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Relationship between social engagement and diabetes incidence in a middle-aged population: Results from a longitudinal nationwide survey in Japan

Taiga Shibayama[1]*, Haruko Noguchi[2], Hideto Takahashi[3], Nanako Tamiya[1]

[1]Faculty of Medicine, University of Tsukuba, Ibaraki, [2]Faculty of Political Science and Economics, Waseda University, Tokyo, and [3]National Institute of Public Health, Saitama, Japan

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***Correspondence**
Taiga Shibayama
Tel: +81-29-853-3433
E-mail address:
taiga@md.tsukuba.ac.jp

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ABSTRACT

Aims/Introduction: Social engagement can positively affect health status, but its effect on diabetes incidence remains unclear. The present study aimed to assess the relationship between social engagement and diabetes incidence in a middle-aged Japanese population.

Materials and Methods: We analyzed data on 31,615 people aged 50–59 years from a prospective national survey carried out in Japan from 2005 to 2013. Diabetes incidence was measured by asking respondents annually whether they had been diagnosed with diabetes by a physician in the previous year. We used the complementary log–log model for interval-censored survival time analysis. Social engagement was assessed at baseline as participation in social activities, having the companionship of friends, living with someone and employment status. Covariates including sex, age, health status and health behaviors were also measured at baseline.

Results: After adjusting for covariates measured at baseline, the effect size of social engagement on diabetes incidence was the same as or larger than that of the covariates. Respondents who participated in social activities (hazard ratio [HR] 0.89, 95% confidence interval [CI] 0.87–0.92), had the companionship of friends (HR 0.97, 95% CI: 0.95–1.00), lived with someone (HR 0.85, 95% CI: 0.82–0.89) and were employed (HR 0.94, 95% CI: 0.92–0.96) were significantly less vulnerable to diabetes than were those who did not.

Conclusions: The present study found a prospective association between social engagement and diabetes incidence among a middle-aged population. Future strategies to prevent diabetes in Japan should focus on both social and personal factors.

INTRODUCTION

Diabetes mellitus is a chronic metabolic disorder that is increasing rapidly around the world[1]. From 2006 to 2015, the prevalence of diabetes in Japan increased from 12.3 to 19.5% for men, and from 8.2 to 9.2% for women. This increase was particularly marked among people aged ≥50 years or older. In 2015, 18.8% of men and 6.5% of women aged in their 50s had diabetes[2]. Long-term complications of diabetes mellitus have profound impacts on patients' quality of life[3] and mortality[4], and raise medical care expenditures, resulting in a serious financial burden for society[5]. Given the deterioration of patients' quality of life and the current financial stringency of the Japanese government, reducing the incidence of diabetes among middle-aged people is an urgent and crucial public health concern for Japan.

Cases of type 2 diabetes account for the majority of people with diabetes. The risk of type 2 diabetes is determined by the interplay of environmental and genetic factors. Environmental factors, including an unhealthy diet, being overweight or obese, physical inactivity[6,7], active smoking[8], alcohol intake[9] and psychological stress[10], are factors that can be modified to prevent diabetes.

There have been various population-based strategies to prevent diabetes in Japan. For example, 'Health Japan 21' (started

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in 2000) boosted health promotion services and raised public awareness of diabetes and supporting healthy lifestyles[11]. 'Specific Health Guidance' has been provided for groups at high risk for lifestyle-related diseases since 2008, under the Act on Assurance of Medical Care for Elderly People (Act No. 80 of 1982). Following the identification of risk for lifestyle-related diseases based on the results of annual medical examinations for medical insurance subscribers aged 40–74 years, guidance is provided by a doctor or public health nurse regarding modifying dietary and exercise habits. However, given the recent increase in people with diabetes in Japan, these strategies have not been sufficiently effective in reducing the prevalence of diabetes. There is a clear need for a decisive and innovative strategy to support population-based diabetes prevention.

Strategies to stop the rapid increase of diabetes incidence should also consider the impact of social factors. Empirical studies suggest that social networks are significantly correlated with health outcomes[12–15], including diabetes management[16]. Using four longitudinal datasets representative of the USA population, Yanga *et al.*[17] reported a prospective association between social relationships and physiological determinants of longevity across the human lifespan. These findings suggest that social relationships influence the incidence of diabetes.

