

BMJ Open Association between procrastination, white-collar work and obesity in Japanese male workers: a cross-sectional study

Akihiko Narisada ,¹ Kohta Suzuki ^{1,2}

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¹Institute for Occupational Health Science, Aichi Medical University, Nagakute, Japan

²Department of Health and Psychosocial Medicine, Aichi Medical University, Nagakute, Japan

Correspondence to

Dr Akihiko Narisada;
akihikonarisada@yahoo.co.jp

ABSTRACT

Objective To investigate the associations among procrastination (time inconsistency), work environment and obesity-related factors in Japanese male workers.

Design Cross-sectional study.

Setting Data were collected at two work sites of Japanese electronics manufacturing company in 2015.

Participants 795 full-time male workers in a Japanese electric company, aged 35–64 years, who underwent health checkups in 2015.

Main outcome measures Body mass index (BMI), adult weight change, obesity (BMI ≥ 25 kg/m²), adult weight gain over 10 kg (AWG10) and metabolic syndrome (MetS). Multivariable linear and logistic regression analyses were performed to assess the associations of procrastination assessed by using a one-item questionnaire and white-collar and blue-collar work with obesity-related factors.

Results White-collar workers with high procrastination levels showed positive associations with BMI (B: 0.75, 95% CI 0.06 to 1.44) and adult weight change (B: 1.77, 95% CI 0.26 to 3.29), and had increased odds of AWG10 (OR: 1.85, 95% CI 1.04 to 3.29) and MetS (OR: 2.29, 95% CI 1.18 to 4.44) after adjustment for age, education, work-related factors and lifestyle factors. However, such positive associations were not observed among blue-collar workers.

Conclusions Procrastination and white-collar work might have a joint effect on weight gain during adulthood and consequential obesity.

INTRODUCTION

Obesity and the obesity-related epidemic are serious public health problems worldwide.¹ Obesity and diseases related to obesity, such as metabolic syndrome (MetS), are major risk factors for hypertension, type 2 diabetes mellitus (DM) and cardiovascular disease (CVD) and are associated with several types of cancer.² As in western developed countries, the prevalence of obesity in Japan has increased.^{3 4} Particularly among Japanese men, this prevalence has nearly doubled over the past several decades. The association between the obesity-related gene (ie, the *FTO* gene) and body mass index (BMI)

Strengths and limitation of this study

- This is the first study among workers to document the different relationships between procrastination (time inconsistency) and obesity, by occupation.
- This is the first study indicating the epidemiological relationship between time preference and metabolic syndrome (MetS) in male white-collar workers.
- Our data was cross-sectional in nature, therefore a causal relationship between procrastination and obesity cannot be inferred.
- Procrastination was assessed using a one-item question which asked participants to recall their homework habits from when they were in school which may be affected by social desirability bias.

weakens after age 20 years,⁵ and most individuals gain weight between the ages of 20 and 50 years,^{4 6 7} which means the working generation. Weight gain during adulthood (ie, weight gain of more than 10 kg from age 20 years) increases the risk for DM, CVD, cancer and mortality.^{8–11}

There are increasing concerns regarding the associations of socioemotional skills, especially self-control and self-regulation, with consequential poor health outcomes including obesity.¹² Time-inconsistent preference (hyperbolic discounting or present-biased preference), which is a behavioural economics perspective that is considered a person's degree of impatience or self-control, is empirically related to obesity.^{13–16} According to the hyperbolic discounting model by Ainslie,^{17 18} people often prefer smaller rewards sooner to larger ones later. Individuals with higher hyperbolic rates of discounting, who are considered impulsive or lacking self-control, tend to eat unhealthy diets (ie, high caloric intake and many sweets), to drink too much alcohol, and to procrastinate when it comes to engaging in healthy behaviours (ie, going to the gym less

often), which together lead to obesity. Empirical studies by Ikeda *et al*¹⁹ and Kang and Ikeda,²⁰ which targeted Japanese people, also showed that procrastination (a proxy variable of hyperbolic discounting that is assessed using a questionnaire item about homework while in school) was related to obesity.

Environment, including the working environment, is also considered an important factor that contributes to obesity (ie, 'obesogenic environment').²¹ Previous studies have shown that shift work, sedentary work and long working hours are associated with obesity-related behaviours and excess weight gain.^{22–24} Additionally, the interplay between time inconsistency (self-control) and environmental state is thought to contribute to the obesity epidemic.²⁵ People often abandon long-term plans (ie, to maintain a desirable weight or not eat too many sweets) in favour of immediate reward in response to environmental cues, which is responsible for impulsive preference reversal. Hyperbolic discounting might be sufficient to explain such cue-triggered behaviours.²⁶ (Indeed, in Japan, in contrast to obesity, the prevalence of smokers, which is also related to time inconsistency,²⁷ has declined along with stricter tobacco control and smoking environment.²⁸) However, there are few empirical studies examining the associations between time inconsistency, environment and obesity.

