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Socioeconomic status relates to exercise habits and cardiorespiratory fitness among workers in the Tokyo area

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Abstract

Objectives: This survey aims to investigate consciousness regarding habitual exercise among workers in urban areas and to analyze the associations of workers' socioeconomic status with their habitual exercise and cardiorespiratory fitness (CRF).

Methods: Ten thousand participants, who worked in the Tokyo area of Japan, were recruited for the questionnaire-based survey. The questionnaire elicited participant's characteristics, socioeconomic status (eg, employment status and annual income), habitual exercise status, and consciousness regarding exercising. After the data-cleaning procedure, 9406 participants were selected for analyses. CRF was estimated by a validated equation model.

Results: Some (32.9%) participants had an exercise habit, and 93% recognized that exercise is good for health. Of the nonexercise habit group (n = 6308), 73% wanted to develop an exercise habit, and "spare time (40%)" and "financial capability (16%)" were the two most necessary conditions for habituating exercise. As socioeconomic statuses increased, the odds ratios (ORs) for engaging in habitual exercise increased among full-time (1.22) versus part-time (reference) employees and those having high (1.76) versus low (reference) incomes, whereas the ORs for low CRF risk decreased among full-time (0.78) versus part-time (reference) employees and those having high (0.53) versus low (reference) incomes.

Conclusions: Although most workers recognized the benefits of exercise, many were unable to develop exercise habits and believed that they could develop exercise habits if they had the time and financial capabilities. The survey suggests that workers with a higher socioeconomic status more likely to obtain favorable physical fitness, indicating a health disparity among workers in urban areas.

KEYWORDS

health behavior, health disparity, maximal oxygen consumption, physical fitness

1 | INTRODUCTION

Japan is one of the developed countries managing the serious problem of an aging and declining population, where the relative number of workers is also declining. This type of society must increase the retirement age to maintain its economic level; thus, workers' health and physical fitness become priorities for the government, employers, and workers. Nevertheless, in this mechanized society, working adults are more likely to be placed in sedentary situations.[1,2] The latest World Health Organization survey[3] reports that the prevalence of insufficient physical activity has elevated among adults living in high-income countries. Insufficient physical activity induces lower cardiorespiratory fitness (CRF) level.[4,5] A continued decline in CRF level among adults has been noted in the past decades, which is a pattern observed at the international level.[6]

The CRF level is a crucial risk factor for mortality,[7] and some studies have indicated that midlife CRF plays a significant role in health-related incidents in later life, for example, the development of severe diseases,[8] increased health care costs,[9] and decreased longevity.[10] Because exercising is effective to prevent declines in CRF,[11] habitual exercise is generally recommended for public health. However, in today's time-pressed society, some barriers, for example, lack of time,[12,13] may prevent working adults from habitual exercise. Moreover, studies[14,15] have indicated that social status may affect individuals' health behaviors. Notably, regarding the physical activity level, disparities between countries have been observed.[16]

Thus, from the perspective of preventative medicine, an understanding of the consciousness of today's workers for habitual exercise is important. Therefore, the survey aimed to investigate the awareness regarding habitual exercise among workers in the Tokyo area, which is one of the most urbanized areas worldwide. Furthermore, the study aimed to analyze the associations of workers' socioeconomic status, such as educational attainment, type of employment, position at work, and income levels, with their habitual exercise and CRF. In addition, because the 2020 Tokyo Olympic and Paralympic Games will be held in 2021 (the International Olympic Committee postponed the event to 2021 because of the coronavirus disease 19 pandemic), the survey asked workers in the Tokyo area whether the major event would enhance their consciousness regarding habitual exercise.