Five pathways mediating the relationship between social networks and health outcomes have been proposed: (i) social support; (ii) social influence; (iii) access to healthcare resources; (iv) social engagement and participation; and (v) person-to-person contact[18]. Person-to-person contact is applicable only to infectious diseases, but the first four pathways might be applicable to chronic illnesses, such as diabetes.

There might be some trade-off between social influence and access to healthcare resources. Social influence can emerge from shared norms about health behaviors among network members[18]. National strategies, such as 'Health Japan 21,' that plan to share healthy behavioral norms among the wider population have had limited effect in Japan[19]. This might be because the easy access to healthcare resources under Japan's universal health insurance coverage reduces people's motivation to prevent diabetes. Although social support facilitates health behaviors in terms of managing chronic illnesses other than diabetes[20,21], interventions to enhance social support without considering the specific nature of social relationships have not shown consistent positive effects on diabetes health outcomes[22,23].

The present study focused on the fourth pathway (social engagement). This encompasses participation and engagement in real-life activities where two or more people interact with one another, such as participating in social activities, living with someone, occupational roles and gathering with friends. Previous studies have suggested that social engagement has positive effects on physical and mental health[24–26], risk of cardiovascular disease[27] and cognitive impairment[28]. However, to our knowledge, the relationship between social engagement and diabetes incidence has not been well examined. In a super-aged society, such as Japan, scientific evidence regarding social factors among middle-aged people is necessary to reduce the incidence of diabetes in later life, particularly because the influence of social engagement on health status can accumulate over time[29].

The present study aimed to examine the prospective association between social engagement and diabetes incidence, using data drawn from an 8-year longitudinal national survey of middle-aged people in Japan. If the effect of social relationships on the incidence of diabetes is significant, social relationships must be given more consideration in health promotion programs, such as 'Health Japan 21' and 'Specific Health Guidance,' in addition to factors, such as diet and physical activity. If social relationships have a larger effect than do individual lifestyle factors, the focus of diabetes prevention might need to be redirected to place more emphasis on the improvement of social relationships rather than individual behavior modification. This might lead to a new approach to stopping the increase of diabetes in Japan.

METHODS

Data

Data for the present study were drawn from the Longitudinal Survey of Middle-aged and Elderly Persons (LSMEP), a nationally representative longitudinal survey. This survey has been carried out by Japan's Ministry of Health, Labor and Welfare (MHLW) on the first Wednesday in November each year beginning in 2005. Respondents were selected with a stratified two-stage sampling strategy. In the first stage, the MHLW chose 2,515 districts at random from the 5,280 districts that were surveyed in a previous MHLW population-based survey (the Comprehensive Survey of the Living Conditions of People on Health and Welfare, carried out in 2004). Each district was determined for the 2000 census, and included approximately 50 households. In the second stage of the sampling strategy, 40,877 residents aged 50–59 years were randomly selected in proportion to the population size each census district.

Of the 40,807 people who received an initial self-administered questionnaire in 2005, 84.6% (34,505) responded. In the present study, we used nine waves of the LSMEP panel data. The numbers of respondents in the panel surveys from 2006 to 2013 were: 32,285, 30,730, 29,605, 28,736, 26,220, 25,321, 24,026 and 23,722, respectively. To examine the incidence of diabetes, we excluded 2,363 respondents, who reported in 2005 that they had been diagnosed as having diabetes by a physician. We also excluded 37 respondents with missing data on diabetes incidence over the entire survey period and 490 respondents whose precise year of diabetes incidence was not identified during the survey period. Ultimately, we analyzed 31,615 respondents.

Measurements

All measurements in the present study were collected via the self-administered LSMEP questionnaires.

Diabetes Incidence

The primary outcome in the present study was diabetes incidence from 2005 to 2013. Respondents were asked each year whether they had been diagnosed by a physician as having diabetes in the previous year. Individuals who responded 'yes' were identified as having diabetes. We regarded the incidence year of diabetes as the year when an individual first reported a diabetes diagnosis, regardless of whether diabetes response was missing during some follow ups.

Social Engagement

The main predictor in the present study was social engagement at baseline. We assessed social engagement status as participation in social activities, such as community events, volunteerism or providing support to older people. Other social engagement factors were living with someone, having the companionship of friends and employment status. We used living arrangements rather than marital status for two reasons. First, marital status is highly correlated with living arrangements among middle-aged people in Japan. Second, because some people lived with their children and/or parents instead of with a spouse, living arrangements more comprehensively assessed social ties than did marital status. Respondents were asked each year about the status of each social engagement factor, with dichotomous response values (yes or no).

