

平成 19 年度学位申請論文

Relationship of BMI increase to eating behavior and job stress in a 2-year cohort study of non-obese male Japanese workers

(日本人の非肥満男性労働者における 2 年間のコホート研究による

BMI 増加と食行動及び職場ストレスとの関連)

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Introduction

Obesity is known to be a health problem leading to diabetes mellitus, hypertension, and hyperlipidemia, and to heart disease and stroke [1-3]. According to the WHO criteria, BMI of 25 kg/m² or more and less than 30 kg/m² indicates overweight, and BMI of 30 kg/m² or more obesity [4]. On the other hand, it has been realized that the WHO's criteria for obesity should be different for various ethnic groups [5]. In Japan, the prevalence of the obesity-related diseases was shown to increase with BMI even lower than the 30 kg/m² [2, 6], and hence the Japan Society of the Study of Obesity has adopted BMI of 25 kg/m² and more as a criteria for obesity [7]. The eating behaviors of obese patients have been characterized by a strong tendency to eat fast and to eat until full [8]. Such characteristic behaviors are considered to be forms of substitution eating and drinking such as 'diversionary eating' and 'irritability eating' [8]. Eating behaviors are shown to readily change when people under stress unconsciously seek relief in eating and drinking [9]. In Japan, obesity is on the rise mainly among working males in their 30s through 60s. In addition an increasing number of workers feel

stressed by the need to cope with current rapid technical innovations and diversifying work patterns. When thinking about modern working and living conditions, it is necessary to consider job stress as well as eating behavior in relation to obesity, since job stress may affect eating behavior which in turn contributes to obesity.

With respect to the relation between obesity and job stress, no consensus has been reached [10], and few studies on the subject exist. Therefore, in 2003 we conducted a study on the relation of obesity to eating behavior and job stress in male manufacturing industry workers [11]. The results showed that obese workers tended to have the eating behaviors of eating to satiety and substitution eating. In addition, they were more likely to feel tension/anxiety as a psychological stress response. And the eating behavior of eating to satiety was also associated with tension/anxiety from high job demands and low job latitudes. These findings suggest the possibility that workers feeling stressed are prone to change the eating behavior to eat much and result in obesity.

On the other hand, weight gain as well as obesity is known to be a risk factor for health problems. An earlier study indicated that an increase in body mass index (BMI) of 1 kg/m^2 raised the risk of

various health disorders [12]. Increasing BMI, even in the non-obese level, rises a risk for diabetes mellitus [13]. A BMI increase of 1 kg/m² may raise that risk about 26% in non-obese male Japanese [14]. Therefore, it is important to prevent weight gain and subsequent obesity in non-obese subjects. Previous studies suggest the relationship of weight gain in workers to night and late-shift work, long working hours, psychological job demands, work fatigue, and the like [15, 16]. However, there are still few studies on weight gain and job stress. Hence, to clarify the interactions among weight gain, eating behavior, and job stress, we conducted the present 2-year cohort study by following the non-obese male Japanese workers examined in 2003.

Cross - sectional study (2003)

Methods

Study subjects

The subjects were all 214 male employees of a synthetic fiber manufacturing plant. Self-completed questionnaire forms were distributed to these 214 men at the end of April 2003 and collected in May from those who consented to participate. After the questionnaires were collected, they were checked for completeness by an occupational health nurse. Questionnaires were collected from 210 men, for a response rate of 98.1%. Two of the respondents with a history of mental disorders under treatment were excluded; the present analysis was thus conducted with the remaining 208 men aged 19-60 years (mean age \pm standard deviation; 33.7 ± 12.3 y).

Body mass index (BMI; kg/m^2) was calculated from the results of the annual health examinations conducted March–May 2003 in the manufacturing plant. Based on the criteria of the Japan Society for the Study of Obesity, obesity was defined as a BMI ≥ 25.0 kg/m^2 in this study, though it is classified as overweight and obesity according to the WHO criteria; the 208 subjects were divided into a non-obese group (141 subjects with BMI ≤ 24.9 kg/m^2) and an obese group (67

subjects with BMI ≥ 25.0 kg/m²).

This study has been approved by the ethics committee of the Nagoya University School of Medicine.

Contents of questionnaire survey

Basic attributes and life style

The survey asked about age, sex, work pattern, job type, overtime working hours, walking time during commute, average sleeping time, health state, regular exercise, smoking habit, alcohol consumption, and so on.

