Factors Affecting Walking Speed of Elderly People

M. J. BENDALL, E. J. BASSEY, M. B. PEARSON

Summary

Associations between walking speed and other variables have been investigated in a group of 67 women and 58 men aged between 65 and 90 years and living independently. In men, walking speed was related positively to calf strength, step-score (a measure of customary physical activity), hours spent in active leisure, height and weight, and negatively to age and the presence of health problems. In women, the relations were the same, with the exception of weight, and reported leg pain was negatively associated with walking speed. Multiple regression analysis showed that in men 44% of the variance in walking speed was accounted for by height, calf strength and the presence of health problems, and that in women 42% of the variance was accounted for by height, calf strength, step-score and the presence of leg pain limiting mobility. The significance of these findings to maintenance and improvement of walking speed in the elderly is discussed.

Introduction

The ability to maintain adequate walking speeds for reasonable time periods without undue fatigue contributes to a comfortable and independent lifestyle in old age. Chosen normal walking speeds have been found in cross-sectional studies to be 4%–8% less at 60 years of age than at 20 years in both men and women [1, 2]. After retirement there may be an accelerated loss; chosen walking speeds in men have been found to decline longitudinally by 4% in the year following retirement [3]. It has also been found that the energy cost of walking at moderate speeds may be substantially higher for healthy elderly women than for young fairly sedentary women [4]. It appears therefore that the chosen walking speeds of some elderly people may decrease to functionally inadequate levels. For instance, time taken to cross the road or reach a destination may be so long that motivation to travel on foot is lost. This may lead to further reduction in physiological capacity so that a negative spiral of deterioration is initiated.

An association between walking speed and strength of the plantar flexor muscles of the calf has been described [5]. We examine here the possible additional effects on walking speed of customary activity and health in the same group of 125 subjects aged 65–90 years, with a view to identifying potentially remediable factors for elderly individuals who walk very slowly.

Methods

The subjects were 67 women and 58 men of mean age 72 and 71 years, respectively. The group, and the larger sample from which they were recruited, have been described previously [5, 6]. No significant differences were found between those subjects in whom walking speed was measured and the larger group for any of the measured variables.

All measurements were conducted at the subjects' general practice health centre. The techniques used to measure weight, height, skinfold thickness and isometric strength of triceps surae (calf strength), and the method used to collect information about health problems and leisure activity have been previously described [5]. Health was assessed by a simple structured questionnaire which identified

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Table I. Characteristics of subjects and results of objective measurements

	Men (n = 58)	Significance of difference p	Women (n = 67)
(*a*)			
Age (years)	71 ± 4	NS	72 ± 4
Height (m)	1.7 ± 0.06	< 0.001	1.56 ± 0.06
Weight (kg)	73 ± 10	< 0.001	65 ± 9
Four skinfold measurements (log sum mm)	1.47 ± 0.12	< 0.001	1.86 ± 0.10
Calf strength (kg)	115 ± 21	< 0.001	89 ± 18
Walking speed (km/h)	4.8 ± 0.6	< 0.001	4.2 ± 0.6
10^{-3} × Step-score (steps)	50 ± 27	NS	42 ± 28
(*b*)			
Subjects reporting (%):			
Mobility impaired by			
Breathlessness	14	NS	21
Chest pains	9	NS	3
Leg pains	16	< 0.01	37
Health problems	71	NS	67
Total time reported as being spent in active leisure (h/wk)	14.6	< 0.001	9.4

In (*a*) results are given as means ± SD. Significance of differences tested using unpaired *t* tests (*a*) and Mann–Whitney U tests (*b*).
NS = not significant.

those subjects who considered their mobility to be impaired by leg pain, chest pain or breathlessness. Subjects were also rated as having a health problem if they reported any current chronic illness, current medication or a serious illness during the last year.