Covariates

Covariates including age, self-rated health, current hypertension and dyslipidemia status, and health behaviors were measured at baseline. Self-rated health was measured on a 6-point ordinal scale (1 = very bad, 2 = bad, 3 = rather bad, 4 = rather good, 5 = good, 6 = very good). Current hypertension and dyslipidemia statuses were identified through questions asking whether the respondent had been diagnosed with the diseases in the past year since the last survey, with dichotomous response values (yes or no). For risk behaviors, respondents were asked whether they actively smoked and whether they habitually consumed alcohol. For healthy behaviors, respondents were asked whether they were aware of appropriate portion sizes, took care to eat a balanced diet, maintained a healthy bodyweight, brushed their teeth after every meal and attended a medical checkup each year. Exercise status was assessed at three degrees of intensity: low (stretching or light exercises); moderate (walking or jogging); and high (aerobic exercises or swimming). Respondents reported 'yes' or 'no' for all questions about health behaviors.

Statistical Analysis

Because survival times of diabetes incidence in the LSMEP were observed as the 1-year interval within which the incidence occurred, we used the complementary log–log model for survival time analysis[30]:

$$\log(-\log(1-\lambda_{ij})) = \alpha_j + \beta' x_i,$$

where λ_{ij} was the discrete-time hazard of the ith subject ($i = 1,\ldots, n$) in the jth time interval ($j = 1, \ldots J$) with covariate vector x_i (n = the number of subjects) and β was a parameter vector. The model leads to the baseline survival function S_0 at the j th time interval of

$$S_{0j} = \prod_{k=1}^{j} \exp(-\exp(\alpha_k))$$

and the survivor function adjusted by covariates at the jth time interval of

$$S_j = [S_{0j}]^{\exp(\beta' x)}.$$

We reported the complementary hazard (=1 − λ) when all covariates were set to zero at each year calculated as exp (-exp (α)) and the hazard ratio (HR) for each variable calculated as exp (β), with 95% confidence intervals (CI). The parameters were estimated by maximum likelihood estimation. People who were lost to follow up were censored at the date of their last follow-up survey. People who did not have diabetes during follow up were censored for overall survival analysis. We excluded data for the 4,536 (14.3%) respondents who had missing values for predictors included in the multivariate analysis. The level of significance was set at 0.05, and all *P*-values were based on two-sided tests. All statistical analyses were carried out with SAS 9.4 for Windows (SAS Institute Inc., Cary, North Carolina, USA).

Ethical Approval

The present study received official approval to use secondary data from the MHLW Statistics and Information Department (permission number 'Tohatsu-1218-1') on 18 December 2015. We were not required to undergo an ethical review of this study, according to the Japanese government's Ethical Guidelines for Epidemiological Research (http://www.lifescience.mext.go.jp/files/pdf/n796_01.pdf).

RESULTS

Table 1 shows the characteristics of the respondents at baseline. Because the LSMP investigators visited the participants' homes and collected the completed questionnaires directly at baseline, the percentage of responses on each variable might have been more than 92.6% (29,280/31,615).

The effects of social engagement on diabetes incidence are shown in Table 2. Social engagement had a negative association with diabetes incidence. Living with someone was the most influential of the 19 studied predictors in terms of preventing diabetes (HR 0.85, 95% CI: 0.82–0.89). Participation in social activities was the second most influential predictor (HR 0.89, 95% CI: 0.87–0.92), along with having a medical checkup each

Table 1 | Respondents' characteristics at baseline

	n		
Sex	31,615		
Women (%)		52.8	
Mean age, years (SD)	31,615	54.6	(2.7)
Mean self-rated health† (SD)	30,811	4.3	(1.0)
Hypertension (%)	31,054	16.0	
Dyslipidemia (%)	31,054	7.9	
Actively smoke (%)	30,694	30.0	
Habitually consume alcohol (%)	30,376	50.1	
Aware of appropriate portion sizes (%)	30,403	40.3	
Take care to eat a balanced diet (%)	30,403	38.8	
Maintain a healthy bodyweight (%)	30,403	36.5	
Brush teeth after every meal (%)	30,403	34.6	
Attend a medical checkup each year (%)	30,704	72.7	
Exercise	29,280		
Low intensity (%)		34.5	
Moderate intensity (%)		26.9	
High intensity (%)		7.7	
Social engagement			
Participate in social activities (%)	29,458	22.4	
Have the companionship of friends (%)	29,458	19.0	
Live with someone (%)	30,894	93.8	
Employed (%)	31,007	80.7	

Total *n* = 31,615. †1, very bad; 2, bad; 3, rather bad; 4, rather good; 5, good; 6, very good. SD, standard deviation.

year (HR 0.89, 95% CI: 0.87–0.91). The effects of having the companionship of friends (HR 0.97, 95% CI: 0.95–1.00) and being employed (HR 0.94, 95% CI: 0.92–0.986) were also statistically significant.