Job stress

The Job Stress Questionnaire [17], which was made in a study commissioned by the Japanese Ministry of Health, Labor and Welfare, was used in the present study. The Questionnaire has been shown to have Cronbach α coefficient of 0.74 for job stress factors, 0.84 for psychological stress response, 0.81 for physical stress response and 0.83 for support [17]. The questionnaire consists of three main parts of job stress factors of psychological workload, psychological stress response, and stress mitigation factors.

The questions have a total of 17 items to measure job stress factors of psychological workload (Table 1). These are categorized as quantitative workload (1-3), qualitative workload (4-6), physical workload (7), job latitude (8-10), application of technology (11), interpersonal conflict (12-14), workplace environment (15), and appropriateness of work (16, 17). The section on psychological stress response (Table 2) has a total of 18 items to measure positive responses (activity (1-3)) and negative responses (anger (4-6), fatigue (7-9), tension/anxiety (10-12), and depression (13-18)). The section to assess physical stress response (Table 2) has a total of 11 items. Stress mitigation factors were measured by nine items

incorporating support in the family and workplace and 2 items on satisfaction with workplace and family.

The respective scores for psychological and physical stress responses are then totaled and assessed. Each item was rated on a four-point scale ranging from 'strongly disagree' to 'strongly agree.' Subjects with a psychological stress response score of 51 points or more are considered to have a high mental stress response. Similarly, persons with a total score for physical stress response of 25 points or more are considered to have a high physical stress response.

Eating behavior

Of the 50 items on the Sakata's Eating Behavior Questionnaire, thirty questions (Table 3) were used that have been shown to differ significantly between obesity patients and healthy people [8, 18]. This questionnaire is used in some hospitals for obesity treatment in Japan [19]. These 30 questions are classified into the seven areas regarding cognition of constitution (1-3), eating style (4-6), eating rhythm abnormalities (7, 8, 16, 17, 30), feeling of satiety (9, 10, 24, 25, 28), substitute eating and drinking (11, 18, 19, 21-23), meal contents (12-15, 20), and motivation for eating (26, 27, 29).

Statistical analysis

The relationship between obesity, job stress, and eating behavior in the obese and non-obese groups was investigated as follows. The χ^2 test and Mann-Whitney U-test were used for basic attributes, life style, job stress, and eating behavior. The relation between obesity and each category of job stress factors, stress responses and eating behaviors was investigated with a logistic regression analysis after adjusting for age. The relation between psychological stress response and each category of job stress factors and eating behaviors was also investigated using the Spearman correlation coefficient. All statistical analyses were completed with the statistical package SPSS 11.5J.

Results

Basic attributes and life style

Mean age was significantly higher in the obese group (36.0 ± 12.2 y) than in the non-obese group (32.6 ± 12.2 y), while working pattern, type of job, hours of overtime work, exercise, or smoking or drinking habits were not different between the two groups (Table 4).

Job stress

Job stress factors

Since there was a significant difference in age between the obese and non-obese subjects, logistic regression analyses for relations between obesity and job stress factors were conducted while considering age. The results showed no significant relation between obesity and job stress factors (Table 5).

Psychological and physical stress response

Subjects with a total of 51 points or more for mental stress response accounted for 9.2% of the non-obese group and 10.4% of the obese group. Subjects with 25 points or more for physical stress response accounted for 10.6% of the non-obese group and 19.4% of the obese group. There were no significant differences between the two groups.

The results of each category about psychological and physical stress response were shown in Table 6. A significant association was found in a psychological stress response category of "Tension/Anxiety" (OR 1.22; 95% CI 1.05-1.42, p=0.008).

Associations between obesity and the respective item for category of “Tension/Anxiety” were shown in “be tense” (OR 1.88; 95% CI 1.31-2.70, $p=0.001$), “be anxious” (OR 1.25; 95% CI 0.88-1.76, $p=0.213$) and “be unsettled” (OR 1.40; 95% CI 0.96-2.07, $P=0.085$). Physical stress response did not show a significant association with obesity (Table 6).

Correlation between job stress factors and psychological stress response

Since a significant relation was found between obesity and the psychological stress response category of “Tension/Anxiety,” an association between the stress response of “Tension/Anxiety” and job stress factors was examined using the Spearman correlation coefficient. “Tension/Anxiety” was positively correlated with job stress factors related to job demand of quantitative and qualitative workload, and Interpersonal conflict ($p < 0.01$, Table 7). “Tension/Anxiety” was also negatively associated with job latitude ($p < 0.01$).

