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Impact of income and eating speed on new-onset diabetes among men: a retrospective cohort study

Reiko Ishihara ,[1] Akira Babazono,[2] Ning Liu,[3] Reiko Yamao[2]

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[1]Department of Healthcare Management, College of Healthcare Management, Miyama, Japan
[2]Department of Health Care Administration and Management, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan
[3]Department of Preventive Medicine and Community Health, University of Occupational and Environmental Health, Kitakyushu, Japan

Correspondence to
Ms Reiko Ishihara;
rei-ishihara@healthcare-m.ac.jp

ABSTRACT

Objective To examine the impact of income and eating speed on new-onset diabetes among men.

Design This was a retrospective cohort study.

Setting We used the administrative claims and health check-up data for fiscal years 2010–2015 obtained from the Fukuoka branch of the Japan Health Insurance Association.

Participants Participants were 15 474 non-diabetic male employees, aged between 40 and 74 years. They were categorised based on their eating speeds (ie, fast, normal and non-fast).

Primary and secondary outcome measures To calculate the OR of the development of diabetes, we created generalised linear regression models with diabetes onset as the dependent variable and eating speed and income as covariates and calculated corresponding 95% CI values. The analyses were performed after adjusting the data for age, obesity and comorbidities.

Results Of the total participants, 620 developed diabetes during the 5-year study period. A univariate analysis using the generalised linear regression model revealed that eating fast (OR: 1.35, 95% CI 1.17 to 1.55) and having a low income wereincome (OR: 1.47, 95% CI 1.24 to 1.74) were significantly associated with the onset of diabetes. After adjusting for age, obesity and comorbidities, both eating fast (OR: 1.17, 95% CI 1.02 to 1.35) and having a low income (OR: 1.24, 95% CI 1.03 to 1.50) were recognised as independent risk factors for diabetes onset.

Conclusions The study revealed that eating fast and having a low income were independent risk factors, leading to the development of diabetes. While it is difficult to address income differences, it may be possible to address the factors that contribute to income differences to manage diabetes appropriately and at low healthcare costs. However, eating speed can be controlled. Hence, the provision of education and coaching on dietary habits, including eating speed, may be effective in preventing diabetes onset.

Strengths and limitations of this study

- ► We conducted a retrospective cohort study on a sample of 15 474 participants.
- ► We followed up the participants' diabetes onset for a period of approximately 5 years.
- ► We evaluated diabetes onset based on haemoglobin A1c levels, diagnoses and drug prescriptions according to health insurance claims.
- ► Unlike other similar studies, our study considered eating speed and income together as factors affecting diabetes onset.
- ► This study has some limitations, such as not considering possible changes in eating speed and income during the 5-year observation period.

INTRODUCTION

The Global Report on Diabetes (2016) indicated that approximately 422 000 000 individuals worldwide were affected by diabetes in 2014. It also reported that the diabetes incidence rate doubled from 4.7% in 1980 to 8.5% in 2014.[1] In Japan, the 2018 National Health and Nutrition Survey reported that 18.7% and 9.3% of the total male and female population, respectively, were suspected to have diabetes.[2] Furthermore, it was estimated that approximately 3 289 000 individuals (1 848 000 men and 1 442 000 women) underwent treatment for diabetes in 2017.[3]

Eating behaviour is a factor that contributes to both obesity and diabetes. Several studies have investigated the impact of eating speed in this context and demonstrated its association with obesity and diabetes.[4–13] For instance, a Japanese study conducted on a large cohort of 197 825 participants over a period of 3 years reported that eating fast was the sole predisposing factor among several eating habits that led to new-onset diabetes.[5] Studies have found that obesity,[8] insulin resistance[14 15] and postprandial glucose metabolism,[16] which are all affected by eating speed, influence one another and cause diabetes. However, in a survey conducted on 2050, male Japanese employees of a metal product factory, although eating speed was associated with the incidence of diabetes, it was found to be insignificant once adjustments were made to account for body mass index (BMI).[9]

