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Changes in Subjective Questionnaires of Sleep Quality and Mood States when Breakfast Skippers Consistently Eat Breakfast in Japanese Office Worker

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Abstract

Introduction: In recent years, the percentage of people who skip breakfast has been increasing. This has become a social issue in Japan. Previous reports showed that the quality of sleep declines in people who usually skip breakfast, and that depressive moods are also more likely. In this study, we conducted an open-label trial with the purpose of investigating the effects of eating breakfast for 8 weeks on subjective sleep quality and mood by people who usually skip breakfast

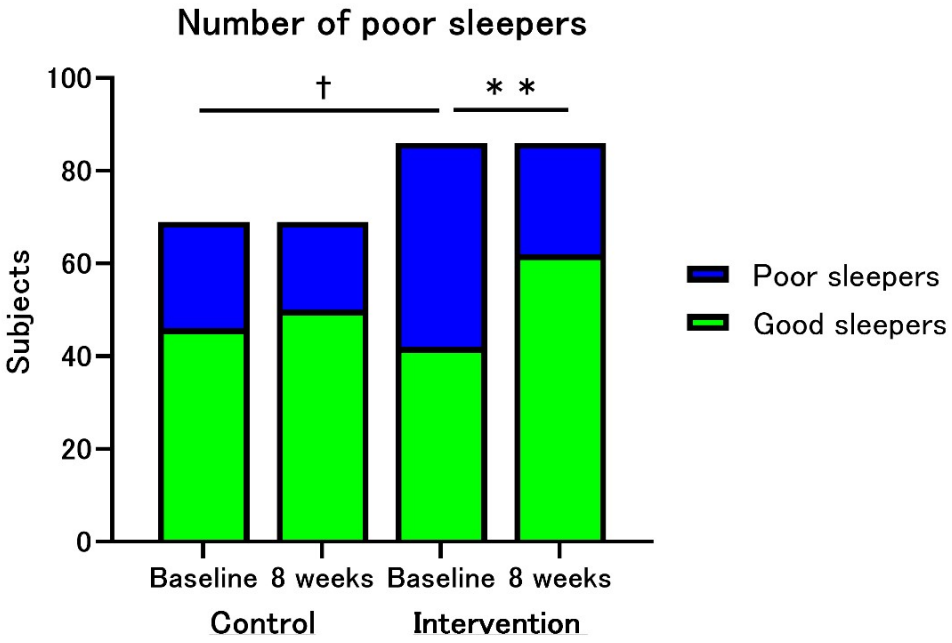
Methods: The study recruited healthy adults who were office workers in the city of Yokohama, Japan. The subjects were instructed to eat a breakfast containing a staple food (i.e., rice, bread, noodles, or cereals) each day for 8 weeks. The intervention group (n = 86) usually skipped breakfast more than five times a week, and the control group (n = 69) usually ate breakfast. Body composition by InBody470 and questionnaire surveys on the subjective sleep quality by Pittsburgh Sleep Quality Index (PSQI) and mood states by Profile of Mood States (POMS) were conducted a total of three times; baseline the study, at 4 weeks, and at 8 weeks.

Results: The body composition of subjects did not change during the test period. The results of the PSQI showed that the PSQI global score and daytime dysfunction of intervention group improved. In intervention group, there was a larger proportion of poor sleepers than in control group. Eating breakfast regularly decreased the number of poor sleepers in intervention group. The fatigue - inertia of POMS was only decreased in intervention group.

Conclusion: It is suggested that eating breakfast regularly could improve the subjective sleep quality and daytime dysfunction among individuals who usually skip breakfast. This study will help us understand the importance of breakfast

intake and the effects of the intervention of breakfast.

Keywords: Breakfast; Sleep Quality; PSQI; POMS; Office Worker.



