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Relationship between appetitive motives and non-exercise lifestyle in a young adult population

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Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
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Background: We aimed to examine the association of appetitive motives with a non-exercise lifestyle, defined as exercising less than once per year, in a young adult population.

Material/Methods: We asked university students to answer questions about their exercise habits. We also assessed their appetitive motives, with or without hunger, by using a simple questionnaire in a preliminary survey, and we assessed the hedonic motives to consume palatable foods by using the Power of Food Scale (PFS) in the main experiment.

Results: On multivariate logistic regression analyses in the preliminary survey (n=119) adjusted for age, gender, and body mass index (BMI), appetitive motives under the condition of hunger were positively associated with the non-exercise lifestyle. In the main experiment (n=268), simple regression analyses revealed a positive association between the non-exercise lifestyle and the subscale scores of factor-2 of PFS related to physically present foods. On multiple regression analyses adjusted for age, gender, and BMI, the aggregated scores and the subscale scores of factor-2 of PFS were positively associated with the non-exercise lifestyle.

Conclusions: These findings suggest the intriguing possibility that appetitive motives under the condition "with hunger" and those "with hedonic consumption" can be suppressed even by infrequent exercise.

Key words: appetitive motives • power of food scale (PFS) • non-exercise life style • physical inactivity • young adult population

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Background

During the last few decades scientific evidence has confirmed a wide range of health benefits related to regular physical activity [1]. Similarly, healthy diet and appropriate dietary restriction is known to reduce the impact of numerous diseases such as abdominal obesity, diabetes, hypertension, cardiovascular diseases, and cancer, as well as to have beneficial effects on the aging process in humans [2–4]. However, many people often lack sufficient motivation to participate in the recommended amount and frequency of physical activity [5] and/or to maintain a healthy diet. Much effort has been devoted to develop theories that explain changes in or adherence to specific health behaviors. Although many of these theories have resulted in prevention activities including brief advice and counseling [6], very few studies have developed the theories on the basis of the direct association of eating behaviors with exercise lifestyle.

In modern society, consumption behaviors are often affected by external as well as internal factors [7,8]. A person may try to avoid excessive energy intake, but such efforts are often hampered by enhanced appetitive motives in response to the current widespread availability of foods, with a powerful drive to hedonic consumption even in the absence of energy deficit [9]. Such appetitive motives differ among individuals partly because of individual differences in reinforcing the value of food-related cues that predict food availability or consumption [10,11]. The Power of Food Scale (PFS) was developed to examine the individual differences in appetitive motives [12]. Recently, we validated the Japanese version of the PFS (PFS-J) [13]. Based on factor analyses, the PFS has been shown to contain a 3-factor structure of food proximity, consisting of: (1) 'food available', which describes the reaction when food is not physically present but is always available; (2) 'food present', which characterizes the reactions to palatable foods when they are physically present, but have not yet been tasted; and (3) 'food tasted', which characterizes the reactions to palatable foods when first tasted, but not yet consumed. Understanding the neural mechanisms of appetitive motives would help to elucidate the background of variation of appetitive motives among individuals. A recent neuroimaging study using fMRI on appetite used the original English version of PFS for measurement of appetitive motives, demonstrating the involvement of brain networks (e.g., the insular cortex) in the appetitive motives assessed by the PFS [14]. Interestingly, other neuroimaging studies also demonstrated that a 3-month intervention of regular exercise suppressed neural activities in the insular cortex caused by viewing food cues [15,16]. Accordingly, it is plausible that the appetitive motives might be associated with the exercise lifestyle. In other words, promotion of exercise lifestyle might provide an additional benefit for correction of excessive appetitive motives. Furthermore, since the reliability and validity of the PFS has been confirmed by previous studies, the scale is appropriate to use in examination of a possible association of intensity of hedonic motives of appetite with the exercise lifestyle. Appetitive motives are likely to depend on hunger status (with or without hunger).

