

Associations of non-standard employment with cardiovascular risk factors: findings from nationwide cross-sectional studies in Japan

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Abstract. This study aimed to examine the cross-sectional association of non-standard employment with cardiovascular disease risk factors. Five yr of data from the Comprehensive Survey of Living Conditions and National Health and Nutritional Survey were combined. We used logistic regression to examine the association of employment contract (non-standard [part-time, dispatched, or contract] vs. standard [full-time and permanent]) with eight cardiovascular disease risk factors among 1,636 men and 2,067 women aged 40–60 yr. There were significant associations between non-standard employment and cardiovascular disease risk factors such as current smoking among men (odds ratio [OR] 1.39; 95% confidential interval [CI], 1.13–1.86) and diabetes among women (OR 1.83; 95% CI, 1.10–3.09). Non-standard employment was associated with a few cardiovascular disease risk factors in this middle-aged cohort in Japan.

Key words: Cardiovascular diseases, Diabetes mellitus Type 2, Non-standard employment, Preventive medicine, Smoking

Introduction

Cardiovascular diseases (CVDs), such as coronary heart disease and cerebrovascular disease, are the leading causes of death¹⁾, a major source of the physical burden of diseases²⁾, and a primary cause of escalating medical costs³⁾. Prevention and control of CVDs are critical issues globally. However, the public health approach to lifestyle-related disease prevention, including CVDs, has focused primarily on health behavior initiatives that aim to change

individuals' motivation, knowledge, and autonomy, but has failed to decrease the incidence of disease^{4, 5)}. Because of this, epidemiologists and public health investigators have evaluated socioeconomic factors, i.e., social determinants of health⁶⁾. Researchers have identified an inverse association between indicators of socioeconomic status (e.g., education, occupation, and income), CVD risk factors (obesity, hypertension, diabetes, and related health behaviors), and CVD-related mortality^{7, 8)}. Among socioeconomic indicators of health, interest in non-standard employment, which includes part-time, fixed-term, and dispatched employment, is rapidly increasing in public health research^{7–10)}. The number of non-standard employees has increased worldwide under the competitive pressures of the increas-

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ingly globalized economy. For example, in Japan, 22.1% of male employees and 55.9% of female employees are working in non-standard employment settings¹¹). This type of employment may have a strong, negative impact on the quality of life and health of employees due to lower wages, suboptimal social security, or isolation from the workplace or community^{12–14}). Thus, non-standard employment might represent another key CVD risk factor.

However, study results are mixed. For example, the Finnish and Korean studies did not find a significant relationship between temporary employment and CVD-related mortality¹⁵) or CVD prevalence¹⁶). In contrast, CVD risk factors and biomarkers, including blood pressure (BP), serum triglyceride, fasting glucose, and hemoglobin A1c (HbA1c) levels, were higher among Japanese male non-standard workers¹⁷). Regarding CVD-related health behaviors, current smoking^{17, 18}) and frequent alcohol consumption¹⁹) were positively associated with non-standard employment in Japanese men and Dutch workers²⁰). Additionally, a perception of job insecurity, a disadvantage of non-standard employment, was associated with high systolic BP among men in the United States in a 3 yr cohort study²¹). These results are limited in terms of their generalizability based on the study design, such as a sample restricted only to men^{17, 19}), study setting (e.g., one worksite)^{17, 19}), relatively younger participants who have been less exposed to risk factors for lifestyle-related diseases^{15, 17, 19, 21}), and small sample sizes^{19, 21}). A nationwide, population-based, comprehensive study using non-standard employment as a main predictor of health outcomes is lacking.

Hence, the aim of the present study was to examine the cross-sectional association between non-standard employment and CVD risk factors among a nationwide sample of the Japanese middle-aged population. The study hypothesis was that those with non-standard employment contracts have a higher prevalence of CVD risk factors than standard (full-time and permanent contract) employees. To interpret the results, we took into account how many CVD risks were significantly associated with non-standard employment. Some researches indicated that accumulation of risk factors may forecast the incidence of CVDs among Japanese samples^{22, 23}).

In this study, gender-stratified analysis was conducted due to unique gender roles in eastern Asia. In Japan, women tend to choose non-standard more, but flexible work because of female gender roles that may emphasize housework and child rearing. Thus, women's demographic (e.g., marital status) and occupational characteristics differ from

male, non-standard employees²⁴). In addition, middle-aged employees aged 40 to 60 yr were studied for the following two reasons: (1) The age range of this population is the main target for national prevention of lifestyle-related diseases including CVD. Health insurance providers in Japan are legally required to deliver a health promotion program called "Health Checkups and Healthcare Advice with a Particular Focus on the Metabolic Syndrome" to insured patients between the ages of 40 and 74^{25, 26}); (2) In Japan, non-standard employees >60 yr tend to be former standard employees with a mandatory retirement at age 60. We regarded them as "atypical" non-standard employees and excluded from the analyses.

Subjects and Methods

Data sources

We used linkage data from two nationally representative surveys conducted by the Ministry of Health, Labour and Welfare: Comprehensive Survey of Living Conditions (CSLC)²⁷) and National Health and Nutritional Survey (NHNS)²⁸), 2007–2011.