Eating behavior

Relation between obesity and eating behavior

An age-adjusted logistic regression analysis was conducted to investigate a relation between obesity and eating behaviors. As shown in Table 8, significant odds ratios over 1.2 were encountered in the category of “Cognition of constitution” (OR 1.95; 95% CI 1.61–2.36, $p < 0.001$), “Feeling of satiety” (OR 1.28; 95% CI 1.15–1.42, $p < 0.001$), “Substitute eating and drinking” (OR 1.23; 95% CI 1.11–1.37, $p < 0.001$). Significant odds ratios over 2.0 were encountered in the items of “I tend to gain weight more easily than others” (OR 6.32; 95% CI 3.88–10.30, $p < 0.001$) and “I gain weight just by drinking water” (OR 2.90; 95% CI 1.99–4.22, $p < 0.001$) in the category of “Cognition of constitution,” and “I feel regret after eating too much” (OR 2.82; 95% CI 1.93–4.13, $p < 0.001$) and “I am often cautioned by others about overeating” (OR 2.45; 95% CI 1.64–3.65, $p < 0.001$) in the category of “Feeling of satiety,” and “I eat to get rid of irritability” (OR 3.10; 95% CI 1.93–4.98, $p < 0.001$) in the category of “Substitute eating and drinking,”

Correlation between eating behavior and psychological stress response

A possible relation between the psychological stress response of “Tension/Anxiety” and eating behaviors was also investigated using the Spearman correlation coefficient. The results were given in Table 9. A positive correlation ($r > 0.2$) with “Tension/Anxiety” was found in the category such as "Eating style," "Feeling of satiety," "Cognition of constitution," "Motivation for eating." All these categories corresponded with eating behaviors for which a significant correlation was encountered in the obese group.

Cohort study (2003 - 2005)

Methods

Subjects and data collection

The subjects were male employees in a synthetic fiber manufacturing plant who had participated in an annual health examination in April–May of 2003 and 2005. At the health examination, surveys on eating behavior and job stress were conducted using the same self-reporting questionnaire, which was distributed to 214 men in 2003 and 261 men in 2005. Forms were collected from all workers who gave their consent, and were checked for completeness by an occupational health nurse at the health examination. Questionnaires were collected from 210 men in 2003 and 259 men in 2005, for response rates of 98.1% and 99.2%, respectively. After excluding six having current treatment or a history of mental disorder (n=2), diabetes (n=3), or hormone treatment (n=1), there were the remaining 184 men who participated in the questionnaire survey and a health examination in both 2003 and 2005. Among them, non-obese subjects with BMI ≤ 24.9 kg/m² in 2003 numbered 122 men (21–60 years of age, mean age 35.3 ± 12.2 (SD)) who formed the present cohort. BMI was calculated from heights and body

weights measured during the health examinations in 2003 and 2005, respectively.

This study has been approved by the ethics committee of the Nagoya University School of Medicine.

Contents of questionnaire survey

Basic attributes and lifestyle

Survey items included age, sex, work pattern, whether or not living with family, job type, overtime working hours, walking time during commute, average sleeping time, regular exercise, smoking habit, alcohol consumption, and so on.

Eating behavior

Eating behaviors were examined using the 30 questions of the 50 items on the Sakata's Eating Behavior Questionnaire, which have been shown to reliably discriminate between obesity patients and healthy people [8, 11]. The 30 questions were classified into seven categories: Cognition of constitution, motivation for eating, substitute eating and drinking, feeling of satiety, eating style, meal contents, and eating rhythm abnormalities. Responses were selected from: 'I do not,' 'I sometimes,' 'I tend to,' and 'I always.' Higher scores indicated eating behaviors that could lead to obesity.

Job stress

Psychological job stress was assessed with the Job Stress Questionnaire, which was designed for a study commissioned by the Japanese Ministry of Health Labor and Welfare [11, 17]. The job stress factors were assessed using a total of 17 items, including quantitative workload, qualitative workload, physical workload, job latitude, application of technology, interpersonal conflict, workplace environment, and appropriateness of work. Responses were: 'strongly agree,' 'somewhat agree,' 'somewhat disagree,' and 'strongly disagree.' A heavier burden of stress was indicated by lower scores for job latitude and appropriateness of work and higher scores for all other items. The section on psychological stress response had a total of 18 items to measure responses both negative (tension/anxiety, anger, fatigue, and depression) and positive (activity). The section on physical stress response (physical complaints) had a total of 11 items. A stress mitigating factor was social support in the workplace and family. Responses for mental and physical stress were: 'almost never,' 'sometimes,' 'often,' and 'almost always.' For the psychological stress response, lower scores for activity and higher scores for all other items indicated a high level

of stress. For physical stress responses, higher total scores indicated higher stress levels. For social support, lower scores indicated lower levels of support.