Furthermore, lifestyle, which encompasses eating habits such as eating speed, is affected by not only personal choices but also socioeconomic factors. The 2018 National Health and Nutrition Survey conducted by the Ministry of Health, Labour and Welfare demonstrated that the risks of occurrence of obesity and stroke are approximately 1.5 times higher in low-income than high-income groups.[2] Furthermore, the 2010 Japan Gerontological Evaluation Study demonstrated that the risk of diabetes was negatively correlated with income among individuals aged over 65 years who did not qualify for the Certification of Needed Long-Term Care.[17] Collectively, these findings suggest that societal factors can contribute to the onset of diabetes.

Personal lifestyle factors, such as eating and exercising habits, and the societal factors that determine individuals' personal lifestyle choices contribute to the development of lifestyle diseases, including diabetes. However, there is a lack of evidence on the impact of personal lifestyle and socioeconomic factors on diabetes. A cross-sectional study conducted by Nagamine *et al*[17] evaluated the association between diabetes and socioeconomic factors, such as income, education and employment, and adjusted their data to account for the time that participants spent walking per day and their intake of meat, fish and vegetables. However, to date, no study has simultaneously evaluated the association between eating speed and income on diabetes onset. Simultaneously evaluating these factors makes it possible to investigate whether income affects the association between eating speed and diabetes onset. To bridge this research gap, we conducted a 5-year retrospective cohort study to examine the impact of eating speed and income on diabetes onset in male employees of small and medium-sized enterprises (SMEs).

METHODS

Data source

In this study, we collected specific health check-up and claims data from the Fukuoka branch of the Japanese Health Insurance Association, which insured employees of SMEs. The participants' health check-up data included details like check-up dates, BMI values, and the results of blood chemical analysis. They included a self-reported questionnaire to obtain the participants' responses to several questions on medical history, comorbidities and lifestyle factors, like eating habits.[18] The claims data included information on the dates of consultations, treatments and participants' details like gender, age, diagnoses, specific treatments and healthcare expenditure. Furthermore, the health check-up and claims data were linked at the individual subject level for analysis.

Study population

We selected non-diabetic individuals from a group of 81 193 male employees who had undergone a specific health check-up documented at the Fukuoka branch of the Japan Health Insurance Association in 2010. This study only included men since only a small proportion of those who are insured with the Fukuoka branch of the Japan Health Insurance Association are women (36.9%) and since previous studies have reported that women eat slower than men.[4 12] Additionally, since the specific health check-up is legally required of those aged 40–74 years, the participants of this study are also aged 40–74 years. Individuals were excluded from the study if (1) they reported a history of cerebrovascular disease, cardiac disease, renal failure and/or dialysis, (2) sufficient data on their eating speed were not available or (3) adequate data on their income were not available. Among the 19 214 men who met the inclusion criteria, 15 474 men, whose information could determine the presence of diabetes according to the 2015 check-up and health insurance claim, were eventually included in the analysis.

Outcome

The onset of diabetes was defined as the primary outcome in this study. Since the Japan Diabetes Society unit for haemoglobin A1c (HbA1c) measurement was used in specific health check-ups until 2011, for this study, we converted the HbA1c value measured in 2011 to the National Glycohemoglobin Standardization Program unit of measurement.[19] Participants were considered diabetic if (1) their HbA1c (National Glycohemoglobin Standardization Program) values from the check-up exceeded 6.5% or (2) they were diagnosed with diabetes (International Classification of Diseases 10th revision codes: E10–14) according to the health insurance claim, and they were administered either an oral antidiabetic medication or insulin.

Variables

The exposure variables consisted of: eating speed and income. Based on their responses to the self-reported questionnaire, participants were categorised as having fast (the fast eater group), slow or normal (the non-fast eater group) eating speeds. Furthermore, according to the information on personal standard monthly income, the participants were categorised into those with income US$<2500; income=US$2500 to 3499 and income US$≥3500. This categorisation was made based on the information that the average income in Japan in 2010 was approximately US$3050 (US$1=Kr100).[20]

The covariates were selected from factors thought to influence the onset of diabetes. Participants were categorised into three age groups (40–49, 50–59 and ≥60 years of age) based on their age as on 1 April 2010. Based on participants' health check-up records, obesity was defined as having a BMI ≥25 kg/m^2.[21] Comorbidities were noted if participants reported taking medications for hypertension and/or dyslipidaemia.