The CSLC consists of large surveys conducted every 3 yr in June with approximately 5,000 randomly selected census tracts and small surveys in the interim years with approximately 1,000 randomly selected census tracts. A self-administered questionnaire including demographic and occupational factors is distributed to the respondents and collected later by trained investigators during home visits. Eligible respondents include all household members within the randomly selected census tracts from prefectures and designated cities with a population >500,000 individuals. Of the 287,807, 57,572, 56,882, 289,363, and 57,232 households recruited during 2007–2011, respectively, the household-based response rate was 80.1% in 2007, 79.1% in 2008, 81.9% in 2009, 79.4% in 2010 and 80.5% in 2011, resulting in data from 1,591,573 individuals.

Data for objective health measurements such as anthropometric and laboratory data were obtained from the NHNS, which collects data annually in November on the health and nutritional status of the Japanese population. Eligible respondents include all household members aged ≥1 yr within 300 randomly selected census tracts from CSLC census tracts. The government did not release the numbers of households recruited for the 2007–2009 NHNS. Of the 5,357 and 5,422 households recruited in 2010 and 2011, respectively, the household-based response rates were 68.8% and 62.9%, respectively, resulting in

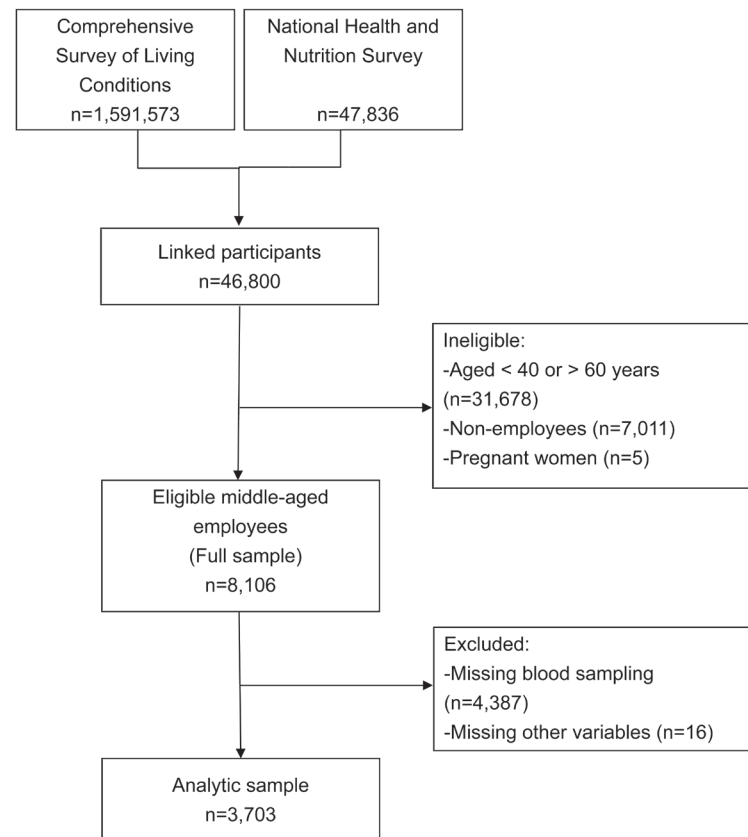


Fig. 1. Sampling flow diagram.

data from 47,836 individuals.

Based on previous investigations⁷⁾, data was linked from the CSLC and NHNS according to prefecture, area, household number, number of household members, gender, and age, because both surveys share sampling units (Fig. 1). Of the 47,836 NHNS participants, 46,800 were linked. The analyses were restricted to 8,106 middle-aged employees (40–60 yr; total sample). The analyses then excluded 4,387 employees with missing blood samples and 16 employees with missing variables of interest. A total of 3,703 employees (analytic sample) were included in this study.

Permission was obtained from the Ministry of Health, Labour and Welfare to use the data from these surveys. Ethical approval was not required as the research involved a retrospective analysis of a national surveillance dataset that was free of personally identifiable information.

Outcomes and definitions

Based on a similar study conducted by Fukuda and Hiyoshi⁷⁾, the following CVD risk factors were selected and defined: obesity, abdominal obesity, hypertension,

diabetes, dyslipidemia, current smoking, excessive alcohol consumption, and metabolic syndrome (MetS). In Japan, these indicators are employed for screening CVD risk (*Tokuteikenshin*) among people aged 40–74^{29, 30)}.

Participants underwent anthropometric and BP measurements as well as blood sampling. Height and weight were measured to the nearest 0.1 cm and 0.1 kg, respectively, in light clothing without shoes. Body mass index (BMI; kg/m²) was calculated from measured height and weight. Obesity was defined as a BMI ≥ 25 kg/m²³¹⁾. Waist circumference was measured to the nearest 0.5 cm at the level of the umbilicus using an anthropometric tape. Abdominal obesity was defined as a waist circumference ≥ 85 cm for men and ≥ 90 cm for women³¹⁾. Using a standard mercury sphygmomanometer, the first BP measurement was taken at the right arm with the participant seated after at least 5 min of rest. The second measurement was taken 1–2 min later. The mean of the two measurements was calculated for both systolic and diastolic BP. Hypertension was defined as a systolic BP ≥ 140 mmHg, a diastolic BP ≥ 90 mmHg, and/or current use of medications for hypertension³²⁾.

