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Food Intake Behavior and Chronotype of Japanese Nurses Working Irregular Shifts

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Abstract

Shift work is the popular working pattern in many fields in industrialized nations. However, the shift worker does not pay much attention to his (her) own health. It is known that shift work has strong associations with various diseases. The aim of this study was to investigate the relationship between food intake and chronotype in Japanese nurses working an irregular rotation of shifts. This questionnaire-based study used a cross-sectional design. Participants were nurses working in several hospitals, data from 159 respondents being analyzed. The questionnaire covered demographics, the Diurnal Type Scale (DTS) and a Food Intake Questionnaire (FIQ). The DTS scores were classified into three chronotype groups: modified Morning-type (M-type), modified Evening-type (E-type) and modified Intermediate-type (I-type). For food intake behavior, meal habits of the M-types were compared with the E-types before / after day- and night-work. In the morning, just after the night-shift, the M-types chose cold food more frequently (p = .016) and felt less satiated after the meal (p = .016) than the E-types. Furthermore, the E-types chose significantly larger meals (p = .023) than the M-types, the M-types snacking more frequently. Chronotype was associated with the food intake behavior both in day- and night-shift. These results suggest that the Morning-type person suffered more inconvenience with regard to food intake behavior during night-work.

Keywords: shift work, chronotype, food intake behavior, nurse

1. Introduction

Shift work is a common working pattern that is essential for improvement of productivity in many areas of work in industrialized nations. Shift work has been commonly utilized in the police, firefighters and the medical profession, as well as in the service industries and many manufacturing fields, for several decades. On the other hand, there are reports from all over the world that the shift worker has a greater risk of diseases such as breast cancer (Davis, Mirick, & Stevens, 2001; Schernhammer et al., 2001), prostate cancer (Zhu, Zheng, Stevens, Zhang, & Boyle, 2006), cardiovascular disorders (Nabe-Nielsen, Garde, Tüchsen, Hogh, & Diderichsen, 2008; Suwazono et al., 2008) and gastrointestinal disorders (Angersbach et al., 1980; Saberi & Moravveji, 2010). These increased incidences might reflect the fact that the biological clock becomes desynchronised by shift work (Knutsson, 2003; Stevens, 2005; Kolstad, 2008). However, the shift worker does not seem to pay much attention for his / her health, and this problem applies also to nurses.

Human are naturally diurnal, their circadian clock being adjusted mainly by solar light which acts as a zeitgeber. Therefore, it is unnatural to work (at any circadian phase) under continuous artificial lighting, though this unnatural circumstance is necessary for those undertaking shift work. Such unnatural environments and circadian phases may influence food intake behavior of shift workers.

With regard to food intake, many previous studies have reported that shift workers eat a reduced number of meals and, instead, eat high-calorie snacks more frequently than do day-workers (de Assis et al., 2003; Waterhouse et al., 2003). Furthermore, Arble et al. (2009) reported that the timing of meals was related to obesity / body weight gain in mice, and an irregular timing of meals due to shift work might be connected with weight control. These problems are believed to apply to nurses who work shifts; nevertheless, the detailed relationship between irregular meal times and obesity has not yet been tested scientifically. Such a detailed examination of the food intake behavior of nurses on shift work would be necessary for the promotion of this aspect of their health.

Further, the shift worker becomes sleep-deprived due to the delayed / advanced work schedules, this problem being similar to that observed after time-zone transitions, i.e. jet lag syndrome. For example, a simulated time-zone transition using an isolation chamber produced changes of food intake behavior after the transition (Waterhouse et al., 2005), and this indicates that an endogenous factor (circadian rhythmicity) affects food intake behavior.

Waterhouse et al. (2003) have also compared food intake habits between day- and night-workers using a "Food Intake Questionnaire (FIQ)". They reported that the amounts of snacks and cold meals eaten by night-workers in the UK were greater than those by day-time workers. Also, less hunger before meals and feelings of being over-full after meals were more common in the night-workers. These results might be attributed in part to the effects of the biological clock.