Statistical analysis

Initially, we conducted a χ^2 test to compare participants' characteristics, including age, obesity, comorbidity, income, eating speed and the onset of diabetes, over the past 5 years. The χ^2 test also helped compare the outcomes in the three income groups. Subsequently, to calculate the OR of the development of diabetes among participants, generalised linear regression models were created with diabetes onset as the dependent variable and eating speed and income as covariates, and 95% CI values were calculated. The analyses were performed after adjusting for age, obesity and comorbidity. Model 1 was adjusted for eating speed and income; model 2 was adjusted for age added to model 1; model 3 was adjusted for obesity added to model 1; model 4 was adjusted for age and obesity added to model 1 and model 5 was adjusted for comorbidities added to model 4. The same analysis was also conducted for each age group to assess the influence of age on eating speed and income level. Model 1 was adjusted for eating speed and income; model 2 was adjusted for obesity added to model 1 and model 3 was adjusted for comorbidities added to model 2. The following were used as reference categories for covariates: non-fast eating speed and a standard monthly income US$≥3500. Furthermore, the log-likelihood ratio test, Akaike's information criterion and Bayesian information criterion were used as indicators to determine how well the generalised linear regression model fitted the data. Data were analysed using Stata V.15.0 (Stata Corp, College Station, Texas), and statistical significance was set at p<0.05.

Patient and public involvement statement

We used administrative claim data and health check-up data and, hence, patients were not directly involved in this study.

RESULTS

Table 1 summarises the characteristics of participants categorised by eating speed. It was found that 5866 participants (37.5%) were fast eaters, and the remaining 9608 (62.1%) were non-fast eaters. Fast eaters were more likely to be younger, obese (BMI ≥25 kg/m^2), have one or more comorbidities and have a higher income (p<0.001) than non-fast eaters. The 5-year risk of developing diabetes was significantly higher in the fast eater group than in the non-fast eater group (p<0.001).

Table 2 summarises the characteristics of participants categorised by income. According to the table, 2931 participants (18.9%) had a monthly income US$<2500; 4847 (31.3%) had a monthly income between US$2500 and US$3499; and the remaining 7696 participants

Table 1 Number and proportion of participants by eating speed

	Speed of eating category					
	Fast		Non-fast		Total	P value
Total	n=5866	(37.5%)	n=9608	(62.1%)	n=15 474	
Age, year						
40–49	3345	(57.0%)	4852	(50.5%)	8197	<0.001
50–59	1976	(33.7%)	3609	(37.6%)	5585	
≥60	545	(9.3%)	1147	(11.9%)	1692	
Obese						
BMI <25	3641	(62.1%)	7271	(75.7%)	10 912	<0.001
BMI≥25	2225	(37.9%)	2337	(24.3%)	4562	
Hypertension with medication						
Yes	1815	(30.9%)	2673	(27.8%)	4488	<0.001
No	4051	(69.1%)	6935	(72.2%)	10 986	
Dyslipidaemia with medication						
Yes	2682	(45.7%)	3804	(39.6%)	6486	<0.001
No	3183	(54.3%)	5804	(60.4%)	8987	
Standard monthly remuneration category						
<2500 USD	952	(16.2%)	1979	(20.6%)	2931	<0.001
2500–3499 USD	1719	(29.3%)	3128	(32.6%)	4847	
≥3500 USD	3195	(54.5%)	4501	(46.8%)	7696	
Diabetes onset						
Yes	278	(4.7%)	342	(3.6%)	620	<0.001
No	5588	(95.3%)	9266	(96.4%)	14 854	

P values were calculated using χ^2 test.
1 USD=100 Japanese Yen.
BMI, body mass index.