Blood samples were obtained from the antecubital vein after at least a 4-h fast. Standard enzymatic methods were used to measure serum total cholesterol, triglycerides, low-density lipoprotein (LDL) cholesterol, and plasma glucose levels. High-density lipoprotein (HDL) cholesterol was measured using the direct method. HbA1c was measured using a latex agglutination inhibition method and is expressed in accordance with the National Glycohemoglobin Standardization Program (NGSP) scale³³). Dyslipidemia was defined as an LDL cholesterol level ≥ 140 mg/dl, HDL cholesterol level < 40 mg/dl³⁴), and/or current use of medications for dyslipidemia. Diabetes was defined as a non-fasting plasma glucose level ≥ 200 mg/dl, HbA1c $\geq 6.5\%$ ³⁵), and/or current use of medications for diabetes. According to the NHNS criteria²⁸), MetS was defined as abdominal obesity plus ≥ 2 of the following: HDL cholesterol level < 40 mg/dl and/or current use of medications for dyslipidemia; systolic BP ≥ 130 mmHg, diastolic BP ≥ 85 mmHg, and/or current use of medications for hypertension; and HbA1c $\geq 5.9\%$ and/or current use of medications for diabetes.

Smoking and alcohol consumption information was gathered from the self-administered NHNS questionnaire. Current smoking was defined if participants smoked every day or some days. Weekly alcohol consumption was calculated by combining the amount of alcohol consumed per day and the frequency per week. Excessive alcohol consumption was defined as alcohol consumption ≥ 300 g/week, according to the results of the Japan Public Health Center study³⁶).

Employment contract

Employment contract was assessed using the answer to a single question, which had six possible response options. We classified these responses into the following two categories: standard (“full-time and permanent”) and non-standard (“part-time”, “*arbeit* [short time and term]”, “dispatched”, “contract”, or “others”). Although non-standard employment has diverse characteristics (direct/indirect employment, part-time/full-time, employment preference), in this study, non-standard employment was applied as a dummy variable in line with discussion regarding adverse effect of non-standard employment in Japan (i.e., non-standard vs. standard).

Statistical analyses

All analyses were performed separately for each gender because the responses to key variables were considerably different between men and women. First, because approxi-

mately half of the total sample had missing blood samples, the demographic characteristics were compared between the total and analytic samples whether there is any sampling bias or not. Next, CVD risk factors were compared between standard and non-standard employees. Finally, a logistic regression analysis was conducted to examine the associations between employment contract and CVD risk factors. The models were controlled for age, marital status, and survey year (Final model). Alongside of previous studies^{22, 23}), we also compared the cumulative number of CVD risks (from zero to seven) between standard and nonstandard employees. Additionally, using combined data from the 2010 survey, educational attainment (high school vs. college graduate or higher) was added to the final model if the association was significant, in order to explore the confounding effects of educational attainment on the association. Education has also been regarded as a strong predictor of both occupation-related factors³⁷) and CVDs^{7, 8}).

All statistical tests were two-sided, with a 5% significance level. All analyses were conducted using SAS Version 9.3 for Windows (SAS Inc., Cary, NC, USA).

Results

The demographic characteristics of the total ($n=8,106$; 4,338 men; 3,768 women) and analytic ($n=3,703$; 1,636 men; 2,067 women) samples are shown in Table 1. In both genders, the analytic sample was older (men, 51.7 (SD 6.8) yr; women, 51.0 (SD 6.5) yr) and had a greater proportion of married individuals (men, 85.7%; women, 81.3%). The analytic sample had a slightly higher proportion of individuals with non-standard employment than the total sample for both genders; however, the proportion of non-standard employment differed by gender (men, 16.8%; women, 65.0%).

Table 2 includes the comparison of CVD risk indicators between individuals with non-standard (274 men; 1,345 women) and standard (1,362 men; 722 women) employment contracts. The body weight of non-standard employees (men, 65.5 (SD 9.6) kg; women, 53.8 (SD 8.3) kg) was lower than that of standard employees (men, 68.2 (SD 10.7) kg; women, 54.9 (SD 8.9) kg) in both genders. BMI (23.5 (SD 3.2) kg/m², $p=0.022$), total and LDL cholesterol levels (203.1 (SD 35.7) mg/dl, $p=0.047$; 119.1 (SD 30.7) mg/dl, $p=0.008$, respectively) were lower, but prevalence of use of medications for hypertension ($n=66$, 24.1%, $p=0.002$) was higher in the male non-standard employees than in the male standard employees. Female non-

Table 1. Demographic characteristics of full and analytic sample by gender

Demographics	Men								Women							
	Full sample (n=4,338)				Analytic sample ^a (n=1,636)				Full sample (n=3,768)				Analytic sample ^a (n=2,067)			
	Standard (n=3,702)		Non-standard (n=636)		Standard (n=1,362)		Non-standard (n=274)		Standard (n=1,409)		Non-standard (n=2,359)		Standard (n=722)		Non-standard (n=1,345)	
Age (yr), Mean (SD)	50.1 ± 6.4		55.0 ± 7.0		50.8 ± 6.5		55.3 ± 6.5		50.2 ± 6.2		50.8 ± 6.7		50.8 ± 6.2		51.1 ± 6.7	
Marital status, n (%)																
Married	3,201	86.5	475	74.7	1,192	87.5	210	76.6	961	68.2	2,005	85.0	513	71.1	1,168	86.8
Never married	381	10.3	103	16.2	124	9.1	41	15.0	236	16.8	125	5.3	86	11.9	53	3.9
Divorced/widowed	120	3.2	58	9.1	46	3.4	23	8.4	212	15.1	229	9.7	123	17.0	124	9.2
Medications, n (%)																
Antihypertensive	258	7.0	76	12.0	219	16.1	66	24.1	90	6.4	175	7.4	75	10.4	149	11.1
Antidiabetic	84	2.3	10	1.6	71	5.2	8	2.9	14	1.0	29	1.2	10	1.4	28	2.1
Antidyslipidemic	130	3.5	28	4.4	107	7.9	23	8.4	56	4.0	122	5.2	49	6.8	111	8.3

