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Association between Sleep, Stress and BMI with Chrononutrition Behaviors among Military Personnel in Malaysia

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ABSTRACT

This study aimed to find the association between sleep quality, stress level, and Body Mass Index (BMI) with the chrononutrition behaviors of military personnel. Six chrononutrition behaviors were assessed using the Chrononutrition Profile Questionnaire (CPQ). Sleep quality was measured by the Pittsburgh Sleep Quality Index (PSQI) and perceived stress using the Perceived Stress Scale (PSS-10). The associations between chrononutrition behaviors and sleep quality, stress level, and BMI were determined using the Fisher exact test. Data was collected from 210 participants (median age: 27.5 years). Most military personnel, 62% (n=129) experienced moderate stress. Approximately 59.2% (n=122) demonstrated poor sleep quality. Out of six chrononutrition behaviors, sleep quality was significantly associated with evening eating (p=0.004) and night eating (p=0.028). Stress level was significantly associated with evening eating (p=0.051), night eating (p=0.019), and eating window (p=0.014). No association was found between chrononutrition behaviors and BMI of military personnel. Chrononutrition behaviors are associated with sleep quality and stress level but not body mass index in military personnel. Further understanding of sleep quality and stress among military personnel is imminent to prevent future weight issues concerning altered eating behaviors in this population.

Keywords: BMI, chrononutrition, circadian rhythm, sleep quality, stress

INTRODUCTION

Chrononutrition can describe the association between food intake and the circadian clock and generally represents the timing of eating on health. It is acclaimed that sleep and food intake exhibit 24-hour patterns, and health problems can occur as a result of the interruptions of these patterns. Psychological, biological, and social factors may affect many nutritional behaviors and influence the behavioral components of chrononutrition. The chrononutrition behaviors that are possible to have a detrimental effect on health are breakfast skipping, the largest meal, evening eating, evening latency, night eating, and eating window (Veronda *et al.* 2020). Circadian rhythms play a vital function in the physiological processes involved in energy metabolism and balance. The alteration of the circadian clock is associated with changes in time of feeding behavior as well as increased weight gain (Engin 2017).

In emergencies, military personnel must be available 24/7, with working hours varying based on unit and tasks. This leads to occasional work during unconventional hours. Shift work induces circadian misalignment, as the working timetable overlaps with the sleep-wake cycle, particularly affecting individuals on rotating, night, or early morning shifts (James *et al.* 2017). Working during the daytime has caused individuals to be active during their rest time, thus disturbing the circadian rhythm (James *et al.* 2017). Likewise, the timing of food intake will be modified, and the feeding–fasting cycle will be deliberately altered.

Military personnel reside and operate within an exclusive cultural environment characterized by physically, emotionally, and cognitively demanding tasks that can elevate the probability of encountering restricted food availability, heightened stress levels, and insufficient sleep, which can impact dietary behaviors (Cole *et al.* 2021). Given their physical training, military personnel are expected to be of normal weight compared to the general population. However, military personnel worldwide, particularly in the United States, Saudi Arabia, Czech Republic,

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Nigeria, and India, have been found to have a high prevalence of overweight and obesity (Aliyu *et al.* 2014; Horaib *et al.* 2013; Fajfrová *et al.* 2016; Ray *et al.* 2011; Reyes-Guzman *et al.* 2015).

In Malaysia, a previous study has shown that 29.3% of male Royal Malaysian Navy were overweight, and 7.2% were obese (Sedek *et al.* 2010). However, the study of body mass index among military personnel in Malaysia does not include chrononutrition, rendering the relationship unknown. Military personnel's social and physical environment is unlike the general population; therefore, detailed comprehension of the risk factors causing overweight and obesity is crucial. Thus, this study aimed to find the association between stress, sleep, and BMI with chrononutrition behaviors.

METHODS

Design, location, and time

A cross-sectional study was carried out to observe the association between sleep, stress, and BMI with chrononutrition behaviors among military personnel in Malaysia. Ethical approval of this research was obtained from UiTM ethical committees (REC/08/2021 (MR/701)).

Sampling

The sampling method in this study was convenient sampling to ensure the chance of each member of the subset being selected as a part of the sampling process was equal and bias could be avoided. The inclusion criteria for recruitment were Malaysian armed forces, including the Malaysian army, Royal Malaysian Air Forces, and Royal Malaysian Navy, aged 18 to 50 years old and still in service. The exclusion criteria were veterans or someone with a history of steroid use, either as medication or supplements.

Data collection

Informed consent was acquired from all subjects before recruitment into this study. All information was kept confidential. Participation in this research is entirely voluntary, and individuals have the right to decline participation or withdraw from the study without facing any negative consequences.

A set of questionnaires was distributed through Google Forms. Consented subjects were given a set of questionnaires that consisted of four sections about sociodemographic characteristics, self-reported anthropometry, chrononutrition behaviors and preferences, sleep quality, and stress level.