Customary physical activity was measured by a cumulated daily step-score. The step-score for each subject was obtained with a mechanical accelerometer attached to the waistband and worn during waking hours over 7 consecutive days. These devices give a digital count proportional to the number of footsteps taken [7]. Walking speed was assessed by measuring the time subjects took to walk round a 100 m paved outdoor course, having been given standard instructions to walk steadily at a pace which was 'normal and just right' for them.

Relationships between walking speed and other variables were examined by Pearson's product moment correlation for normally distributed interval data, by Mann–Whitney U test for bivariate data, and by Spearman's correlation for ordinal or skewed data. Multiple regression analysis was used to explore the relationships of variables to walking speed.

Re-test variation in step-score and walking speed measurements was assessed as the standard deviation of the differences between two measurements taken a week apart, expressed as a percentage of the mean first test value. For step-score, measured in seven subjects it was ± 6%. For walking speed, measured in ten subjects, it was ± 6%.

Results

The characteristics of the study population are listed in Table I; further details are given elsewhere [5]. As expected, men were significantly taller, heavier, leaner and stronger than women, and also had significantly greater mean walking speed. About 70% of the group reported having a health problem with no sex difference in prevalence. Some individuals of both sexes found their mobility limited by health factors, leg pain being the commonest, particularly among the women who had a

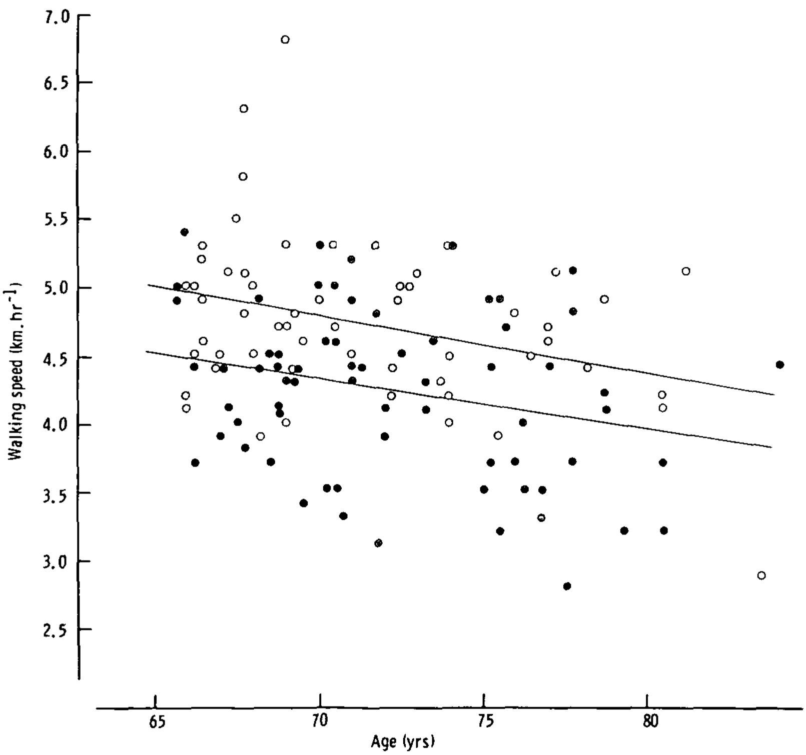

Figure. Walking speed and age. The symbols are plotted values for individual subjects, open symbols for men and closed symbols for women. The lines are least squares best fit regression lines, the upper line being that for men and the lower for women.

significantly greater prevalence (37%) of this symptom than men (16%). Men spent a significantly greater time (on average 5 h/day more) in leisure activity than women, though there was no significant sex difference in step-score.

The Figure shows the regression line of walking speed against age, speed declining significantly with age in men ($r = 0.32$, $p < 0.01$) and women ($r = 0.28$, $p < 0.05$). The rate of decline in walking speed was similar in both sexes, about 0.7% per year.