^aThose with complete data.**Table 2. Comparison of cardiovascular risk indicators between standard and non-standard employees by gender**

Characteristics	Men					Women				
	Standard (N=1,362)		Non-standard (N=274)		<i>p</i> value ^a	Standard (N=722)		Non-standard (N=1,345)		<i>p</i> value ^a
Demographics										
Age (yr)	50.8 ± 6.5		55.3 ± 6.5		<0.001	50.8 ± 6.2		51.1 ± 6.7		0.330
Marital status										
Married	1,192	87.5	210	76.6	<0.001	513	71.1	1,168	86.8	<0.001
Never married	124	9.1	41	15.0		86	11.9	53	3.9	
Divorced/widowed	46	3.4	23	8.4		123	17.0	124	9.2	
Anthropometric data										
Height (cm)	168.3 ± 6.2		166.8 ± 5.8		<0.001	156.0 ± 5.6		155.4 ± 5.7		0.041
Weight (kg)	68.2 ± 10.7		65.5 ± 9.6		<0.001	54.9 ± 8.9		53.8 ± 8.3		0.009
Body mass index (kg/m ²)	24.0 ± 3.4		23.5 ± 3.2		0.022	22.6 ± 3.5		22.3 ± 3.3		0.090
Waist circumference (cm)	86.0 ± 8.8		85.2 ± 8.4		0.150	80.4 ± 10.4		79.9 ± 9.3		0.241
Blood pressure										
Systolic (mm Hg)	132.6 ± 17.1		134.3 ± 17.7		0.126	125.2 ± 17.5		125.1 ± 17.5		0.865
Diastolic (mm Hg)	84.9 ± 11.3		84.9 ± 11.3		0.993	78.5 ± 10.9		78.2 ± 10.8		0.496
Lipid metabolism										
Total cholesterol (mg/dl)	207.5 ± 32.9		203.1 ± 35.7		0.047	210.8 ± 33.3		213.0 ± 33.8		0.162
LDL cholesterol (mg/dl)	124.5 ± 30.4		119.1 ± 30.7		0.008	123.8 ± 30.9		125.4 ± 31.0		0.261
HDL cholesterol (mg/dl)	58.5 ± 16.2		57.8 ± 16.9		0.496	68.8 ± 15.5		69.5 ± 15.7		0.280
Triglyceride (mg/dl)	131.0 (89.0–197.0)		126.0 (90.0–196.0)		0.986	92.0 (64.0–138.0)		93.0 (65.0–138.0)		0.765
Glucose metabolism										
Non-fasting plasma glucose (mg/dl)	101.1 ± 33.1		101.5 ± 34.0		0.873	97.1 ± 18.7		98.1 ± 23.5		0.329
Hemoglobin A1c (%) (NGSP)	5.7 ± 0.8		5.7 ± 0.7		0.263	5.6 ± 0.5		5.7 ± 0.6		0.019
Medications										
Antihypertensive	219 (16.1%)		66 (24.1%)		0.002	75 (10.5%)		149 (11.1%)		0.641
Antidiabetic	71 (5.2%)		8 (2.9%)		0.105	10 (1.4%)		28 (2.1%)		0.263
Antidyslipidemic	107 (7.9%)		23 (8.4%)		0.764	49 (6.8%)		111 (8.3%)		0.234
Lifestyle habits										
Current smoking	466 (34.2%)		111 (40.5%)		0.048	57 (7.9%)		121 (9.0%)		0.407
Alcohol consumption (g/wk)	175.0 (45.0–275.0)		210.0 (70.0–350.0)		0.051	35.0 (0.0–70.0)		35.0 (0.0–75.0)		0.153

LDL: low-density lipoprotein; HDL: high-density lipoprotein; NGSP: National Glycohemoglobin Standardization Program.

Values are mean ± SD, median (interquartile range), or number (percentage).

^aMeans were compared using t-test, medians using Wilcoxon rank-sum test, and proportions using χ^2 test.