In a recent study of PER2-LUC knock-in mice, the phase of clock gene expression in the kidney or liver (peripheral clock phase) was adjusted by the timing of meals (Kuroda et al., 2012). Scheer et al. (2013) demonstrated that the internal circadian clock controlled the sense of hunger and appetite, using a "forced de-synchrony protocol" in humans. Thus, in this experiment, appetite and hunger increased during the subjective night. Because the shift worker works during the night, it is possible that appetite increases at this time, resulting in eating larger meals than day-workers due to the influence of their circadian rhythms.

It is well known that the core body temperature and hormonal secretions show circadian rhythms whose phase can show individual differences. The individual differences are classified into several types, based on their circadian phase, and refer to the chronotype of the individual (Morningness-Eveningness). Some people (Morning-types) like to wake up early in the morning, whilst others (Evening-types) cannot do this; also, Evening-types like to be active late at night, whilst Morning-types like to go to bed early. Chronotype in humans is often determined using a questionnaire (e.g. the 19-item, Morningness-Eveningness scale: Horne & Östberg, 1976; the 7-items Diurnal Type Scale: Torsvall & Åkerstedt, 1980).

Moog (1987) showed that Morning-types adapted to night-work with significantly more difficulty than Evening-types. Furthermore, the intake of certain nutrients and foods differed significantly among different chronotypes, chronotype being assessed as the midpoint of sleep time in young Japanese female students (Sato-Mito et al., 2011). A late midpoint, an Evening-type, was associated with high energy intakes from alcohol, fat, confections and meat. By contrast, the Morning-type showed greater intakes of calcium and vitamin B6, as well as eating more vegetables and pulses.

Although food intake by shift worker has been studied by multiple approaches, including aspects of circadian rhythms, these previous studies have had three problems. Firstly, few studies focused on shift worker's food intake; secondly, the characteristics of food intake have not been clarified according to the individual's chronotype, although differences in chronotype affect the ease of adapting to night-work (Kawasaki et al., 2014); thirdly, many previous studies have compared food intake between night- and day-workers on fixed schedules (de Assis, et al, 2003; Waterhouse, et al., 2003). However, many Japanese nurses work irregular rotating shifts in hospitals, and there are few studies of these. Therefore, it is unknown how chronotype affects food intake behavior in those working on an irregular rotation of shifts, and the results from such a study might differ from those reported in previous studies of shift work in Europe and USA.

The results of this study could lead to reducing the risk of diseases related to shift work among nurses and to proposing new work environments suitable for individuals of different chronotype. The aim of this study is to investigate the relationship between food intake behavior during shift work and chronotype in Japanese nurses working on irregularly rotating shifts.

2. Methods

2.1 Study Design and Participants

This study used a cross-sectional design for Japanese nurses working irregular two- and three-shift systems in hospitals in 2009. The direction of rotation of the shifts was both forwards and backwards. Participants were nurses working in several hospitals in the Kansai region, Japan. We visited each hospital and distributed questionnaires to the shift working nurses at several wards in the hospitals. It was requested that the nurses answered the questionnaire less than 2 weeks after having received it. The questionnaires that had been answered were returned to the researchers by normal mail. Of the 394 questionnaires that had been handed out, 225 (57%) were answered and returned. Of these, 66 were excluded from analysis because individuals were current or past smokers, had food intake restrictions due to disease, were dieting, or answered imperfectly the questionnaire defines chronotype. The data from the remaining 159 nurses were analyzed. The 159 nurses consisted of 82 (51.6%) persons 20-29 years old, 33 (20.8%) in the age range 30-39, 32 (20.1%) in the range 40-49, 11 (6.9%) aged 50-59 and 1 (0.6%) over 60; 135 (84.9%) of them were female. Eighty-four (52.8%) nurses worked a 2-shift system and 70 (44.0%) nurses a 3-shift system; only 4 (2.5%) worked a combination of 2- and 3-shift systems. The mean number of years working shifts among all nurses was 9.0 ± 0.7 years, ranging from 0 to 37 years.