The relations between walking speed and other measured variables are shown in Table II. In men, calf strength, step-score, hours spent in active leisure, height and weight were all positively related to walking speed; age and the presence of a health problem were negatively related to it. Health factors limiting mobility had no significant relationship. In women, calf strength, step-score, hours spent in active leisure and height were positively related to walking speed; age, the presence of leg pain and the presence of a health problem were negatively related to it.

Multiple regression analysis showed that in men 44% of the variance in walking speed was accounted for by the following factors: height (17%), calf strength (13%) and the presence of health problems (14%): age, step-score, active leisure hours and weight were no longer significant factors after calf strength or health problems had been entered into the regression. The most efficient regression equation for walking speed by men was:

Speed (km/h) = 3.35 height (m) + 0.01 calf strength (kg) − 0.5 for those with a health problem − 1.8
Standard error of the estimate (SEE) = ± 0.46.

For women 42% of the variance in walking

Table II. Relations between walking speed and other measured variables

	Men (n = 58)	Women (n = 67)
Pearson's r value		
Calf strength	0.41**	0.36**
Height	0.42***	0.39***
Weight	0.29*	NS
Step-score	0.30*	0.36**
Age	−0.34**	−0.28*
Skinfolds†	NS	NS
Leisure activity	0.24*	0.42***
Mann-Whitney U test		
Breathlessness	NS	NS
Chest pain	NS	NS
Leg pain	NS	***
Spearman's ρ		
Health problem	−0.34**	−0.33**

*$p \leqslant 0.05$; **$p \leqslant 0.01$; *** $\leqslant 0.001$. NS = not significant. † Skinfolds = four skinfold measurements (log sum mm).

speed could be accounted for by the following factors: calf strength (13%), leg pain (12%), step-score (9%) and height (8%): age was no longer a significant factor after calf strength or step-score had been entered. In women, active leisure hours could be substituted for step-score (these two indicators of activity were significantly correlated in both sexes, $p < 0.01$), and health problems could be substituted for leg pain, but the resulting description explained less of the variance. The most efficient regression equation for walking speed by women was:

Speed (km/h) = 3.03 height (m) + 0.007 calf strength (kg) + 0.005 step-score (10^3 steps) − 0.42 for leg pain − 1.2 SEE = ± 0.49.

Discussion

The group of subjects studied was part of a larger group of vounteers and did not differ significantly from it. As previously described, the larger group was, on recruitment, representative of the population from which it was drawn, at least for age and sex [6]. Screening for disabilities incompatible with participation in the study led to some shortfall among older subjects, especially men. The prevalence of chest pain and breathlessness reported to restrict mobility was low compared with a representative sample of 1042 subjects of this age group [8], confirming our impression that the current sample was a rather healthy one, though the prevalence of leg pain reported to restrict mobility was similar in the two studies.

The assessment of walking speed using the standard instruction to walk around the level 100 m course at a pace which was normal and just right assumes that this chosen normal speed reflects what the subject normally does and can comfortably achieve. Repeat testing in this study showed the technique to be a stable measure of performance, and another study has demonstrated that walking speeds measured in this way are related to aerobic capacity [9].

Measured normal walking speeds varied over a wide range (see Figure). For those aged 65 years there was broad agreement with previously reported values [1]. The expected decline with age within the group was observed and, on average, chosen walking speed declined at a similar rate in both men and women. The rate of decline (7% per decade) was considerably greater than that found in another study in which walking speed declined by 7% across the four decades between 20 and 60 years [1]. This high rate of decline of walking speed in elderly people has also been found in a Canadian study [2] though the loss of speed with age was even greater (12% per decade in women, and 16% per decade in men), and the mean walking speeds of 3.2 km/h in women and 4.3 km/h in men were somewhat lower than in our study. These differences may be due to the walkway used in the Canadian study—it was indoors and subjects walked repeatedly up and down a 20 m course; the turns at each end probably reduced walking speed, an effect likely to be greater in the older subjects.