Graphical Abstract

Introduction

The percentage of people who do not usually eat breakfast has become an increasing social issue in Japan. According to the National Health and Nutrition Survey conducted in Japan in 2017 by the Ministry of Health, Labor and Welfare, the percentage of breakfast skippers was relatively large, at 15.3% for men and 12.7% for women [1]. A breakdown by age group revealed that both men and women in their twenties exhibited the highest rate of skipping breakfast, with 37.4% for men and 23.1% for women. As a result, the Ministry of Health, Labor and Welfare set targets to reduce breakfast skipping in "Health Japan 21", specifically, 15% or lower for men in their twenties and thirties and 0% for junior high and high school students [2]. One problem in the city of Yokohama is the high rate of breakfast skipping among workers. Yokohama City Hall set a target to reduce breakfast skipping to 15% or lower for men in their twenties and thirties and women in their twenties [3]. It has been discovered that not eating breakfast can have various effects on people [4]. Skipping breakfast has been reported to be associated with obesity, poor sleep quality, poor mental quality of life (QOL), and risk of a depressive mood [5-8].

As research on sleep has progressed worldwide, problems related to sleep have been recognized as important issues that need to be addressed [9]. Obtaining a good night of sleep is thought to help lead to a physically and psychologically fulfilling life, and to contribute to the improvement of overall health and an enhanced QOL [6,9], Insomnia can increase the risk of lifestyle-related diseases, including obesity and related diseases [10]. The National

Health and Nutrition Survey conducted in Japan in 2014 showed that the average number of hours of sleep per night was 6 hours and 34 minutes for Japanese men and 6 hours and 25 minutes for Japanese women [11]. Research by the Organization for Economic Co-operation and Development (OECD) indicated that people in Japan sleep about an hour less than those in other countries [10,11]. In fact, a large-scale epidemiological study reported that 21.4% of the Japanese population suffers from insomnia [12]. The effects of lifestyle habits and job environment on sleep among office workers was reported that lack of morning breakfast was also associated with eveningness [13]. A cross-sectionally has been reported of the association between the midpoint of sleep and these dietary variables in young Japanese women that the subjects with a later midpoint of sleep tended to begin meals later, skip meals more frequently, not only at breakfast but also at lunch and dinner [14]. As these findings show, sleep is one of the most important health issues that Japan is facing.

In recent years, mental health in the workplace has become an important issue. Guidelines for maintaining and improving workers' mental health were published in 2006 [15]. Currently, approximately one in eleven employees in Japan has experienced at least one common mental disorder in the past year, such as a mood, anxiety, and/or substance use disorder [16]. Psychological health is an important factor and is also thought to be associated with lifestyle [17]. The having Italian breakfast was improved the self-reported mood and physiological state, and also short-term verbal memory assessed by means of the forward digit span [18]. It has been reported that among males, those who did not consume breakfast had less vigor independent of sleep, and among females, those who did not consume breakfast had higher feelings of anxiety, suggesting breakfast skipping and poor sleep may jointly affect mood [19].

It is not clear whether a personal behavior improvement, such as eating breakfast, can lead to an improvement in the quality of sleep and/or mood state. Therefore, in this study, we investigated the effect of eating breakfast regularly for eight weeks on people who usually skip breakfast. We examined the effects on the participants' subjective quality of sleep and mood states.

Materials and Methods

Study Design and Subjects

We conducted an open-label trial with the purpose of investigating the effects of eating breakfast for 8 weeks on subjective sleep quality and mood by people who usually skip breakfast (Figure 1A). We recruited healthy Japanese men and women from 11 facilities in the city of Yokohama, Japan who usually eat or skip breakfast 5 times a week. The intervention subjects were those who usually skipped breakfast more than 5 times a week and the control subjects were those who usually ate breakfast at least 5 times a week. The inclusion criteria were as follows: (1) Healthy adults over 20 years of age; (2) office workers who worked in the city of Yokohama, Japan; and (3) people who provided written consent for participation.

The exclusion criteria were as follows:

(1) Patients with severe liver, kidney, heart, lung, or blood disease or with psychiatric disorders; (2) people who wished to become pregnant, were pregnant, or were breastfeeding during this survey; (3) people using a cardiac pacemaker; and (4) people who were judged inappropriate to participate by study supervisor (YS).