Table 3. Association of employment contract with cardiovascular risk factors by gender

Employment contract	Obesity		Abdominal obesity		Hypertension		Diabetes		Dyslipidemia		Current smoking		Excessive alcohol consumption		MetS	
	%	OR ^a (95% CI)	%	OR ^a (95% CI)	%	OR ^a (95% CI)	%	OR ^a (95% CI)	%	OR ^a (95% CI)	%	OR ^a (95% CI)	%	OR ^a (95% CI)	%	OR ^a (95% CI)
Male																
Standard (n=1,362)	34.7	1.00	54.0	1.00	47.9	1.00	8.7	1.00	42.1	1.00	34.2	1.00	17.0	1.00	20.4	1.00
Non-standard (n=274)	28.5	0.82 (0.61–1.11)	51.1	0.86 (0.65–1.13)	53.3	0.80 (0.60–1.06)	8.4	0.65 (0.40–1.06)	38.0	0.82 (0.62–1.08)	40.5	1.39 (1.13–1.86)	18.6	1.14 (0.81–1.60)	20.4	0.76 (0.54–1.07)
Female																
Standard (n=722)	20.2	1.00	14.4	1.00	27.3	1.00	2.8	1.00	34.6	1.00	7.9	1.00	2.2	1.00	4.9	1.00
Non-standard (n=1,345)	18.4	0.87 (0.69–1.09)	14.1	0.93 (0.72–1.22)	28.5	1.09 (0.88–1.35)	4.9	1.83 (1.10–3.09)	36.9	1.11 (0.90–1.35)	9.0	1.29 (0.91–1.81)	2.2	1.11 (0.59–2.09)	5.0	0.99 (0.64–1.53)

OR: odds ratio; CI: confidence interval; MetS: Metabolic syndrome (Japan).

Bold values indicate significance at $p < 0.05$.^aAdjusted for age, marital status, and survey year.

standard employees had higher HbA1c levels (5.7% (SD 0.5), $p=0.019$) than the female standard employees.

Table 3 shows the prevalence, odds ratios (ORs), and 95% confidential intervals (95% CIs) of each CVD risk factor. After adjusting for age, marital status, and survey year, male non-standard employees had a statistically significant higher OR for current smoking than the male standard employees (OR 1.39; 95% CI, 1.13–1.86). Using standard employees as the reference, the prevalence of diabetes was significantly higher among female non-standard employees (OR 1.83; 95% CI, 1.10–3.09). In contrast, the ORs for obesity, abdominal obesity, hypertension, dyslipidemia, excessive alcohol consumption, and MetS were not significant for either gender. We also tested whether individual's number of CVD risks differs or not between standard and nonstandard employees. Chi-square test did not show the statistically significant difference for the percentage of employees belonging to the each category of cumulative risks both men ($p=0.958$) and women ($p=0.680$). (Supplementary Table 1)

Additional analyses were conducted using education levels from the combined data from 2010 survey that included education-related variables. However, the sample size was not large enough to examine the confounding effect of education on the above-observed associations (men=330, women=419). Before adjusting for education level, the OR of current smoking among male non-standard employees (OR 1.31; 95% CI, 0.72–2.37) was not statistically significant but had almost the same magnitude of effect as the OR obtained from the final model using the 2007–2011 survey data (OR 1.39). After adjusting for education level, the OR decreased to 1.15 (95% CI, 0.60–2.19). Similarly, the confounding effect of educational level on the association between non-standard employment and diabetes in women was explored. After adjusting for educational level in the final model, the OR of diabetes among female non-standard employees remained statistically insignificant but decreased from 2.55 (95% CI, 0.82–7.90) to 1.63 (95% CI, 0.50–5.28).

Discussion

Using two national datasets in Japan, the association between non-standard employment and eight CVD risk factors was examined. The original hypothesis was partially supported by the findings from previous study regarding current smoking in men and diabetes in women. In the final model, a non-standard employment contract was significantly associated with current smoking in men

and diabetes in women.

The finding regarding current smoking status in male non-standard employees is consistent with the findings for men in previous studies, indicating a significant association of non-standard employment with current smoking status^{17, 20}. The mechanism for an association between non-standard employment and current smoking might be explained in part by educational level. Employees with a lower educational level are more likely to engage in unfavorable health behaviors like smoking, compared to their counterparts with a higher educational level^{38, 39}. A lower education level may also lead to a non-standard employment position⁴⁰. The results from additional analysis using only the combined data from 2010 survey also indicate that education level might have confounded the association. A significant association of diabetes with non-standard employment was present only among women. Similar to smoking among men, these results indicate that education level may explain the mechanism underlying this association among women. Further surveys should include education-related factors to explore the mechanism underlying the association between employment status and risk factors of lifestyle-related diseases.

There are possible reasons for gender differences in the results of this study. Regarding current smoking, the prevalence among Japanese women remains too small to detect a significant difference according to employment status (women: 8.2%, men: 32.2%)⁴¹. Regarding diabetes and its relevant indicators, the incidence of glucose intolerance among male standard employees in Japan may be higher compared to male non-standard employees due to selection bias (healthy worker effect)⁴². On the other hand, a report suggested that female non-standard employees may be reluctant to undergo a health check-up compared to their female standard employees⁴³. This tendency might make it difficult to detect not only impaired glucose tolerance, but also untreated diabetes, which might explain the higher incidence of diabetes among female non-standard employees compared to female standard employees.

