Walking to Work Is an Independent Predictor of Incidence of Type 2 Diabetes in Japanese Men

The Kansai Healthcare Study

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Previous epidemiological studies have shown that vigorous physical activity reduces the development of type 2 diabetes (1–3). A recommendation from the Centers for Disease Control and Prevention reported that individuals should engage in ≥30 min of moderate-intensity physical activity, such as brisk walking, on most days of the week for health promotion and disease prevention (4); however, it is unclear whether mild physical activity (i.e., walking to walk) reduces the risk for type 2 diabetes. In the present study, we examined the relationship between walking to work and the development of type 2 diabetes during a 4-year observational period.

RESEARCH DESIGN AND METHODS — The Kansai Healthcare Study is an ongoing cohort investigation designed to clarify the risk factors for cardiometabolic diseases. Between April 2000 and March 2001, 12,647 male employees of a company in the area of Kansai, Japan, who were aged 40–55 years at entry and considered to be involved in sedentary jobs were enrolled in this study. All employees aged ≥40 years underwent annual detailed medical check-ups. The protocol for this research was reviewed by the Human Subjects Review Committee at Osaka City University.

For current analysis, study participants consisted of 11,073 Japanese men aged 40–55 years at entry with a fasting plasma glucose (FPG) <126 mg/dl and not taking oral hypoglycemic medication or insulin. A 4-year follow-up examination after baseline was conducted between April 2004 and March 2005. We excluded 53 men because of death and 2,016 men because of loss to follow-up. Another 428 individuals who completed follow-up but had missing information were also excluded. Thus, the study population consisted of 8,576 men.

Blood samples were drawn after an overnight 12-h fast to measure FPG levels. BMI was calculated as the weight in kilograms divided by the squared height in meters. To determine the duration of their walk to work, each participant was asked "How long does it take you to walk to this office?" The questionnaire had five possible answers: 0–10, 11–20, 21–30, 31–40, and ≥41 min. In a voluntary sample (n = 80) of cohort participants, we assessed the validity of the self-administered questionnaire about walking by comparing the mean number of walking steps for 2 days counted from their home to their office by a pedometer (Citizen, Tokyo, Japan). Spearman's correlation between the duration of the walk to work and pedometer steps was 0.453 ($P < 0.001$). The 1-year test-retest correlation for the walking questionnaire was 0.567 ($P < 0.001$).

The single-item questionnaire regarding leisure-time physical activity had three possible answers: rarely, sometimes, or regular (at least once weekly). Participants were classified as engaging in regular leisure-time physical activity at least once weekly or less than once weekly. We examined the validity of the simple questionnaire on leisure-time physical activity. In a voluntary sample (n = 219) of this cohort, a detailed questionnaire was administered about the types of leisure-time physical activities they took part in (described as light, moderate, or vigorous in accordance with the Centers for Disease Control and Prevention) (4), their weekly activity frequency, and time spent in each activity. Participants were classified as engaging in regular leisure-time physical activity at least once weekly if they reported that they engaged in moderate- or vigorous-intensity activities at least once weekly and spent ≥30 min doing so weekly. Cohen's κ between simple and detailed questionnaires was 0.59 ($P < 0.001$).

Regarding smoking habits, participants were classified as current smokers, past smokers, or lifelong nonsmokers. Questions about alcohol intake included the weekly frequency of alcohol consumption and the usual amount of alcohol consumed on a daily basis. Alcohol intake was converted to total alcohol consumption (in grams of ethanol per day), using standard Japanese tables. Type 2 diabetes at baseline and follow-up examination was diagnosed if the FPG level was ≥126 mg/dl or if participants were taking oral hypoglycemic medication or insulin (5).

We used multiple logistic regression analysis to estimate the odds ratio (OR) for the incidence of type 2 diabetes in relation to baseline variables. We calculated the 95% CI for each OR. P values were two tailed. Statistical analyses were per-

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Abbreviations: FPG, fasting plasma glucose.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Characteristics of study participants at baseline according to whether type 2 diabetes developed after the 4-year follow-up and multivariate model of the incidence of type 2 diabetes*