Statistical analysis

The statistical analyses of basic attributes and lifestyles in 2003 and 2005 were conducted using the Wilcoxon signed rank test and McNemar test. With regard to weight gain, an increase in BMI of 1 kg/m² has been suggested to rise a risk of health disorders [12, 14]. Therefore, we divided the 122 subjects into the following three groups according to BMI changes over the 2 years: decrease; no change or increase of less than 1 kg/m² (body weight; about 3 kg under the study weight); and increase of 1 kg/m² or more. Differences between 2003 and 2005 mean scores of eating behaviors were investigated using the Wilcoxon signed rank test. In addition, the relation between differences in BMI and scores of eating behavior over the 2 years was examined using Spearman's correlation coefficient, which was also used to investigate the relation of psychological and physical stress responses to eating behaviors and job stress factors. Statistical analyses were completed with the statistical package SPSS 12.0J.

Results

Basic attributes and life style between the 2 years

Among basic attributes and lifestyles, weekly overtime working hours were significantly shorter in 2005 than in 2003 ($P < 0.05$). No significant differences were found in other items such as body weight, presence or absence of shift work, smoking or exercise habit (Table 10).

Characteristics of the three groups by BMI changes over the 2 years

Among 122 non-obese men in 2003, 48 (age 32.7 ± 13.2 (SD) years in 2003) lost weight, 60 (age 34.3 ± 12.3 years) were unchanged or had an increased BMI of less than 1 kg/m^2 , and 14 (age 25.5 ± 7.1 years) showed a BMI increase of 1 kg/m^2 or more. BMI in 2003 among the three groups were $21.5 \pm 1.9 \text{ kg/m}^2$ (range: $17.4 - 24.6 \text{ kg/m}^2$) in the lost-weight group; $21.7 \pm 2.1 \text{ kg/m}^2$ ($16.5 - 24.9 \text{ kg/m}^2$) in the group with no change or an increase of BMI $< 1 \text{ kg/m}^2$; and $22.5 \pm 1.5 \text{ kg/m}^2$ ($20.6 - 24.6 \text{ kg/m}^2$) in the group that gained BMI ≥ 1

kg/m². The mean age tended to be younger and BMI showed a tendency to be higher in the group that gained BMI ≥ 1 kg/m², but they were not significantly different among the three groups. There were no significant differences in other basic attributes, weekly overtime working hours and lifestyles among the three groups at the baseline in 2003. Changes in BMI between 2003 and 2005 were -0.8 kg/m² in the lost weight group (20.7 \pm 1.8 kg/m² in 2005); +0.4 kg/m² in the group with no change or an increase of BMI < 1 kg/m² (22.1 \pm 2.1 kg/m² in 2005); and +1.6 kg/m² in the group that gained BMI ≥ 1 kg/m² (24.1 \pm 1.5 kg/m² in 2005).

Changes in eating behaviors over the 2 years

As shown in Table 11, the overall scores for eating behaviors in 2003 and 2005 showed no significant differences in any category. However, in the group that gained BMI ≥ 1 kg/m², the score for 'feeling of satiety' category was higher in 2005 than in 2003 (P<0.01), while such a trend was not found in the group that lost weight or increased BMI < 1 kg/m². In the feeling of satiety category, the scores for 'I do not feel satisfied unless I eat until full' and 'I am often cautioned by others about eating too much' significantly increased in the group that gained BMI ≥ 1 kg/m². The scores of eating behaviors other than the feeling of satiety category did not change in any group based on a BMI increase. The BMI change was correlated with differences in the score of 'feeling of satiety' over the 2 years (P<0.05) (Table 12).

Relation between eating behaviors and job stress responses in changes over the 2 years

The relation between eating behaviors and job stress responses in differences over the 2 years was examined using Spearman's correlation coefficient (Table 13). In the group that gained BMI ≥ 1 kg/m², psychological stress responses of tension/anxiety and depression as well as a physical stress response were associated with eating behavior of feeling of satiety (P<0.05). However, no correlation was seen in the lost weight group and the group with no change or an increase of BMI < 1kg/m².

Relation between job stress responses and job stress factors in changes over the 2 years

With respect to the relation between job stress responses and job stress factors, changes in the category score for tension/anxiety and depression were correlated positively with quantitative workload and negatively with job latitude ($P < 0.05$ or $P < 0.01$, Table 14). Changes in physical stress responses were associated with physical workload ($P < 0.01$).