Therefore, we performed a preliminary study to examine the possible association of the non-exercise lifestyle with appetitive motives with or without hunger, using single logistic regression analyses and multivariate logistic regression analyses adjusted for age, gender, and body mass index (BMI). Next, in the main experiment, we investigated the possible association of intensity of appetitive motives (according to the aggregated and subscale scores of the PFS-J) with sedentary lifestyle, using simple regression analyses and multiple regression analyses adjusted for age, gender, and BMI.

Material and Methods

Participants

All participants were recruited from a list of Osaka City University students. Since the presence of mental or physical diseases may be potential confounding variables, our analysis excluded subjects with current medical illnesses such as bronchial asthma, otitis media, or gastroenteritis. The present study was approved by the Ethics Committee of Osaka City University Graduate School of Medicine. All the participants provided informed consent prior to participating in the study.

Questionnaires

Paper-and-pencil questionnaires were distributed to the participants in the experiments. The questionnaires completed by all participants dealt with health status and lifestyle factors. Questions included items about BMI, exercise, and smoking and drinking habits (yes or no). BMI was calculated as body weight in kilograms divided by height in meters squared. The non-exercise lifestyle was defined as exercising less than once per year, so participants were instructed to answer yes if they had an exercise occasion less than once per year and no if they exercised one or more occasions per year.

In the preliminary experiment, we aimed to examine the difference in appetitive motives during fasting and under a condition without hunger between the participants with a non-exercise lifestyle and others. The participants were instructed to answer the following questions: *Do you think you have more motivation to eat when you feel hungry than the general population similar to your age?* and *Do you snack between meals even when you don't feel hungry?* These questions were presented on a 5-point Likert-type scale ranging from 1 (*No, I don't agree at all*) to 5 (*Yes, I strongly agree*). Responses coded as a 1, 2, or

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3 were considered to be normal, while responses coded as a 4 or 5 showed excessive appetitive motives for each question.

After the preliminary experiment, we performed the main experiment examining the relationship of non-exercise lifestyle with appetitive motives assessed by the recently established standard questionnaire (PFS). Thus, we recruited other participants in the same manner as the preliminary study, and administered the PFS. After we obtained permission to use the original English version of the PFS from its author and translated the questionnaire into Japanese, we validated the Japanese version of PFS (PFS-J) [13]. The PFS was designed to measure appetite rather than consumption of palatable foods. The scale comprises 15 items reflecting the appetitive responsiveness to the food environment, categorized into 3 domains according to food proximity: 1) food readily available in the environment but not physically present (food available), 2) food present but not tasted (food present), and 3) food when first tasted but not consumed (food tasted). For instance, the PFS includes the following items: *If I see or smell a food I like, I get a powerful urge to have some; It seems like I have food on my mind a lot;* and *I think I enjoy eating a lot more than most other people.* The participants had to score their reactions for each item on a 5-level scale: 1 = I don't agree at all, 2 = I agree a little, 3 = I agree somewhat, 4 = I agree, and 5 = I strongly agree. Thus, the scores for each domain indicate hedonic hunger motivation at different levels of food availability. The average scores of all 15 items were also calculated to obtain an aggregated score. Higher scores indicate greater levels of appetitive motives in each domain.

Statistical analyses

In the preliminary experiment, simple and multivariate logistic regression analyses were performed to identify factors associated with the appetitive motives in the fasting condition and those without hunger. The 95% confidence interval (CI) was calculated for each odds ratio (OR). Simple regression analyses and multiple regression analyses were also performed in the main experiment to identify factors associated with the appetitive motives assessed by PFS-J. The number of cases in the analyses varied due to incidental missing values. All *P* values were 2-tailed, and *P* values less than 0.05 were considered to be statistically significant. Statistical analyses were performed using the SPSS 20.0 software package including Amos 5 (SPSS, Chicago, IL).

