HEALTH SERVICES RESEARCH

Impact of walking upon medical care expenditure in Japan: the Ohsaki Cohort Study

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Background Physical activity is expected to reduce medical costs by lowering the risk for a variety of chronic diseases. However, little is known about the actual magnitude of medical cost saved by physical activity. We attempted to quantify the association between time spent walking and medical care costs, based on a 4-year prospective observation of National Health Insurance (NHI) beneficiaries in rural Japan.

Methods In 27,431 Japanese men and women, aged 40–79 years, who had no functional limitation or conditions interfering with physical activity at the baseline survey in 1994, we ascertained all hospitalizations, outpatient visits, and the costs through computerized linkage with NHI claims history files between January 1995 and December 1998.

Results Medical costs significantly reduced with longer time spent walking. Per capita medical cost was £111.80 per month (95% CI: 109.3, 114.2) in those who walked for ≤30 minutes/day, £108.10 (95% CI: 105.7, 110.5) in those who walked for 30 minutes–1 hour, and £97.30 (95% CI: 95.5, 99.0) in those who walked for ≥1 hour, after multivariate adjustment of potential confounders.

Conclusions This prospective study in Japan indicated that time spent walking was significantly associated with lower medical costs.

Keywords Cohort study, physical activity, walking, medical cost

An epidemic of sedentary lifestyle prevails all over the world. As a sedentary lifestyle is associated with an increased risk for a variety of chronic diseases and disability,1–9 it might translate into an increase in medical care costs. In this case, encouraging physical activity may be an investment towards reducing medical costs and improving people’s health status simultaneously.10 Knowledge about the actual cost-benefit of physical activity would lead to better decisions for more efficient allocation of resources. However, little is known about the actual magnitude of the medical costs saved by physical activity. Most previous studies were limited because they observed a small sample for only a short period, or relied upon model analyses incorporating uncertain parameters.10–14 Direct observation of the population regarding the relation between physical activity and medical costs has rarely been conducted.15

The purpose of this study was to determine the impact of physical activity upon medical care utilization and costs. We chose to focus on walking because it is the most common type of physical activity among middle-aged or older individuals. Our data were derived from a 4-year prospective observation of National Health Insurance (NHI) beneficiaries in rural Japan.16–19 The strengths of this study included a large sample size (N = 52,029), coverage of almost all the medical care under the NHI system, and 100% monitoring of medical care utilization from claim history files. The comprehensive health and lifestyle information for each subject at baseline allowed us to adjust for a variety of potential confounders. In this study, we calculated the medical costs according to the time spent walking for the subjects, after excluding those who had functional limitation or conditions interfering with physical activity at baseline.
Data and Methods

Study design and setting

The data were derived from the Ohsaki NHI Cohort Study. The study design has been reported in detail elsewhere. This study was approved by the Tohoku University School of Medicine Ethics Committee. We conducted a questionnaire survey on all NHI beneficiaries aged 40-79 years, living in the catchment area of Ohsaki Public Health Center, Miyagi Prefecture, Japan, between October and December 1994. The Public Health Center is a local government agency that provides preventive health services in the community.

The health insurance system, compulsory for everyone living in Japan, is classified into two different categories. One is the insurance system for employees and their dependents, and the other is a system of community-based health insurance called NHI. It covers farmers, the self-employed, and pensioners as beneficiaries. Because the study area was in a rural part of Japan where the main industry is agriculture, about 55% of the population in this area were NHI beneficiaries. NHI covers almost all medical treatment and the medical providers’ fees. Payment from NHI to medical providers is made on a fee-for-service basis, where the price of each service is determined by a uniform national fee schedule.

The baseline questionnaire included demographic, medical history, physical functioning, and health-related lifestyle. Trained survey personnel visited the subjects, informing them of the study objectives and their right to decline, and asked them to complete the questionnaire if they consented. They revisited the subjects to collect the questionnaire about a week later. Out of 54,996 eligible individuals, 52,029 (95%) responded and formed the study cohort.

Study variables

We examined the impact of the time spent walking upon medical care use and costs. All lifestyle information was obtained from the questionnaire survey in 1994. The question on the walking time for each subject was worded as ‘How long do you walk a day, on average?’, and the subjects were asked to choose one out of three options: ≤30 minutes, 30 minutes–1 hour, and >1 hour. We have already reported that this questionnaire on walking time was reasonably reproducible and valid in studying the health effects of walking.