The prevalence of obesity, abdominal obesity, hypertension, dyslipidemia, excessive alcohol consumption, and MetS did not significantly differ between the two employment contract types in both genders. However, BMI, total cholesterol, and LDL cholesterol levels were significantly higher for male standard employees than for male non-standard employees (Table 2). These results suggest that the health status of male standard employees might be the same or worse than their non-standard counterparts. There may be at least three possible explanations. First,

the percentage of non-standard employees has recently increased in all industrial sectors in Japan, which may also negatively affect the health of standard employees owing to hidden costs, i.e., excessive responsibility and supervision demand^{42, 44}. Second, in the context of workplaces in Japan, standard employees tend to have more opportunities than non-standard employees for alcohol intake with colleagues or during client dinners for the purpose of building social networks, resulting in increased CVD risk especially among men^{17, 45}. This social context might explain the higher clinical values of BMI, total cholesterol, and LDL cholesterol among standard employees, and differences in exposure to CVD risks compared with non-standard employees. Finally, selection bias, called *healthy worker effect*, may exist among non-standard employees⁴⁶. They are less protected by social welfare programs (e.g., they are not entitled to paid sick leave) compared to standard employees, if they fall sick or become disabled. In addition, because most non-standard employees are employed on limited-term contracts, their employment may be terminated due to illness. These situations may not enable non-standard employees with acute or chronic disease to remain employed, which may result in dropping out of the workforce⁴⁷. This issue may occur more frequently among non-standard employees than among standard employees who tend to have more social safety nets.

The present study had some limitations. First, owing to the cross-sectional nature of the study, causality remains unknown. Second, approximately half of the sample did not undergo blood tests. The survey schedule and setting might have been inconvenient for employees⁴⁸; for example, the blood tests were held only on weekdays. Moreover, blood test participants received prescription more than full sample, indicating that analytic sample would prefer healthy lifestyle⁴⁸ or higher drug adherence (Supplementary Table 2). Thus, selection bias of healthy participants might have attenuated the association due to the low prevalence of CVD risk factors. In addition, we could not tackle another selection bias called “*healthy worker effect*”. In non-standard employment study, it should be considered that unhealthy non-standard workers may drop out from labor market due to their poor contract protection, thus effect of non-standard employment on health may be underestimated. In the future, either longitudinal cohort study or information of previous employment status is needed. Fourth, scientific evidence for blood test protocol was unknown. (ie, why were blood sample obtained from the antecubital vein *after at least a 4-h fast*) This unique protocol may make our results generalized to

other study settings. Finally, a series of work-related confounders, for example occupation or company size, were not asked in some survey years. We could not take into account for their effect on our results but, some CVD risk indicators were not statistically significant without adjusting for occupation. This result implied that occupation was not a major confounder between employment contract and CVD risks at least among our sample.

However, although there remain some limitations to overcome, the present study may be the first study examining the association of non-standard employment with CVD risks with clinically measured outcomes from a nationwide, extracted dataset. The methodological advantages of the study over preceding studies leads to the generalizability of results in Japan, and may also allow for comparison between other industrialized countries.

Conclusions

In conclusion, non-standard employment was associated with two CVD risk factors, current smoking among men and diabetes among women. Future studies should consider not only the adverse effects of non-standard employment, but also the impact of the increase in the number of non-standard employees in the workplace on the health of standard employees.

Conflicts of Interest and Source of Funding

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References

- 1) World Health Organization Cardiovascular Diseases (CVDs). Fact Sheet N 317. 2011. <http://www.who.int/mediacentre/factsheets/fs317/en/index.html>. Accessed April 7, 2017.
- 2) Lim GB (2013) Global burden of cardiovascular disease. *Nat Rev Cardiol* **10**, 59.
- 3) World Health Organization Prevention of cardiovascular disease: pocket guidelines for assessment and management of cardiovascular risk. 2007. http://www.who.int/cardiovascular_diseases/guidelines/PocketGL.ENG.LISH.AFR-D-E.rev1.pdf. Accessed April 7, 2017.
- 4) Shaten BJ, Kuller LH, Kjelsberg MO, Stamler J, Ockene JK, Cutler JA, Cohen JD (1997) Lung cancer mortality after 16 years in MRFIT participants in intervention and usual-care groups. Multiple Risk Factor Intervention Trial. *Ann Epidemiol* **7**, 125–36.
- 5) Ministry of Health Labour and Welfare. Healthy Japan 21 final assessment (in Japanese). <http://www.mhlw.go.jp/stf/houdou/2r9852000001r5gc-att/2r9852000001r5np.pdf>. Accessed April 7, 2017.
- 6) Wilkinson RG, Marmot M Social determinants of health: the solid facts. http://www.euro.who.int/__data/assets/pdf_file/0005/98438/e81384.pdf. Accessed April 7, 2017.
- 7) Fukuda Y, Hiyoshi A (2013) Associations of household expenditure and marital status with cardiovascular risk factors in Japanese adults: analysis of nationally representative surveys. *J Epidemiol* **23**, 21–7.
- 8) Havranek EP, Mujahid MS, Barr DA, Blair IV, Cohen MS, Cruz-Flores S, Davey-Smith G, Dennison-Himmelfarb CR, Lauer MS, Lockwood DW, Rosal M Yancy CW, American Heart Association Council on Quality of Care and Outcomes Research, Council on Epidemiology and Prevention, Council on Cardiovascular and Stroke Nursing, Council on Lifestyle and Cardiometabolic Health, and Stroke Council (2015) Social determinants of risk and outcomes for cardiovascular disease: a scientific statement from the American Heart Association. *Circulation* **132**, 873–98.
- 9) Honjo K, Tsutsumi A Kayaba K, Jichi Medical School Cohort Study Group (2010) Socioeconomic indicators and cardiovascular disease incidence among Japanese community residents: the Jichi Medical School Cohort Study. *Int J Behav Med* **17**, 58–66.
- 10) Vathesatogkit P, Batty GD, Woodward M (2014) Socioeconomic disadvantage and disease-specific mortality in Asia: systematic review with meta-analysis of population-based cohort studies. *J Epidemiol Community Health* **68**, 375–83.
- 11) Ministry of Internal Affairs and Communications Statistics Bureau. Labor Force Survey 2016 yearly average results (in Japanese). <http://www.stat.go.jp/data/roudou/sokuhou/nen/ft/pdf/index.pdf>. Accessed April 7, 2017.
- 12) Quinlan M, Mayhew C, Bohle P (2001) The global expansion of precarious employment, work disorganization, and consequences for occupational health: a review of recent research. *Int J Health Serv* **31**, 335–414.
- 13) Benach J, Vives A, Amable M, Vanroelen C, Tarafa G, Muntaner C (2014) Precarious employment: understanding an emerging social determinant of health. *Annu Rev Public Health* **35**, 229–53.
- 14) Virtanen M, Kivimäki M, Joensuu M, Virtanen P, Elovainio M, Vahtera J (2005) Temporary employment and health: a review. *Int J Epidemiol* **34**, 610–22.
- 15) Kivimäki M, Vahtera J, Virtanen M, Elovainio M, Pentti J, Ferrie JE (2003) Temporary employment and risk of overall and cause-specific mortality. *Am J Epidemiol* **158**, 663–8.
- 16) Kim IH, Khang YH, Muntaner C, Chun H, Cho SI (2008) Gender, precarious work, and chronic diseases in South Korea. *Am J Ind Med* **51**, 748–57.