Table 2 Number and proportion of participants by standard monthly remuneration category

	Standard monthly remuneration category								
	US$<2500		US$2500–3499		US$≥3500		Total		P value
Total	n=2931	(18.9%)	n=4847	(31.3%)	n=7696	(49.7%)	n=15474	(100.0%)	
Age, year									
40–49	777	(26.5%)	2885	(59.5%)	4535	(58.9%)	8197	(51.8%)	<0.001
50–59	1151	(39.3%)	1610	(33.2%)	2824	(36.7%)	5585	(35.3%)	
≥60	1003	(34.2%)	352	(7.3%)	337	(4.4%)	1692	(10.7%)	
Obese									
BMI <25	2143	(73.1%)	3458	(71.3%)	5311	(69.0%)	10912	(69.0%)	<0.001
BMI≥25	788	(26.9%)	1389	(28.7%)	2385	(31.0%)	4562	(28.8%)	
Hypertension with medication									
Yes	1086	(37.1%)	1348	(27.8%)	2054	(26.7%)	4488	(28.4%)	<0.001
No	1845	(62.9%)	3499	(72.2%)	5642	(73.3%)	10986	(69.5%)	
Dyslipidaemia with medication									
Yes	1208	(41.2%)	2013	(41.5%)	3265	(42.4%)	6486	(41.0%)	<0.001
No	1723	(58.8%)	2834	(58.5%)	4430	(57.6%)	8987	(56.8%)	
Category of eating speed									
Fast	952	(32.5%)	1719	(35.5%)	3195	(41.5%)	5866	(37.1%)	<0.001
Non-fast	1979	(67.5%)	3128	(64.5%)	4501	(58.5%)	9608	(60.7%)	
Diabetes onset									
Yes	157	(5.4%)	182	(3.8%)	281	(3.7%)	864	(5.5%)	<0.001
No	2774	(94.6%)	4665	96.2	7415	(96.3%)	14954	(94.5%)	

P values were calculated using χ^2 test.
BMI, body mass index.

(49.7%) had a monthly income US$>3500. The low-income group was more likely to be aged over 60 years. Additionally, they had BMI <25 kg/m^2, hypertension and were more likely to develop diabetes than the middle-income and high-income groups (p<0.001).

Table 3 depicts the risk of diabetes (OR and 95% CI data) as determined by the generalised linear regression model. Univariate analysis demonstrated that eating fast (OR: 1.35, 95% CI 1.17 to 1.55) and having a low income (OR: 1.47, 95% CI 1.24 to 1.74) were significantly associated with the onset of diabetes. Additionally, multivariate analysis revealed that the OR of the low-income group decreased by 0.30 from 1.51 (95% CI 1.27 to 1.80) to 1.21 (95% CI 1.01 to 1.46) once adjustment was made to account for age (model 2). Furthermore, it was noted that after adjusting for obesity (model 3), the OR of eating fast decreased by 0.21 from 1.41 (95% CI 1.23 to 1.62) to 1.20 (95% CI 1.04 to 1.39). In each model, after adjusting for age, obesity and comorbidities, both eating fast and having a low-income were recognised as independent risk factors for diabetes onset.

Table 4 shows the results of the same analysis performed on age, after adjusting for obesity and comorbidities. After adjusting for obesity and comorbidities (model 3), eating fast and having low income were recognised as significant risk factors for diabetes onset for participants only in their 40s, but none was found for those in their 50s and 60s or older.

DISCUSSION

We conducted a 5-year retrospective cohort study on male employees of SMEs to examine how eating speed and income affected diabetes onset. The results indicated that eating fast and having a low income were independent risk factors for the development of diabetes.