2 | METHODS

2.1 | Participants and survey procedure

This web-based survey was conducted from January to July 2018, and participants answered a self-completed questionnaire. An invitation email containing a summary of the survey was sent to enrolled workers at an internet research company. If they agreed to participate, screening questions regarding inclusion criteria were asked. The inclusion criteria were as follows: aged 20-65 years, working in the Tokyo area of Japan (the Tokyo, Saitama, Chiba, and Kanagawa Prefectures), working at least 6 hours per day, and working part-time or full-time at least 3 days per week. The recruitment of participants was conducted until we reached the sampling goal: 10 000 workers with a wide range of employment types, based on the composition ratio of employed persons according to sex, age group, and industry type listed in the 2017 Japan Labor Force Survey (Ministry of Internal Affairs and Communications).[17] The participants earned internet use points according to their answers. Through a data-cleaning procedure, we excluded 594 respondents because of inappropriate answers, such as erroneous values and outliers. The final sample was 9406 participants. The study was conducted in accordance with the guidelines proposed in the Declaration of Helsinki. The Ethics Committee of the National Institute of Occupational Safety and Health, Japan reviewed and approved the study protocol (H2921). All participants provided web-based informed consent.

2.2 | Questionnaire

The questionnaire elicited age, sex, body height and weight, educational attainment, current marital status, work start and end times on a typical day, type of employment, namely, full-time (regular) employee, part-time (temporary or contract) employee, freelancer or employer, current position at work, and annual income. The questionnaire included items regarding the participants' habitual exercise status and their consciousness regarding exercising, such as "*Do you think exercise has a favorable effect on your health?*"; "*Do you like exercise?*"; "*If you could, would you like to develop an exercise habit?*"; and "*What is the most important condition for habituating exercise*?" The participants selected their answers for each question using a four-point scale. Engagement in habitual exercise was defined as "continual exercise for at least 30 minutes per day, 2 days per week, over a year or more," and this is the national recommendation as defined by the Japanese Ministry of Health, Labor and Welfare.[18] Furthermore, we asked the participants two other questions to investigate the influence of the Olympics on their consciousness regarding habitual exercise and the potential need for CRF testing in health checkups. Body mass index (BMI) was calculated as the participant's weight in kilograms divided by the square of his or her height in meters. Maximal oxygen consumption ($\dot{V}O_{2max}$), as a CRF assessment, was estimated using

the following equation model: estimated $\dot{V}O_{2max}$ = 59.96 + (−0.23 × age) + (7.39 × sex, 0 for women and 1 for men) + (−0.79 × BMI) + (0.33 × physical activity score), which was validated by another study[19]; the physical activity score (0-44 points) was calculated as the sum of the points scored on seven questions that asked about exercise frequency, duration, and intensity.

2.3 | Data analysis

Chi-square tests were used to analyze categorical values. Participants were divided into $\dot{V}O_{2max}$ tertile groups according to age and sex. The $\dot{V}O_{2max}$ tertile (33.3% and 66.6%) values (mL/kg/min) were 43.3 and 46.9 in men aged 20-39 years, 37.4 and 41.0 in men aged 40-65 years, 37.4 and 40.1 in women aged 20-39 years, and 32.3 and 35.6 in women aged 40-65 years, respectively. Multiple logistic regression analyses were used to compute the odds ratios (ORs) and 95% confidence intervals (CIs) with exercise habit (1: with, 0: without) and low CRF (1: lowest tertile group, 0: middle and highest tertile groups) as response variables and other characteristics as explanatory variables. In the analyses, $P < .05$ was considered statistically significant. The analyses were performed using SAS, version 9.4 (SAS Institute Japan, Tokyo, Japan).

3 | RESULTS

Characteristics of the participants, including exercise habit status, are presented in Table 1. There were 5264 (56.0%) men and 4142 (44.0%) women. Average age, BMI, and estimated $\dot{V}O_{2max}$ of men were 44.5 ± 11.2 years, 23.4 ± 3.5 kg/m^2, and 41.3 ± 5.1 mL/kg/min, respectively, and those of women were 41.7 ± 10.8 years, 21.0 ± 3.5 kg/m^2, and 35.9 ± 4.7 mL/kg/min, respectively. Average hours in the workplace per day (from work start time to end time) were 10.6 ± 1.8 hours for men and 9.6 ± 1.8 hours for women. The percentage of participants with and without an exercise habit was 32.9% (n = 3098) and 67.1% (n = 6308), respectively. We observed higher percentages of participants with an exercise habit for the following characteristics: men (36.5%) versus women (28.4%); normal BMI (34.1%) versus underweight (30.3%) or overweight (30.5%); high CRF (60.3%) versus low CRF (12.3%); high educational attainment, namely, graduate school (36.7%) versus ~high school (27.8%); married (34.7%) versus unmarried (30.9%); employer (41.5%) versus part-time employee (27.6%); higher position at work, namely, the CEO or at the executive level (45.7%) versus general employees (29.1%); and high income, namely, ≥JPY 8 million/year (44.3%) versus low income, namely, <4 million/year (28.6%).