Physical functioning status was assessed with the 6-item measure of the Medical Outcomes Study (MOS) Short-form General Health Survey. The following variables were included as potential confounders in multivariate models: age (by 10-year categories); sex; smoking status (never, ever smoker); alcohol intake (non-drinker, 1-449 g, ≥450 g ethanol/week), and body mass index (BMI: weight in kg/height in m²) (<21, 21–25, ≥25). The question for self-rated health was worded as ‘How would you rate your health: excellent, good, fair, poor, or very poor?’. We grouped the former two and the latter three. We asked the subjects how long they participated in sports or exercise activity per week, and to choose one of four options: very little, 1-2, 3-4, or ≥5 hours/week. In this analysis, the subjects were classified into <3 or ≥3 hours/week. We also included history of hypertension, diabetes, cancer, liver disease, and renal disease into multivariate models.

Data on medical care use and costs

We prospectively collected data on medical care use and costs for all individuals in the cohort between January 1995 and December 1998. We obtained the NHI claims history files from the Miyagi NHI Association. The files included the number of outpatient visits, the number of days of inpatient care, and the charges for outpatient and inpatient care, respectively.

When a beneficiary was withdrawn from the NHI, the date and reason were coded on the NHI withdrawal history file. With this file, the survival and emigration status were identified for all subjects. Both the NHI claims and withdrawal history files were linked with our baseline survey data file, based on the beneficiary’s ID number as the key code.

Study subjects

In order to minimize the potential bias due to the inter-relationship between health status and physical activity, we excluded from analysis the subjects who had functional limitation or chronic conditions interfering with physical activity. The subjects were excluded if, at the baseline survey, they were unable to perform moderate or vigorous activities on the MOS questionnaire (N = 15,858). Out of the remaining 36,171 subjects, we further excluded those who reported severe bodily pain (N = 805), or history of cerebrovascular disease (N = 327), myocardial infarction (N = 596) or arthritis (N = 2167) at the baseline survey. We excluded subjects who died or emigrated by 31 December 1994 (N = 774) because their cost data were not available. We also excluded those who died in 1995 (N = 172) because most of them may have been too ill to walk at the baseline. Finally, we excluded the subjects with incomplete data in the physical activity questionnaire (N = 3,848), or invalid data in medical costs (N = 3), or self-reported height and weight (N = 48).

The remaining 27,431 subjects (15,019 men and 12,412 women) were then analyzed. The mean age was 57.2 (SD = 10.0) years. All were free from conditions interfering with physical activity, allowing us to estimate the magnitude of excess medical costs incurred by those who did not walk enough, although they were able to do so if desired.

Statistical analysis

We calculated medical care costs as the product of the probability of utilization (i.e. hospitalization rate or visit rate) multiplied by the expected number of utilizations among those who used the index care. The impact of the time spent walking upon the probability of outpatient visit and hospitalization, respectively, was examined using a logistic regression model. We examined the impact of walking time upon the medical costs, and the numbers of outpatient visits and hospital days, respectively, using analysis of covariance. Per month values for each subject were calculated by dividing the accumulated values through follow-up by the number of months observed. Except for the data shown in Figure 1, we examined per month values in order to avoid underestimating the medical care use and costs of the subjects who died or emigrated. In these statistical analyses, we used multivariate models to adjust for the effect of potential confounders: age, sex, smoking status, alcohol drinking, body mass index, self-rated health, time spent in sports activities or exercise, and history of hypertension,
Results

Demographics

Of 27,431 subjects, 13,314 (49%) reported that they walked for ≥1 hour/day, 7,061 (26%) for 30 minutes–1 hour, and 7,056 (26%) for ≤30 minutes. Table 1 shows the baseline characteristics of the subjects by categories of the time spent walking. Those who walked for 30 minutes–1 hour/day were the highest in mean age and lowest in percentages of smoking and drinking. A longer walking time was associated with a lower prevalence of BMI >25, a greater likelihood of rating self-health as excellent or good, and more time spent on sports or exercise activity. The prevalence of self-reported illness was highest among those walking for 30 minutes–1 hour, possibly because the mean age was highest in this group.