Discussion

The present 2-year cohort study on non-obese Japanese workers showed that weight gain was most closely associated with the eating behavior of eating to satiety. In addition, in the group that gained BMI ≥ 1 kg/m², the eating behavior of eating to satiety was positively correlated with the psychological stress responses of tension/anxiety and depression, which in turn were related to job demand positively and job latitude negatively. These findings suggest that non-obese workers feeling job stress may be more likely to develop an eating behavior to eat much and result in weight gain. Our previous cross-sectional study in 2003 indicated that obese male Japanese workers tended to experience psychological job stress responses of tension/anxiety that might affect eating behavior to eat much and lead to obesity [11]. The present findings were generally in accord with the results of the cross-sectional study.

In the present study, the scores for feeling of satiety category significantly increased over the 2 years in male workers who gained ≥ 1 kg/m², and the scores tended to be the highest in 2005, though they appeared to be the lowest in 2003 (but not significantly different).

On the other hand, the scores did not markedly change in those who lost weight or gained $< 1 \text{ kg/m}^2$. The scores of eating behaviors other than the feeling of satiety category did not change in any group based on a BMI increase. In addition, the BMI increase was correlated with an increase in the score of 'feeling of satiety' over the 2 years. These findings suggest the possibility that eating behavior of eating until full in subjects who gained $\text{BMI} \geq 1 \text{ kg/m}^2$ was reinforced and thereby facilitated weight gain. An earlier study of male workers reported that eating behaviors related to 'a high level of satiety after eating' and 'short meal times' were closely associated with weight gain from the age of 20 [20]. It is, thus, considered that eating to satiety is a key eating behavior for weight gain as well as obesity.

The scores for feeling of satiety category tended to be the lowest in 'increase of $\geq 1 \text{ kg/m}^2$ ' in 2003, although the difference was not significant among three groups based on a BMI increase. In our previous study, where the subjects included obese persons, the 'feeling of satiety' category in 2003 showed a significant association with obesity [11]. The present study aimed at investigating eating behaviors related to weight gain by a 2-year cohort study. Hence, the present subjects were limited to non-obese workers in 2003. This

may be one of the reasons why 'the feeling of satiety' appeared to be the lowest in 'increase of $\geq 1 \text{ kg/m}^2$ ' in 2003.

In our previous study in 2003, the eating behavior of 'cognition of constitution' was associated with obesity, and that the scores for 'cognition of constitution' category were lower in non-obese persons than obese ones [11]. In the present study, the scores appeared to be higher in the group that gained BMI $\geq 1 \text{ kg/m}^2$, but a significant increase between 2003 and 2005 was not found in the 'cognition of constitution' category. Hence, the eating behavior of cognition of constitution did not seem to be a significant factor for weight gain.

Our previous study showed that obesity was associated with the psychological stress response of tension/anxiety, which was in turn related to eating behaviors to eat much [11]. In the present study, the eating behavior of eating to satiety was correlated with the psychological stress responses of tension/anxiety and depression in the group that gained BMI $\geq 1 \text{ kg/m}^2$, but not in other groups that lost weight or gained $< 1 \text{ kg/m}^2$. It is said that people generally tend to overeat to relieve tension and anxiety under conditions of increased stress [21]. It is also reported that overweight people are more likely to experience anxiety, anger, and emotion of depression than those

of normal weight [22]. In addition, the relation of weight gain to long working hours and job-related fatigue has been reported [15]. Job stress reportedly affects eating habits more readily than exercise habits [23]. Therefore, people who feel stressed may tend to overeat to relieve stress, and continued stressful job conditions might strengthen their tendency to eat to satiety, thus contributing to weight gain.

An increase in the psychological stress responses of tension/anxiety and depression for the 2 years were associated positively with job stress factors of quantitative workload and negatively with job latitude. Our previous study also showed that the psychological stress responses of tension/anxiety were correlated with high workload and low job latitudes [11]. As in the 'job demands-control model' proposed by Karasek [24], high job demands and low job latitudes seem to bring on the psychological stress responses such as tension/anxiety and depression among male workers, and may contribute to weight gain through eating behavior of eating to satiety.

Weight gain is reported to be a risk factor for diabetes mellitus even in non-obese persons [13]. A previous study showed that an

increased BMI of 1 kg/m² raised the risk for diabetes mellitus by about 26% in non-obese male Japanese [14]. Hence, weight maintenance in non-obese subjects is important in preventing such diseases as diabetes. The present study has shown that the eating behavior of eating to satiety may be a key eating habit for weight gain, and that continued stressful job conditions might strengthen their tendency to eat to satiety, thus contributing to weight gain. Taking measures to deal with job stress as well as improving the eating behavior of eating to satiety will be needed to prevent weight gain and obesity among male Japanese workers.

The present study was conducted on a limited number of non-obese male workers in a manufacturing industry plant in Japan. Further studies are necessary to get conclusive results.