The participants were also asked questions on consciousness regarding habitual exercise. Table 2 presents the results: 93% recognized that exercise is good for their health (with exercise habit group, 98%; without exercise habit group, 90%); and 65% prefer exercise (with exercise habit group, 86%; without exercise habit group, 55%). In addition, 73% of workers who did not exercise habitually (n = 6308) wanted to develop an exercise habit (Table 2), and "spare time" (40%) and "financial capability" (16%) were the two most necessary conditions they required to develop the habit of exercising (Figure 1).

The ORs and 95% CI for engaging in habitual exercise and risk of low CRF are presented in Table 3. The ORs for engaging in habitual exercise were 45% higher for men than for women; 15% lower for underweight and overweight participants than for those of normal weight; 10.8 times and 2.5 times higher in the highest tertile and middle tertile of CRF, respectively, than in the lowest tertile; approximately 40% higher in high educational attainment (graduate school or university) than in ~ high school; 20% lower in the highest category of work time than in the lowest category; 10% higher for married than for unmarried; 16% and 12% higher for employers and full-time employees, respectively, than for part-time employees; and gradually increased as the position at work increased, namely, from 1.2 times higher for the subsection chief level to 1.9 times higher for CEOs and the executive level than for the general employee level. The ORs for the risk of low CRF were 94% lower for underweight participants and eight times higher for overweight participants than for those with normal weight; 15% lower in high educational attainment (university) than in ~high school; 15% lower in the highest category of work time than in the lowest category; 27% and 22% lower for employers and full-time employees, respectively, than for part-time employees; and 20%-50% lower for higher positions at work than for general employees. Furthermore, Figure 2 presents the ORs of two response variables by annual income levels. As the annual income increased from low to high, the ORs for an exercise habit increased and those for the risk of low CRF decreased.

Table 4 presents frequency distributions for answers to two additional questions regarding the Olympics event and CRF testing: a total of 19% of workers expect that the Tokyo Olympic and Paralympic Games will influence their exercise habits (with exercise habit group, 32%; without exercise habit group, 13%), while 79% follow routine CRF measurements as required for health checkups at their workplace (with exercise habit group, 86%; without exercise habit group, 75%).

4 | DISCUSSION

This study conducted a web-based cross-sectional survey of 9406 adults working in the Tokyo area of Japan. Of all the

TABLE 1 Characteristics of the study population and prevalence of an exercise habit based on characteristics