Thus, the purpose of the present study is to assess the associations between time inconsistency, work environment and obesity-related factors (obesity, adult weight gain and MetS) among Japanese male workers. In this cross-sectional study using data of Japanese workers, we evaluated the difference between white-collar and blue-collar work environments. In terms of the interplay between time inconsistency and work environment in which time preference might affect daily personal decisions, we focused on how often workers make cue-triggered decisions during work (impulsive unhealthy behaviours influenced by work environment). Workers' behaviours during work, such as occupational activity, are generally determined not only by personal decisions but also by job duties. In this study, we assess relationships between time inconsistency and obesity-related factors by 'occupational class' which is a proxy for work environments. White-collar workers make more personal decisions about work than blue-collar workers. In other words, blue-collar workers who are more regulated with respect to when to act, take a rest, and snack at work may be more protected from cue-triggered obesogenic behaviours. Thus, we hypothesise that occupational status (ie, white-collar or blue-collar) might be a significant effect modifier in the associations between time inconsistency and obesity-related factors.

METHODS

Participants

The enrolled participants included 885 full-time male workers (567 white collar workers, 64.1%) aged 35–64

Box 1 A question about procrastination ('Homework in Schooldays')

Q: 'Reflecting back on when you were a child and were given an assignment to be completed during school vacation, how early did you usually finish the assignment?'

1. Got it done right away.
 2. Tended to get it done early, before the due date.
 3. Worked on it daily up until the due date.
 4. Tended to get it done toward the end.
 5. Got it done at the last minute.
- The responses were grouped into three categories; none (1–3), medium (4) and high (5).

(47.0±8.2) years, from two work sites of the same electronics manufacturing company located in central Japan (Chubu area). All participants underwent annual health checkups in 2015 at their workplaces. These were performed using standardised methods, in accordance with the Japanese Occupational Safety and Health Act. At the health checkups, participants were asked to complete questionnaires that included items about procrastination.

Patient and public involvement

No patient involved.

Procrastination

Along the lines of studies by Ikeda *et al*¹⁹ and Kang and Ikeda,²⁰ procrastination, which is considered a proxy for hyperbolic discounting, was assessed using one questionnaire item about homework assignments that were given when respondents were still in school: "Reflecting back to when you were a child and were given an assignment to be completed during school vacation, how early did you usually finish the assignment?". Responses were scored using a five-point Likert scale (Box 1). This questionnaire was consistent with the major method to assess time preference or hyperbolic discounting, in which participants make a series of binary choices, such as preferring to receive a smaller amount of money sooner or a larger amount later.²⁹ Students in Japanese schools usually have many homework assignments during their school vacations. Psychological studies by Michel and colleagues, as well as other empirical studies, have shown that self-control ability during childhood and adolescence predict future obesity.^{12 30} In addition, using the method assessed by making a series of binary choices, a certain rate of participants must be excluded for analyses because of their irrational and non-assessable responses.¹⁹ (For example, in the study of Takagi *et al*,³¹ 20% of participants were excluded.) Thus, we included this item in the questionnaires. The higher the score for this item, the stronger the tendency toward procrastination. Responses were grouped into three categories: none (1–3), medium (4) and high (5) levels of procrastination.

Obesity, adult weight change, abdominal obesity and metabolic syndrome

Anthropometric parameters (height, body weight and waist circumference) were measured at the health checkups. We calculated BMI and weight change during adulthood (adult weight change). BMI was calculated as weight in kilograms divided by the square of height in metres (kg/m^2). Using the Japanese-specific criteria, obesity was defined as BMI over $25 \text{ kg}/\text{m}^2$.³² Adult weight change was calculated as the difference between body weight in 2015 and self-reported body weight at 20 years of age. We defined participants with adult weight change over 10 kg as having 'adult weight gain' (AWG10).⁸⁻¹¹ Abdominal obesity was defined as excessive waist circumference ($\geq 85 \text{ cm}$).

Using health check-up data, MetS was assessed according to Japanese criteria, which is defined as excessive waist circumference as well as the presence of two or more of the following: hypertension, glucose intolerance and dyslipidaemia.³³

Work-related factors

Whether participants were white-collar or blue-collar workers was assessed according to the substance of their work, which was obtained from their personnel file. Along with the Japan Standard Occupational Classification,³⁴ we defined professional and technical, administrative and managerial, clerical, and sales and service workers as white-collar workers. Blue-collar workers were defined as security/protection, transport, production workers and labourers.

Working hours were assessed using a self-report questionnaire (online supplementary table 1). Long working hours were defined as the participant working after 21:00 hours '3-4 days per week' or 'almost all weekdays'. At the target company, regular employees work from 08:30 to 17:00, so employees with long working hours work overtime at least 45 hours per month. Shift work (night shift work) was assessed using information of the health checkups for shift workers. According to the Japanese Occupational Safety and Health Act, shift workers must have health checkups once or more every 6 months. All shift workers were blue-collar workers.