		Type 2 diabetes status after follow-up		Multivariate model*	
	Total	Not type 2 diabetes	Type 2 diabetes	Multiple-adjusted OR (95% CI)	*P*
n	8,576	7,698	878		
Walk to work†					
0–10 min	1,698 (19.8)	1,508 (19.6)	190 (21.6)	1.00	
11–20 min	4,491 (52.4)	4,028 (52.3)	463 (52.7)	0.86 (0.70–1.06)	0.158
≥21 min	2,387 (27.8)	2,162 (28.1)	225 (25.6)	0.73 (0.58–0.92)	0.007
Age (years)	47.8 ± 4.2	47.7 ± 4.1	48.7 ± 4.1		
Age categories					
40–44	2,163 (25.2)	1,993 (25.9)	170 (19.4)	1.00	
45–49	3,055 (35.6)	2,776 (36.1)	279 (31.8)	1.02 (0.81–1.27)	0.899
50–55	3,358 (39.2)	2,929 (38.0)	429 (48.9)	1.37 (1.11–1.70)	0.003
BMI (kg/m^2)	23.4 ± 2.9	23.3 ± 2.8	24.6 ± 3.2	1.11 (1.08–1.14)	<0.001
FPG (mg/dl)	97.6 ± 9.5	96.3 ± 8.5	109.1 ± 9.8		
FPG categories (mg/dl)					
<100	5,348 (62.4)	5,199 (67.5)	149 (17.0)	1.00	
100–109	2,235 (26.1)	1,969 (25.6)	266 (30.3)	4.51 (3.65–5.56)	<0.001
110–125	993 (11.6)	530 (6.9)	463 (52.7)	28.01 (22.65–34.63)	<0.001
Daily alcohol consumption (g ethanol)	25.2 ± 21.9	25.1 ± 21.9	25.8 ± 22.3		
Drinking habit categories (g ethanol)					
Nondrinkers	1,334 (15.6)	1,192 (15.5)	142 (16.2)	1.00	
Tertile 1 (0.1–16.3)	1,657 (19.3)	1,493 (19.4)	164 (18.7)	0.94 (0.71–1.23)	0.636
Tertile 2 (16.4–42.6)	3,002 (35.0)	2,711 (35.2)	291 (33.1)	0.75 (0.59–0.95)	0.018
Tertile 3 (42.7–115.0)	2,583 (30.1)	2,302 (29.9)	281 (32.0)	0.83 (0.65–1.06)	0.129
Smoking habit					
Lifelong nonsmokers	1,841 (21.5)	1,662 (21.6)	179 (20.4)	1.00	
Past smokers	1,924 (22.4)	1,710 (22.2)	214 (24.4)	1.07 (0.84–1.36)	0.600
Current smokers	4,811 (56.1)	4,326 (56.2)	485 (55.2)	1.36 (1.11–1.68)	0.004
Regular leisure-time physical exercise					
No	7,028 (81.9)	6,296 (81.8)	732 (83.4)	1.00	
Yes	1,548 (18.1)	1,402 (18.2)	146 (16.6)	0.90 (0.72–1.11)	0.317
Parental history of diabetes					
No	7,472 (87.1)	6,778 (88.0)	694 (79.0)	1.00	
Yes	1,104 (12.9)	920 (12.0)	184 (21.0)	1.65 (1.34–2.02)	<0.001

Data are means ± SD, *n* (%), or multiple-adjusted ORs (95% CI). *In multiple logistic regression analysis, age, fasting plasma glucose level, and daily alcohol consumption showed a nonlinear association with the incidence of type 2 diabetes. Therefore, we fit the model by using these variables categorized for easy understanding. †As only 5.5% of men reported a walk of ≥31 min, we combined them into the 21- to 30-min walk category.

formed using Stata/SE (version 8.0; Stata, College Station, TX).

RESULTS — Of the eligible 8,576 men followed for 4 years, 878 men developed type 2 diabetes. The baseline characteristics of this study population are summarized in Table 1.

After adjusting for age, BMI, FPG level, daily alcohol consumption, smoking habits, leisure-time physical activity, and parental history of diabetes, the OR of incident type 2 diabetes was 0.73 (95% CI 0.58–0.92) in participants who walked to work for ≥21 min compared with those who did so for ≤10 min. There was no significant first-order interaction term between walking to work and the other variables.

CONCLUSIONS — Several prospective studies (1–3,6) have reported that physical activity is effective in preventing diabetes. The Nurses' Health Study reported that walking decreased the risk of type 2 diabetes (6). The Finnish Diabetes Prevention Study reported that lifestyle change, including an increase in walking for exercise, decreased the risk of type 2 diabetes among individuals with impaired glucose tolerance (7). The population-based study in Finnish reported that walking or cycling to and from work decreased the risk of diabetes in women but not men (8).

There are some studies about the relationship between exercise and insulin sensitivity. Daily walking combined with diet have improved insulin sensitivity among subjects with diabetes (9), and aerobic exercise and a reduced-fat diet have improved insulin sensitivity among Japanese Americans with impaired glucose tolerance (10). Improvement of insulin sensitivity may be one of the beneficial mechanisms in our result.

As all participants were registered employees of the same company, our results may not be representative of the general population; however, they may apply at least to men who work outside the home. As they all had sedentary jobs and relatively uniform educational background and socioeconomic status, these variables were unlikely to represent confounding factors.

In conclusion, the present results provided evidence that duration of the

walk to work has an independent effect on the risk of type 2 diabetes.

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