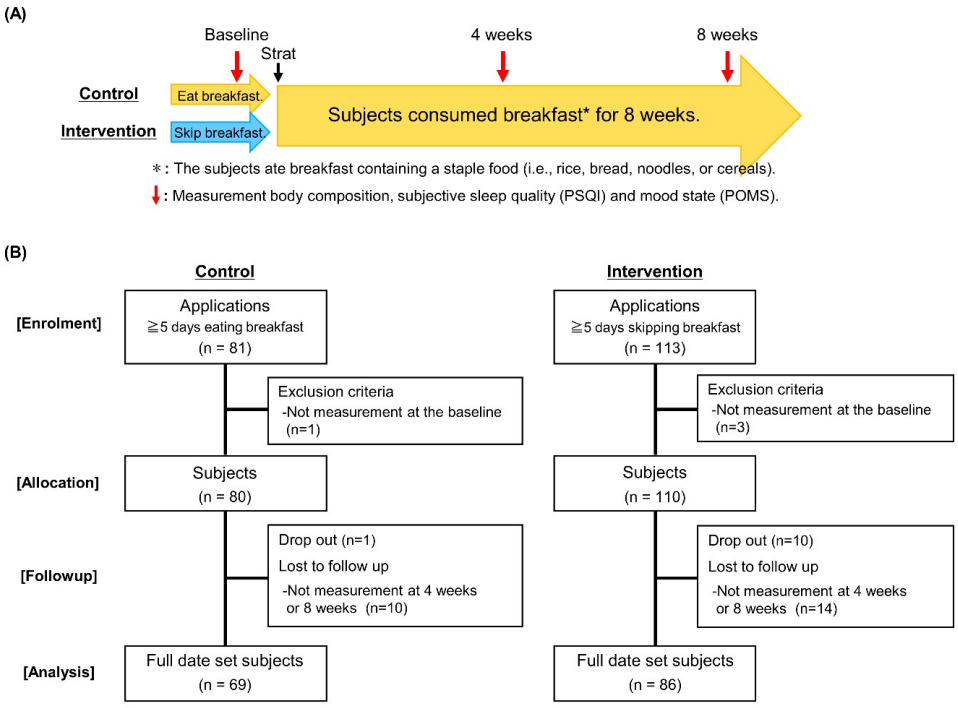


Figure 1: Study design. Study protcol (A). Screening of subjects (B)

We provided each subject with a verbal explanation of the outline and objectives of this research, the main study subject, the protection of personal information, and so on, and obtained written informed consent. The research was conducted according to the Declaration of Helsinki and the protocol was approved by the Ethics Review Committee for Research on Human Subjects at Kanto Gakuin University (Approval Number: H2017-3-1). Each subject gave informed consent before their participation. The study protocol was registered with the University Hospital Medical Information Network Clinical Trial Registry (UMIN-CRT; registration number: UMIN000041016).

Subjects who usually skip breakfast were assigned to the intervention group (n = 113), and subjects who usually ate breakfast were assigned to the control group (n = 81). In this study, we examined the effect of eating breakfast for 8 weeks on the subjective sleep quality and the mood states of people who usually skip breakfast.

According to the National Health and Nutrition Survey, meal skipping is defined as [1] not eating a meal; taking only nutritional supplements such as tablets or energy drinks; eating only sweets, including pastries, fruit, or dairy products; or drinking taste-oriented beverages. Based on these conditions, in this study, the subjects were instructed to eat a breakfast containing a staple food (i.e., rice, bread, noodles, or cereals) each day for 8 weeks (Figure 1A). Subjects were asked to eat breakfast within 2 hours of getting up. Subjects were free to choose any type and amount of food for breakfast. We created a record sheets form to know what breakfast was consumed. Subjects checked the staple foods every day they ate for breakfast on the recording form: rice, bread, noodles, cereals, other (e.g., chinese steamed buns) or skipped breakfast: pastry, none. The content and quantity of meals other than the staple food were entered in the free description column in the record sheet. The record sheets were collected by the study supervisors on assessment days. Fruit granola (Frugra®, Calbee, Inc., Tokyo, Japan) was provided to subjects who wanted it.