Covariates

Previous and current medical history, education, smoking habits, alcohol consumption, physical activity and eating habits were recorded using a self-report questionnaire (online supplementary table 1). Education was classified as college graduate or higher or no higher education. Smoking status was classified as smoker, past smoker, or never smoker. Alcohol consumption was classified as heavy drinker (consuming 300 g or more of alcohol per week), moderate drinker (consuming 150-300 g of alcohol per week) or light drinker (consuming 1-150 g of alcohol per week). Leisure time physical activity was defined as exercising in free time over 30 min twice or more per week, and daily physical activity was defined as

physical activity in daily life equal to more than an hour of walking. Eating habits were classified according to eating speed (fast or not), eating a late evening meal (within 2 hours before bedtime on 3 days or more week), late-night snacking (snacking after the evening meal on 3 days or more per week), and skipping breakfast on 3 days or more per week.

Statistical analysis

We tested differences in the baseline characteristics of participants between the three procrastination categories using a chi-square test for categorical variables and analysis of variance for continuous variables. To evaluate the association between procrastination and obesity-related outcomes, we used multivariable linear regression models for continuous variables (BMI and adult weight change) and logistic regression models for categorical variables (obesity, adult weight gain and MetS). We calculated age-adjusted and multivariable-adjusted partial regression coefficients (Bs), ORs and their corresponding 95% CIs, using the procrastination category of 'None' as the reference group. We performed three-step analysis in addition to the crude model: models 1, 3, 5 and 7 were adjusted for age, education and working conditions, which were considered as confounding factors. Models 2, 4, 6 and 8 additionally controlled for physical activity, smoking status, and alcohol consumption in order to exclude the possibility that procrastination was associated the obesity through lifestyle other than work.

We entered interaction terms into the models to test whether procrastination interacted multiplicatively with working condition (blue-collar or white-collar work) in analyses using total samples (combined blue-collar and white-collar workers). We then calculated Bs and ORs using blue-collar and white-collar worker samples separately. In the analyses using logistic models, we calculated P for trend across three procrastination categories.

To assess the robustness of the relationships between obesity and procrastination among white-collar workers, sensitivity analyses were performed by excluding each white-collar occupation (ie, professional and technical, administrative and managerial, clerical, and sales and service workers).

RESULTS

A total of 885 employees who underwent health checkups in 2015 were enrolled in this study. We excluded one worker (0.1%) who did not complete the health check-up, and 89 workers (10.1%) who did not complete the questionnaires. Finally, 795 workers (46.9 ± 8.1 years old; BMI $23.1 \pm 3.2 \text{ kg}/\text{m}^2$; 515 white-collar workers, 64.8%) with complete data were included in the analyses. Among these 795 workers, 182 (22.9%) were obese, 169 workers (21.3%) had AWG10, and 123 workers (15.5%) had MetS.

Table 1 shows the characteristics of participants according to occupation and procrastination categories.

There were no significant differences in BMI at age 20 years across procrastination categories. Workers with high procrastination levels were likely to be less educated, current smokers, and shift workers, and were less likely to engage in daily physical activity and more likely to skip breakfast. White-collar workers with high procrastination levels had greater waist circumference and greater weight gain during adulthood. The highest prevalence of obesity, AWG10 and MetS was among white-collar workers with high procrastination, at 29.1%, 27.4% and 23.1%, respectively. Blue-collar workers without procrastination had the highest prevalence of obesity, AWG10 and MetS (24.7%, 24.7% and 19.5%, respectively).

The associations of procrastination with BMI and adult weight change using multivariate linear regression models are shown in [table 2](#). White-collar workers had higher BMI and gained more weight during adulthood than blue-collar workers. Among white-collar workers, not blue-collar or all workers, there were significant positive associations of high procrastination with BMI (B: 0.75, 95% CI 0.06 to 1.44) and adult weight change (B: 1.77, 95% CI 0.26 to 3.29), after adjusting for covariates.

[Table 3](#) shows the results of multivariate logistic regression analysis for obesity, AWG10 and MetS. For obesity among all categories of workers (the total, white- and blue-collar workers), high procrastination showed no significant associations of obesity. For AWG10 and MetS among white-collar workers, high procrastination had about a twofold greater odds of AWG10 and MetS compared with no procrastination, even after controlling for related covariates (OR: 1.85, 95% CI 1.04 to 3.29 for AWG10; OR: 2.29 95% CI 1.18 to 4.44 for MetS). However, such positive associations of high procrastination with AWG10 and MetS were not observed among all workers and blue-collar workers. Furthermore, among blue-collar workers, procrastination tended to show a decreased odds of MetS (OR: 0.40, 95% CI 0.15 to 1.06) in the fully adjusted model. We observed increased rates of AWG10 and MetS across categories by increased procrastination in white-collar workers ($p < 0.05$, respectively), while such monotonic increases in odds were not observed in all workers or in blue-collar workers. Similar results were observed in the calculation of odds for adult weight gain over 5 kg (AWG5). High procrastination showed significantly greater risk of AWG5 among white-collar workers but not all or blue-collar workers (OR: 1.91, 95% CI 1.18 to 3.09; [online supplementary table 2](#)).

