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Gender-related Differences in Maximum Gait Speed and Daily Physical Activity in Elderly Hospitalized Cardiac Inpatients

A Preliminary Study

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Abstract: Maximum gait speed and physical activity (PA) relate to mortality and morbidity, but little is known about gender-related differences in these factors in elderly hospitalized cardiac inpatients. This study aimed to determine differences in maximum gait speed and daily measured PA based on sex and the relationship between these measures in elderly cardiac inpatients.

A consecutive 268 elderly Japanese cardiac inpatients (mean age, 73.3 years) were enrolled and divided by sex into female (n = 75, 28%) and male (n = 193, 72%) groups. Patient characteristics and maximum gait speed, average step count, and PA energy expenditure (PAEE) in kilocalorie per day for 2 days assessed by accelerometer were compared between groups.

Gait speed correlated positively with in-hospital PA measured by average daily step count ($r = 0.46$, $P < 0.001$) and average daily PAEE ($r = 0.47$, $P < 0.001$) in all patients. After adjustment for left ventricular ejection fraction, step counts and PAEE were significantly lower in females than males (2651.35 ± 1889.92 vs 4037.33 ± 1866.81 steps, $P < 0.001$; 52.74 ± 51.98 vs 99.33 ± 51.40 kcal, $P < 0.001$), respectively.

Maximum gait speed was slower and PA lower in elderly female versus male inpatients. Minimum gait speed and step count values in this study might be minimum target values for elderly male and female Japanese cardiac inpatients.

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Abbreviations: ANCOVA = one-way analysis of covariance, LVEF = left ventricular ejection fraction, MACE = major adverse cardiac events, PA = physical activity, PAEE = PA energy expenditure.

INTRODUCTION

The association between maximum gait speed, physical activity (PA), and mortality in community-dwelling older adults and cardiac patients, including those with coronary artery disease, cardiac surgery, and heart failure, has been the focus of several studies.[1–8] Previous research has shown gait speed to be a good predictor of the activities of daily living and mortality in elderly adults and cardiac inpatients.[3,5] Purser et al[5] reported that slow gait speed was a strong predictor of 6-month mortality in elderly cardiac inpatients.

Reduced daily PA is also associated with health-related quality of life, mortality, major adverse cardiac events (MACE), and length of hospital stay in cardiac patients.[1,2,6] Nery et al[6] previously investigated the effects of leisure-time PA on the prognosis of coronary artery bypass graft surgery and found PA to be an important predictor of MACE and length of hospital stay. Our previous study has determined that daily step count objectively measured by accelerometer may be a prognostic indicator of mortality in Japanese outpatients with heart failure.[2]

Sex-related differences in physiological functioning, specifically muscle strength, spirometric variables, and exercise capacity at baseline in cardiac patients, are well documented.[9–11] A previous study found in cardiac outpatients that measures of physiological outcome such as upper and lower extremity muscle strength and exercise capacity in women were significantly lower than those in men.[9] The number of cardiac patients in Japan, as in other several countries, has been increasing and is becoming a growing public health problem mainly due to aging of the general population and the increased prevalence of cardiac disease in the elderly.[7,12] It is thus important to understand the sex-related differences related to physical function and/or daily PA when educating or prescribing exercise for elderly cardiac inpatients.

A positive correlation was hypothesized to exist between maximum gait speed and PA and both factors might be lower in elderly female versus male cardiac inpatients. The purpose of the present study therefore was to evaluate both the relation

between maximum gait speed and PA and differences in PA according to sex in elderly Japanese cardiac inpatients.

METHODS

Participants

This cross-sectional study comprised 628 consecutive hospitalized cardiac inpatients admitted to St. Marianna University School of Medicine Hospital from April 2006 to November 2012 for myocardial infarction, coronary artery bypass grafting, valve replacement, or heart failure who were selected for evaluation of gait speed and objectively measured PA. Patients with acute myocardial infarction or heart failure were evaluated within 14 days after admission and surgical patients within 14 days after heart surgery. Of these 628 patients, cardiac inpatients aged 65 to 95 years were included in the study. Patients classified as New York Heart Association functional class IV and those with neurological, peripheral vascular, orthopedic, or pulmonary disease were excluded. Of the 628 potential subjects, 295 met the inclusion criteria; however, 27 patients were excluded because the data necessary to evaluate clinical characteristics, gait speed, and/or PA were either incomplete or missing. Thus, 268 patients were included for analysis on the basis of the inclusion criteria and available data.