Body composition and questionnaire surveys on the subjective sleep quality and mood state were conducted a total of three times: Baseline the study, at 4 weeks, and at 8 weeks. Subjects completed body composition measurements and a questionnaire at the same time on the same day of the week in all three assessments.

Body Composition

In Body is a machine that uses bioelectrical impedance analysis to measure body components, such as body water, muscle mass, and fat mass [20,21]. InBody 470 was used for the measurement of body composition (InBody 470, Biospace Japan Inc., Tokyo, Japan). Body composition estimates were calculated by using the manufacturer's software (Lookin'Body 120, Biospace Japan Inc., Tokyo, Japan).

The Pittsburgh Sleep Quality Index (PSQI)

The Japanese version of the Pittsburgh Sleep Quality Index (PSQI) was used as the questionnaire on sleep [22,23]. The PSQI assesses the sleep quality of the month prior to the evaluation [22]. The sum of the scores for 7 components (i.e., overall sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction due to sleepiness) yields a total score [24]. A global PSQI score of > 5 points indicates a "poor sleeper" [23,24].

The Profile of Mood States (POMS)

The Japanese version of the Profile of Mood States (POMS) 2nd Edition Adult Short Form (Kaneko Shobo Co., Ltd., Tokyo, Japan) was used for the measurement of mood states. The POMS is a self-reported questionnaire regarding mood. It is designed to assess 7 clusters of feelings or mood states: Anger–hostility, confusion–bewilderment, depression-dejection, fatigue–inertia, tension–anxiety, vigor–activity, and friendliness [25]. We assessed the subjects' mood states over the previous week using POMS.

Statistical Analysis

A Mann Whitney test were performed for group, and a Friedman test post-hoc Dunn test were performed for test period were performed for statistical analysis of the breakfast contents, body compositions, PSQI scores, sleep duration component, and POMS scores. A chi-squared test was performed for the number of poor sleepers. Graph Pad Prism 8 statistical software was used, and tests were performed at the 0.05 level of significance ($p < 0.05$).

Results

Screening

In the control group, 80 subjects were recruited (i.e., people who ate breakfast more than five times a week) (Figure 1B). In this group, 11 subjects could not complete the trial, of whom subjects lost to follow up (10 subjects could not participate in the week 4 or week 8 assessment) and one subject dropped out because they could not continue eating breakfast for 8 weeks. Sixty-nine subjects completed the trial, 44 of whom were men and 25 of whom were women, aged 22-61 y, with an average age of 39.4 ± 9.7 years (Table 1).

Table 1: Characteristics of participants

	Control	Intervention
Participants	69	86
- Men / Women	44 / 25	44 / 42
Age(range)	39.4 ± 9.7(22-61y)	37.3 ± 10.4(21-63y)

Age values are mean ± standard deviation (SD).

In the intervention group, 110 subjects were recruited (i.e., people who skipped breakfast more than five times a week) (Figure 1B). In this group, 24 subjects could not complete the trial: 14 subjects lost to follow up (Not participate in the week 4 or week 8 assessment) and 10 dropped out because they could not continue eating breakfast for 8 weeks. Eighty-six subjects completed the trial, 44 of whom were men and 42 of whom were women, aged 21-63 y, with an average age of 37.3 ± 10.4 years (Table 1).

Breakfast Contents

In the control group, the average number of days that subjects ate breakfast increased from 6.2 to 6.6 days a week during the test period (Table 2). Meanwhile, the average number of days that subjects from the intervention group ate breakfast increased from 0.4 to 6.4 days during the test period

(Table 2).