We performed sensitivity analyses, excluding each occupation for white-collar work to assess whether a specific occupation affected the relationship between procrastination, white-collar work and obesity-related factors; we obtained similar results from the analyses. For example, among white-collar workers, excluding sales and service workers ($n=75$), high procrastination was positively associated with AWG10 (OR: 1.83, 95% CI 0.98 to 3.39) and MetS (OR: 2.26, 95% CI 1.12 to 4.59) in the fully adjusted model ([online supplementary table 3](#)).

Workers with high procrastination tended to engage in less daily physical activity and to skip breakfast ([table 1](#)). When we estimated the effects of procrastination, controlling for all these unhealthy habits, the findings remained significant ([online supplementary table 4](#)).

DISCUSSION

In this cross-sectional study, we examined the association of procrastination, a proxy for hyperbolic discounting and self-control, with obesity-related factors among Japanese male employees. The results showed that white-collar workers with high procrastination levels showed positive associations with BMI, adult weight change, AWG10 and MetS; BMI at age 20 years was not different across procrastination categories. Such significant positive relationships were not observed among blue-collar workers, suggesting that working conditions might modify the association of procrastination with obesity-related factors ([table 2](#)).

Evidence has indicated that self-regulation (ie, procrastination and undesirable time preference) and socioemotional skills at large scale, as well as cognitive skills (ie, IQ score), have a profound impact on an individual's health. In addition, there is increasing interest in the hypothesis that socioemotional skills and environmental factors during the life course, such as in the family, school, community and workplace, interact to produce health effects.^{12 13} Our study evaluating the interactive effects of procrastination and workplace factors is line with this hypothesis. To our knowledge, this is the first study indicating the joint association of time inconsistency and work condition with obesity.

Many empirical studies have shown the associations of time inconsistency with obesity-related habits and obesity.^{15 16} Our results showed workers with high procrastination tended to engage in less daily physical activity and to skip breakfast ([table 1](#)), behaviours that are well-known risk factors of obesity. However, these unhealthy life habits alone could not explain our results. When we estimated the effects of procrastination, controlling for all these habits, the findings remained significant positive ([online supplementary table 1](#)). This suggests that in addition to procrastination and obesity, other unhealthy habits such as fast food consumption,³⁵ and impulsive (sometimes automatic) unhealthy behaviours interact with the work environment.³⁶ In Ainslie's hyperbolic discounting model, people with high hyperbolic discounting (procrastination) tend to engage in impulsive unhealthy behaviours,^{17 18} which are often induced by environmental cues. White-collar workers, who generally have not only longer sedentary time at work but can also make more personal decisions about when to take a break, snack, and about doing physical activity during work, might be more influenced by obesogenic work environment (environmental cues). Our results showed that procrastination is a powerful contributing factor to adult weight gain and MetS among such white-collar workers, although our study did not assess work environment

Table 1 Characteristics of analytic participants (all, white-collar or blue-collar workers)