Sociodemographic. The first section included data on age, gender, marital status, ethnicity, household income, education level, duration of services, health status, and employment. The employment questions were composed of the location of the workplace (military base), working hours (shift), unit, and rank.

Self-reported anthropometry. The respondents were required to measure their height and weight filled in centimetres (cm) for height and kilograms (kg) for weight. The data collected was used to calculate the Body Mass Index (BMI) by using the formula BMI=Weight (kg) / (Height (m))2. BMI was classified based on the World Health Organization (WHO) as underweight (<18.5), normal weight (18.5–24.9 kg/m2), overweight (25.0– 29.9 kg/m2), or obese class I (30.0–34.9 kg/m2), II (35.0–39.9 kg/m2) and III (≥40 kg/m2).

Chrononutrition behaviors and preferences. The validated Chrononutrition Profile Questionnaire (CPQ) was used to assess the individual chrononutrition behaviors, sleep timing, eating timing, and frequency. The questionnaire was translated into Malay language and also back translation. There were six components of chrononutrition behavior, which were breakfast skipping, largest meal, evening eating, evening latency, night eating, and eating window. They were assessed into good (scored 0), fair (scored 1), and poor (scored 2). The total chrononutrition profile score was obtained through the sum of six chrononutrition behavior scores and ranged from 0–12, in which 0 = 'Good chrononutrition status' while 12 = 'Poor chrononutrition status'.

Sleep quality. The validated Pittsburgh Sleep Quality Index (PSQI) was used to measure the sleep quality of participants. The total sum of the seven components produced one global score ranging from 0 to 21 points, with scores ranging from 0 to 5 indicating good sleep quality while scores ranging from 6 to 21 indicating poor sleep quality.

Stress level. The validated Perceived Stress Scale (PSS-10) consist of 10 items that was rated on a 5-point Likert scale, ranging from 0 (never) to 4 (very often). The total score was obtained from the sum of the scores of each item and the reversed score of items 4, 5, 7, and 8. The PSS total scores ranged from 0 to 40, in which '0–13' is low stress, '14–26' is moderate stress, and '27–40' is high perceived stress.

Data analysis

All statistical analysis was performed using SPSS software. The normality of the distribution of continuous variables was assessed using Kolmogorov-Smirnov tests, where p=<0.05 is considered as not normal. Descriptive statistical analysis such as frequency and percentage were carried out to describe collected data of sociodemographics. Continuous data was reported in the median and interquartile range, while categorical data was reported in number and percentage. Fisher exact test was used to find the association between chrononutrition behaviors and body mass index categories, stress level, and sleep quality. The statistically significant variable outcome was indicated by p<0.05.

RESULTS AND DISCUSSION

Characteristic of participants

Table 1 compares the characteristics of participants based on their Body Mass Index (BMI) categories. There was no significant association between the three different branches of the military with BMI categories (p=0.292). However, the rank of the military personnel (p=0.001) and duration of services (p=<0.001) were significantly associated with BMI categories. The age of the participants ranged from 18 to 50 years, with a median of 27.5 years. There were significant age differences between the three BMI categories. Gender had a significant association with BMI categories (p<0.01).

Components of chrononutrition profile questionnaire

Table 2 details the components of the participants' Chrononutrition Profile Questionnaire (CPQ) in a week (seven days span). The average weekly sleep duration ranged from 0 to 8.73 hours, with the midpoint ranging from 1:26 a.m. to 7:23 a.m. One hundred eight participants did not sleep during the workday.

All components of the eating timing variable were significantly correlated between workday and free day (p<0.05). Most participants had lunch as their largest meal, with a frequency of 149 (71%), followed by dinner with a frequency of 41 (19.5%). The participants' breakfast skipping, nighttime snacking, and night eating behaviors ranged from 0 to 7 days per week, with a median of 1, 0, and 0.

Association between chrononutrition behaviors and BMI categories

Table 3 shows the chrononutrition behaviors with three cut-offs: good, fair, and poor with body mass index categories. Most of the participants had fair evening eating behaviors 145 (69.0%), good eating window 201 (95.7%), good breakfast skipping behaviors 110 (52.4%), good night eating behaviors 157 (74.8%), and fair scores for the largest meal 149 (71.0%). Almost half of the participants had good evening latency 87 (42.2%), while the other half had fair evening latency 99 (48.1%). All chrononutrition behaviors were not significantly associated with BMI categories (p>0.05).

Association between chrononutrition behaviors and sleep quality

Table 4 depicts the chrononutrition behaviors with three cut-offs for good, fair, and poor sleep quality. No association was found between evening latency, eating window, breakfast skipping, and the largest meal with sleep quality. However, evening eating (p=0.004) and night eating (p=0.028) were found to have a significant association with sleep quality. Most of the participants had good night eating behaviors 154 (74.8%) and fair evening eating behaviors 141 (68.4%).

Association between chrononutrition behaviors and stress levels

Table 5 presents the association between chrononutrition behaviors and stress levels. The stress level was divided into three categories: low stress, moderate stress, and high perceived stress. There were no participants who had high perceived stress. Among all chrononutrition behaviors, evening eating (p=0.051), eating window (p=0.014), and night eating (p=0.019) were significantly associated with stress.

