)
45–54	214	0.97 (0.93, 1.0)
55–64	358	0.90 (0.87, 0.93)
65–74	321	0.75 (0.72, 0.78)
75–84	78	0.59 (0.53, 0.65)
Men	426	0.93 (0.90, 0.96)
Women	648	0.81 (0.79, 0.83)
Social class		
I	61	1.02 (0.95, 1.09)
II	347	0.9 (0.87, 0.93)
IIINM	218	0.85 (0.81, 0.89)
IIIM	238	0.86 (0.82, 0.89)
IV	163	0.79 (0.74, 0.83)
V	38	0.69 (0.59, 0.79)
Missing	9	0.48 (0.23, 0.73)
Employment Status		
Paid employment	378	1.01 (0.98, 1.03)
Retired	466	0.77 (0.75, 0.80)
Sick/disabled	73	0.73 (0.67, 0.80)
Unpaid employment	92	0.85 (0.79, 0.90)
Unemployed	27	0.90 (0.77, 1.03)
BMI categories*		
Underweight (< 18.5)	3	0.43 (0.10, 0.80)
Normal range (18.5–24.9)	323	0.94 (0.91, 0.97)
Overweight (25.0–29.9)	335	0.86 (0.83, 0.90)
Obese (≥ 30)	198	0.76 (0.72, 0.80)
Missing	215	0.83 (0.78, 0.87)
Deprivation index		
1st quintile (affluent)	303	0.93 (0.89, 0.96)
2nd quintile	244	0.87 (0.83, 0.91)
3rd quintile	163	0.87 (0.83, 0.91)
4th quintile	196	0.82 (0.78, 0.86)
5th quintile	170	0.77 (0.72, 0.81)
Diseases		
Rheumatoid arthritis	89	0.72 (0.66, 0.79)
Heart trouble		
Other heart conditions	47	0.72 (0.64, 0.79)
Eye trouble		
Cataract	54	0.58 (0.51, 0.66)
Other problems		
Claudication in legs	33	0.69 (0.63, 0.74)
Ability to walk on flat ground: time before stopping		
≥ 1 hour	634	0.94 (0.92, 0.96)
30 min	236	0.83 (0.79, 0.87)
15 min	150	0.68 (0.64, 0.73)
< 5 min	56	0.55 (0.47, 0.63)
Knee and hip (pain or stiffness)**		
Mild/none (≤ 2)	464	0.97 (0.94, 0.99)
Moderate (3–5)	425	0.81 (0.78, 0.84)
Severe (6+)	189	0.70 (0.66, 0.74)
Smoking		
Smoking (current)	132	0.83 (0.78, 0.88)

* BMI: body mass index; WHO categories, kg/m^2. ** Measured doing any of 4 activities of daily living (1: standing up from a chair, 2: putting on socks or shoes, 3: going up steps or stairs, 4: going down steps or stairs).

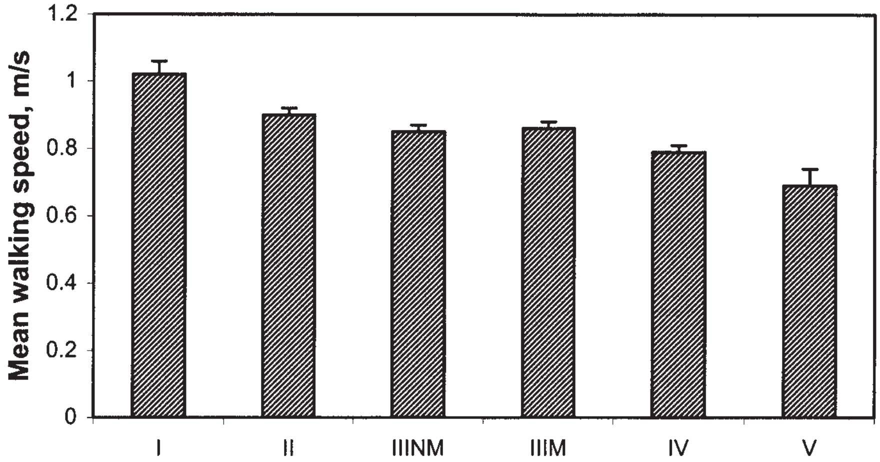

Figure 2. Mean walking speed by social class. Social class scale: I: professional; II: intermediate; IIINM: skilled nonmanual; IIIM: skilled manual; IV: partly skilled; V: unskilled.