	All workers (n=795)				White-collar workers (n=515)				Blue-collar workers (n=280)			
	Procrastination none (n=270)	Medium (n=323)	High (n=202)	P value	None (n=193)	Medium (n=205)	High (n=117)	P value	None (n=77)	Medium (n=118)	High (n=85)	P value
Age, years	47.1±8.1	46.7±7.8	47.0±8.5	0.8	46.7±8.1	47.3±8.0	46.7±8.3	0.725	48.1±8.2	45.6±7.5	47.3±8.6	0.081†
Weight, kg	67.0±10.2	66.9±10.0	68.0±10.9	0.49	67.6±10.1	67.4±9.1	69.5±10.5	0.159	65.5±10.6	66.1±11.2	65.9±11.2	0.944
BMI, kg/m ²	22.9±3.1	23.1±3.1	23.4±3.4	0.254	22.9±3.0	23.3±2.7	23.8±3.3	0.065†	22.7±3.4	22.8±3.7	22.9±3.6	0.97
Waist circumference, cm	81.5±8.8	82.1±8.8	82.8±8.6	0.23	81.8±8.6	82.7±7.8	84.2±8.4	0.048*	80.6±9.5	80.9±10.2	81.0±8.5	0.963
Weight at the age of 20, kg	62.2±9.8	62.1±8.9	62.5±9.3	0.902	62.9±9.7	61.7±8.3	62.7±9.6	0.376	60.6±9.8	62.9±9.9	62.2±8.9	0.274
BMI at the age of 20, kg/m ²	21.3±2.9	21.5±2.7	21.5±2.9	0.581	21.4±2.8	21.3±2.4	21.5±2.9	0.841	21.0±3.1	21.7±3.2	21.6±3.0	0.269
Adult Weight change, kg	4.78±6.88	4.81±7.24	5.47±7.50	0.511	4.72±6.45	5.73±6.71	6.75±6.69	0.031*	4.90±7.90	3.21±7.84	3.71±8.20	0.343
Education (college graduated), n (%)	112 (41.5%)	95 (29.4%)	61 (30.2%)	0.004**	111 (57.5%)	94 (45.9%)	57 (48.7%)	0.058†	1 (1.3%)	1 (0.8%)	4 (4.7%)	0.145
Long work hours, n (%)	81 (30.0%)	87 (26.9%)	52 (25.7%)	0.55	70 (36.3%)	74 (36.1%)	44 (37.6%)	0.961	11 (14.3%)	13 (11.0%)	8 (9.4%)	0.612
Shift work, n (%)	15 (5.6%)	33 (10.2%)	25 (12.4%)	0.028*	—	—	—	—	15 (19.5%)	33 (28.0%)	25 (29.4%)	0.294
Smoking status												
Current smoking, n (%)	77 (28.5%)	117 (36.2%)	81 (40.1%)	0.024*	44 (22.8%)	64 (31.2%)	39 (33.3%)	0.076†	33 (42.9%)	53 (44.9%)	42 (49.4%)	0.687
Past smoking, n (%)	85 (31.5%)	89 (27.6%)	60 (29.7%)	0.577	63 (32.6%)	58 (28.3%)	39 (33.3%)	0.538	22 (28.6%)	31 (26.3%)	21 (24.7%)	0.855
Alcohol habits												
Drinking, n (%)	82 (30.4%)	113 (35.0%)	77 (38.1%)	0.199	61 (31.6%)	76 (37.1%)	47 (40.2%)	0.273	21 (27.3%)	37 (31.4%)	30 (35.3%)	0.547
Light drinker, n (%)	17 (6.3%)	31 (9.6%)	20 (9.9%)	0.262	14 (7.3%)	21 (10.2%)	14 (12.0%)	0.352	13 (16.9%)	10 (8.5%)	6 (7.1%)	0.083†
Moderate drinker, n (%)	48 (17.8%)	69 (21.4%)	40 (19.8%)	0.551	40 (20.7%)	45 (22.0%)	24 (20.5%)	0.938	8 (10.4%)	24 (20.3%)	16 (18.8%)	0.175
Heavy drinker, n (%)	7 (2.6%)	13 (4.0%)	17 (8.4%)	0.009**	7 (3.6%)	10 (4.9%)	9 (7.7%)	0.282	0 (0%)	3 (2.5%)	8 (9.4%)	0.005**
Physical activity												
Leisure time physical activity, n (%)	78 (28.9%)	86 (26.6%)	55 (27.2%)	0.822	58 (30.1%)	61 (29.8%)	35 (29.9%)	0.998	20 (26.0%)	25 (21.2%)	20 (23.5%)	0.739
Daily physical activity, n (%)	101 (37.4%)	113 (35.0%)	55 (27.2%)	0.059†	64 (33.2%)	52 (25.4%)	27 (23.1%)	0.097†	37 (48.1%)	61 (51.7%)	28 (32.9%)	0.024*
Eating habits												
Eating quickly, n (%)	98 (36.3%)	100 (31.0%)	69 (34.2%)	0.383	73 (37.8%)	67 (32.7%)	44 (37.6%)	0.502	25 (32.5%)	33 (28.0%)	25 (29.4%)	0.796