Results

Preliminary experiment

A total of 154 university students participated in the preliminary study. Thirty-four (18.7%) students were excluded due to medical illnesses, including upper respiratory infection, allergic rhinitis, atopic dermatitis, and Hashimoto's disease. All the participants, except 1 female, responded to the questionnaire about appetitive motives while fasting and those without hunger. Thus, 119 students (67 males and 52 females, aged from 18 to 31 years) were included in the preliminary analyses (Table 1). Of 119 participants, 35 (29.4%) participants had a non-exercise lifestyle. To identify lifestyle factors associated with appetitive motives with and without hunger, univariate and multivariate logistic regression analyses were performed (n=119). On simple logistic regression analyses, the levels of appetitive motives in the fasting condition were positively associated with female gender (female *vs.* male, OR 2.969, 95% CI 1.364–6.463, *P*=0.006) and with the non-exercise lifestyle (OR 3.215, 95% CI 1.312–7.874, *P*=0.011) (Table 2). In contrast, there were no significant associations of

Table 1. Characteristics of study participants in the preliminary experiment (n=119).

Age (years)	19.6±1.7
Female	52 (43.7%)
BMI (kg/m^2)	20.2±1.9
Drinking habit (yes)	94 (79.0%)
Smoking habit (yes)	6 (5.0%)
Non-exercise lifestyle (<1 occasion per year)	35 (29.4%)

Data are presented as mean ±SD or number (%). BMI – body mass index.

Table 2. Simple logistic regression analyses of the appetitive motives in the fasting condition and those without hunger in the preliminary experiment (n=119).

	OR (95%CI)	*P* value
Appetitive motives at fasting condition		
Age (years)	1.009 (0.815–1.249)	0.934
Female	2.969 (1.364–6.463)	0.006
BMI (kg/m^2)	0.941 (0.773–1.146)	0.547
Non-exercise lifestyle (<1 occasion per year)	3.215 (1.312–7.874)	0.011
Appetitive motives without hunger		
Age (years)	0.979 (0.794–1.208)	0.844
Female	2.541 (1.179–5.476)	0.017
BMI (kg/m^2)	0.970 (0.797–1.179)	0.757
Non-exercise lifestyle (<1 occasion per year)	1.072 (0.480–2.392)	0.866

OR – odds ratio; CI – confidence interval; BMI – body mass index.

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Table 3. Multiple logistic regression analyses of appetitive motives in the fasting condition and without hunger according to the exercise lifestyle in the preliminary experiment, adjusted for age, gender, and BMI (n=119).

	OR (95%CI)	*P* value
Appetitive motives in the fasting condition		
Non-exercise lifestyle (<1 occasion per year)	5.025 (1.802–14.286)	0.002
Appetitive motives without hunger		
Non-exercise lifestyle (<1 occasion per year)	1.073 (0.456–2.525)	0.872

OR – odds ratio; CI – confidence interval; BMI – body mass index.

Table 4. Characteristics of study participants in the main experiment (n=268).

Age (years)	19.2±1.4
Female	120 (44.8%)
BMI (kg/m^2)	20.5±2.4
Drinking habit (yes)	176 (65.7%)
Smoking habit (yes)	10 (3.7%)
Non-exercise lifestyle (<1 occasion per year)	73 (27.2%)

Data are presented as mean ±SD or number (%). BMI – body mass index.

the levels of appetitive motives with any parameters examined except for female gender for the condition without hunger. On multivariate logistic regression analyses adjusted for age, gender, and BMI, the levels of appetitive motives at fasting condition were positively associated with non-exercise lifestyle (OR 5.025, 95% CI 1.802–14.286, *P*=0.002). No significant associations were observed between the levels of appetitive motives without hunger and any parameters examined (Table 3).