2.2 Questionnaire

The self-administered questionnaire was composed of demographics (gender, age, shift pattern, years working shifts, living with or without a housemate), the Diurnal Type Scale for self-rating chronoype (Torsvall & Åkerstedt, 1980), and some items of the Food Intake Questionnaire (FIQ).

2.2.1 Morningness-Eveninngness Questionnaire (MEQ)

The MEQ was developed by Horne and Östberg (1976); it defined scores from 45 to 58 as “Intermediate-type”, from 59 to 86 as “Morning-type”, and scores from 16 to 31 as “Evening-type”. However, the Diurnal Type Scale (DTS) score, which ranges from 7 to 28, does not define chronotype but the tendency of chronotype. It has been reported that there is a positive correlation (an r value > 0.85 using Person’s correlation upon data from children and university students) between MEQ scores and DTS scores (Harada, personal communication, September 1, 2009). Therefore, we postulated that the distributions of DTS scores were equivalent to those obtained by MEQ and that the DST defined a score of more than 19 as “modified Morning-type (M-type)” and of less than 13 as “modified Evening-type (E-type)”. The DST was adopted to save time for the nurses who were very busy.

2.2.2 Food Intake Questionnaire (FIQ)

The FIQ was developed by Waterhouse and his colleagues (2003) and was designed to assess food intake behavior. The FIQ was translated into Japanese and adjusted so that it was appropriate to the lifestyle of a Japanese respondent. This revised FIQ was composed of 7 items (the type of meal, whether hot or cold, the reason for eating it, factors influencing the food eaten, hunger before the meal, enjoyment during the meal and satiety after the meal.). With regard to the type of the meal, after discussing this with the nurses, it was decided that the choice was between “not eat”, “snack”, “meal” and “large meal”. Also “cool large meal” was not in the original version but was inserted into the Japanese version since cold noodles, like the So-ba, are one of the main sources of carbohydrate throughout the year. Therefore, we adapted questions not only with regard to the type of the meal but also according to whether it was hot or cold. Distinguishing between a “meal” or “snack” is subjective. To offer further advice on this, the modified version of the food-based classification of eating episodes model (Lennernäs & Andersson, 1999) was used in order to define these terms in a Japanese context. Other items consisted of the reason for having meal, the consideration of selection food, and subjective responses to the meal. The subjective scores were evaluated with these numerical values: 1 = *not at all;* 2 = *comparatively not;* 3 = *tend to be not;* 4 = *tend to be yes;* 5 = *comparatively yes;* 6 = *completely yes*). The FIQ was given to each nurse on four occasions to assess: “a” = meal before day-work; “b” = meal after day-work; “c” = meal before night (not evening)-work; and “d” = meal after night-work (see Figure 1).

Before the questionnaire was distributed to nurses, it was piloted to ensure that the translated version and the modified questions were suitable for the Japanese nurses we studied; for this, current shift working nurses and nurses who had worked shifts in the past were consulted.

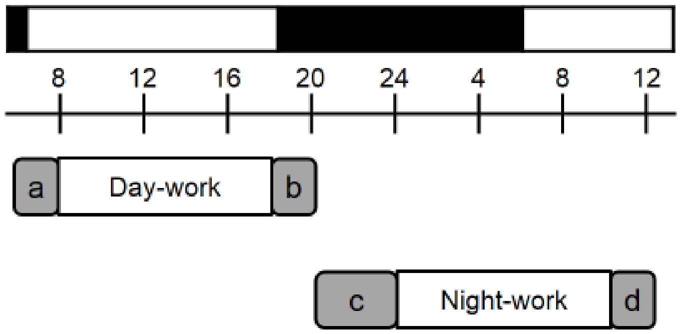

Figure 1.The schema of four kinds of food intake measured by questionnaire (meals “a” – “d”)

Note. LD cycle is indicated by black (dark) and white (light) bars. X-axis was time of day (hours).