Measures

Clinical characteristics were evaluated by review of medical records and included age, sex, body mass index, left ventricular ejection fraction (LVEF), etiology of cardiac disease, and medications. A cardiologist assessed LVEF as the index of cardiac function by echocardiography in all patients. The number of hospital admission days was also calculated.

Patient readiness for exercise before admission was evaluated with the transtheoretical model of exercise behavior change, which suggests that changes in an individual's exercise behavior progress through the stages of precontemplation, contemplation, preparation, action, and maintenance.[13,14] Patients in the preparation, action, or maintenance stage are defined as currently exercising, and those in the pre-contemplation or contemplation stage are defined as currently nonexercising.[13,14] The percentage of patients not exercising before admission was also determined. This study was approved by the St. Marianna University School of Medicine Institutional Committee on Human Research (Approval No. 1480). Informed consent was obtained from each patient.

Maximum Gait Speed

To measure maximum gait speed, the 10-m gait test was performed on flat ground along a 10-m line at a gym. Each patient was asked to walk on the 10-m line as fast as possible.[8] A physiotherapist measured by stopwatch the time required for patients to walk from the beginning to the end of the line. Three trials were performed. Afterwards, gait speed was calculated as 10 m/time required in sec and the highest value measured was considered to be the gait speed in meter per second. These values were measured at patient discharge from hospital.

Physical Activity

Averages of daily number of steps taken and daily energy expenditure on PA (PAEE) for 2 days were used as the indices of daily in-hospital PA. These indices were determined with the Kenz Lifecorder EX 1-axial accelerometer (Suzuken Co, Ltd, Nagoya, Japan), a validated device with good reliability.[15,16] The Lifecorder records number of steps taken and PAEE based on pre-entered age, sex, height, and weight data. All subjects wore the accelerometer at waist level.[15,16] Daily PAEE is computed by the accelerometer every 4 s, using body weight (W) and a proprietary manufacturer's factor Ka (exercise index), which depends upon the exercise intensity level: daily energy expenditure (kcal) = Ka (kcal/kg/4 s) × W (kg).[17] After 4 days of continuous wear (from Friday through Monday), the device was retrieved, and the data were downloaded into a computer and analyzed with Microsoft Excel software. Patient in-hospital PA level was assessed using the middle 2 days (Saturday and Sunday) of the 4-day collection period. The average of daily number of steps taken was calculated as total step count over 2 days/2, and the average daily PAEE was calculated as kcal expended over 2 days/2.

Statistical Analysis

Results are expressed as mean ± standard deviation (SD). One-way analysis of covariance (ANCOVA) and $\chi 2$ tests were used to test for differences between the 2 groups for clinical characteristics, number of hospital admission days, and patient readiness for exercise before admission. Because comparisons between the 2 groups were performed for sex and the sample across the clinical characteristics and in-hospital PA, Tukey post hoc test was used to test for differences between 2 independent groups. The relation between maximum gait speed and in-hospital PA data in all subjects was assessed by Pearson correlation coefficients. A P value of <0.05 was considered to indicate statistical significance. Statistical analyses were performed with IBM SPSS 17.0 J statistical software (IBM SPSS Japan, Inc, Tokyo, Japan).

RESULTS

Patient Characteristics, Hospital Admission Days, and Readiness for Exercise Before Admission

Patient clinical characteristics are presented in Table 1. The 268 patients were divided in 2 groups by sex: female and male. Patient characteristics except for LVEF were similar between the 2 groups. The number of hospital admission days and readiness for exercise before admission are also shown in Table 1. There were no significant differences in either factor between the 2 groups.

Relation Between Maximum Gait Speed and PA

There was a positive correlation between gait speed and in-hospital PA as measured by average daily number of steps ($r = 0.46$, $P < 0.001$) and average daily PAEE ($r = 0.47$, $P < 0.001$) in all patients (Figure 1).