to be important in the final model. Self-reported rheumatoid arthritis and other heart conditions, cataract, and intermittent claudication were also significantly and independently associated with slower walking. The other self-reported health conditions that were significant in the univariate analysis but were excluded from the final model ($p > 0.10$) were angina, myocardial infarction, heart failure, rheumatism, bronchitis, asthma, emphysema, other chest trouble, glaucoma, hypertension, depression, and diabetes. With the exception of bronchitis and "other chest troubles," where p was close to borderline ($p = 0.12$), the remaining excluded risk factors had a p value ≥ 0.30 in the final multivariate model. Age, sex, socioeconomic status, BMI, rheumatoid arthritis, other heart conditions, cataract, current smoking, and self-reported walking ability at baseline were all independent predictors of walking speed.

Current smoking was also an independent risk factor for a relatively small reduction in walking speed in current smokers compared to nonsmokers or ex-smokers. The predicted walking speed 7–8 years after baseline assessment for a nonsmoking, social class I woman aged 35–44 years with no illness or any reported difficulty or pain while doing basic activities of daily living was 1.26 m/s (95% CI 1.19, 1.34). For a man with similar characteristics the predicted walking speed was 1.35 m/s (1.28, 1.42).

Because of its size, the association of cataract and walking speed was investigated further. Figure 3 shows the average walking speed for age groups ≥ 55 years, where most of the cases with cataract were reported. Interactions between cataract and other factors were also examined for the same age group in an attempt to detect possible modification effects by age or other health conditions. Being in the age band 65–74 years and having a cataract was found to be associated with a slightly higher risk of slower walking compared to the overall average reduction for the whole age group (55–84 yrs): the main effect for cataract was increased in magnitude for those aged 55–64 years, whereas the interaction was not significant in the oldest group examined (75–84 yrs). No interaction of cataract with any other reported illness or with walking ability at baseline was apparent. Similarly, no interactions between age and any health condition or between sex and social class were found to be important.

DISCUSSION

In this prospective study of a community based cohort of people with hip or knee pain, we have found that the development of slow walking can be predicted by the presence of comorbidities and socioeconomic status, as well as by age and sex.

Overall, only 10% of participants walked at or above the speed usually required to use controlled road crossings (1.22 m/s); the average walking speed for the sample was only 0.86 m/s (SD 0.31). All participants aged > 75 years were well below the threshold of 1.22 m/s. The average walking speed for a healthy population is much faster than that for our sample, all of whom had musculoskeletal symptoms (predominantly OA) of varying severity. Walking speed is known to vary by age and sex; among a range of normal walking speeds quoted in a literature review[24], 1.60 m/s, 1.39 m/s, and 1.76 m/s were reported for healthy populations aged 61.5 ± 3.4, 74.7 ± 6.6, and 39.2 ± 12.6 years, respectively.

In our study, age, sex, social class, obesity, comorbidity, self-reported walking ability at baseline, and smoking were all found to be independent longterm predictors of objectively measured walking speed 8 years later. Visual impairment due to cataract was found to contribute further to slow walking in older people.

Women were found to be at higher risk of slow walking than men, concurring with many previous studies[25-28]. However, some authors have explained the higher prevalence of disability among women at older age as largely due to their longer survival with disability, rather than reflecting a higher incidence of disability[29-32]. The age association with walking

Table 2. Estimated change in walking speed by each potential risk factor; results of final multiple linear regression model ($R^2 = 0.43$).