The study investigated three mechanisms in the context of the association between eating speed and diabetes, namely, obesity, insulin resistance and postprandial glucose metabolism.[7 9–11 14–16] Sakurai *et al*[9] reported that the associations between eating speed and diabetes incidence were not significant in models once they were additionally adjusted for BMI. Furthermore, they mentioned that eating speed might be associated with diabetes since it affects body weight gain in a causal pathway and any BMI adjustment could be an overadjustment. In the current study, the OR of diabetes onset was reduced by 21% after BMI adjustment, and the results were similar to the findings of an earlier study that suggested that obesity affects the relationship between eating speed

Table 3 ORs and 95% CIs for the onset of diabetes

	Univariate			Multivariate														
				Model 1			Model 2			Model 3			Model 4			Model 5		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Category of eating speed																		
Fast	1.35	1.17 to 1.55	<0.001	1.38	1.20 to 1.59	<0.001	1.41	1.23 to 1.62	<0.001	1.17	1.02 to 1.35	0.027	1.20	1.04 to 1.39	0.010	1.17	1.02 to 1.35	0.028
Non-fast	(Reference)			(Reference)			(Reference)			(Reference)			(Reference)			(Reference)		
Standard monthly remuneration category																		
<US$2500	1.47	1.24 to 1.74	<0.001	1.51	1.27 to 1.80	<0.001	1.21	1.01 to 1.46	0.042	1.58	1.33 to 1.88	<0.001	1.26	1.04 to 1.52	0.017	1.24	1.03 to 1.50	0.025
US$2500–3499	1.07	0.91 to 1.26	0.398	1.09	0.93 to 1.28	0.277	1.08	0.92 to 1.27	0.330	1.11	0.95 to 1.31	0.197	1.10	0.94 to 1.30	0.233	1.09	0.93 to 1.29	0.285
≥US$3500	(Reference)			(Reference)			(Reference)			(Reference)			(Reference)			(Reference)		
Log-likelihood				−3332.2			−3311.3			−3219.3			−3195.5			−3168.7		
AIC				6672.4			6632.5			6448.6			6403.1			6353.4		
BIC				6703.1			6670.9			6486.9			6449.1			6414.8		

Model 1 was adjusted for category of eating speed and standard monthly remuneration category.
Model 2 was adjusted for category of eating speed, standard monthly remuneration category and age.
Model 3 was adjusted for category of eating speed, standard monthly remuneration category and obese.
Model 4 was adjusted for category of eating speed, standard monthly remuneration category, age and obese.
Model 5 was adjusted for category of eating speed, standard monthly remuneration category, age, obese, hypertension with medication and dyslipidaemia with medication.
AIC, Akaike's information criterion; BIC, Bayesian information criterion.

and diabetes onset.[8] Additionally, eating fast was found to be an independent risk factor for the development of diabetes even after adjustments were made for other factors like BMI and income. Kudo *et al*[5] reported that fast eaters have a higher risk of developing diabetes, irrespective of whether they undergo an increase in body weight. This can be due to the following reasons: first, a high eating speed reduces the consumption of energy after meals.[22] Second, a decrease in the number of chews significantly increases postchewing blood glucose and insulin levels.[23] In this study, insulin resistance and postprandial glucose metabolism have not been investigated. However, it is noted that these mechanisms affect each other and cause diabetes; hence, further studies should be conducted on these mechanisms.

Furthermore, like many previous studies, the study identified low-income as a risk factor for new-onset diabetes.[17 24 25] In a Swedish study by Agardh *et al*,[26] it was found that BMI explained the low-income group's excessive risk for subjectively diagnosed type 2 diabetes. Nonetheless, some other studies that investigated the association between diabetes and socioeconomic status found that BMI did not explain the associations between income and diabetes.[17 25] Similarly, in the current study, BMI did not explain the associations between income and diabetes; low income was an independent risk factor for diabetes even after adjustment was made for BMI.