Differences in Maximum Gait Speed and Daily In-Hospital PA

After ANCOVA was used to adjust for LVEF, significant differences were found between the 2 groups of hospitalized patients in gait speed, average daily step count, and average daily PAEE. Gait speed, average daily step count, and average daily PAEE in the females were all significantly lower than those in the males (Table 2).

DISCUSSION

To our knowledge, this is the first time that maximum gait speed and objectively measured in-hospital PA have been evaluated in relation to sex difference in elderly Japanese cardiac

TABLE 1. Patient Characteristics, Hospital Admission Days, and Readiness for Exercise Before Admission

Variable	Male	Female	t & χ^2 Value	P
No. of patients (n)	193	75		
Age, years	73.4 ± 6.2	73.1 ± 5.7	0.24*	0.80
Body mass index, kg/m^2	22.3 ± 2.6	22.5 ± 3.5	0.65*	0.51
LVEF (%)	46.7 ± 14.7	51.2 ± 13.1	2.13*	0.02
Etiology (n)				
Cardiomyopathy	58	25	2.17	0.33
CABG/VR	47	23		
Myocardial infarction	88	27		
Medications (%)				
Beta blockers	73.5	62.6	3.09	0.10
ARB	26.4	26.6	0.02	0.96
ACE-I	53.3	49.3	0.35	0.55
Diuretic	56.9	56.0	0.02	0.88
Hospital admission days, days	26.9 ± 15.4	27.6 ± 13.8	−0.34*	0.73
Non-exercising patients before admission (%)	43.5	46.6	0.21	0.64

Values are shown as mean ± standard deviation unless otherwise noted. ACE-I = angiotensin-converting enzyme inhibitor, ARB = angiotensin receptor blocker, CABG = coronary artery bypass grafting, LVEF = left ventricular ejection fraction, VR = valve replacement.
* t value.

inpatients. Maximum gait speed correlated positively with the average daily number of steps and in-hospital PAEE in all subjects. Although a previous study did not include elderly cardiac inpatients, it suggested that leisure-time PA as assessed by questionnaire was significantly related ($P < 0.01$) to the Short Physical Performance Battery score based on performance in completing a repeated chair rise test, standing balance test, 4-meter walk test, and 6-minute walk distance in older men and women (age ≥65 years and living independently at home).[18] Maximum gait speed in the present study correlated positively with objectively measured daily PA, indicating a similar relation between PA in elderly cardiac inpatients as was found in a community-based cohort of elderly men and women without cardiac disease.[18]

With the exception of LVEF, clinical characteristics of the patients were almost identical between the 2 groups. In a previous study, LVEF as estimated by quantitative gated SPECT was found to be significantly higher in women than in men in 181 asymptomatic individuals with no evidence of heart disease.[19] Sex-related differences in LVEF values might positively or negatively affect maximum gait speed and PA in hospitalized patients, and therefore, both maximum gait speed and PA in the present study patients were analyzed after adjusting for LVEF.

Hospital admission days and prior readiness for exercise before admission (as indicated by the percentage of nonexercising patients before admission) were not significantly different between the 2 groups (Table 2). Readiness for exercise was