Two other reports found lower chosen walking speeds. The walkways used were much shorter and in one study poorly illuminated [10] and in the other study the subjects had multiple disabilities [11].

Both Bassey *et al.* [1] and Himann *et al.* [2]

found age and height to be the two significant variables predicting walking speed; however, neither study examined the effects of calf strength, customary physical activity and health. In our study, though in simple regression walking speed was significantly negatively related to age, in multiple regression age no longer had any effect. The effect of age was explicable by its association with calf strength and health in men and with calf strength, step-score and leg pain in women. These age-associated variables were statistically unrelated to each other in this study [12].

The effects of height seem to be mediated through leg length and hence stride length [1, 10]. The effects of calf strength have been described [5]. Customary activity, measured objectively as step-score, or reported during an interview as total hours per week spent in active leisure, was significantly associated with speed. These effects appeared to be explicable by calf strength in men, but not in women: women, during housework, may take many little steps which are perhaps not as effective in increasing calf muscle strength as longer steps taken by men who may spend more time out of doors.

Walking speed was affected by health problems as expected, but not by chest pain or breathlessness. The effects of leg pain on walking speed were not accounted for by calf muscle strength although this might have been expected. A weak relation between calf strength and leg pain was apparent only when men and women were considered together [5]. This may be because strength is measured statically whereas during prolonged dynamic movement such as walking the effects of arthritis, intermittent claudication or fatigue due to poor stamina can all lead to leg pain.

Associations between walking speed and other factors do not necessarily imply causality, but they do suggest possible ways in which intervention might restore loss of walking speed in the elderly. The variables which can potentially be modified—calf strength and health problems for men, and calf strength, step-score and the presence of leg pain limiting mobility in women, are not interrelated when the data for the sexes is analysed separately [5]. It is therefore possible to use the above equations to describe the likely mean effect on walking speed of remedial interventions. Such interventions may be particularly important for women, who had a mean walking speed 15% lower than men, and of whom a proportion walk very slowly.

The speed required to negotiate a Pelican crossing is 3.85 km/h [13]: about 20% of our sample of women had walking speeds below this, whereas only 2.5% of the men walked this slowly. The short-term potential for getting women to walk faster may be limited by the point at which systemic blood lactate begins to accumulate being close to normal walking speed [14], so that although some could increase their walking speed for short periods a significant proportion would still be at risk on crossing the road. Measures to produce more substantial improvement in their customary walking speed might have significant benefits for safety.

In the women, amelioration of leg pain might produce, on average, an increase of 0.42 km/h, an increase of 10% of their mean walking speed, whereas a doubling of customary walking activity measured as step-score (i.e. walking 2 h/day instead of 1 h) would produce an increase of only 0.21 km/h (5% of mean walking speed). An increase of 10% in calf strength which might be achievable with training [15] would have little effect on walking speed in men or women. An increase of 20% in calf strength would give as big an increment in speed as doubling the step-score: in very weak individuals in whom such an increase in strength might be achievable this would represent a significant improvement in speed.

The correlations between the independent variables and walking speed are low so the predictive power of the equations may be limited. Also the changes described are mean effects: the standard errors of the equations are large, therefore it is likely that in some individuals intervention would have little effect whereas in others the effects may be much larger than predicted. The predictions also assume that the associations within the equations are linear in individuals.

Thus an attempt to improve walking speed, in selected subjects found to walk very slowly, by control of leg pain, encouragement to walk more and exercises aimed at strengthening leg muscles, might be worthwhile. Also encouragement of regular exercise and early treatment of leg pain may prevent the negative spiral of deterioration before significant loss of walking speed has occurred.

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Authors' addresses

M. J. Bendall
Department of Health Care of the Elderly

E. J. Bassey, M. B. Pearson
Department of Physiology and Pharmacology

University of Nottingham Medical School, Queen's Medical Centre, Nottingham NG7 2UH

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