As reported by Nishi *et al*,[27] individuals with low income tend to avoid regular check-ups and, consequently, have poorer control over their blood sugar levels than those with high income. Individuals with low income have limited access to materials and services, such as a balanced diet and healthcare facilities required to prevent diabetes onset. Such limitations can cause social isolation, which can act as a source of psychological stress. Stress not only negatively impacts health behaviour but also has a direct effect on the stress hormone levels that regulate blood sugar levels and insulin resistance.[28] In Japan, households with low-income consume more staple foods but less vegetable, fish and fruit compared with those with high income.[29] Furthermore, it has been reported that people with low-income are less likely to eat a balanced diet and less likely to realise its importance.[2 30] Moreover, they are more likely to consume foods with a high glycaemic index and high calories, such as fast food, sweet bread and soft drinks that can easily satisfy hunger.[31–33] This can potentially lead to high levels of obesity and postprandial glucose metabolism and make people with low income more prone to diabetes than those with high income.

The OR of eating speed and low income for diabetes onset was increased significantly among participants in their 40s. Compared with the whole, the OR of eating fast in participants in their 40s increased by 14%, and the OR of low-income participants increased by 25%. It has been reported that people who eat fast tend to be young and have a high BMI.[5 9 34] Furthermore, the proportion of eating fast was higher in the younger generation, which may indicate that the influence of BMI was greater in

Table 4 ORs and 95% CIs for the onset of diabetes by age

	Univariate			Multivariate								
				Model 1			Model 2			Model 3		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Age: 40–49 year												
Category of eating speed												
Fast	1.62	1.27 to 2.06	<0.001	1.65	1.29 to 2.10	<0.001	1.34	1.05 to 1.71	0.020	1.31	1.03 to 1.68	0.030
Non-fast	(Reference)			(Reference)			(Reference)			(Reference)		
Standard monthly remuneration category												
<US$2500	1.46	0.99 to 2.14	0.054	**1.52**	**1.04 to 2.23**	**0.033**	**1.51**	**1.03 to 2.23**	**0.036**	**1.49**	**1.01 to 2.20**	**0.045**
US$2500–3499	1.18	0.91 to 1.53	0.212	1.21	0.93 to 1.57	0.151	1.23	0.95 to 1.60	0.122	1.21	0.93 to 1.58	0.149
≥US$3500	(Reference)			(Reference)			(Reference)			(Reference)		
Log-likelihood				−1193.6			−1133.4			−1116.9		
AIC				2395.2			2276.7			2247.8		
BIC				2423.3			2311.8			2296.9		
Age: 50–59 year												
Category of eating speed												
Fast	**1.40**	**1.08 to 1.82**	**0.011**	**1.40**	**1.08 to 1.82**	**0.011**	1.19	0.91 to 1.55	0.196	1.15	0.88 to 1.50	0.301
Non-fast	(Reference)			(Reference)			(Reference)			(Reference)		
Standard monthly remuneration category												
<US$2500	1.28	0.94 to 1.75	0.118	1.32	0.96 to 1.80	0.085	1.36	0.99 to 1.86	0.057	1.33	0.97 to 1.83	0.075
US$2500–3499	0.84	0.61 to 1.16	0.289	0.87	0.63 to 1.19	0.384	0.90	0.65 to 1.23	0.503	0.89	0.65 to 1.23	0.479
≥US$3500	(Reference)			(Reference)			(Reference)			(Reference)		
Log-likelihood				−996.7			−967.3			−958.5		
AIC				2001.4			1944.6			1930.9		
BIC				2027.9			1977.7			1977.3		
Age: over 60 year												
Category of eating speed												
Fast	0.84	0.54 to 1.31	0.438	0.84	0.54 to 1.31	0.435	0.80	0.51 to 1.25	0.320	0.78	0.50 to 1.22	0.282
Non-fast	(Reference)			(Reference)			(Reference)			(Reference)		
Standard monthly remuneration category												
<US$2500	0.96	0.57 to 1.60	0.868	0.95	0.57 to 1.59	0.843	0.99	0.59 to 1.67	0.983	0.99	0.59 to 1.65	0.955
US$2500–3499	0.91	0.48 to 1.70	0.761	0.90	0.48 to 1.70	0.750	0.91	0.48 to 1.71	0.767	0.90	0.48 to 1.69	0.738
≥US$3500	(Reference)			(Reference)			(Reference)			(Reference)		
Log-likelihood				−382.2			−378.6			−375.9		