Of the other covariates, having dyslipidemia (HR 0.94, 95% CI: 0.91–0.98) and habitually consuming alcohol (HR 0.97, 95% CI: 0.95–0.99) were negatively correlated with diabetes incidence.

DISCUSSION

The present study prospectively investigated the relationship between social engagement and diabetes incidence, using data from a population-based survey in Japan. The results suggested that all four types of social engagement were significantly associated with the incidence of diabetes. Furthermore, the influence of social engagement on the incidence of diabetes might be the same as or greater than that of health behaviors. These relationships might be sociologically plausible, because participation in social networks through social engagement can decrease the negative health effects of social isolation[31] and increase opportunities for receiving social support from other network members, thereby contributing to diabetes prevention.

To our knowledge, this is the first study to show the statistical significance and effect size of the association between participation in social activities and future diabetes incidence. A recent large-scale prospective study did not show rigorous associations between social participation and cardiovascular disease risk among middle-aged women after adjusting for confounding factors including smoking, physical activity and self-rated health[32]. The present results showed that the effect of participation in social activities remained significant after adjusting

Table 2 | Complementary log–log model predicting 8-year diabetes incidence using social engagement and covariates at baseline

Intercept		CH	95% CI
1st year		0.81	(0.72, 0.87)
2nd year		0.85	(0.79, 0.90)
3rd year		0.89	(0.84, 0.92)
4th year		0.91	(0.86, 0.94)
5th year		0.84	(0.77, 0.89)
6th year		0.86	(0.79, 0.90)
7th year		0.84	(0.77, 0.89)
8th year		0.76	(0.66, 0.83)
Explanatory variables		**HR**	**95% CI**
Social engagement			
Participate in social activities	Yes/no	0.89	(0.87, 0.92)†
Have the companionship of friends	Yes/no	0.97	(0.95, 1.00]†
Live with someone	Yes/no	0.85	(0.82, 0.89)†
Employed	Yes/no	0.94	(0.92, 0.96)†
Sex	Women /men	0.91	(0.89, 0.93)†
Age (years)		0.99	(0.98, 1.00)†
Self-rated health‡	(1–6)	0.90	(0.88, 0.92)†
Hypertension	Yes/no	1.00	(0.98, 1.03)
Dyslipidemia	Yes/no	0.94	(0.91, 0.98)†
Actively smoke	Yes/no	1.10	(1.08, 1.13)†
Habitually consume alcohol	Yes/no	0.97	(0.95, 0.99)†
Exercise			
Low intensity	Yes/no	0.97	(0.95, 0.99)†
Moderate intensity	Yes/no	0.97	(0.94, 0.99)†
High intensity	Yes/no	0.97	(0.93, 1.00)
Aware of appropriate portion sizes	Yes/no	1.02	(1.00, 1.04)
Take care to eat a balanced diet	Yes/no	0.97	(0.95, 0.99)†
Maintain a healthy bodyweight	Yes/no	0.96	(0.94, 0.98)†
Brush teeth after every meal	Yes/no	0.97	(0.95, 0.99)†
Attend a medical checkup each year	Yes/no	0.89	(0.87, 0.91)†
Hosmer–Lemeshow test		$\chi^2(8) = 6.19$; $P = 0.63$	

Total *n* = 27,079. †Statistically significant estimates of the effects of explanatory variables. ‡1, very bad; 2, bad; 3, rather bad; 4, rather good; 5, good; 6, very good. CH, complementary hazard when all covariates were set to zero at each year; CI, confidence interval; HR, hazard ratio.

for these confounding factors. Surprisingly, the effect size of participation in social activities was as strong as that of having a medical checkup each year. The results of a medical checkup might give people the opportunity to think about their health or self-care. Stimulating people to engage in social activities in their communities should be considered in future health promotion programs in Japan. It might be difficult for people to change individual habits, such as diet and exercise, and being socially active might be a feasible strategy to prevent diabetes.