- 17) Inoue M, Minami M, Yano E (2014) Body mass index, blood pressure, and glucose and lipid metabolism among permanent and fixed-term workers in the manufacturing industry: a cross-sectional study. *BMC Public Health* **14**, 207.
- 18) Tsurugano S, Inoue M, Yano E (2012) Precarious employment and health: analysis of the Comprehensive National Survey in Japan. *Ind Health* **50**, 223–35.
- 19) Nakao M, Yano E (2006) A comparative study of behavioural, physical and mental health status between term-limited and tenure-tracking employees in a population of Japanese male researchers. *Public Health* **120**, 373–9.
- 20) Kompier M, Ybema JF, Janssen J, Taris T (2009) Employment contracts: cross-sectional and longitudinal relations with quality of working life, health and well-being. *J Occup Health* **51**, 193–203.
- 21) Kalil A, Ziol-Guest KM, Hawkey LC, Cacioppo JT (2010) Job insecurity and change over time in health among older men and women. *J Gerontol B Psychol Sci Soc Sci* **65B**, 81–90.
- 22) Nakamura Y, Yamamoto T, Okamura T, Kadowaki T, Hayakawa T, Kita Y, Saitoh S, Okayama A, Ueshima H, NIPPON DATA 80 Research Group (2006) Combined cardiovascular risk factors and outcome: NIPPON DATA80, 1980–1994. *Circ J* **70**, 960–4.
- 23) Kadota A, Hozawa A, Okamura T, Kadowaki T, Nakamura K, Murakami Y, Hayakawa T, Kita Y, Okayama A, Nakamura Y, Kashiwagi A, Ueshima H, NIPPON DATA Research Group (2007) Relationship between metabolic risk factor clustering and cardiovascular mortality stratified by high blood glucose and obesity: NIPPON DATA90, 1990–2000. *Diabetes Care* **30**, 1533–8.
- 24) The Japan Institute for Labour Policy and Training No.144 Youth employment status and current situation of careers and vocational ability development (2): from the 2012 Employment Status Survey (In Japanese) <http://www.jil.go.jp/institute/siryo/2014/144.html>. Accessed April 7, 2017.
- 25) Yamamoto H (2008) Health checkups and healthcare advice with a particular focus on the metabolic syndrome in the health care system reform. *J Natl Ins Public Health* **57**, 3–8 (In Japanese).
- 26) Matsuda S (2008) Strategy for the health checkups and healthcare advice with a particular focus on the metabolic syndrome in the occupational settings. *J Natl Ins Public Health* **57**, 28–34 (In Japanese).
- 27) Ministry of HealthLabour and Welfare: Comprehensive survey of living conditions. <http://www.mhlw.go.jp/english/database/db-hss/cslc-index.html>. Accessed April 7, 2017.
- 28) Ministry of HealthLabour and Welfare. National health and nutrition examination survey (In Japanese). <http://www.mhlw.go.jp/toukei/itiran/gaiyo/k-eisei.html>. Accessed April 7, 2017.
- 29) Ministry of HealthLabour and Welfare Japan. Cardiovascular diseases (In Japanese). http://www1.mhlw.go.jp/topics/kenko21_11/b8.html. Accessed November 3, 2017.
- 30) Ministry of HealthLabour and Welfare Japan. Tokuteikenshin and Hokenshidou (In Japanese) <http://www.mhlw.go.jp/stf/seisakunitsuite/bunya/0000161103.html>. Accessed November 3, 2017.
- 31) Examination Committee of Criteria for 'Obesity Disease' in Japan; Japan Society for the Study of Obesity (2002) New criteria for 'obesity disease' in Japan. *Circ J* **66**, 987–92.
- 32) Ogihara T, Kikuchi K, Matsuoka H, Fujita T, Higaki J, Horiuchi M, Imai Y, Imaizumi T, Ito S, Iwao H, Kario K, Kawano Y, Kim-Mitsuyama S, Kimura G, Matsubara H, Matsuura H, Naruse M, Saito I, Shimada K, Shimamoto K, Suzuki H, Takishita S, Tanahashi N, Tsuchihashi T, Uchiyama M, Ueda S, Ueshima H, Umemura S, Ishimitsu T, Rakugi H, Japanese Society of Hypertension Committee (2009) The Japanese Society of Hypertension Guidelines for the Management of Hypertension (JSH 2009). *Hypertens Res* **32**, 3–107.
- 33) Kashiwagi A, Kasuga M, Araki E, Oka Y, Hanafusa T, Ito H, Tominaga M, Oikawa S, Noda M, Kawamura T, Sanke T, Namba M, Hashimoto M, Sasahara T, Nishio Y, Kuwa K, Ueki K, Takei I, Umemoto M, Murakami M, Yamakado M, Yatomi Y, Ohashi H, Committee on the Standardization of Diabetes Mellitus-Related Laboratory Testing of Japan Diabetes Society (2012) International clinical harmonization of glycated hemoglobin in Japan: From Japan Diabetes Society to National Glycohemoglobin Standardization Program values. *J Diabetes Investig* **3**, 39–40.
- 34) Japan Atherosclerosis Society (2007) Japan Atherosclerosis Society (JAS) guidelines for prevention of atherosclerotic cardiovascular diseases. *J Atheroscler Thromb* **5**–57 (In Japanese).
- 35) Committee of the Japan Diabetes Society on the Diagnostic Criteria of Diabetes Mellitus, Seino Y, Nanjo K, Tajima N, Kadowaki T, Kashiwagi A, Araki E, Ito C, Inagaki N, Iwamoto Y, Kasuga M, Hanafusa T, Haneda M, Ueki K (2010) Report of the Committee on the classification and diagnostic criteria of diabetes mellitus. *J Jpn Diabetes Soc* **53**, 450–67 (In Japanese).
- 36) Tsugane S, Fahey MT, Sasaki S, Baba S, Japan Public Health Center (1999) Alcohol consumption and all-cause and cancer mortality among middle-aged Japanese men: seven-year follow-up of the JPHC study Cohort I. *Am J Epidemiol* **150**, 1201–7.
- 37) Galobardes B, Shaw M, Lawlor DA, Lynch JW, Davey Smith G (2006) Indicators of socioeconomic position (part 1). *J Epidemiol Community Health* **60**, 7–12.
- 38) Corsi DJ, Boyle MH, Lear SA, Chow CK, Teo KK, Subramanian SV (2014) Trends in smoking in Canada from 1950 to 2011: progression of the tobacco epidemic according to socioeconomic status and geography. *Cancer Causes Control* **25**, 45–57.
- 39) Tabuchi T, Kondo N (2017) Educational inequalities in smoking among Japanese adults aged 25–94 years: 2017.