Table 2: Breakfast contents

	Control		Intervention	
	Baseline	Test period	Baseline	Test period
Eating Breakfast	6.2 ± 0.9	6.6 ± 0.4**	0.4 ± 0.8 †††	6.4 ± 0.2 ***
- Rice	2.7 ± 2.7	1.1 ± 1.6***	0.2 ± 0.7 †††	1.1 ± 1.6 ***
- Bread	3.0 ± 2.7	1.4 ± 1.5 ***	0.1 ± 0.5 †††	1.1 ± 1.4 ***
- Noodles	0.1 ± 0.6	0.0 ± 0.1	0.0 ± 0.5	0.1 ± 0.2 ***
- Cereal	0.4 ± 1.2	4.1 ± 2.0 ***	0.1 ± 0.5	4.0 ± 2.2 ***
- Other	0.0 ± 0.0	0.0 ± 0.0	0.0 ± 0.0	0.1 ± 0.2 ***
Skipping Breakfast	0.8 ± 1.3	0.4 ± 0.6 *	6.6 ± 1.2 †††	0.6 ± 0.6 ***
- Pastry	0.3 ± 0.8	0.2 ± 0.4	0.9 ± 2.1	0.1 ± 0.2 ***
- None	0.5 ± 0.9	0.2 ± 0.4 *	5.7 ± 2.1 †††	0.5 ± 0.6 ***

Values (days a week) are mean ± SD. A Mann Whitney test were performed for group, and a Friedman test post-hoc Dunn were performed for statistical analysis of the breakfast contents. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, indicating a significant difference compared to the value at the baseline. Significantly different to the group, ††† $p < 0.001$.

Body Composition

The body weight, Body Mass Index (BMI), body fat percentage, fat mass and lean mass of all subjects did not change during the test period (Table 3). The lean body mass of the intervention group was lower than the control group at all points.

Table 3: Body compositions

	Control			Intervention		
	Baseline	4 weeks	8 weeks	Baseline	4 weeks	8 weeks
Body weight (kg)	63.2 ± 13.5	63.0 ± 13.5	63.1 ± 13.5	60.7 ± 13.5	60.6 ± 13.4	60.6 ± 13.4
BMI (kg/m^2)	22.4 ± 3.8	22.4 ± 3.8	22.4 ± 3.8	22.4 ± 3.8	22.4 ± 3.7	22.4 ± 3.7
Body fat (%)	24.4 ± 6.7	24.3 ± 6.5	24.6 ± 6.7	25.9 ± 7.1	25.8 ± 7.0	26.2 ± 7.0
Fat mass (kg)	15.7 ± 6.7	15.5 ± 6.6	15.8 ± 6.8	16.0 ± 6.7	15.9 ± 6.5	16.1 ± 6.6
Lean mass (kg)	47.6 ± 9.5	47.6 ± 9.4	47.4 ± 9.3	44.7 ± 9.6 †	44.7 ± 9.6 †	44.5 ± 9.6 †

Values are means ± SD. Control group, $N = 69$; intervention group, $N = 86$. A Mann Whitney test were performed for group, and a Friedman test post-hoc Dunn were performed for statistical analysis of the body compositions. † $p < 0.05$, indicating a significant difference compared to the value at the group.

Sleep Quality

The PSQI results showed that the PSQI global scores of the intervention group was worse than that of the control group at the baseline (Table 4). The PSQI global scores of the intervention group decreased (i.e., improved) significantly from 5.7 points at the baseline to 4.5 points after 4 weeks and 4.4 points after 8 weeks. The sleep quality of the intervention group decreased (i.e., improved) significantly from 1.5 points at the baseline to 1.2 points after 8 weeks. The

sleep latency of the intervention group decreased (i.e., improved) significantly from 0.7 points at the baseline to 0.4 points after 4 weeks and 0.4 points after 8 weeks. The daytime dysfunction of the intervention group was worse than that of the control group at the baseline. The daytime dysfunction of the intervention group decreased (i.e., improved) significantly from 1.1 points at the baseline to 0.8 points after 4 weeks and 0.7 points after 8 weeks.