Continued

Table 1 Continued

	All workers (n=795)				White-collar workers (n=515)				Blue-collar workers (n=280)			
	Procrastination none (n=270)	Medium (n=323)	High (n=202)	P value	None (n=193)	Medium (n=205)	High (n=117)	P value	None (n=77)	Medium (n=118)	High (n=85)	P value
Skipping breakfast, n (%)	34 (12.6%)	33 (10.2%)	36 (17.8%)	0.040*	22 (11.4%)	26 (12.7%)	23 (19.7%)	0.104	12 (15.6%)	7 (5.9%)	13 (15.3%)	0.048*
Late night snacking, n (%)	38 (14.1%)	51 (15.8%)	33 (16.3%)	0.764	29 (15.0%)	31 (15.1%)	18 (15.4%)	0.996	9 (11.7%)	20 (16.9%)	15 (17.6%)	0.517
Late evening meal, n (%)	104 (38.5%)	124 (38.4%)	89 (44.1%)	0.494	87 (45.1%)	96 (46.8%)	64 (54.7%)	0.237	17 (22.1%)	28 (23.7%)	25 (29.4%)	0.612
Obesity (BMI≥25), n (%)	64 (23.7%)	67 (20.7%)	51 (25.2%)	0.454	45 (23.3%)	43 (21.0%)	34 (29.1%)	0.257	19 (24.7%)	24 (20.3%)	17 (20.0%)	0.716
Severe obesity (BMI ≥30), n (%)	6 (2.2%)	10 (3.1%)	9 (4.5%)	0.387	5 (2.6%)	4 (2.0%)	6 (5.1%)	0.25	1 (1.3%)	6 (5.1%)	3 (3.5%)	0.379
AWG5, n (%)	124 (45.9%)	147 (45.5%)	106 (52.5%)	0.249	87 (45.1%)	102 (49.8%)	72 (61.5%)	0.018*	37 (48.1%)	45 (38.1%)	34 (40.0%)	0.37
AWG10, n (%)	50 (18.5%)	70 (21.7%)	49 (24.3%)	0.312	31 (16.1%)	52 (25.4%)	32 (27.4%)	0.028*	19 (24.7%)	18 (15.3%)	17 (20.0%)	0.26
Abdominal obesity (a), n (%)	85 (31.5%)	102 (31.6%)	70 (34.7%)	0.592	59 (30.6%)	69 (33.7%)	47 (40.2%)	0.222	26 (33.8%)	33 (28.0%)	23 (27.1%)	0.592
MetS (b), n (%)	37 (13.7%)	50 (15.5%)	36 (17.8%)	0.473	22 (11.4%)	35 (17.1%)	27 (23.1%)	0.024*	15 (19.5%)	15 (12.7%)	9 (10.6%)	0.233

(a): waist circumferences ≥85 cm; (b): defined by the Japanese criteria (excessive waist circumference as well as the presence of two or more of the following symptoms; hypertension, glucose intolerance and dyslipidaemia).

*p<0.05; **p<0.01.

†p<0.10

AWG5, adult weight gain over 5 kg; AWG10, adult weight gain over 10 kg; BMI, body mass index; MetS, metabolic syndrome.

Table 2 Association of procrastination and work environment with body mass index and adult weight change

	All workers (n=795)			White-collar workers (n=515)			Blue-collar workers (n=280)			All workers (n=795)			White-collar workers (n=515)			Blue-collar workers (n=280)		
	Model 1a	Model 2b	Model 3a	Model 4b	Model 5c	Model 6d	Model 7a	Model 8b	Model 1a	Model 2b	Model 3a	Model 4b	Model 5c	Model 6d	Model 7a	Model 8b		
	Model 1a	Model 2b	Model 3a	Model 4b	Model 5c	Model 6d	Model 7a	Model 8b	Model 1a	Model 2b	Model 3a	Model 4b	Model 5c	Model 6d	Model 7a	Model 8b		
Procrastination																		
Medium	0.24	0.24	0.14	-1.55	0.26	0.64	0.14	0.2	0.08	0.06	-1.53	-1.55	0.74	0.64	-1.58	-1.64		
	-0.28-0.76	-0.29-0.76	-0.78-1.06	-3.59-0.50	-0.33-0.84	-0.66-1.94	-0.91-1.18	-0.85-1.25	-1.08-1.23	-1.09-1.22	-3.59-0.51	-3.59-0.50	-0.55-2.04	-0.66-1.94	-3.92-0.74	-3.99-0.70		
High	0.55†	0.54†	0.13	-1.07	0.79*	0.75*	0.09	0.22	0.87	0.87	-1.09	-1.07	1.85*	1.77*	-1.25	-1.25		
	-0.04-1.14	-0.06-1.13	-0.86-1.12	-3.28-1.14	0.11-1.48	0.06-1.44	-1.03-1.21	-0.93-1.36	-0.44-2.17	-0.45-2.18	-3.29-1.11	-3.28-1.14	0.35-3.36	0.26-3.29	-3.75-1.25	-3.81-1.31		
Work environment																		
White-collar	0.66*	0.65*	0.43	0.54					2.48**	2.30**	0.71	0.54						
	0.07-1.25	0.06-1.25	-0.49-1.34	-1.50-2.58					1.17-3.79	0.97-3.62	-1.32-2.75	-1.50-2.58						
Interaction																		
White-collar			0.13	0.12							2.32†	2.31†						
*Procrastination Medium			-0.99-1.24	-1.01-1.24							-0.17-4.81	-0.17-4.79						
White-collar			0.67	0.61							2.97*	2.91*						
*Procrastination High			-0.57-1.90	-0.62-1.85							0.23-5.71	0.18-5.65						

^aAdjusted for age, education, long work hours and shift work.

^bAdjusted for age, education, long work hours, shift work, smoking, drinking and physical activity.

^cAdjusted for age, education and long work hours.

^dAdjusted for age, education, long work hours, smoking, drinking and physical activity.