Summary

Objective: To clarify the relation of weight gain to eating behavior and job stress through a 2-year cohort study of non-obese male Japanese workers.

Method: A survey of life style, eating behavior, and job stress was conducted in 2003 and 2005 using the same questionnaire. The subjects were 122 non-obese ($\text{BMI} \leq 24.9 \text{ kg/m}^2$) male workers aged 21–60 years (mean age 35.3 ± 12.2 (SD) years) in a manufacturing industry in 2003. BMI was calculated from height and weight obtained from health examinations in 2003 and 2005. BMI changes over the 2 years were classified into three groups: decrease; no change or increase of $\text{BMI} < 1 \text{ kg/m}^2$; and increase of $\text{BMI} \geq 1 \text{ kg/m}^2$.

Results: Weight gain over the 2 years was associated with the eating behavior of 'eating to satiety'. In the workers who gained $\text{BMI} \geq 1 \text{ kg/m}^2$, the score for 'eating to satiety' category increased over the 2 years, while no such trend was found in the subjects who lost weight or gained $< 1 \text{ kg/m}^2$. The score of eating to satiety in those who gained $\geq 1 \text{ kg/m}^2$ was also correlated with the psychological stress responses of tension/anxiety and depression, which were

related to job demands positively and job latitudes negatively.

Conclusions: The present study suggests that eating to satiety is a key eating behavior for weight gain in non-obese male Japanese workers. The eating behavior can be affected by psychological job stress responses such as tension/anxiety and depression. Workers feeling stressed may be more likely to develop their eating behavior to eat much and gain weight.

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Table 1 Items of job stress factors in the Job Stress Questionnaire

Job stress factors

1. Have to do very much tasks
 2. Cannot complete tasks in the allotted time
 3. Have to work very intensely
 4. Much concentration is required
 5. Difficult work requiring a high level of knowledge and skill
 6. Must think about tasks always throughout working hours
 7. Work is physically demanding
 8. Can work at my own pace
 9. Can decide myself how to do the work and the work order
 10. Work policy in workplace matches my own opinions
 11. Little chance to use my own skill and knowledge in my work
 12. There is a conflict of opinions in my department
 13. My department does not get along well with other departments
 14. My workplace has a good atmosphere
 15. My workplace environment (noise, lighting, temperature, ventilation, etc.) is not good
 16. My work suits me
 17. My work is worthwhile
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Table 2 Items of psychological and physical stress responses in the Job Stress

Questionnaire

Stress response

Psychological stress response

1. Am vitalized
2. Have much energy
3. Am animated
4. Feel angry
5. Feel annoyed inside
6. Am irritable
7. Am very tired
8. Am exhausted
9. Feel languid
10. Am tense
11. Am anxious
12. Am unsettled
13. Am depressed
14. Everything is troublesome
15. Cannot concentrate on things
16. Am gloomy
17. Cannot focus on work
18. Feel sad

Physical stress response

19. Feel dizzy
 20. Joints ache
 21. Head is heavy/get headaches
 22. Neck and shoulders are stiff
 23. Lower back aches
 24. Eyes are tired
 25. Have palpitations or get out of breath
 26. Stomach and intestines in poor condition
 27. Have no appetite
 28. Am constipated or have diarrhea
 29. Cannot sleep well
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Table 3 Items of eating behaviors in the Sakata's Eating Behavior Questionnaire

Eating behavior
1. Tend to gain weight more easily than others
2. Gain weight just by drinking water
3. Have eaten a lot since childhood
4. Eat fast
5. Chew food very little
6. Can not chew well
7. Eat at all different times
8. Do not have time to eat leisurely
9. Do not feel satisfied unless I eat until full
10. If it is food I like, I can eat more after meals
11. Eat together if others are eating
12. Like noodles
13. Prefer strong tastes
14. Like oily foods
15. Often eat fast food
16. Eat daytime snacks
17. Snack after dinner
18. Always have a bowl of fruit or sweets out
19. If fruit or sweets are out, I always eat some
20. Often eat snack foods
21. If given food, I eat it all because I don't want to waste it
22. Always gain weight on consecutive holidays or the New Year and <i>O-bon</i> holidays
23. Eat to get rid of irritability
24. Often cautioned by others about eating too much
25. Feel regret after eating too much
26. When buying food, am not content unless I buy more than necessary
27. When making food, am not content unless I make a lot
28. If food is left over, I eat it so as not to waste it
29. When eating out or getting home delivery, I always order a lot
30. Often drink canned soft drinks, canned coffee, sports drinks, or nutritional drinks