Risk Factors	Adjusted Coefficient (95% CI)	p
Constant (overall adjusted mean)	1.26 (1.19, 1.34)	0.0
Sociodemographic		
Age group, yrs		
34–44 (reference)	0.0	
45–54	–0.02 (–0.07, 0.03)	0.46
55–64	–0.05 (–0.11, 0.0)	0.05
65–74	–0.18 (–0.25, –0.12)	0.00
75–84	–0.29 (–0.37, –0.21)	0.00
Women	0.0	0.00
Men	0.09 (0.06, 0.12)	0.00
Social class		
I	0	
II	–0.06 (–0.12, 0.0)	0.07
IIINM	–0.10 (–0.16, –0.03)	0.005
IIIM	–0.10 (–0.17, –0.04)	0.003
IV	–0.13 (–0.20, –0.06)	0.00
V	–0.22 (–0.31, –0.12)	0.00
BMI categories*		
Normal range (18.5–24.9)	0	
Underweight (< 18.5)	–0.26 (–0.41, –0.12)	0.00
Overweight (25.0–29.9)	–0.04 (–0.07, 0.00)	0.06
Obese (≥ 30)	–0.12 (–0.16, –0.08)	0.00
Diseases		
Rheumatoid arthritis	–0.09 (–0.15, –0.04)	0.001
Heart trouble		
Other heart conditions	–0.10 (–0.16, –0.04)	0.001
Eye trouble		
Cataract	–0.09 (–0.15, –0.03)	0.004
Other problems		
Claudication in legs	–0.07 (–0.12, –0.03)	0.002
Ability to walk on flat ground: time before stopping		
≥ 1 hour (reference)	0	
30 min	–0.06 (–0.10, –0.03)	0.00
15 min	–0.14 (–0.18, –0.09)	0.00
< 5 min	–0.25 (–0.33, –0.17)	0.00
Knee and hip (pain or stiffness)**		
Mild/none (≤ 2)	0	
Moderate (3–5)	–0.04 (–0.08, –0.01)	0.02
Severe (6+)	–0.09 (–0.13, –0.04)	0.00
Smoking		
Smoking (current)	–0.06 (–0.10, –0.01)	0.02

* BMI: body mass index; WHO categories, kg/m^2. ** Measured doing any of 4 activities of daily living (1: standing up from a chair, 2: putting on socks or shoes, 3: going up steps or stairs, 4: going down steps or stairs).

speed we observed was also consistent with other research on walking speed[13], walking behavior[6], mobility[4], and motor performance in women[33].

A major new finding of this study is the association of walking speed with socioeconomic status. In general the relationship between health outcomes and socioeconomic status has been widely investigated, previous data suggesting that low socioeconomic status is associated with mortality[22,34,35], morbidity[23], knee disease[36], and other adverse health outcomes[37-43]. It is apparent that such outcomes are socially patterned, and it now appears that walking speed is as well. The mechanisms underlying this patterning are not fully understood[44,45]. A plausible hypothesis is that social class in adult life is associated with childhood disadvantage that has influenced growth and development, and subsequent decline in functional ability[46,47].

Another new finding from our study is the strong predictive value of comorbidities on the subsequent development of slow walking in people with hip and knee disease. The association with obesity concurs with previous research, in which obesity has been linked with locomotor disability[48], walking difficulty[6], poor motor performance in women[33], women's usual and fast-paced walking[49], and disability[50]. Despite differences in design, 2 other studies of highly active women aged 70–79 years have also shown the importance of excess weight and muscle strength in the transition to mobility difficulty[51,52].

Although a general link between visual impairment and functional status has been reported[20,53-55], an important new finding of our study is the large association between cataract and walking speed. The slower walking speed in people with cataract may be attributed to factors such as loss of confidence or fear of falling, and difficulty in adapting to locomotor difficulties that result from lower-limb pain. The size of the effect in those aged ≥ 55 years (Figure 3) suggests that clinicians should encourage older people with musculoskeletal disease to have regular assessments of their vision.