Table 4: PSQI component scores

	Control			Intervention		
	Baseline	4 weeks	8 weeks	Baseline	4 weeks	8 weeks
PSQI global scores	5.1 ± 2.1	4.7 ± 2.3	4.8 ± 2.3	5.7 ± 2.3 †	4.5 ± 2.2 ***	4.4 ± 2.3 ***
Sleep quality	1.4 ± 0.6	1.3 ± 0.6	1.3 ± 0.7	1.5 ± 0.6	1.3 ± 0.6	1.2 ± 0.6 *
Sleep latency	0.6 ± 0.7	0.4 ± 0.6	0.4 ± 0.6	0.7 ± 0.8	0.4 ± 0.7 *	0.4 ± 0.7 ***
Sleep duration	1.5 ± 0.9	1.4 ± 0.9	1.5 ± 0.8	1.4 ± 1.0	1.3 ± 1.0	1.3 ± 0.9
Sleep efficiency	0.1 ± 0.5	0.1 ± 0.4	0.1 ± 0.4	0.2 ± 0.4	0.1 ± 0.3	0.2 ± 0.6
Sleep disturbance	0.8 ± 0.4	0.8 ± 0.5	0.7 ± 0.5	0.7 ± 0.5	0.6 ± 0.5 †	0.6 ± 0.5
Hypnotic medication use	0.0 ± 0.3	0.0 ± 0.3	0.0 ± 0.4	0.1 ± 0.6	0.1 ± 0.6	0.1 ± 0.6
Daytime dysfunction	0.8 ± 0.7	0.8 ± 0.7	0.8 ± 0.8	1.1 ± 0.7 ††	0.8 ± 0.7 **	0.7 ± 0.8 ***

Values are means ± SD. Control group, $N = 69$; intervention group, $N = 86$. A Mann Whitney test were performed for group, and a Friedman test post-hoc Dunn were performed for statistical analysis of the PSQI scores. Significantly different to the value at the baseline, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.01$. Significantly different to the group, † $p < 0.05$.

The sleep duration component showed that the bedtime and the wake-up time of the intervention group were later than that of the control group (Table 5). The bedtime and the wake-up time of all subjects did not change during the test period. There was no difference in latency and sleep duration of all subjects.

Table 5: Sleep duration component

	Control			Intervention		
	Baseline	4 weeks	8 weeks	Baseline	4 weeks	8 weeks
Bedtime (hh:mm)	23:44 ± 1:02	23:43 ± 1:02	23:44 ± 1:03	24:15 ± 1:07 ††	24:10 ± 1:05 †	24:14 ± 1:13 ††
Latency (min)	32 ± 32	26 ± 25	30 ± 28	34 ± 31	30 ± 29	32 ± 36
Wake-up time (hh:mm)	6:05 ± 0:39	6:03 ± 0:40	6:00 ± 0:43	6:43 ± 0:53 †††	6:34 ± 1:02 †††	6:44 ± 0:48 †††
Sleep duration (hh:mm)	6:21 ± 0:57	6:20 ± 0:58	6:18 ± 0:55	6:28 ± 1:07	6:31 ± 1:07	6:32 ± 1:08

Values are means ± SD. Control group, $N = 69$; intervention group, $N = 86$. A Mann Whitney test were performed for group, and a Friedman test post-hoc Dunn were performed for statistical analysis of the sleep duration component. †† $p < 0.01$, ††† $p < 0.001$, indicating a significant difference compared to the group.

In this study, 23 subjects in control group and 44 subjects in intervention group had PSQI scores over 5 at the baseline and were classified as poor sleepers (Table 6). In the intervention group, there was a larger proportion of poor sleepers than in the control. At the end of the assessment period, 19 subjects in the control group and 24 subjects in the intervention group were determined to be poor sleepers. The number of poor sleepers in the intervention group decreased after 8 weeks.

Table 6: Number of poor sleepers

		Time		Statistics (χ^2)
		Baseline	8 weeks	
Control	Good sleepers	46	50	$p = 0.46$
	Poor sleepers	23	19	
Intervention	Good sleepers	42	62	$p < 0.01$
	Poor sleepers	44 †	24 **	
Statistics (χ^2)		$p < 0.05$	$p = 0.96$	

Values are number of subjects. A chi-square test was performed for the number of poor sleepers. Significantly different compared to the value at the baseline, ** $p < 0.01$. Significantly different to the group, † $p < 0.05$.