Main experiment

After exclusion of 28 participants with medical illness and 1 male who did not respond to the PFS-J, a total of 268 participants (148 males and 120 females, aged from 18 to 31 years) were included in the final analysis (Table 4). Of these 268 participants, 73 (27.2%) participants had a non-exercise lifestyle. To identify lifestyle factors associated with the appetitive motives assessed by the PFS-J, simple and multiple regression analyses were performed (n=268). On simple regression analyses, female gender was positively associated with aggregated scores (R=0.222, *P*<0.001) and subscale scores of factor-1 (R=0.296, *P*<0.001) and those of factor-2 (R=0.179, *P*=0.003) (Table 5). In addition, the non-exercise lifestyle was also positively associated with the subscale scores of factor-2 (R=0.139, *P*=0.023) (Table 5). On multiple regression analyses adjusted for age, gender, and BMI, non-exercise lifestyle was positively associated with the aggregated scores (β=0.140, *P*=0.028) and subscale scores of factor-2 (β=0.200, *P*=0.002) (Table 6).

Table 5. Simple regression analyses of the appetitive motives assessed by aggregated score and subscale scores of PFS-J in the main experiment (n=268).

	R	*P* value
Aggregated scores		
Age (years)	–0.079	0.205
Female	0.222	<0.001
BMI (kg/m^2)	0.091	0.158
Non-exercise lifestyle (<1 occasion per year)	0.081	0.189
Food available (factor 1)		
Age (years)	–0.056	0.373
Female	0.296	<0.001
BMI (kg/m^2)	0.046	0.483
Non-exercise lifestyle (< 1occasion per year)	0.023	0.712
Food present (factor 2)		
Age (years)	–0.116	0.062
Female	0.179	0.003
BMI (kg/m^2)	0.099	0.126
Non-exercise lifestyle (<1 occasion per year)	0.139	0.023
Food tasted (factor 3)		
Age (years)	–0.030	0.635
Female	0.050	0.419
BMI (kg/m^2)	0.091	0.159
Non-exercise lifestyle (< 1occasion per year)	0.054	0.379

Data are presented as Pearson's regression coefficient (R) and *P* value. PFS-J – Japanese version of Power of Food Scale; BMI – body mass index.

Discussion

The present study highlights the non-exercise lifestyle in modern young adults and its contribution to the responsiveness to

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Table 6. Multiple regression analyses of the appetitive motives assessed by aggregated score and subscale scores of PFS-J according to the exercise lifestyle, adjusted for age, gender, and BMI, in the main experiment (n=268).

	β	*P* value	R^2
Aggregated scores			
Non-exercise lifestyle (<1 occasion per year)	0.140	0.028	0.103
Food available (factor 1)			
Non-exercise lifestyle (<1 occasion per year)	0.077	0.225	0.105
Food present (factor 2)			
Non-exercise lifestyle (<1 occasion per year)	0.200	0.002	0.116
Food tasted (factor 3)			
Non-exercise lifestyle (<1 occasion per year)	0.081	0.221	0.025

Data are presented as standard regression coefficient (β), *P* value, and coefficient of determination (R^2). PFS-J – Japanese version of Power of Food Scale; BMI – body mass index.

exposure to food and food-related cues. The preliminary survey was performed by using a simple questionnaire to identify relationships between the non-exercise lifestyle and appetitive motives with or without hunger. Thereafter, in the main experiment, the relationships between non-exercise lifestyle and appetitive motives were examined using a recently established PFS-J that measures an individual's hedonic appetite for highly palatable foods. We found: 1) approximately 30% of the participants had a non-exercise lifestyle; 2) the non-exercise lifestyle was associated with appetitive motives under the fasting condition, but no association was found under the condition without hunger; and 3) the non-exercise lifestyle was related to a greater drive to consume hedonically salient and palatable foods as evidenced by means of the PFS-J even after adjusting for age, gender, and BMI.

Regular physical exercise is broadly recommended for the maintenance of health and for prevention and treatment of various diseases [2,17,18]. However, the population of people playing sports is smaller than expected; the National Health and Nutrition Survey in Japan reported that for the general adult population, less than 50% had an exercise habit, defined as more than 30 minutes a day, more than twice a week, continued for more than 1 year. In fact, only 34.8% of males and 28.5% of females over 20 years old had an exercise habit; when restricted to the young adult range of ages 20–29, the percentages dropped to 28.6% in males and 10.8% in females [19]. Although data about the population of adults with a non-exercise lifestyle are lacking, the prevalence is appreciable; our present data show that approximately 30% of the young adult participants had a non-exercise lifestyle.