	Total			Exercise habit						
				With			Without			
	N	Column %	Row %	N	Column %	Row %	N	Column %	Row %	Chi-squared te's *P*
Total	9406		(100)	3098		(32.9)	6308		(67.1)	
Age group										
20-39 y	3573	(38.0)	(100)	1165	(37.6)	(32.6)	2408	(38.2)	(67.4)	.59
40-65 y	5833	(62.0)	(100)	1933	(62.4)	(33.1)	3900	(61.8)	(66.9)	
		(100)			(100)			(100)		
Sex										
Men	5264	(56.0)	(100)	1923	(62.1)	(36.5)	3341	(53.0)	(63.5)	<.01
Women	4142	(44.0)	(100)	1175	(37.9)	(28.4)	2967	(47.0)	(71.6)	
		(100)			(100)			(100)		
Body mass index										
Underweight, ˂18.5	1071	(11.4)	(100)	324	(10.5)	(30.3)	747	(11.8)	(69.7)	<.01
Normal, 18.5-24.9	6433	(68.4)	(100)	2194	(70.8)	(34.1)	4239	(67.2)	(65.9)	
Overweight, ≥25.0	1902	(20.2)	(100)	580	(18.7)	(30.5)	1322	(21.0)	(69.5)	
		(100)			(100)			(100)		
Cardiorespiratory fitness, grouped by $\dot{V}O_{2max}$ tertile by age and sex[a]										
Lowest tertile	3134	(33.3)	(100)	385	(12.4)	(12.3)	2749	(43.6)	(87.7)	<.01
Middle tertile	3137	(33.4)	(100)	824	(26.6)	(26.3)	2313	(36.7)	(73.7)	
Highest tertile	3135	(33.3)	(100)	1889	(61.0)	(60.3)	1246	(19.7)	(39.7)	
		(100)			(100)			(100)		
Educational attainment										
~High school	1894	(20.1)	(100)	526	(17.0)	(27.8)	1368	(21.7)	(72.2)	<.01
~Junior college/ Technical college	2023	(21.5)	(100)	591	(19.1)	(29.2)	1432	(22.7)	(70.8)	
~University	4691	(49.9)	(100)	1700	(54.8)	(36.2)	2991	(47.4)	(63.8)	
~Graduate school	624	(6.6)	(100)	229	(7.4)	(36.7)	395	(6.3)	(63.3)	
Prefer not to answer	174	(1.9)	(100)	52	(1.7)	(29.9)	122	(1.9)	(70.1)	
		(100)			(100)			(100)		
Current marital status										
Unmarried	4033	(42.9)	(100)	1246	(40.2)	(30.9)	2787	(44.2)	(69.1)	<.01
Married	5168	(54.9)	(100)	1791	(57.8)	(34.7)	3377	(53.5)	(65.3)	
Prefer not to answer	205	(1.9)	(100)	61	(2.0)	(29.8)	144	(2.3)	(70.2)	
		(100)			(100)			(100)		
Hours in workplace per day										
≤9.0 h	2246	(23.9)	(100)	746	(24.1)	(33.2)	1500	(23.8)	(66.8)	<.05
9.1-10.9 h	4171	(44.3)	(100)	1422	(45.9)	(34.1)	2749	(43.6)	(65.9)	

(Continues)

TABLE 1 (Continued)

	Total			Exercise habit						
				With			Without			
	N	Column %	Row %	N	Column %	Row %	N	Column %	Row %	Chi-squared te's *P*
≥11.0 h	2479	(26.4)	(100)	780	(25.2)	(31.5)	1699	(26.9)	(68.5)	
Unclear	510	(5.4)	(100)	150	(4.8)	(29.4)	360	(5.7)	(70.6)	
		(100)			(100)			(100)		
Type of employment										
Part-time (contact, temporary) employee	2268	(24.1)	(100)	625	(20.2)	(27.6)	1643	(26.0)	(72.4)	<.01
Full-time (regular) employee	6480	(68.9)	(100)	2200	(71.0)	(34.0)	4280	(67.9)	(66.0)	
Employer/ freelancer	658	(7.0)	(100)	273	(8.8)	(41.5)	385	(6.1)	(58.5)	
		(100)			(100)			(100)		
Current position at work										
General employee/ section staff member	5310	(56.5)	(100)	1543	(49.8)	(29.1)	3767	(59.7)	(70.9)	<.01
Subsection chief level	1606	(17.1)	(100)	553	(17.8)	(34.4)	1053	(16.7)	(65.6)	
Section chief level	855	(9.1)	(100)	337	(10.9)	(39.4)	518	(8.2)	(60.6)	
Department director level	440	(4.7)	(100)	187	(6.0)	(42.5)	253	(4.0)	(57.5)	
CEO/executive level	350	(3.7)	(100)	160	(5.2)	(45.7)	190	(3.0)	(54.3)	
Sole proprietor/ freelancer	845	(9.0)	(100)	318	(10.3)	(37.6)	527	(8.4)	(62.4)	
		(100)			(100)			(100)		
Annual income, Japanese yen										
Low , <4 million	3628	(38.6)	(100)	1037	(33.5)	(28.6)	2591	(41.1)	(71.4)	<.01
Middle, 4-7.9 million	3397	(36.1)	(100)	1174	(37.9)	(34.6)	2223	(35.2)	(65.4)	
High, 8 million≤	1298	(13.8)	(100)	575	(18.5)	(44.3)	723	(11.5)	(55.7)	
Prefer not to answer	1083	(11.5)	(100)	312	(10.1)	(28.8)	771	(12.2)	(71.2)	
		(100)			(100)			(100)		