Mood States

The POMS results showed that the fatigue–inertia of the intervention group decreased (i.e., improved) significantly from 48.3 points at the baseline to 45.9 points after 4 weeks and 45.1 points after 8 weeks (Table 7). Total mood disturbance, anger–hostility, confusion–bewilderment, depression–dejection, and tension–anxiety of the control group and intervention group decreased after 4 and/or 8 weeks.

Table 7: POMS (Profile of Mood States) component scores

	Control			Intervention		
	Baseline	4 weeks	8 weeks	Baseline	4 weeks	8 weeks
Total Mood Disturbance	47.0 ± 8.0	45.8 ± 9.1	44.4 ± 9.3 ***	47.5 ± 8.5	45.5 ± 9.1 **	44.4 ± 8.6 ***
Anger–Hostility	47.8 ± 7.7	45.4 ± 8.5 *	45.0 ± 8.2 ***	48.3 ± 9.7	45.5 ± 8.8 **	44.5 ± 8.0 ***
Confusion–Bewilderment	48.4 ± 8.1	47.1 ± 9.1 *	45.9 ± 8.2 ***	49.4 ± 7.9	47.5 ± 9.2 **	46.1 ± 8.4 ***
Depression–Dejection	47.9 ± 8.6	46.6 ± 8.1 **	46.6 ± 8.0	47.9 ± 7.4	47.1 ± 8.0	46.2 ± 7.9 **
Fatigue–Inertia	47.1 ± 8.8	47.2 ± 10.0	45.9 ± 10.4	48.3 ± 9.1	45.9 ± 9.8 **	45.1 ± 10.0 ***
Tension–Anxiety	46.7 ± 8.5	45.1 ± 9.3	43.6 ± 9.2 **	47.2 ± 9.2	45.3 ± 9.0 **	44.4 ± 8.3 ***
Vigor–Activity	51.8 ± 10.5	51.2 ± 11.8	53.0 ± 11.9	52.3 ± 9.6	52.2 ± 10.3	52.4 ± 9.9
Friendliness	53.7 ± 10.8	51.1 ± 11.6	52.4 ± 12.1	53.9 ± 8.1	52.9 ± 8.1	53.0 ± 9.3

Values are means ± SD. Control group, $N = 69$; intervention group, $N = 86$. A Mann Whitney test were performed for group, and a Friedman test post-hoc Dunn were performed for statistical analysis of the POMS scores. Significantly different to the value at the baseline, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Discussion

In this study, the PSQI global score and daytime dysfunction was improved in regard to the subjective sleep quality of those who started eating breakfast regularly. The number of poor sleepers decreased, as those who skipped breakfast began to eat breakfast. In a survey of Japanese people on breakfast by the Ministry of Agriculture, Forestry and Fisheries, there were 156 papers related to breakfast [26]. There were 140 cross-sectional studies, 10 prospective cohort studies, and 2 observational studies, and there have been no reports of breakfast intervention in breakfast skip people. The report of this breakfast intervention study may be important in clarifying the significance of breakfast.

In this study, 28 subjects lost to follow up (Figure 1B). Those who withdrew could not be measured on the specified date and time due to work commitments. In this

study, subjects completed body composition measurements at the same time (within one-hour half) on the same day of the week in all assessments. It is possible that time constraints led to the withdrawal of the subject. Many people do not eat breakfast because they do not have time in the morning, and thus preparing breakfast is troublesome [27]. A further 11 subjects dropped out (Figure 1B), as they could not get up early enough in the morning and did not have time to eat breakfast. Since 11 subjects dropped out despite the provision of breakfast, further studies are needed in the future regarding making breakfast a habit.

