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BRIEF REPORT

THE ASSOCIATION BETWEEN DAILY WALKING BEHAVIOR AND SELF-REPORTED PHYSICAL FUNCTION IN COMMUNITY-DWELLING OLDER ADULTS

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Abstract: Many older people do not participate in organized exercise, and daily walking may be the most substantial contributor to physical activity. To investigate the association between daily walking behavior and self-reported health-related physical function, older community-dwelling volunteers wore activity-registering sensors for three days. Self-reported health-related physical functioning was measured using the SF36 10-item Physical Function subscale. Forty-six participants wore a sensor (mean age 77.6, SD 3.6, 61 % women). In a multiple regression model, steps per day (B=.005, p≤.001) and walks per day (B=-.174, p=.010) were associated with the SF36-PF subscale. The association between physical functioning and walks per day was negative: Those who took many walks per day may have been walking more indoors. Health professionals are likely justified in advising older people to incorporate walking into daily life for health purposes. The cross-sectional design does not allow for inferences about causality.

Key words: Walking, older adults, physical function.

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Background

Many older people do not exercise (1), and walking in daily life situations may be the greatest contributor to their physical activity (2). Walking at least 7500 steps per day has been suggested as sufficient to meet recommendations of daily physical activity (3, 4). Many studies have investigated walking behavior using self-report, which may be prone to both over- and underestimations (5). Use of small, body-worn, unobtrusive sensors that allow for multi-day continuous recording of movements has become more widespread, providing direct information about walking behavior in the wearer's own surroundings. The association between objectively measured walking behavior and health and functioning has not been studied extensively. We hypothesized that volume and intensity in walking behavior is associated with having few health-related functional limitations. To investigate this, we assessed the association between three days of free-living walking behavior, and health-related physical functioning.

Method

Study design and participants

A cross-sectional design was used, with randomly selected volunteers, between 70-81 years old and one third male. Participants were invited by mail and telephone and those who were able to walk 10 meters independently and able to give an informed consent, were included. The study was approved by the Regional Ethics Committee (No. 2010/1621)

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Measurements

Daily walking

Daily walking was assessed by use of ActivPAL^{TM} activity monitors (PAL Technologies Ltd, Glasgow, UK), (53*35*7 mm, 20 g, 20Hz). Participants wore the accelerometer on the front of the thigh, attached by a gel pad that was adhesive on both sides. The ActivPAL was waterproofed to allow for showering, however, the participants were asked not to go swimming or bathing. The monitors detect lying/sitting and standing positions, transitions between positions, and steps. ActivPALs have been shown to have high accuracy for step detection at different speeds and under different conditions (6, 7). In this study, data from three consecutive days are used for analysis. Time spent walking per day, walks per day and steps per day are believed to reflect volume of walking, while longest walk during the three days of recording and steps per walk reflect intensity of walking.

Physical function

The 10-item physical function subscale from the SF36-questionnaire is a measure of limitations in mobility and physical functioning due to health problems. It includes 10 questions concerning limitations in vigorous activity, moderate intensity activity, lifting/carrying a shopping basket, squatting/bending, walking, stair ascending and bathing/dressing ("How much does your health prevent you from…?"). A score of 100 indicates no limitations in either of the items and a score of zero indicates serious limitations in all items. The SF36 10-item physical function subscale (SF36-PF) has been described as a

valid measure of mobility disability (8).

Data analysis

Activity monitoring data was analysed by use of software version 7.1.18 from PAL Technologies Ltd. A custom-made MATLAB program (MATLAB version 7.1, The MathWorks Inc., Natick, MA, 2005) derived event information about walking.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics 20 and Microsoft Excel 2010 for Windows. Age, daily walking variables and the SF36-PF subscale are presented as means and standard deviations. To explore which of the daily walking variables that had closest association with the SF36-PF subscale, we used multiple regression with a backwards method, entering all daily walking variables simultaneously, with only variables with p-values ≤.10 remaining in the final model. In the same model, we adjusted for age and gender by including these using forced entry. In the results, unstandardized coefficients, standardized coefficients, p-value and explained variance (R^2) are presented. The variance inflation factor (VIF) was inspected for assessment of collinearity.

Results

Data was available for 46 individuals (61% women). The mean age was 77.3 (SD 3.6) years. Participants' descriptive details are shown in Table 1.