2.3 Statistical Analysis

Results are expressed as mean ± standard error (*SE*). Data were analyzed with non-parametric tests. In cases which had a nominal scale (e.g. type of food, temperature of food, reasons for choice), χ^2 tests and Fisher’s exact tests were used. For values on an ordinal (hunger, enjoyment and satiety) or interval (DTS score) scale, Mann-Whitney U-tests were used. Spearman’s correlation coefficient, ρ, was used to analyze the relationships between subjective responses to food intake and DTS scores. Differences were considered to be statistically significant when p values were less than 0.05. The range $0.05 < p < 0.10$ was defined as a tendency to be significant. All statistical analyses were performed using the program of SPSS for windows (version 15.0).

2.4 Ethical Considerations

The questionnaire was completely anonymous. Before administering the questionnaire, a written explanation was given to all participants. The explanation described the aims of the study and stated that answers would be used only for academic purposes. The study was conducted with the approval of the Ethics Committee of Kyoto University Graduate School and Faculty of Medicine.

3. Results

3.1 The Correlation between Food Intake Behavior and DTS Score

Figure 2 illustrates the distribution of DTS scores; the mean ± *SE* was 16.2 ± 0.3 (n = 159), ranging from 8 to 27. These scores was classified as M-type (score: 8-13, n = 35), E-type (score: 19-27, n = 32) and I-type (n = 92).

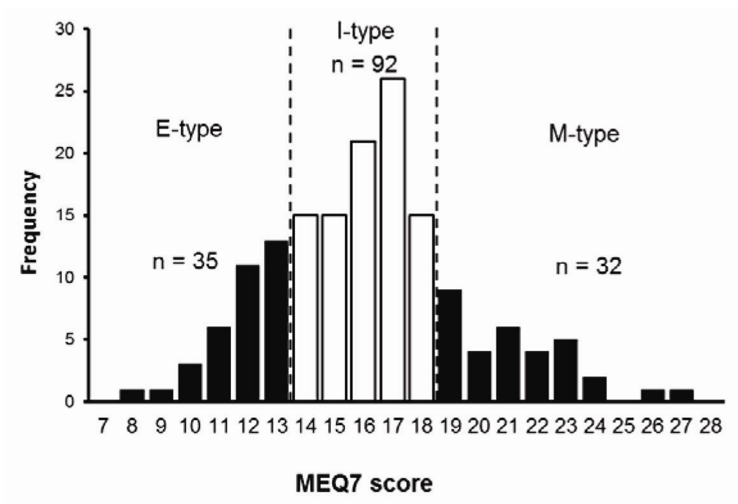

Figure 2. The frequency distribution of The Diurnal Type Scale (DTS) scores

Table 1. The relationship between DTS scores and food type, food temperature & reasons for choice

Variable	Before day-work (a)		After day-work (b)		Before night-work (c)		After night-work (d)	
	mean ± SE	n	mean ± SE	n	mean ± SE	n	mean ± SE	n
Type of food:								
Did not eat	15.4 ± 0.5	(44)	12	(1)	**18.0 ± 0.9**	**(9)**	16.0 ± 0.7	(27)
Eat something	16.6 ± 0.3	(111)	16.3 ± 0.3	(151)	**16.1 ± 0.3**	**(148)**	16.2 ± 0.3	(127)
Snack	16.3 ± 0.5	(53)	17.0 ± 0.8	(8)	15.4 ± 0.6	(27)	16.5 ± 0.4	(84)
meal or Large meal	16.9 ± 0.4	(58)	16.3 ± 0.3	(143)	16.2 ± 0.3	(121)	15.6 ± 0.5	(43)
Temperature of food:								
Hot	16.9 ± 0.5	(50)	16.3 ± 0.4	(107)	15.9 ± 0.4	(78)	**15.7 ± 0.6**	**(44)**
Not hot	16.5 ± 0.4	(58)	16.9 ± 0.4	(37)	16.4 ± 0.4	(64)	**16.6 ± 0.3**	**(81)**
Reasons for choice								
Appetite	17.6 ± 0.8	(27)	16.3 ± 0.4	(89)	15.5 ± 0.4	(57)	16.5 ± 0.4	(92)
Time	16.6 ± 0.3	(75)	16.7 ± 0.4	(52)	16.4 ± 0.4	(82)	15.7 ± 0.6	(29)