<table>
<thead>
<tr>
<th>Time spent walking a day, hours</th>
<th>No. of subjects</th>
<th>Women (%)</th>
<th>Mean age (SD)</th>
<th>Smoking (%)</th>
<th>Drinking (%)</th>
<th>Self-reported illness (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥1.0</td>
<td>13,314</td>
<td>43.1</td>
<td>56.9 (9.9)</td>
<td>47.6</td>
<td>56.3</td>
<td>19.3</td>
</tr>
<tr>
<td>0.5–1.0</td>
<td>7,061</td>
<td>52.0</td>
<td>58.8 (10.0)</td>
<td>44.8</td>
<td>28.3</td>
<td>25.3</td>
</tr>
<tr>
<td>≤0.5</td>
<td>7,056</td>
<td>55.2</td>
<td>56.1 (10.3)</td>
<td>49.1</td>
<td>55.2</td>
<td>22.0</td>
</tr>
<tr>
<td>P-value</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

A test for trend across the time spent walking, where appropriate, was conducted by treating the category as a continuous variable.

In this paper, monetary values were converted into UK Pounds using the exchange rate £1.00 = 180 Japanese Yen. We used approximate variance formulae to calculate 95% CI. $P \leq 0.05$ was regarded as statistically significant. SAS software, Version 8.02 (SAS Institute Inc, Cary, NC) was used for all statistical calculations.

Total medical costs

Table 2 shows the total medical costs by group of the time spent walking. Medical costs significantly reduced as the walking time increased. Per capita medical cost was £111.80 per month (95% Cl: 109.3, 114.2) in those who walked for ≥1 hour/day, £108.10 (95% Cl: 105.7, 110.5) in those who walked for 30 minutes–1 hour, and £97.30 (95% Cl: 95.5, 99.0) in those who walked for ≤0.5 hour/day, after adjustment for age, sex, smoking, alcohol drinking, BMI, self-rated health, time spent on sports activities, and any history of hypertension, diabetes, cancer, liver disease, or renal disease.

The total costs did not differ between the groups walking for 30 minutes–1 hour/day and ≤30 minutes ($P = 0.285$). Taking the two groups together, those walking ≥1 hour/day incurred medical costs of £109.90 per capita per month, 13% higher than for those walking for ≥1 hour/day (£97.30).

Figure 1 shows the accumulated medical costs for the group walking for ≥1 hour/day versus the group walking for <1 hour. The cost did not differ between the groups until June 1996 (1.5 years after the baseline survey). Since then, difference in the costs has become larger over time. The accumulated costs over 4 years for those walking ≥1 hour/day (£3855) were 15% lower than for those walking for <1 hour/day (£4563).

Inpatient and outpatient care use

The odds ratio for inpatient care significantly increased with shorter walking time (Table 2). So did the mean number of days in hospital and the mean medical cost for inpatient care. Compared with those walking ≥1 hour/day, per capita per month cost for inpatient care in those walking ≤30 minutes was 16% higher. For outpatient care, both the number of visits and the medical cost also significantly increased with shorter walking time (Table 2).

There was no notable gender difference in the above findings. All were consistently observed in those who spent <3 hours/week on sports or exercise activity.
week on sports or exercise activities and in those who spent ≥3 hours, respectively.

**Discussion**

Although we have copious data on the relationship between physical activity and diseases, we have very little knowledge on how this might translate into potential cost savings. Most of the previous studies were based on hypothetical cohorts, with assumptions for values for the costs of services, and a direct observation of the population has rarely been conducted. Our prospective study indicates that longer walking time was associated with lower medical costs. Among the subjects who were free from functional limitation or conditions interfering with physical activity, medical cost was significantly lower (12%) in the subjects walking for ≥1 hour/day than in those walking for <1 hour (£97.3 versus £109.9), after adjustment for age, sex, smoking, alcohol, body mass index, participation in sports activities, self-rated health, and history of hypertension, diabetes, cancer, liver disease, or renal disease.

The observational studies regarding the health effect of physical activity are subject to the bias due to the interrelationship between physical function and physical activity. Some people do not walk because illness or disability limits their ability to walk. We attempted to minimize this bias by excluding the subjects who at baseline reported limited physical functioning or conditions interfering with physical activity. Therefore, we were able to estimate the excess medical costs incurred by those who did not walk enough although they were able to do so. Another source of bias would be the inter-relation between physical activity and other health-related behaviours. As indicated in Table 1, those who walked longer were more likely to lead a healthier lifestyle. In order to control for this effect, we compared medical costs by time spent walking after adjustment of potential confounders.