*p<0.05; **p<0.01.

†p<0.10.



Table 3 Association of procrastination and work environment with obesity, adult weight gain over 10kg and metabolic syndrome

	All participants (n=795)											
	White-collar workers (n=515)						Blue-collar workers (n=280)					
	Crude	Model 1a	Model 2b	Model 3a	Model 4b	Crude	Model 5c	Model 6d	Crude	Model 7a	Model 8b	
Number of obesity												
Procrastination												
None	64/270 23.7%	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	45/193 23.3%	1 (Reference)	1 (Reference)	19/77 24.7%	1 (Reference)	1 (Reference)	1 (Reference)
Medium	67/323 20.7%	0.84 0.57-1.24	0.83 0.56-1.23	0.80 0.40-1.61	0.81 0.40-1.64	43/205 21.0%	0.87 0.54-1.40	0.80 0.49-1.30	24/118 20.3%	0.78 0.39-1.55	0.82 0.41-1.64	0.86 0.42-1.76
High	51/202 25.3%	1.09 0.71-1.67	1.07 0.69-1.65	0.75 0.35-1.59	0.75 0.39-1.39	34/117 29.1%	1.35 0.80-2.27	1.28 0.75-2.17	17/85 20.0%	0.76 0.36-1.60	0.70 0.33-1.51	0.76 0.34-1.67
p for trend	0.777	0.766	0.767			0.341	0.385	0.417	0.477	0.366	0.482	
Work environment												
Blue-collar	60/280 21.4%	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)							
White-collar	122/515 23.7%	1.14 0.80-1.62	1.37 0.87-2.16	1.12 0.57-2.19	1.16 0.59-2.30							
Interaction												
White-collar *Medium procrastination				1.05 0.45-2.45	1.01 0.43-2.37							
White-collar *High procrastination				1.78 0.71-4.45	1.73 0.69-4.34							
Number of AWG10												
Procrastination												
None	50/270 18.5%	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	31/193 16.1%	1 (Reference)	1 (Reference)	19/77 24.7%	1 (Reference)	1 (Reference)	1 (Reference)
Medium	70/323 21.7%	1.22 0.81-1.83	1.21 0.80-1.84	0.59 0.29-1.23	0.59 0.28-1.23	52/205 25.4%	1.78* 1.08-2.92	1.63† 0.98-2.71	18/118 15.3%	0.55 0.27-1.13	0.59 0.28-1.23	0.58 0.27-1.24
High	49/202 24.3%	1.41 0.90-2.20	1.41 0.89-2.23	0.80 0.38-1.68	0.80 0.37-1.71	32/117 27.4%	1.97* 1.12-3.44	1.85* 1.04-3.29	17/85 20.0%	0.76 0.36-1.60	0.78 0.36-1.65	0.73 0.33-1.64
p for trend	0.128	0.132	0.115			0.013*	0.025*	0.021*	0.481	0.512	0.551	
Work environment												
Blue-collar	54/280 19.3%	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)							
White-collar	115/515 22.3%	1.20 0.84-1.73	1.37 0.86-2.17	0.76 0.38-1.53	0.71 0.35-1.44							

Continued

Table 3 Continued

	All participants (n=795)										
	White-collar workers (n=515)					Blue-collar workers (n=280)					
	Crude	Model 1a	Model 2b	Model 3a	Model 4b	Crude	Model 5c	Model 6d	Crude	Model 7a	Model 8b
Interaction											
White-collar *Medium procastination				2.80*	2.84*						
White-collar *High procastination				1.15–6.80	1.16–6.96						
				2.36†	2.33†						
				0.92–6.05	0.90–6.01						
Number of MetS											
Procastination											
None	37/270 13.7%	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)	22/193 11.4%	1 (Reference)	1 (Reference)	15/77 19.5%	1 (Reference)	1 (Reference)
Medium	50/323 15.5%	1.15 0.73–1.83	1.09 0.67–1.76	0.68 0.31–1.52	0.62 0.27–1.39	35/205 17.1%	1.60 0.90–2.84	1.47 0.80–2.70	15/118 12.7%	0.60 0.28–1.32	0.63 0.27–1.44
High	36/202 17.8%	1.37 0.83–2.25	1.23 0.72–2.10	0.49 0.20–1.21	0.39* 0.15–1.00	27/117 23.1%	2.33** 1.26–4.33	2.29* 1.18–4.44	9/85 10.6%	0.49 0.20–1.19	0.40† 0.15–1.06
p for trend		0.223	0.228	0.288			0.007**	0.013*		0.109	0.155
Work environment											
Blue-collar	39/280 13.9%	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)						
White-collar	84/515 16.3%	1.20 0.80–1.82	1.51 0.89–2.56	0.75 0.34–1.69	0.65 0.29–1.46						
Interaction											
White-collar *Medium procastination				2.20	2.32						
White-collar *High procastination				0.81–5.97	0.84–6.41						
				4.81**	5.60**						
				1.58–14.64	1.80–17.41						

*Adjusted for age, education, long work hours and shift work.