- Nationally representative sex- and age-specific statistics. *J Epidemiol* **27**, 186–92.
- 40) Understanding Children's Work (UCW) Programme, United Nations Educational, Scientific and Cultural Organization Educational attainment and employment outcomes: evidence from 11 developing countries. unesdoc.unesco.org/images/0022/002263/226333e.pdf. Accessed April 7, 2017.
 - 41) Ministry of Health Labour and Welfare Japan. Result Summary of General Survey in Diversified Type of Employment 2014 (In Japanese) <http://www.mhlw.go.jp/toukei/itiran/roudou/koyou/keитай/14/d1/gaikyo.pdf>. Accessed April 7, 2017.
 - 42) De Cuyper N, De Jong J, De Witte H, Isaksson K, Rigotti T, Schalk R (2008) Literature review of theory and research on the psychological impact of temporary employment: towards a conceptual model. *Int J Manag Rev* **10**, 25–51.
 - 43) Kimura Y (2012) Does the social stratification factor have any effects upon the response rate of medical examination? (in Japanese). *Bulletin of the Graduate Division of Letters. Arts Sci Waseda Univ* **1**, 35–44.
 - 44) Kagamimori S, Gaina A, Nasermoddali A (2009) Socioeconomic status and health in the Japanese population. *Soc Sci Med* **68**, 2152–60.
 - 45) Ikeda A, Kawachi I, Iso H, Inoue M Tsugane S, JPHC Study Group (2011) Gender difference in the association between social support and metabolic syndrome in Japan: the 'enkai' effect? *J Epidemiol Community Health* **65**, 71–7.
 - 46) Kawada T (2016) Glucose intolerance and General Health Questionnaire 12-item version scores of male two-shift workers stratified by precariousness of work. *Diabetes Metab Syndr* **10**, 75–7.
 - 47) The Japan Institute for Labour Policy and Training (2013) Survey on Support for Compatibility of treatment of Mental Health and non-related work sick, and work (Mental Health, shishitubyu nado no chiryou to shokugyo seikatu no ryouritu shien ni kansuru chousa) (in Japanese). <http://www.jil.go.jp/institute/research/2013/documents/0112.pdf>. Accessed April 7, 2017.
 - 48) Nishi N, Yoshizawa T, Ikeda N, Tsubota M, Okuda N (2015) Factors associated with cooperation for blood testing in the National Health and Nutrition Survey. *Jpn J Cardiovasc Dis Prev* **50**, 27–34 (In Japanese).