Total medical cost did not differ until 1.5 years after the baseline survey between the group of walking for ≥1 hour and the group walking <1 hour (Figure 1). It would be attributable to the two factors as have discussed above; exclusion of the subjects with functional limitation or conditions interfering with physical activity, and multivariate adjustment of potential confounders. The impact of physical inactivity upon health status and medical costs would become larger with time. In this study, the cost difference became apparent after 1.5 years of follow-up, and the difference became larger with time, even after multivariate adjustment. This difference in medical cost after 1.5 years of follow-up should reflect the changes in health status during the follow-up, for which the physical activity level would be one of the responsible factors.

Another interpretation of the present finding would be that longer time spent walking may be a reflection of performing more vigorous activity. Although the present finding was observed even after including the time spent on sports or physical exercise into the multivariate model, it does not necessarily mean that only walking is responsible for the reduced cost. Since we have no data for job or household activities, we are not able to examine the impact of the total physical activity upon medical costs. There is accumulating evidence indicating the health benefit of walking. Prospective studies in the US have indicated that walking was significantly associated with a reduced risk of all-cause mortality, a reduced number of hospitalizations for cardiovascular disease, and lower incidence of type 2 diabetes, coronary heart disease, and stroke. According to a 10-year observation of middle-aged working Japanese men, the duration of the walk to work was significantly associated with lower risk of incident hypertension. In light of these findings, we suggest that walking would be associated with improvement in health thus a decrease in medical costs. However, other types of physical activity would also contribute to the reduction of medical costs.
According to a recent report from the US, based on a direct observation of the population, the medical cost was significantly lower (25%) among those who were regularly engaged in moderate or strenuous physical activities. The impact of the amount, intensity, and type of physical activity on medical costs should be further investigated.

Our study has several limitations. First, the measure of walking was simple. We asked the subjects to report only the time spent walking. We did not ask for the pace of walking or distinguish between walking for exercise and other reasons. Differences in pace and the purpose of walking may have different impacts upon health status of the subjects and thus the medical cost. Second, the diagnosis for each medical care use was not available. This prevented us from examining the importance of walking upon individual diseases. Third, we could not examine any changes in the walking time of the subjects after the baseline survey. These limitations should be counterbalanced by the strengths of our study; the prospective observation of a large population-based cohort, complete monitoring of medical care use and costs, exclusion of the subjects with functional limitations, and adjustment of a variety of potential confounders.

This study indicated that walking time strongly influenced medical care costs. However, it did not answer whether an increase in walking among the sedentary subjects may eventually reduce medical care costs. Some recent studies are highly suggestive of the health benefit of increasing the walking time or distance. A 10-year follow-up of the participants in a randomized clinical trial of walking in the US revealed that the subjects in the walking group continued to walk longer and had lower hospitalization rates than the control group. The Nurses Health Study indicated that sedentary women who became active in middle or later adulthood had a lower risk of stroke than their counterparts who remained sedentary. Therefore, it would be reasonable to expect a saving in medical cost if sedentary people increased their physical activity.

In conclusion, this prospective cohort study in Japan indicated that the time spent walking was significantly associated with lower medical costs. Although most healthcare providers recognize the importance of physical activity, one survey indicated that they actually talked less often with their patients about physical activity than about smoking cessation or weight control. We should step up our efforts to encourage people to increase physical activity in their daily life.

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KEY MESSAGES
- In spite of the copious data on relationship between physical activity and diseases, little is known about the actual magnitude of the medical costs saved by physical activity.
- The association between time spent walking and medical care use was examined in a 4-year prospective population-based cohort in Japan (N = 27 431).
- Among the subjects without functional limitation, medical cost was significantly lower (12%) in those walking for ≥1 hour a day than in those walking for <1 hour.

References
7 Hansen CJ, Stevens LC, Coast JR. Exercise duration and mood state: how much is enough to feel better? Health Psychol 2001; 20:267–75.

Commentary: Can walking lower medical care costs?

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There is a great deal of evidence that supports the health benefits of physical activity for the general population. For instance, participating in at least 30 minutes of moderate intensity physical activity (such as brisk walking) has been shown to reduce morbidity and mortality due to chronic disease and disability. Walking is the most accessible form of physical activity and is recommended for health benefits because it is an activity most people can do and is associated with a very low injury rate. While it makes sense to recommend walking for health benefits and it is logical to assume that promoting physical activities such as walking could translate into lower medical care costs. Although in general, people with arthritis are not as active as those without arthritis, another study found lower medical costs among active people with arthritis when compared with inactive people with arthritis. Further analyses of the NHI data might show that physical activities such as walking may result in medical care cost savings even among those with chronic conditions.