Table 1
Descriptive statistics for daily walking variables and physical function (n=46, mean age 77.6, SD 3.6)

	Mean or %	SD	Range
Background variables			
Usual gait speed (m/s)	1.13	0.20	0.53-1.49
Body mass index (kg/m^2)	24.64	3.03	19.29-32.11
≥3 daily medications (%)	35		
Living alone (%)	50		
Daily walking			
Steps per day (no.)	7368	2389	1802-12509
Walks per day (no.)	131	42	45-262
Steps per walk (no.)	58	19	27-126
Time per day (min)	96	28	26-157
Longest walk (min)	14	10	2-47
Physical function			
SF36-PF subscale (0-100)	78	19	30-100

BMI: body mass index; SF36-PF: SF36 questionnaire Physical Function; SD: standard deviation; range: minimum-maximum value

Before performing a multivariate analysis, bivariate correlations between all variables were inspected. The association between walking time per day and steps per day was very high (r=.933, p≤.001). As these variables would essentially convey the same information, time per day was not used in further analyses. In a multiple regression model with age and gender entered using a fixed method and daily walking variables entered using a backwards method, and the SF36-PF subscale as the dependent variable, steps per day and walks per day remained in the final model, with positive and negative associations respectively. In addition, being female was negatively associated with the SF36-PF subscale. There was no significant interaction between the two daily walking variables that remained in the final model (steps per day*walks per day). The explained variance for the final model was .37. When removing the variable "walks per day" explained variance was .27, while removing the variable "steps per day" gave an explained variance of .12, suggesting that steps per day had most explanatory power in the model (Table 2). Steps per day and walks per day and longest walk had VIF-values above 8.1 in the initial model, suggesting collinearity between these variables. VIF-values in the final model were found to be less than 1.4, giving no concern for collinearity.

Discussion

In this study, we have investigated daily walking behavior and self-reported physical functioning in older community-dwelling people. In a multiple regression analysis, steps per day and walks per day were significantly associated with the SF36-PF subscale, positively and negatively respectively.

Daily number of steps is a widely reported measure. On average, the participants in our study walked approximately 7300 steps per day, which may be characterized as being "low active". 54% walked less than 7500 steps per day, which is lower than the equivalence of 30 daily minutes of moderate to vigorous physical activity (4).

There was a negative association between number of walks and the SF36-PF subscale, suggesting that participants who took many walks per day experienced more difficulties in physical functioning than those who took few walks. One possible interpretation is that those who took many walks stayed indoors more: Outdoor walking generally requires walking over longer distances, while being indoors allowstasks to be completed with relatively fewer steps per walk. Restrictions in life-space mobility are associated with low physical functioning, and movement through more life-space areas is associated with higher physical activity (9). The questions in the SF36-PF are also to some degree directed towards outdoor mobility.

The variables longest walk and steps per walk were not retained in the multiple regression model. As the questions in the SF36-PF subscale are directed primarily towards volume (distance), and not intensity of walking, this is perhaps unsurprising. In another study, longest walk was associated

Table 2
Multiple regression model with gender and age (fixed method) and daily walking variables (backwards method) as independent variables, and the SF36 PF subscale as dependent variable

	Unstandardized Coefficients	Standardized Coefficients		Model R^2	Changes in R^2 if variable removed
	B	Beta	Sig.		
Gender (1=female)	-12.545	-.321	.017		
Age (years)	.250	.048	.711		
Steps per day	.005	.605	≤.001		-.27
Walks per day	-.174	-.390	.010		-.12
				.37	

with fewer falls; however, the participants were older and had dementia and cannot be directly compared to the participants in our study (10). The participants may have used cars or public transport for mobility, or for other reasons chosen not to walk more than they did on the days of recording. There may be a clear distinction between what persons are capable of doing (when tested in the laboratory) and what they actually choose do (during free living).

Explained variance in the regression model was modest, suggesting that other factors not measured here also play important roles. Limitations of this study include sample size, a potential observer effect and the cross-sectional design that does not allow for inferences about causality. Also, we did not control for season or weather in the analysis, which may affect the inclination to venture outside (11). In addition, non-walking physical activity was not measured.

In this study of daily life walking in community-dwelling older people, we show that steps per day was positively associated with health-related physical functioning. Health professionals are likely justified in advising older people to walk for health-purposes.

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Conflict of Interest: None of the authors report any conflict of interest.

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