Table 4 Characteristics of obese and non-obese subjects

Characteristic	Non-obese n=141	Obese n=67	p value
BMI (kg/m ²)	21.7 ± 1.9	27.9 ± 3.6	
Age (years)	32.6 ± 12.2	36.0 ± 12.2	0.009**
Blue collar worker	87 (61.7)	42 (62.7)	0.546
Overtime work	103 (73.0)	48 (71.6)	0.832
Overtime (hrs/week)	3.7 ± 4.9	3.7 ± 5.3	0.627
Do not exercise	89 (63.1)	39 (58.2)	0.786
Smoke	93 (66.0)	37 (55.2)	0.327
Drink alcohol ≥5 days/week	28 (19.8)	20 (29.9)	0.113
Sleeping hours	6.5 ± 1.0	6.5 ± 1.0	0.914

**p<0.01

Table 5 Age-adjusted odds ratio and 95 % confidential interval between obesity and job stress factors

Job stress factors	Age-adjusted odds ratio	95% CI	p value
Quantitative workload	1.07	0.90-1.28	0.452
Qualitative workload	1.14	0.96-1.36	0.146
Physical workload	0.81	0.61-1.09	0.164
Job latitude	1.09	0.92-1.28	0.314
Application of technology	1.01	0.70-1.47	0.956
Interpersonal conflict	1.01	0.85-1.20	0.888
Workplace environment	0.98	0.73-1.31	0.891
Appropriateness of work	1.08	0.88-1.34	0.456
Incorporating support	1.01	0.94-1.08	0.823

Table 6 Age-adjusted odds ratio and 95 % confidential interval between obesity, psychological and physical stress responses

Job stress response	Age-adjusted odds ratio	95% CI	p value
Psychological stress response			
Activity	1.02	0.88-1.17	0.815
Anger	1.15	1.00-1.32	0.052
Fatigue	1.06	0.93-1.22	0.388
Tension/Anxiety	1.22	1.05-1.42	0.008
Depression	1.02	0.93-1.12	0.635
Physical stress response	1.02	0.96-1.08	0.573

Table 7 Spearman's correlation coefficients between psychological stress response (Tension/anxiety) and job stress factors

Job stress factors	Tension/Anxiety
Quantitative workload	.279**
Qualitative workload	.236**
Physical workload	-.011
Job latitude	-.300**
Application of technology	.202**
Interpersonal conflict	.277**
Workplace environment	.192**
Appropriateness of work	-.221**
Incorporating support	-.164*

*p < 0.05, **p < 0.01

Table 8 Age-adjusted odds ratio and 95 % confidential interval between obesity and eating behaviors

Eating behavior	Age-adjusted odds ratio	95% CI	p value
Cognition of constitution	1.95	1.61-2.36	<0.001
Motivation for eating	1.19	1.04-1.36	0.011
Substitute eating and drinking	1.23	1.11-1.37	<0.001
Feeling of satiety	1.28	1.15-1.42	<0.001
Eating style	1.15	1.00-1.31	0.045
Meal contents	1.12	1.01-1.26	0.040
Eating rhythm abnormalities	1.05	0.94-1.17	0.385

Table 9 Spearman's correlation coefficients between psychological stress response (Tension/Anxiety) and eating behaviors

Eating behaviors	Tension/Anxiety
Cognition of constitution	.206**
Motivation for eating	.205**
Substitute eating and drinking	.192**
Feeling of satiety	.212**
Eating style	.259**
Meal contents	.120
Eating rhythm abnormalities	.109

**p < 0.01

Table 10 Basic attributes and lifestyle

<i>Item</i>	<i>2003 (%)</i>	<i>2005 (%)</i>	<i>P value</i>
Age (years)	32.7 ± 12.4	35.3 ± 12.2	
Body weight (kg)	63.4 ± 6.8	63.6 ± 7.6	0.298
BMI (kg/m ²)	21.7 ± 2.0	21.8 ± 2.2	0.317
Blue collar worker	67 (54.9)	65 (53.3)	0.625
Overtime work	87 (71.3)	77 (63.1)	0.194
Overtime (h/week)	5.1 ± 5.3	4.1 ± 4.8	0.020 *
No exercise	81(66.4)	79 (64.8)	0.824
Smoking	79 (64.8)	79(64.8)	1.000
Alcohol consumed			
≥5 days/week	23 (18.9)	24 (19.7)	1.000
Sleeping hours	6.5 ± 1.0	6.6 ± 0.9	0.936