Living with someone was the factor most strongly associated with future incidence of diabetes. Furthermore, middle-aged people who had the companionship of friends and were employed were also less vulnerable to diabetes. These results were congruent with those reported by Moriyama *et al.*[33], who found that middle-aged employed men in Japan often lived away from their families for work and tended to have an unhealthy diet. A previous cohort study also suggested that not being married and not cohabiting was a risk factor for mortality in men[34]. The present study showed a similar association between living alone and diabetes incidence. Social support might be related to health behaviors[20,21,35], and people who live alone might not receive adequate social support from family members, close friends or coworkers. However, because it might not be possible to develop an intervention to change the living arrangements of middle-aged people, population-based approaches seeking to prevent diabetes should target this high-risk group (middle-aged people who live alone) to increase social support.

Our findings suggest that the quantitative density of the social networks (social engagement in family, work and community) of middle-aged people in Japan might be influential in determining physical health status. This is inconsistent with findings reported by Yang *et al.*[17] In the USA, social integration among middle-aged people was not associated with biomarkers of physical health, because of these people's natural embeddedness in multiple social networks. This difference might result from qualitative differences in social relationships among middle-aged in the USA and Japan. However, the exact reasons for the difference are unclear, and further examination is warranted.

Strong measures should be implemented to offset the influence of social factors on physical health. Human relationships in Japanese society are becoming attenuated because of the trend toward nuclear families and the dissolution of territorial bonding in recent years. The percentages of individuals who never marry and who live in one-person households have also increased[36]. Japanese people should be provided with more education about the importance of social factors for physical health. However, a simple increase in the density of social connectedness might induce psychological stress. Future health guidance for middle-aged people should include opportunities to learn more about the social skills required to connect well with others with minimal psychological impact. These efforts should be carried out by multidisciplinary teams including specialists in social skills. Furthermore, social relationships built in adolescence influence health in later adulthood[17]. The enrichment of education related to social skills in adolescence could therefore have the potential to prevent lifestyle-related diseases, such as diabetes.

The present results showed that some lifestyle factors were significantly correlated with diabetes incidence. Although some results, including those for a healthy diet, healthy bodyweight, physical activity and active smoking, were in line with the findings of previous studies[6–8], we also found that having dyslipidemia and habitually consuming alcohol were negatively correlated with diabetes incidence. Given that respondents' dyslipidemia was diagnosed by a physician, those respondents who reported having dyslipidemia in the survey might have been receiving more proper treatment than were those who did not report having the condition. Further investigation with clinical data on serum lipids is required to confirm the result. Although a recent systematic review showed that moderate alcohol consumption is protective against diabetes incidence in non-Asian populations[37], for the Japanese population, the risk of diabetes incidence depends on the interaction of sex, body mass index and the quantity of alcohol consumption[9]. More accurate measurements of body mass index and alcohol consumption are required to support the present findings.

Several limitations of this study should be acknowledged. First, we used self-report data rather than clinical data or a physician's diagnosis to identify diabetes incidence. In this study, among middle-aged people, 12.8% (1,971/15,359) of men and 6.6% (1,075/16,234) of women reported having diabetes in 2006. The value for men is similar to the estimated prevalence of diabetes in the middle-aged male population, whereas the value for women is smaller than that for the middle-aged female population in 2006[2]. Caution is required in interpreting the results of the present study. Second, the LSMEP did not measure the perceived quality of social relationships. Similar to social support, the perceived quality of social networks might be more influential in physical health than the quantity of network ties (social integration)[17]. To clarify the effect of social relationships on the incidence of diabetes, future studies should capture both the structural–quantitative and the functional–qualitative dimensions of social relationships. Third, healthy behaviors were not measured objectively in the survey. Respondents were asked whether they maintained a healthy bodyweight, but obesity measured by bodyweight or body mass index might be a significant predictor of diabetes. To confirm the results, the covariates should have been measured in a more accurate and precise manner. Fourth, we did not have information about respondents' family history of diabetes, which might have confounded the relationship between social engagement and diabetes incidence.

In summary, we carried out a survival analysis using nationally representative longitudinal data on middle-aged people in Japan to determine the relationship between social engagement

and diabetes incidence. Social engagement was prospectively associated with the incidence of diabetes, and the effect size of social engagement was the same as or larger than that of health behaviors. This study highlights the importance of social relationships for physical health among middle-aged people in Japan.

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DISCLOSURE

The authors declare no conflict of interest.

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