[a]The $\dot{V}O_{2max}$ tertile (33.3% and 66.6%) values (mL/kg/min) were 43.3 and 46.9 in men aged 20-39 y, 37.4 and 41.0 in men aged 40-65 y, 37.4 and 40.1 in women aged 20-39 y, and 32.3 and 35.6 in women aged 40-65 y, respectively.

participants, the ratio of workers that engaged in habitual exercise was 33%. This percentage was relatively higher than those (32% in 2017, 29% in 2018) from National Health and Nutrition Surveys in Japan,[18] which included adults aged over 20 years and living in all areas of Japan (not limited to workers in the Tokyo area). The ratio of workers without an

TABLE 2 Frequency distributions for answers to questions on participants' consciousness regarding exercise

	Total			Exercise habit						
				With			Without			Chi-squared test's *P*
	N	Column %	Row %	N	Column %	Row %	N	Column %	Row %	
Total	9406		(100)	3098		(32.9)	6308		(67.1)	
Do you think exercise has a favorable effect on your health?										
I think so/Maybe so	8721	(92.7)	(100)	3025	(97.6)	(34.7)	5696	(90.3)	(65.3)	<.01
Maybe not/I don't think so	685	(7.3)	(100)	73	(2.4)	(10.7)	612	(9.7)	(89.3)	
		(100)			(100)			(100)		
Do you like exercise?										
Yes, definitely/ Mostly, yes	6097	(64.8)	(100)	2657	(85.8)	(43.6)	3440	(54.5)	(56.4)	<.01
Not really/Not at all	3309	(35.2)	(100)	441	(14.2)	(13.3)	2868	(45.5)	(86.7)	
		(100)			(100)			(100)		
If you could, would you like to develop an exercise habit?										
I would/I probably would							4573	(72.5)		
I probably would not/I would not							1735	(27.5)		
(This question was asked only to the non-exercise habit group.)								(100)		

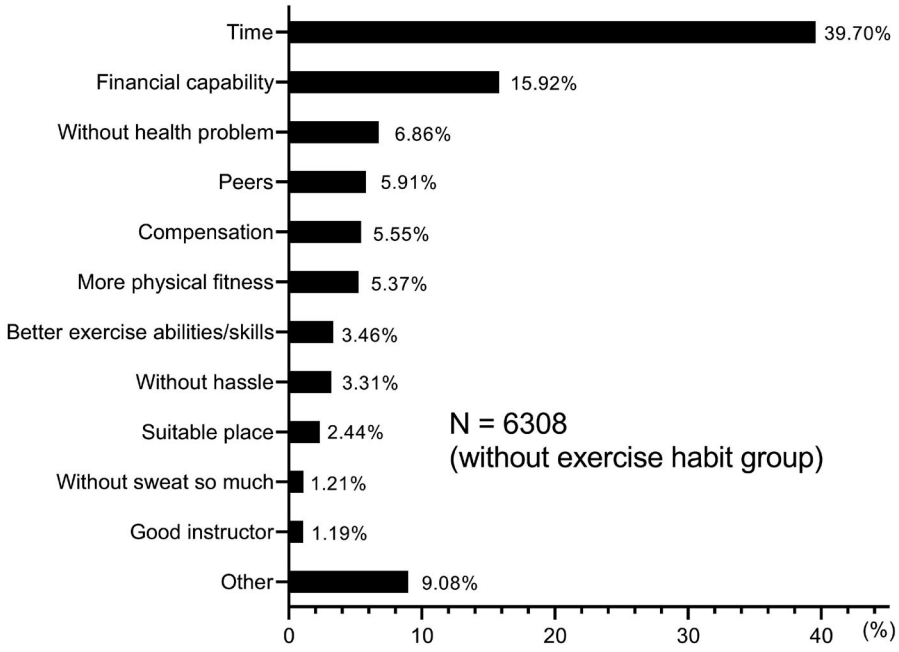

FIGURE 1 Answer distributions for the conditions for habituating exercise, asked only to the nonexercise habit group

exercise habit was 67%, a figure similar to other countries' survey results, for example, 68% of Australian workers[20] or 66% of South Korean adults[21] insufficiently participate in physical activities. Furthermore, the study suggested that workers' socioeconomic status would relate to their habitual exercise and physical fitness levels, indicating a health disparity in workers of urban areas.