The body compositions (body weight, BMI, percent of body fat, fat mass, and lean mass) of all subjects did not change during the test period (Table 3). In order to reduce the burden on the subject, a questionnaire survey was conducted in which only the breakfast content was stated. Therefore, it was not possible to track the content of other meals and the number of calories per day of the subjects. It is unclear why the body compositions did not change, as the subjects' behavioral changes could not be followed. Further studies are required to explain these results such as Food Frequency Questionnaire.

The PSQI global score and daytime dysfunction of the intervention group improved significantly after four weeks and eight weeks (Table 4). Those who normally skip breakfast have high PSQI global scores [6]. Components of daytime dysfunction include having trouble staying awake and keeping up enthusiasm [20]. Those who skip breakfast have higher drowsiness and lower motivation in the morning [29]. Eating breakfast reduces hunger and enhances intellectual work ability [30]. Eating breakfast also improves work efficiency and concentration compared to those who skip breakfast [31]. It was concluded that those who normally skipped breakfast reduced their daytime drowsiness and improved their intellectual work efficiency by eating breakfast. The sleep quality and sleep latency of the intervention group improved significantly (Table 4). Supporting this result, thirteen adults consumed a high-protein breakfast or skipped breakfast for 7 d/treatment, perceived sleep quality and sleep onset tended to improve after breakfast compared with after breakfast skip [32]. PSQI global scores are the total points of each component, and it was concluded that the improvement of sleep quality, sleep latency, and daytime functioning has an influence on the improvement of PSQI global scores in the intervention group. It was observed that the number of poor sleepers in the intervention group decreased accordingly (Table 6). The sleep duration, bedtime, wake-up time, and sleep time were not changed (Tables 4 and 5). A previous study showed that those who skip breakfast have later bedtime and wake-up times, which was also found in this study (Table 5) [33]. In a future work, the effect of breakfast on sleep quality and sleep latency will be measured by using an objective measuring device such as an actigraph or electroencephalogram [34].

Of the three daily meals, breakfast has the strongest effect on resetting the biological clock [35,36]. It is possible that breakfast skippers can reset their biological clock by eating breakfast regularly. The body clock is also altered by drinks containing caffeine [37]. However, it is necessary to investigate the contents of other daily meals in detail. The circadian rhythm is an important mechanism in homeostasis, and has a cycle longer than 24 h in some cases [38], but it is advantageous to restore it to 24 h wherever possible. It has been reported that time cues (zeitgebers) can adjust the circadian rhythm to a 24-h cycle [39]. Diet is also involved in time cues (zeitgebers) and has been shown to play a role in the formation and restoration of circadian rhythm [40-42]. Circadian rhythm changes with the timing of meals in healthy subjects [43]. Further studies are required to explain the relationship between breakfast and circadian rhythms in breakfast skippers.

The fatigue -inertia of the intervention group decreased significantly after four and eight weeks (Table 7). There are reports that fatigue is high when breakfast is skipped [44]. Those who skipped breakfast felt that the feeling of fatigue was alleviated by eating breakfast, and that their fatigue/mood scores may have improved in the intervention group. The reported improvement in self-reported mood and physiological status after eating an Italian breakfast suggests that both carbohydrate and caffeine played an important role [18]. Total mood disturbance, anger–hostility, confusion–bewilderment, and tension-anxiety of all subjects decreased after four and eight weeks (Table 7). We have previously reported that eating fruit granola for two weeks improved mood state (vitality, anxiety, depression, tension, and frustration) in Japanese women [45]. In this study, subjects ate cereal on four or more days per week (Table 2). As in previous studies, subjects may have

improved their mood depending on how often they ate the fruit granola. However, the mechanism by which fruit granola improves mood is not clear. Further studies are required to explain these results.

Conclusions

The results of this study suggest that eating breakfast regularly can improve the subjective sleep quality and daytime dysfunction of those who usually skip breakfast. This study will help us understand the importance of breakfast intake and the effects of the intervention of breakfast. Future research should focus on the relationship between breakfast intake and objective sleep indices such as electroencephalography, as well as intervention studies with shift workers.

Conflicts of Interest

HM, HH, and KI are employees of Calbee, Inc. YS reports no conflicts of interest in this work.

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