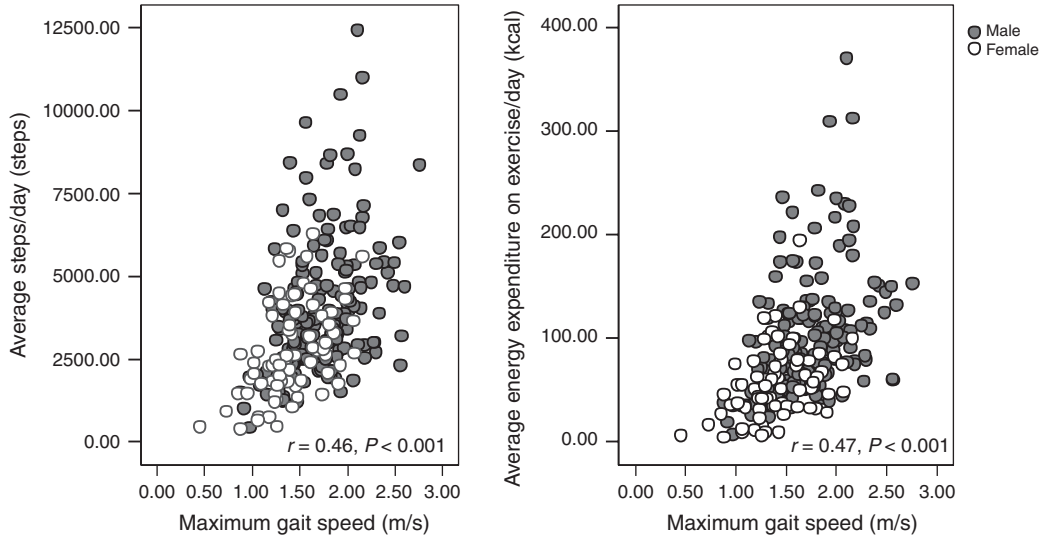

FIGURE 1. Scatter plots show the positive correlation between gait speed and both average daily number of steps taken ($r = 0.46$, $P < 0.001$) and average daily PAEE ($r = 0.47$, $P < 0.001$) in all patients.

TABLE 2. Differences in Gait Speed and Daily In-hospital Physical Activity

Variable	Male	Female	*F* Value	*P*
No. of patients (n)	193	75		
Maximum gait speed, m/s	1.72 ± 0.35 (1.67–1.77)	1.39 ± 0.36 (1.31–1.48)	42.36	<0.001
Average steps/day for 2 days (steps)	4037.33 ± 1866.81 (3765.49–4309.18)	2651.35 ± 1889.92 (2209.60–3093.10)	27.09	<0.001
Average energy expenditure on exercise/day for 2 days, kcal	99.33 ± 51.40 (91.84–106.81)	52.74 ± 51.98 (40.57–64.91)	40.34	<0.001

Values are shown as mean ± standard deviation (95% confidence intervals) unless otherwise noted.

reported to result in effective adherence to exercise maintenance in healthy people,[20] but these factors appeared to have no influence on the promotion of in-hospital PA in the present study. However, after adjustment for LVEF, significant sex-related differences were found in maximum gait speed in the elderly cardiac inpatients, indicating that sex differences might reflect and reduce the maximum gait speed of the elderly female versus male cardiac inpatients.

The lower physical exercise performance of nondisabled elderly women leaves them at greater risk for subsequent disabling and co-morbid conditions, nursing home admission, and mortality than their male counterparts.[18,21–23] In comparison with elderly men, women were found to have impaired exercise performance in the domains of lower extremity strength, balance, and ambulation.[18,21–23] Maximum gait speed of the female patients was 19.2% (1.39/1.72 × 100) lower than that of the male patients. This finding may support that of a previous study that reported an approximately 13% to −24% lower score for a walking test such as maximum walking velocity in elderly Japanese women compared with men.[24] However, the average maximum gait speed of the males in the present study was 1.72 m/s and was approximately 10% to 26% lower than reported values of other elderly men in the community (65–69 years, 1.96 m/s; 70–74 years, 1.79 m/s; and 75–79 years, 1.65 m/s).[24] The average value for gait speed in the females was 1.39 m/s and was approximately 10% to 23% lower than values of other elderly women in the community (65–69 years, 1.80 m/s; 70–74 years, 1.54 m/s; and 75–79 years, 1.55 m/s).[24] Previous research has shown gait speed to be a good predictor of the activities of daily living and mortality in elderly adults and cardiac inpatients.[3–5] Other studies also suggested that lower walking speed (≤1.50 m/s for men; ≤1.35 m/s for women) was strongly associated with cardiovascular mortality in a population of well-functioning elderly people (3208 community-dwelling men and women aged ≥65 years) and that a gait speed of at least 1.0 m/s was required to safely cross the street.[25,26]

The average values for walking speed in the present patients were higher than those reported previously. However, the value of 1.39 m/s for the females in the present study was close to the previously reported value of 1.35 m/s and might indicate that the females do not have the reserve capacity for PA that the men do. The elderly female cardiac inpatients might more easily experience problems with locomotion compared with the male cardiac inpatients.