The first noteworthy result of this survey is that almost all (93%) of the participants in this study recognized that exercise has a favorable effect on their health (Table 2); nevertheless, nearly 70% did not engage in habitual exercise daily (Table 1). Of the participants without exercise habit, greater than 70% wants to develop an exercise habit if they could (Table 2); and their two most necessary conditions for habitual exercise were "spare time" and "financial capability" (Figure 1).

Studies[12,13] have demonstrated that a "lack of time" is a major reason why individuals cannot develop an exercise habit. For working adults, work time is one of the major factors inducing these "lack of time" situations. Actually, our finding demonstrated that the OR for engaging in habitual exercise was significantly lower in the longest work time group than the shortest group (Table 3). However, conversely, previous studies[20,22] indicated that work time was not a significant factor for engaging in habitual exercise; hence, it may not be adequate to conclude that insufficient time to exercise is explained by working time. In general, *the "lack of time" for exercise* situation is created when an individual is busy or considers exercise a low priority compared with other activities, that is although individuals understand the benefits of exercise, most have difficulty prioritizing the time for exercise in their daily lives. Some studies[23,24] have indicated that "lack of willpower" was the most influential factor for not engaging in habitual exercise; certainly, this could be the case, but other backgrounds, such as the social environments of each worker, should be considered for this problem.

According to Table 3, the first factor that demonstrated the relationship with habitual exercise is sex. The OR was 45% higher for the men than for the women. The result was consistent with previous studies,[16,21,25,26] showing that a lower

TABLE 3 Logistic regression analyses for assessing the association of the selected variables with engaging in habitual exercise and risk of low CRF (N = 9406)

			Engaging habitual exercise		Risk of low CRF	
Variable	**(Reference group)**	**Subgroups**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Age group	(20-39 y)	40-65 y	1.024	(0.938, 1.119)	1.001	(0.916, 1.093)
Sex	(Women)	Men	**1.453**	(1.331, 1.587)	1.000	(0.917, 1.090)
Body mass index	(Normal)	Underweight	**0.838**	(0.728, 0.964)	**0.058**	(0.038, 0.089)
		Overweight	**0.848**	(0.759, 0.947)	**7.938**	(7.065, 8.919)
CRF	(Lowest tertile)	Middle tertile	**2.544**	(2.227, 2.906)		
		Highest tertile	**10.825**	(9.520, 12.308)		
Educational attainment	(~High school)	~Junior college/ Technical college	1.147	(0.996, 1.321)[a]	0.917	(0.778, 1.081)[a]
		~University	**1.417**	(1.259, 1.595)[a]	**0.851**	(0.740, 0.980)[a]
		~Graduate school	**1.402**	(1.156, 1.701)[a]	0.874	(0.688, 1.111)[a]
Hours in workplace per day	(≤9.0 h)	9.1-10.9 h	0.953	(0.852, 1.066)[a]	0.886	(0.773, 1.017)[a]
		≥11.0 h	**0.799**	(0.702, 0.909)[a]	**0.852**	(0.726, 0.999)[a]
Current marital status	(Unmarried)	Married	**1.103**	(1.005, 1.210)[a]	1.021	(0.910, 1.145)[a]
Employment status	(Part-time employee)	Full-time employee	**1.221**	(1.089, 1.370)[a]	**0.780**	(0.681, 0.893)[a]
		Employer/freelancer	**1.635**	(1.358, 1.969)[a]	**0.730**	(0.577, 0.924)[a]
Current position at work	(General employee)	Subsection chief level	**1.208**	(1.069, 1.364)[a]	**0.813**	(0.699, 0.947)[a]
		Section chief level	**1.433**	(1.224, 1.678)[a]	**0.503**	(0.410, 0.617)[a]
		Department director level	**1.645**	(1.337, 2.025)[a]	**0.633**	(0.489, 0.819)[a]
		CEO/executive level	**1.892**	(1.511, 2.369)[a]	**0.694**	(0.522, 0.921)[a]
		Sole proprietor/ freelancer	**1.446**	(1.240, 1.687)[a]	**0.747**	(0.613, 0.911)[a]

Note: Bold letters show $P < .05$.