Along with regular exercise, appropriate calorie restriction is recognized as a useful strategy not only for successful weight management but also for maintenance of good health [20,21]. However, one might intuitively anticipate that exercise increases the opportunities to feel hungry and elicits appetitive motives because it promotes energy expenditure, and that the resulting appetitive motives interfere with the long-term control of diet. Conversely, it is assumed that a non-exercise lifestyle causes less appetitive motive even under the fasting condition because of lack of sufficient energy expenditure in daily life. However, contrary to these assumptions, the present survey found that individuals with a non-exercise lifestyle had a greater level of self-awareness of appetitive motives under the fasting condition compared with those without a non-exercise lifestyle. This supports the previous findings that there is not necessarily a cause-effect relationship between exercise-induced energy expenditure and the subsequent increase in appetite [22,23].

Furthermore, hedonic appetitive motives have greater significance that exceeds those under the fasting condition. The hedonic appetitive motives are elicited even in the absence of an energy deficit, referred to as non-homeostatic appetite [24]. Although the preliminary survey using simple questionnaires did not show any associations of non-exercise lifestyle with self-awareness of enhanced appetitive motives without hunger, the main experiment using the PFS demonstrated that the individuals with a non-exercise lifestyle had self-awareness of enhanced appetitive motives when food is physically present but has not yet been tasted, as shown in the subscale scores of factor-2 of PFS-J. Compared with the single question '*Do you snack between meals even when you don't feel hungry?*' in the preliminary survey, the PFS seems to be more specific to a hedonic drive for consumption even in the absence of energy deficit. By using this PFS questionnaire, we identified a specific and characteristic relationship between the non-exercise lifestyle and appetitive motives under the condition without hunger (the hedonic drive of appetitive motives for food consumption without energy deficit).

There are 2 terms related to low levels of physical activity. While the term 'sedentary' is defined as a distinct class of behaviors (e.g., sitting, watching TV, driving) characterized by low energy expenditure [≤1.5 metabolic equivalents (METs)], the term 'physical inactivity' is defined as the absence of physical activity usually reflected as the proportion of time not engaged in physical activity or as an activity level insufficient to meet present recommendations [25,26]. The non-exercise lifestyle as defined in the present study seems to be closely related to physical inactivity. Physical inactivity is known to cause approximately 1 in every 10 deaths each year and to account for

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6–10% of major non-communicable diseases worldwide [27,28]. Based on the present findings, the health menace caused by a non-exercise lifestyle and physical inactivity might be partly associated with the augmentation of a hedonic drive for food consumption even when hunger is lacking.

Our findings should be considered within certain limitations. First, our study involved only young adult university students. Further studies with other types of populations will be needed to generalize our results. Second, conclusions concerning cause-and-effect relationships cannot be drawn due to the cross-sectional nature of our data. Future prospective cohort studies will be needed to confirm any cause-and-effect relationships between appetitive motives and non-exercise lifestyles. Third, although the present study put emphasis on the possibility of an exercise lifestyle to suppress appetitive motives, it is deemed desirable to aim for an appropriate level of appetitive motives not only by eradicating the need to overeat, but also compensating for the lack of appetite caused by medical problems, including cachexia or anorexia nervosa.

Conclusions

The present study demonstrates an important association of the non-exercise lifestyle with enhanced appetitive motives to hedonic consumption, as well as enhanced appetitive motives under the fasting condition. These findings suggest the intriguing possibility that a powerful drive to hedonic consumption can be suppressed even by infrequent exercise. Accordingly, it is possible to integrate promotion of the exercise lifestyle with correction of excessive appetitive motives. Future studies will be needed to confirm the involvement of an exercise lifestyle in the regulation of appetitive motives and to clarify the mechanisms underlying the eating-exercise coupling.

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