Bold: $p < 0.05$; Underlined: $0.05 < p < 0.10$

Table 1 shows the correlation between food intake behavior and DTS scores. In some of the four meals investigated, the type of meal and the temperature of food were significantly associated with the DTS score. In the meal before day-work (meal "a"), participants who "did not eat" (15.4 ± 0.5) tended to show lower DTS scores (a tendency to be Evening-types) than those who did "eat something" (16.6 ± 0.3) (Mann-Whitney: z = -1.929, p = .054). After day-work, no items correlated significantly with the DTS scores. On the other hand, in the meal before night-work (meal "c"), participants who "did not eat" (18.0 ± 0.9) showed significantly higher DTS scores (more Morning-typed) than those who did "eat something" (16.1 ± 0.3) (Mann-Whitney: z = -1.959, p = .049). After night-work (meal "d"), participants who did "eat snack" (16.5 ± 0.4) tended to have higher DTS scores than those who did "eat meal or large meal" (15.6 ± 0.5) (Mann-Whitney: z = -1.814, p = .070). With regard to the temperature of the food, participants who took "hot food" (15.7 ± 0.6) were significantly more Evening-typed (with lower DTS scores) than those who took "cold or room-temperature food" (16.6 ± 0.3) (Mann-Whitney: z = -2.152, p = .031).

The correlations between subjective responses to food intake behavior are shown in Table 2. In meal "a" (eaten before day-work in the morning), enjoyment during meal showed a significant positive correlation with DTS scores (ρ = 0.219, p = .023). Moreover, in the meal after night-work (meal "d"), satiety after the meal was significantly correlated with the DTS score (ρ = -0.236, p = .008), but its association was negative. Other meals showed tendencies to be correlation negatively with DTS scores - hunger before the meal after day-work (meal "b") and before the meal preceding night-work (meal "c") (ρ = -0.169, p = .056 and ρ = -0.154, p = .065, respectively).

3.2 The Comparison of Food Intake Behavior with Chronotypes

The DTS scores were classified into three groups: the M-type, the E-type and the I-type. For aspects of food intake behavior, the M-types were compared with the E-types. Table 3 presents the results of these comparisons. In meal "a", eaten in the morning before day-work, the E-types tended to miss breakfasts more often than the M-types (χ^2 = 5.089, df = 3, p = .079). After day-work (meal "b"), the M-types chose cold or room-temperature food significantly more frequently than the E-types (χ^2 = 6.793, df = 1. p = .013). In meal "c", eaten in the afternoon or evening before night-work, the E-types were significantly more likely to choose hot food (χ^2 = 3.882, df = 1, p = .049). After night-work (meal "d", eaten in the morning), M-types chose colder food significantly more frequently than the E-types (χ^2 = 5.840, df = 1, p = .016). Moreover, the E-types chose a "larger meal" more frequently than the M-types (χ^2 = 5.169, df = 1, p = .023).

Table 2. Results of Spearman's correlations between DTS scores and subjective responses to food intake

	Variable	Spearman ρ	p-value
Before day-work (a):	Hunger before meal	0.135	.160
	Enjoyment during meal	**0.219**	**.023**
	Satiety after meal	0.022	.823
After day-work (b):	Hunger before meal	<u>-0.169</u>	<u>.056</u>
	Enjoyment during meal	-0.019	.907
	Satiety after meal	-0.133	.158
Before night-work (c):	Hunger before meal	<u>-0.154</u>	<u>.065</u>
	Enjoyment during meal	0.122	.147
	Satiety after meal	0.044	.602
After night-work (d):	Hunger before meal	-0.100	.264
	Enjoyment during meal	0.039	.664
	Satiety after meal	**-0.236**	**.008**

Bold: $p < 0.05$; Underlined: $0.05 < p < 0.10$

Table 3. The relationship between chronotype and food type, food quantity, food temperature and reason for eating