Abbreviations: CI, confidence interval; CRF, cardiorespiratory fitness; OR, odds ratio.

[a]Analyses were adjusted for age, sex, and body mass index.

physical activity level was demonstrated in the women than in the men. The results for BMI were also consistent with the literature,[25] showing that there were significantly fewer workers engaging in habitual exercise in the underweight and overweight groups than in the normal BMI group.

Studies[14,15] have suggested that social status significantly affects individuals' health behavior, and we interpreted results presented in Table 3 and Figure 2 in this context. Along with rising up in educational attainment, employment status, and current position at work, the ORs for engaging in habitual exercise gradually increased (Table 3). These findings suggest that the higher the social status, the more likely individuals are to engage in habitual exercise. Similar relationships between social status and exercise/physical activity have been observed in previous studies.[12,13,21,25,26] In addition, Table 3 also shows that having an exercise habit is strongly related to a worker's CRF level, and their higher social status (eg, educational attainment, employment status, and current position at work) is related to a lower risk of low CRF. In general, income levels increase with an increase in social status. Figure 2 indicates that the higher the participants' annual income, the more they engage in habitual exercise and the lower their risk of low CRF. Thus, annual income could have a significant influence not only on workers' health behavior (a similar result has been demonstrated in previous studies[12,21,26]) but also on health benefits (eg, a higher CRF), which is one of the novel insights presented in this study. As aforementioned, most workers recognized the benefit of exercise; nevertheless, many of them had not developed an exercise habit. Socioeconomic status may influence this problem. Thus, this study suggests that health disparities exist between individuals. This public health problem regarding habitual exercise should be treated as not only a personal but also a social or structural concern.[13]

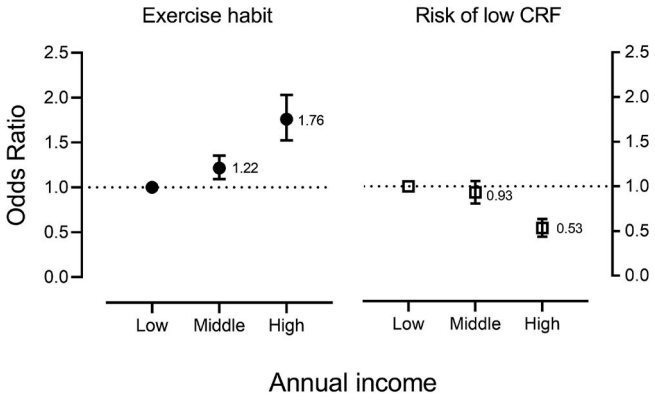

FIGURE 2 Odds ratio for engaging in habitual exercise (left) and risk of low cardiorespiratory fitness (CRF; right) by annual income levels. Participants in the lowest $\dot{V}O_{2max}$ tertile group were defined as having low CRF. Both analyses were adjusted for age, sex (0 for women and 1 for men), and body mass index

In developed countries where computer work is common, if workers had no intentional exercise habit, they tended to become sedentary. Studies have demonstrated that excessive sedentary behavior increases disease risk.[27,28] Therefore, our result that approximately 70% of workers have no exercise habit is noteworthy. Based on this result, the public health field should attempt to understand how to help these individuals adopt exercise habits. In Japan, the Tokyo Olympic and

TABLE 4 Frequency distributions for answers to the two additional questions regarding the Olympics and CRF test

	Total			Exercise habit						
				With			Without			
	N	Column %	Row %	N	Column %	Row %	N	Column %	Row %	Chi-squared test's *P*
Total	9406		(100)	3098		(32.9)	6308		(67.1)	
In 2020, the Tokyo Olympics and Paralympics will be held. Do you think this will influence your exercise habits?										
I think so/ Maybe so	1811	(19.2)	(100)	1004	(32.4)	(55.4)	807	(12.8)	(44.6)	<.01
Maybe not/I don't think so	7595	(80.8)	(100)	2094	(67.6)	(27.6)	5501	(87.2)	(72.4)	
		(100)			(100)			(100)		
If you could measure your CRF safely and easily during your workplace health checkup, would you like to?										
Yes, definitely/ Mostly, yes	7422	(78.9)	(100)	2672	(86.2)	(36.0)	4750	(75.3)	(64.0)	<.01
Not really/Not at all	1984	(21.1)	(100)	426	(13.8)	(21.5)	1558	(24.7)	(78.5)	
		(100)			(100)			(100)		

Abbreviation: CRF, cardiorespiratory fitness.