^bAdjusted for age, education, long work hours, shift work, smoking, drinking and physical activity.

^cAdjusted for age, education and long work hours.

^dAdjusted for age, education, long work hours, smoking, drinking and physical activity.

*p<0.05; **p<0.01.

†p<0.10.

AWG10, adult weight gain over 10 kg; MetS, metabolic syndrome.

directly. In contrast to these workers, we also found that blue-collar workers with high procrastination had no significant risk of obesity-related factors, which supports the hypothesis of an interactive effect between work environment and time inconsistency on obesity among workers.

There are increasing concerns about the development of socioemotional skills, especially during preschool education, because early skills are thought to be important determinants of future skills, which can lead to great health inequalities.^{12 30} In addition, these skills (time inconsistency and procrastination) are partially genetically determined.^{37–39} However, our results suggest that workers with high procrastination (one of adverse socioemotional skills^{12 30}) who work in desirable settings (non-obesogenic; less sedentary, less free to eat during work and better regulated) might not have an increased risk of obesity, that is, work site interventions may be important to prevent obesity among workers.^{21 36} In developed countries, occupationally related physical activities have been decreasing recently.⁴⁰ Further study is needed to assess the kinds of work environments that can reduce the effect of procrastination on obesity.

We inferred some other potential reasons for our finding of no significant relationship between procrastination and obesity in blue-collar workers. One possible reason relates to socioeconomic status, especially household income, and marital and parental status. Previous studies have showed that these variables are associated with obesity.^{41 42} However, our analyses did not include them, because our study did not survey them. Further study is needed to evaluate the relationships between procrastination, work environment and obesity controlling for socioeconomic status. A second possible reason relates to the healthy worker effect. Because blue-collar work requires greater physical activity, workers with obesity-related diseases who cannot do such work may resign or change their position to white-collar work.

MetS and weight gain during adulthood, as well as obesity, are risk factors of type 2DM, CVD, sudden death, and cancer. In the work context (productivity and cost), obesity is also associated with negative consequences among workers, including more frequent absenteeism, sick leave, workplace injury, and greater healthcare costs.^{43 44} Additionally, obesity strengthens the effect of work-related psychological stress on workplace blood pressure and autonomic nervous dysfunction, which can induce CVD and sudden death, including *karōshi* (death from overwork).^{45–47} To prevent these diseases and harmful results, male white-collar workers with high procrastination levels should be monitored more carefully for undesirable adult weight gain (ie, weight gain over 3 kg in 1 year).

The present study has several strengths. First, we used health check-up data, including measured BMI, which is different from many previous studies using self-reported BMI.^{15 16 19} Additionally, our study assessed MetS because our data included the results of blood tests. This is the

first study indicating the epidemiological relationship between time preference and MetS. Finally, as discussed above, ours is the first study among workers to document the different relationships between procrastination and obesity, by occupation.

Limitations of this study include the following. First, our data were cross-sectional in nature and procrastination was assessed using self-report questionnaires; therefore, a causal relationship between procrastination and obesity cannot be inferred. Although we used white-collar or blue-collar work as the exposure variables in this study, we did not assess career changes (ie, blue-collar to white-collar career change and vice versa). Second, in this study, we used one questionnaire addressing homework when workers were in school, which participants were asked to recall, to assess time inconsistency. We did not use the more common type of questionnaire used to assess procrastination, in which participants make a series of binary choices, such as preferring to receive a smaller amount of money sooner or a larger amount later.^{15 16 19} Therefore, we cannot compare our results to previous studies that used the latter type of survey. In addition, we did not assess impatience and the sign effect, which are other time inconsistency indexes related to obesity.¹⁹ Additionally, in the questionnaire about homework while in school, our results may be affected by social disability bias. Third, our analysis did not include family status (marital and parenthood status) and household income data, which are considered important covariance factors.^{41 42} Finally, participants in our study were employees of a manufacturing company and its associate companies in Japan. Obesity and Mets were assessed using Japanese-specific criteria. Therefore, our results may contain healthy worker bias and will be difficult to be generalised to all workers in Japanese companies and other countries.

In conclusion, we investigated the association of procrastination with obesity-related factors among workers in a Japanese manufacturing company. Procrastination was associated with increased risk of obesity-related factors in male white-collar workers but not in all workers and blue-collar workers. To prevent obesity-related diseases among workers, we should monitor male white-collar workers who have high levels of procrastination more carefully, and work site interventions in white-collar obesogenic environments may be useful.

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ORCID iDs

Akihiko Narisada <http://orcid.org/0000-0002-3957-6256>

Kohta Suzuki <http://orcid.org/0000-0002-8151-6927>

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