Variable	Before day-work (a)				After day-work (b)				Before night-work (c)				After night-work (d)			
	M-type		E-type		M-type		E-type		M-type		E-type		M-type		E-type	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
Type of food:																
Did not eat	<u>5</u>	<u>(16.1)</u>	<u>13</u>	<u>(40.6)</u>	0	(0.0)	1	(3.3)	4	(12.9)	1	(2.9)	5	(16.7)	6	(17.6)
Snack	<u>11</u>	<u>(35.5)</u>	<u>10</u>	<u>(31.3)</u>	2	(6.5)	0	(0.0)	5	(16.1)	9	(25.7)	20	(66.7)	14	(41.2)
Meal	<u>15</u>	<u>(48.4)</u>	<u>9</u>	<u>(28.1)</u>	27	(87.1)	23	(76.7)	20	(64.5)	21	(60.0)	4	(13.3)	11	(32.4)
Large meal	<u>0</u>	<u>(0.0)</u>	<u>0</u>	<u>(0.0)</u>	2	(6.5)	6	(20.0)	2	(6.5)	4	(11.4)	1	(3.3)	3	(8.8)
Quantity of food*:																
Snack	11	(42.3)	10	(52.6)	2	(6.5)	0	(0.0)	5	(18.5)	9	(26.5)	**20**	**(80.0)**	**14**	**(50.0)**
Meal or Large meal	15	(57.7)	9	(47.4)	29	(93.5)	29	(100.0)	22	(81.5)	25	(73.5)	**5**	**(20.0)**	**14**	**(50.0)**
Temperature of food:																
Hot	14	(53.8)	8	(42.1)	**21**	**(70.0)**	**26**	**(96.3)**	**13**	**(50.0)**	**24**	**(75.0)**	**6**	**(23.1)**	**15**	**(55.6)**
Not hot	12	(46.2)	11	(57.6)	**9**	**(30.0)**	**1**	**(3.7)**	**13**	**(50.0)**	**8**	**(25.0)**	**20**	**(76.9)**	**12**	**(44.4)**
Reasons for choice:																
Appetite	10	(38.5)	4	(21.1)	16	(53.3)	19	(73.1)	6	(22.2)	14	(43.8)	21	(80.8)	19	(70.4)
Time	16	(61.5)	11	(57.9)	13	(43.3)	6	(23.1)	18	(66.7)	17	(53.1)	5	(19.2)	7	(25.9)
Others	0	(0.0)	4	(21.1)	1	(3.3)	1	(3.8)	3	(11.1)	1	(3.1)	0	(0.0)	1	(3.7)

Bold: $p < 0.05$; Underlined: $0.05 < p < 0.10$

*: "Meal" and "Large meal" were combined and "Did not eat" was excluded from analysis.

Table 4. The results of mean number ± SE of subjective responses to food intake in the M- and the E-types

Variable	Before day-work (a)		After day-work (b)		Before night-work (c)		After night-work (d)	
	M-type	E-type	M-type	E-type	M-type	E-type	M-type	E-type
Hunger	4.0 ± 0.2	3.3 ± 0.4	4.3 ± 0.2	4.8 ± 0.2	3.7 ± 0.3	4.3 ± 0.2	4.4 ± 0.3	4.9 ± 0.2
before meal	(26)	(19)	(29)	(28)	(27)	(32)	(26)	(27)
Enjoyment	**3.2 ± 0.3**	**2.4 ± 0.3**	4.1 ± 0.2	4.0 ± 0.3	2.9 ± 0.3	2.8 ± 0.3	3.4 ± 0.3	3.2 ± 0.3
during meal	**(25)**	**(19)**	(29)	(28)	(26)	(32)	(26)	(27)
Satiety	3.7 ± 0.3	3.5 ± 0.4	4.6 ± 0.2	5.1 ± 0.2	4.3 ± 0.2	4.3 ± 0.2	**3.4 ± 0.2**	**4.3 ± 0.3**
after meal	(25)	(19)	(29)	(28)	(27)	(32)	**(26)**	**(27)**