The women in this study were less physically active than the men, as indicated by the women's 34% lower step count and 47% lower PAEE than those of the men. Leisure-time PA as assessed by questionnaire according to sex difference[27] supports the findings of a previous investigation.[18] In a recent investigation by Yasunaga et al[28] that assessed step counts of PA with a pedometer/accelerometer over 1 year in a community of Japanese aged 65 to 83 years, the men and women reported 7884 steps/day and 6145 steps/day, respectively. These data indicate that physical activity in the women was approximately 22% less than that of the men. The 23% to 28% lower leisure-time PA values reported by the elderly, nondisabled women in that study[28] confirm similar findings from previous studies and may negatively affect their exercise performance and increase their risk of future disability.[18,29] Moreover, leisure-time PA was significantly related to the Walking Velocity Score used to assess the combined group of men and women in the investigation by Gardner and Montgomery.[18] The strength of association between maximum gait speed and PA, as well as each of the 3-component performance scores of the Walking Velocity Score, was similar in the elderly men and women, suggesting that leisure-time PA is equally important in maintaining maximum gait speed in both sexes. The average values of PA found in the present patients appear to be easy to evaluate and easy for patients to understand and may be practical for predicting cardiac-related mortality in chronic heart failure outpatients.[2,30] Values reported in previous studies ranged from 3571.4 to 4889.4 steps/day.[2,30] The step count value for PA of 4037.3 steps/day in elderly male cardiac inpatients was similar to those of these 2 previous studies; however, the value of 2651.4 steps/day in the elderly female cardiac inpatients was lower than those of the 2 previous studies.[2,30] Thus, the step count value of the women appears to indicate lower physical ability than that of the men and that women might not have the reserve capacity for PA that the men do. Female inpatients might have a poorer prognosis from the viewpoint of the PA compared with that for the males.

Ayabe et al[31] suggested that to achieve the total amount of PAEE generally recommended for the secondary prevention of cardiovascular disease, patients should be encouraged to expend 200 to 300 kcal/day. PAEE was 99.3 kcal in the elderly male and 52.7 kcal in the female cardiac inpatients and was much less than that recommended in the Ayabe et al's[31] study. Because there are differences in step counts and PAEE between the present study and those of these previous studies that might relate to several factors such as age difference, etiology and severity of disease, hospitalized versus home-based patients, and socioenvironmental factors, the present results were not compared directly with those of the previous studies. Particularly, in-hospital PA in the present study inpatients could be limited for several reasons. The PA occurred during the acute and not the chronic phase of care and was investigated over the weekend. Nevertheless, the values for step count and PAEE that were determined

might be important in other future research and might also be appropriate sex-based minimum target values for achievement of PA in elderly Japanese cardiac inpatients.

Study Limitations

Limitations in the present study include its small sample size and that measurement of in-hospital PA occurred only over a single 2-day period. We did not evaluate the specific basic activities of daily living of the patients and thus cannot include this data. We also did not evaluate risks such as those of complications developed based on gait speed or of longer hospital stays associated with walking speed. Data on timing of PA in relation to cardiac-related mortality or re-hospitalization were not assessed due to the limited amount of related data available. Therefore, we are planning to address these deficiencies in future longitudinal studies.

CONCLUSIONS

Maximum gait speed was slower and PA lower in elderly female versus male cardiac inpatients. The respective sex-related differences found in gait speed, step count, and PAEE of 1.72 m/s, 4037.3 steps/day, and 99.3 kcal/day in the male and 1.39 m/s, 2651.3 steps/day, and 52.7 kcal/day in the female cardiac inpatients could possibly be minimum target values to be attained by these patients. These values may also be useful for clinicians or patients as targets for improvement of maximum gait speed and leisure-time PA on the basis of sex differences. Future longitudinal studies are required to evaluate the effect of improvement of these values in elderly cardiac inpatients, and long-term follow-up will be needed to evaluate possible time-related benefits of this improvement.

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