Previous research has shown that muscle strength and physical activity are predictors of the severity of general disability, suggesting a possible mediating role of muscle strength between physical activity and disability[56], and between muscle strength and mobility limitations[52,57]. A critical threshold for muscle strength has been reported, with the suggestion that above that threshold muscle strength is not related to walking performance[13]. We attempted to investigate the role of the 2 factors by adding them as explanatory variables in our multivariate regression model. As we did not have direct measures of muscle strength or physical activity at baseline, proxies were derived from activities of daily living items related to muscle strength (lifting and carrying) and to physical function (climbing stairs and walking), taking the same position as other investigators, who have used activities of daily living as surrogates for physiological measures[58,59]. These 2 measures were found to be strongly associated with slow walking speed; they were both correlated with the ability to walk at baseline, however, and in its presence they added little to the total variance explained by the model. This suggests that ability to walk has served as a measure of physical activity, as well as a proxy for muscle strength. The fact that the 2 factors were correlated supports a mediating role for muscle strength.

One of the main strengths of this study is that it is a large, prospective, community based survey containing a wide range of information on sociodemographics, morbidity, and health care utilization. Self-reported morbidity was validated using

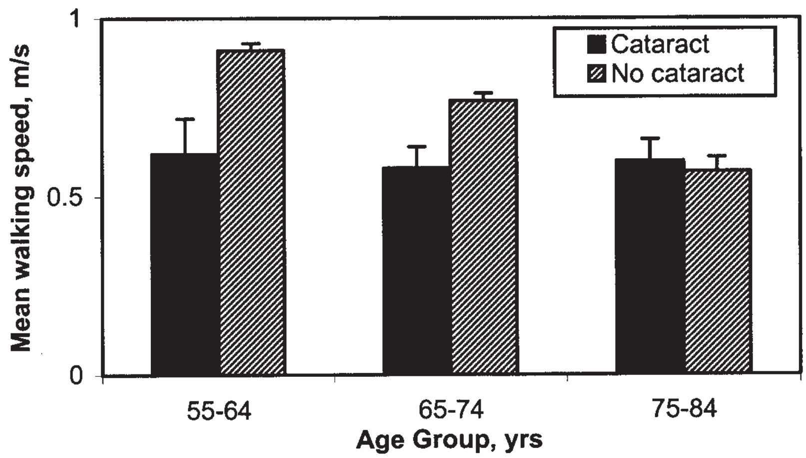

Figure 3. Presence and absence of cataract within 3 age groups.

general practice records and hospital letters. The study followed people with reported pain who were then examined and had radiographs. Radiographs, as we will report, have shown that the majority of people who reported hip or knee pain have OA, as expected[60,61]. An additional strength of our study is the use of an objective measure, walking speed, as the outcome, providing information that may not be available from self-reported items[62]. Walking speed is considered one of the best measures of disability outcomes[2,63]. Further, the data are of direct relevance to clinicians, as people with lower-limb joint pain present to them and often ask about the risk of disability in the future.

A limitation of the study is that the long followup interval may have resulted in differential loss of the most disabled and frail people. However, unmeasured major events, such as a serious new disease or a significant change in social life, were relatively uncommon in the group studied, so it is unlikely that such factors are a major limitation to our findings. As all participants in the study were able to complete the walking speed test, it is likely that nonrespondents represented a group with higher levels of disability and morbidity and consequently, slower walking speed or even inability to walk. Another weakness arises because walking speed was not measured at baseline, so that we had to use the proxy of self-reported walking ability in the predictive model.

Future walking speed among people with lower limb musculoskeletal pain can be predicted from their age, sex, social class, BMI, the presence of other common diseases, smoking, and self-reported walking ability at baseline. In older people, a combination of visual and musculoskeletal problems may be particularly important. We recommend that those with care of people with hip or knee disease pay attention to comorbidities, particularly visual impairment, in order to reduce the risk of future disability. The low walking speed of substantial numbers of the population also suggests that traffic control agencies should give consideration to increasing the time available at controlled road crossings as a means of improving environmental access for older people and those with lower limb musculoskeletal pain.

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