Bold: $p < 0.05$; Underlined: $0.05 < p < 0.10$

Some subjective responses to food intake were dependent upon chronotype (Table 4). Hunger before the meal after day-work tended to be higher in the E-types nurses than the M-types (Mann-Whitney: z = -1.773, p =.077). Before day-work, the M-types showed higher scores for enjoyment of their meal than the E-types (Mann-Whitney: z = -1.975, p = .049). There were no significant difference between the M- and the E-types in "Enjoyment during meal" after night-work (Mann-Whitney: z = -0.319, p = .762), after day-work (Mann-Whitney: z = -0.041, p = .970) or before night-work (Mann-Whitney: z = -0.319, p = .762). After night-work, the E-types showed significantly higher scores of satiety than the M-types (Mann-Whitney: z = -2.399, p = .016).

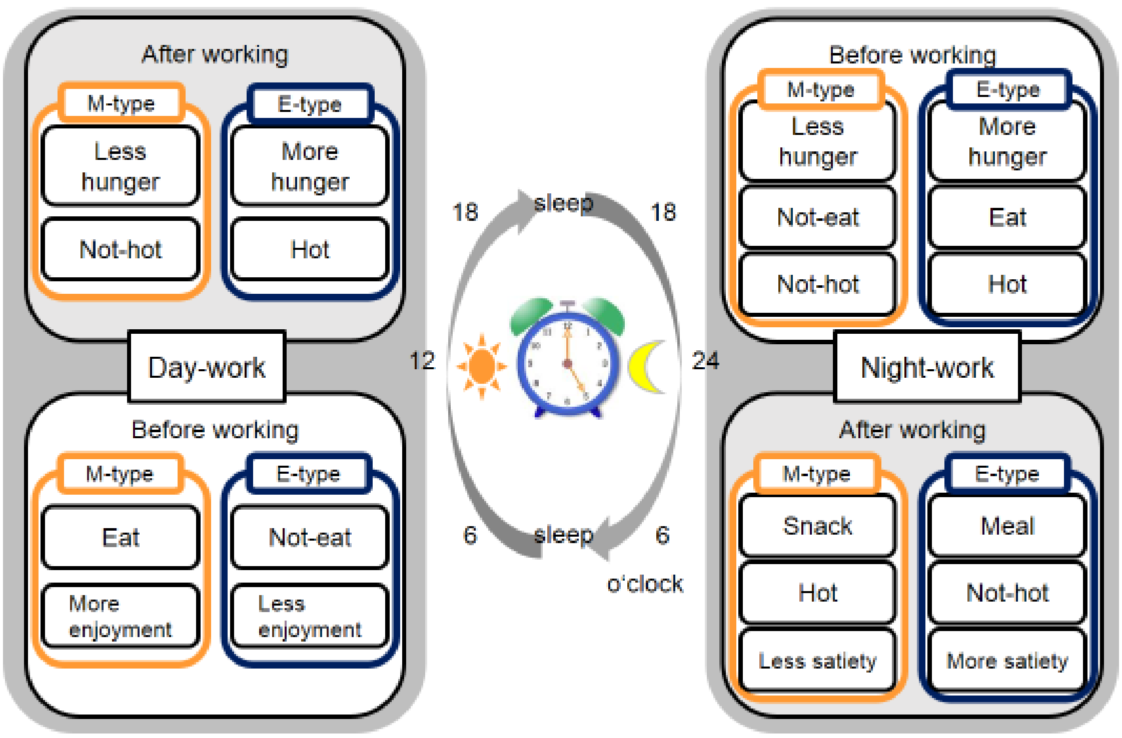

Figure 3. Summary of results from this study

4. Discussion

The results of this study are summarised in Figure3. we interpret them as follows: The Morning-types enjoy the meal before day-work, and there is a possibility that the Evening-type does not eat breakfast, possibly because the Evening-type gets up too late to have time for breakfast. On the other hand, the Evening-types seem to feel more hunger before the meal that is eaten after day-work, and they are more likely to choose a hot meal. When the general characteristics of Morning- and Evening-types are compared, this result accords with those from a previous study (Waterhouse et al., 2001).