*P<0.05 by Wilcoxon signed rank test or McNemar test

Table 11 Mean eating behavior score by BMI change group

<i>Eating behaviors</i>	Change in BMI			<i>Overall</i>
	<i>Decrease</i> <i>n = 48</i>	<i>No change or</i> <i>increase of <1 kg/m²</i> <i>n = 60</i>	<i>Increase of</i> <i>≥1 kg/m²</i> <i>n = 14</i>	
<i>Cognition of constitution</i>				
2003	4.7 ± 1.9	4.8 ± 2.2	6.4 ± 2.2	4.9±2.1
2005	4.7 ± 2.0	4.9 ± 2.3	6.7 ± 2.8	5.0±2.3
<i>Motivation for eating</i>				
2003	4.6 ± 2.1	4.6 ± 2.3	4.9 ± 2.4	4.6±2.2
2005	4.7 ± 2.4	4.5 ± 1.9	5.7 ± 2.2	4.7±2.2
<i>Substitution eating and drinking</i>				
2003	9.2 ± 2.6	9.5 ± 2.9	9.5 ± 2.8	9.4±2.7
2005	9.1 ± 2.7	9.2 ± 2.8	10.5 ± 3.7	9.3±2.9
<i>Feeling of satiety</i>				
2003	8.7 ± 3.1	8.3 ± 3.1	7.8 ± 2.5	8.4±3.0
2005	8.8 ± 3.3	8.2 ± 2.7	9.8 ± 3.4**	
<i>Eating style</i>				
2003	5.9 ± 2.4	5.5 ± 2.2	6.2 ± 2.6	5.7±2.3
2005	6.0 ± 2.4	5.4 ± 2.1	5.6 ± 2.3	5.6±2.3
<i>Meal contents</i>				
2003	10.6 ± 2.7	9.8 ± 2.9	11.8 ± 2.9	10.4±2.9
2005	11.2 ± 3.1	10.0 ± 3.2	11.6 ± 3.3	10.7±3.2
<i>Eating rhythm abnormalities</i>				
2003	10.5 ± 3.0	9.7 ± 3.0	11.4 ± 3.9	10.2±3.2
2005	10.3 ± 3.4	10.3 ± 3.3	11.1 ± 3.4	10.4±3.3

**P<0.01 by Wilcoxon signed rank test

Table 12 Spearman's correlation coefficients between changes in BMI and eating behaviors over the 2 years

<i>Eating behaviors</i>	<i>BMI changes</i>
Cognition of constitution	.080
Motivation for eating	.000
Substitute eating and drinking	.074
Feeling of satiety	.228*
Eating style	-.044
Meal contents	-.024
Eating rhythm abnormalities	.079

*P < 0.05

Table 13 Spearman's correlation coefficients between eating behaviors and job stress responses by BMI change group

	<i>Eating behaviors (Feeling of satiety)</i>			<i>Overall</i>
	<i>Decrease</i> <i>n = 48</i>	<i>No change or increase of <1 kg/m²</i> <i>n = 60</i>	<i>Increase of ≥1 kg/m²</i> <i>n = 14</i>	
Psychological stress response				
Activity	.177	-.095	.051	.091
Anger	.209	.069	-.051	.142
Fatigue	.132	-.028	.092	.034
Tension/Anxiety	.163	.050	.634*	.139
Depression	.040	-.036	.590*	.025
Overall	.161	-.006	.279	.086
Physical stress response	-.288*	-.131	.640*	-.074

Eating behaviors, psychological and physical stress responses: difference in each category score over 2 years

*P<0.05

Table 14 Spearman's correlation coefficients between job stress responses and job stress factors

<i>Job stress factors</i>	<i>Job stress responses</i>						
	<i>Activity</i>	<i>Anger</i>	<i>Fatigue</i>	<i>Tension/Anxiety</i>	<i>Depression</i>	<i>Overall</i>	<i>Physical stress response</i>
Quantitative workload	-.107	.039	.169	.217*	.184*	.223*	.132
Qualitative workload	-.056	-.025	.094	.165	.075	.139	.132
Physical workload	-.056	-.047	.073	.044	.072	.076	.241**
Job latitude	-.035	-.299**	-.123	-.216*	-.275**	-.278**	-.072
Application of technology	-.076	.061	.006	-.079	.047	.042	.036
Interpersonal conflict	-.256**	.146	-.047	-.183*	.033	.079	.018
Workplace environment	-.129	.044	-.114	.071	-.137	-.036	-.053
Appropriateness of Work	.130	-.099	-.093	-.042	-.172	-.163	-.159
Incorporating Support	.121	-.188*	-.242**	.002	-.155	-.239**	-.116

Psychological and physical stress responses, job stress factors: difference in each category score over 2 years

**P<0.01, *P<0.05