Continued

Table 4 Continued

	Univariate			Multivariate								
				Model 1			Model 2			Model 3		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
AIC				772.5			767.2			765.9		
BIC				794.2			794.4			803.9		

Model 1 was adjusted for category of eating speed and standard monthly remuneration category.
Model 2 was adjusted for category of eating speed, standard monthly remuneration category and obese.
Model 3 was adjusted for category of eating speed, standard monthly remuneration category, obese, hypertension with medication and dyslipidaemia with medication.
AIC, Akaike's information criterion; BIC, Bayesian information criterion.

the younger generation. Conversely, low income was not affected by BMI or comorbidities. This suggests that the impact of low income on diabetes onset in the younger generation is more likely due to restricted access to health services rather obesity. Additionally, no significant OR for the onset of diabetes was observed for both eating fast and low income in patients those aged 60 years and older. Furthermore, although the proportion of participants aged 60 and over with a low income was large, the proportion of those who eat fast was small, and it is considered that they may have been less affected by low income, such as guaranteed access to medical care compared with younger people.

In this study, people who eat fast were found to be at increased risk of diabetes, despite the small number of low-income participants. Contrarily, low-income participants were at high risk of diabetes, although fewer people reported eating fast. Thus, the risk factors for diabetes, fast eating and low income are thought to be inversely related to each other. However, since each factor was an independent risk factor even after adjusting the covariates, it was suggested that eating fast is not affected by low-income on diabetes onset, and the mechanism by which eating fast and low income affect diabetes onset is different.

This study has several limitations. First, it did not consider any objective measure of eating speed and used only a self-reported questionnaire to determine each participant's eating speed. However, self-reported eating speed has been shown to correlate well with those reported by friends or objectively measured ones.[35 36] Furthermore, the questionnaire is clinically validated[37] and has been used in the Japanese Specific Health Check and Guidance System that aims to prevent obesity.[35] Second, we were unable to assess changes in eating speed during the study period. We evaluated the effect of eating speed on new-onset diabetes based on the self-reported data on eating speed collected in 2010. However, participants could have changed their eating speed over the 5-year period, and we were not able to determine whether such a change could have affected diabetes onset. Nevertheless, studies do suggest that individuals who are fast eaters at a young age will be fast eaters even as adults.[7] Furthermore, the study's participants were healthy working men who were unlikely to undergo any interventions that would alter their eating habits, including eating speed, during the 5-year study period. Third, we did not consider the changes in income with time since we considered only the data obtained in 2010 to categorise participants into income groups. However, this probably introduced little to no bias since changing jobs are uncommon in the Japanese population.[38] Fourth, we did not consider the effects of factors such as family history and energy intake that may affect the progression of diabetes. The check-up results and claim data used in this study did not provide this information. Future research should consider including the information to obtain more precise results. Additionally, this study did not consider other socioeconomic factors other than industry and income, such as occupational class and educational background, which are associated with the development of obesity and diabetes. As the insurance data did not include these, they could not be considered in this study. However, given the information obtained from income, some occupational classes could be inferred. Finally, a selection bias might have occurred since the study was not a randomised controlled study. The participants of the study were people who regularly underwent medical check-ups. Therefore, they were more aware and conscious about their health compared with those who do not undergo medical check-ups on a regular basis.

CONCLUSIONS

We found that low income and eating speed were two risk factors for diabetes. Hence, lifestyle factors, such as dietary changes and instilling exercise habits, are crucial to avoid the onset of diabetes. The social factors that define lifestyle factors influence the onset of non-communicable diseases, like diabetes. While it is difficult to address income differences, our findings suggest that it is possible to address social factors such as differences in income and educational background to appropriately manage diabetes with low healthcare costs. However, eating speed is a risk factor that can be effectively controlled. Therefore, the provision of education and coaching on dietary habits, including eating speed, may be effective in preventing diabetes onset.

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ORCID iD

Reiko Ishihara http://orcid.org/0000-0002-5246-1867

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