In addition, the Evening-types might feel more hunger before night-work and were able to eat a hot meal; by contrast, the Morning-types chose cold meals or did not eat anything before night-work. These patterns were very similar to those seen after day-work. Food intake of the Morning-types after night-work tended to be a "snack", and they were satisfied with a small meal; food intake after night-work in the Evening types tended to be a "meal" that was cold. Waterhouse et al. (2003) reported that significantly higher intakes of snacks and significantly lower intakes of large, hot meals were shown by night-workers when compared with food intake during work periods in day-workers, results which did not accord with those from the Evening-types in the present study but did accord with those from the Morning-types. However, in comparing these results, it must be remembered that the "Morning-typed" population in Japan corresponds with a large fraction of the population in the UK, because Japan is the extremely evening-orientated society. The UK study did not investigate the effects of chronotype, and the present study stresses the complicated relationship between food habits and an individual's chronotype.

In addition, on rest days (days when there was no work), subjects in the UK were more likely to choose a hot meal compared with work days (Waterhouse et al., 2003). A snack is often chosen merely for convenience. It is known that digestive function is generally lower in those who eat in the evening rather than the morning (Sanders et al., 1992). We suggest that this difference applies in particular to persons who are Morning-types.

The entrainment of the biological clock is primarily due to light acting as a zeitgeber upon the central clock (the SCN, suprachiasmatic nuclei), but food intake also acts as a zeitgeber for peripheral clocks in the liver (Green et al., 2008; Tahara et al., 2010). Even though details of entrainment of peripheral clocks are not yet clear, it is a distinct possibility that food intake during the night-time acts as a zeitgeber in humans. We were not able to investigate details of the food intake during work hours in the present study, but there is the possibility that the phase of circadian clock of the worker can be changed according to the overall pattern of food intake of an individual.

The main finding of this study has been that Morning-type persons suffered inconveniences in their food intake behavior during night-work. However, advice regarding food intake for Morning-types working night-shifts is very sparse (Health & Safety Executive, 2006). The challenges - to improve performance at work and to reduce human error, and to suggest appropriate food intake strategies for Morning- and Evening-types - are important and remain. It is suggested that any future guidelines dealing with humans and their responses to work, sleep and food intake need to take chronotype into account.

This study was conducted along lines based on interviews with nurses. Some nurses answered that, after night-work, they ate larger meals than usual and that they thought that this was an unhealthy habit. This study did not investigate details of meal size after night-work. However, this phenomenon may be similar to the phenomenon that the patients suffering from Seasonal Affective Disorder (SAD) have increased appetites and meal sizes during winter (Rosenthal, 1998). The depressive symptom of SAD could be due to low serotonin and melatonin secretions produced by the decrease of day length in winter (Wirz-Justice et al., 2013). Shift workers also might have suppressed melatonin secretions due to light exposure during night-work; this possibility needs further detailed study in the future.

4.1 Limitation of This Study

This research was a cross-sectional questionnaire survey, so it cannot identify any causal links. Also, there might be unknown biases in the study - for example: nurse working a 2-shift system can nap during night-work, whereas nurses working a 3-shift system are not allowed to nap in Japan. That is to say, we could not clarify differences among hospitals and hospital wards. Further, the sample size was small; more data including those from shift work patterns other than irregular shifts are required. We could not measure the amount of activity undertaken by the nursing staff, and it would be desirable to have more data on the phase relationships between locomotor activity, the sleep-wake cycle and food intake in the different chronotypes. Finally, food intake may be associated with sleep and exercise, and further studies are needed to measure these variables using a sleep diary and actigraphy (Stone & Ancoli-Israel, 2011).

4.2 Conclusion

Chronotype was associated with the food intake when individuals worked in the day- and night-time. Morning-types suffered inconvenience with regard to food intake during night-work. It seems that the employers of nurses working shifts need to consider an individual's chronotype when dealing with working conditions of their employees. Suitable changes to the working environment and guidelines for health in shift workers might lead not only to improved performance but also to less the risk of developing diseases related to shift work.

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