Paralympic Games will be held in the summer of 2021. The event is expected to be a catalyst for individuals to develop exercise habits and increase physical activity. Despite these expectations, Murphy and Bauman[29] indicated that no evidence demonstrates that such a major event has had a positive impact on public health. Actually, the results of this study showed that only 13% of workers without an exercise habit in the Tokyo area thought that the Tokyo Olympic and Paralympic Games could influence their exercise habits (Table 4).

Another possibility that triggers exercise habits may be CRF testing. The results of this study demonstrated that 79% of all workers and 75% even in the nonexercise habit group, expected routine CRF assessments in their workplace (Table 4), suggesting that many workers are concerned about their physical fitness level. CRF is a powerful marker of cardiovascular health compared with other established risk factors.[30] Although an adult's CRF level is not routinely assessed in health checkups, its necessity is strongly advocated.[31] A routine assessment of workers' CRF level may be useful for not only assessing their disease risk but also acting as a catalyst to develop their exercise habits.

Our sample was a large population of workers in the Tokyo area and encompassed a wide range of employment sectors, which is a strength of this study. However, this study has limitations. First, the data were collected through the internet. Therefore, although suspicious data were eliminated as much as possible before analyses, the anonymous nature of web research participants should be considered. Second, we conducted a cross-sectional examination and thus could not determine causality. Therefore, we should have considered an opposite causal relationship between annual income and habitual exercise, that is, engaging in habitual exercise affected a worker's annual income, which cannot be ruled out but is generally unlikely. Third, to define exercise habit, we used the definition generally used in national surveys in Japan, that is, "continual exercise for at least 30 minutes per day, 2 days per week, over a year or more," rather than the physical activity definition, that is, "150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activities every week",[32] used in other studies.[3,25] The main difference between the two definitions is that the former is limited to purposeful, intentional physical activities, whereas the latter includes all daily activities. Therefore, the results of this study cannot be directly compared with those of previous studies [3,25]; nevertheless, we propose that the results are meaningful in understanding the consciousness regarding habitual exercise among today's workers.

5 | CONCLUSIONS

The study elucidated the habitual exercise status and consciousness regarding exercising of workers in the Tokyo area and the associations of workers' socioeconomic status with their habitual exercise and CRF. Although almost all the workers recognize the benefit of exercise, many of them have not developed exercise habits but believe that they could develop exercise habits if they had the time and financial capability. This study also demonstrated that workers of higher socioeconomic status are more likely to adopt healthy behavior and consequently gain the health benefits, that is, favorable physical fitness levels in this study, indicating a health disparity among workers in urban areas. Further research is necessary to find a catalyst for habitual exercise for workers with a low socioeconomic status, and routine CRF assessments in the workplace might be one of those catalysts.

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AUTHOR CONTRIBUTIONS

The contributions of each author were as follows: TM contributed to developing study concept and design, data acquisition, data analysis, and manuscript writing; RS contributed to developing study concept and design, data acquisition, data analysis, and manuscript revisions.

DISCLOSURE

Approval of the research protocol: N/A. *Informed consent:* This study was conducted in accordance with the guidelines proposed in the Declaration of Helsinki. The Ethical Committee of the National Institute of Occupational Safety and Health, Japan reviewed and approved the study protocol (ID H2921). Web-based informed consent was obtained from all participants after explaining to them the aims and design of this study. *Registry and the registration no. of the study/trial*: N/A. *Animal studies*: N/A. *Conflict of interests:* The authors declare no conflict of interests for this article.

DATA AVAILABILITY STATEMENT

On reasonable request, derived data supporting the findings of this study are available from the corresponding author after approval from the Ethical Committee of the National Institute of Occupational Safety and Health, Japan.

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