Association between BMI and chrononutrition behaviors

I. Eating window. Our study found neither significant association between eating window

Table 1. Characteristics of participants (n=210)

Characteristics	Total (n=210)	Body mass index			*p*
		Underweight (n=5)	Normal (n=135)	Overweight/ Obese (n=70)	
Branches[b]					0.292
Malaysian army	102 (48.6)	1 (0.5)	65 (31.0)	36 (17.1)	
Air Force	82 (39.0)	3 (1.4)	50 (23.8)	29 (13.8)	
Navy	26 (12.4)	1 (0.5)	20 (9.5)	5 (2.4)	
Rank[b]					**0.001**
Officer	86 (41.0)	2 (1.0)	56 (26.7)	28 (13.3)	
Non-commissioned officer	98 (46.7)	0 (0.0)	58 (27.6)	40 (19.0)	
Recruit	3 (1.4)	0 (0.0)	2 (1.0)	1 (0.5)	
Cadet officer	23 (11.0)	3 (1.4)	19 (9.0)	1 (0.5)	
Age[a]	27.5 (7)	21.0 (5)	26.0 (6)	30.5 (8)	**<0.01**
Gender[b]					**<0.01**
Male	160 (76.2)	0 (0.0)	101 (48.1)	59 (28.1)	
Female	50 (23.8)	5 (2.4)	34 (16.2)	11 (5.2)	
Live in barracks[b]					0.071
Yes	90 (42.9)	0 (0.0)	63 (30.0)	27 (12.9)	
No	120 (67.1)	5 (2.4)	72 (34.4)	43 (20.5)	
Working at night[b]					0.782
Yes	121 (57.6)	3 (1.4)	75 (35.7)	43 (20.5)	
No	89 (42.4)	2 (1.0)	60 (28.6)	27 (12.9)	
Frequency night work[b]					0.407
No	7 (3.4)	0 (0.0)	4 (2.0)	3 (1.5)	
Less than a week	102 (49.8)	3 (1.5)	68 (33.2)	31 (15.1)	
1–2 weeks	56 (27.3)	1 (0.5)	38 (18.5)	17 (8.3)	
≥3 weeks	40 (19.5)	1 (0.5)	22 (10.7)	17 (8.3)	
Education level[b]					0.336
High school	82 (39.0)	2 (1.0)	49 (23.3)	31 (14.8)	
Diploma	40 (19.0)	0 (0.0)	28 (13.3)	12 (5.7)	
Bachelor degree	75 (35.7)	3 (1.4)	52 (24.8)	20 (9.5)	
Postgraduate studies	13 (6.2)	0 (0.0)	6 (2.9)	7 (3.3)	
Ethnicity[b]					**0.012**
Malay	192 (91.4)	3 (1.4)	123 (58.6)	66 (31.4)	
Chinese	5 (2.4)	1 (0.5)	4 (1.9)	0 (0.0)	
Indian	5 (2.4)	1 (0.5)	1 (0.5)	3 (1.4)	
Others	8 (3.8)	0 (0.0)	7 (3.3)	1 (0.5)	
Marital status[b]					**0.012**
Single	99 (47.1)	4 (1.9)	82(39)	13(6.2)	
Married	108 (51.4)	0 (0.0)	51(24.3)	57(27.1)	
Separated	3 (1.4)	1 (0.5)	2(1.0)	0(0.0)	
Total household income[b]					
Less than RM2,500	62 (29.5)	2 (1.0)	49 (23.3)	11 (5.2)	
RM2,500–RM4,851	95 (45.2)	2 (1.0)	59 (28.1)	34 (16.2)	
RM4,851 per to RM10,970	45 (21.4)	1 (0.5)	21 (10)	23 (11.0)	
RM10,971 and above	8 (3.8)	0 (0.0)	6 (2.9)	2 (1.0)	

[a]Data between the groups were tested using the Kruskal-Wallis and reported as median (IQR); [b]Data between the groups were analyzed using the Fisher exact test and reported as n (%)

Table 2. Components of the chrononutrition profile questionnaire

Characteristic	Overall range	Average	Work day	Free day	*p*
Sleep timing variable					
Sleep duration (hr)	0.00–8.73	3.15 (4.01)	3.00 (6.0)	6.5 (2.0)	0.399[a]
Sleep midpoint (hh:mm)	1:26–7:23	4:04 (1:56)	4:00 (3:00)	3:15 (1:30)	0.327[a]
Eat timing variable					
Eating window (hr)	4.36– 3.43	8.76 (2.14)	12.00 (3.0)	12.00 (2.5)	**<0.01**[a]
Morning latency (hr)	0.20–7.5	2.00 (1.50)	2.00 (1.50)	2.00 (1.50)	**<0.01**[a]
Lunch latency (hr)	0.00–8.5	5.00 (1.54)	5.00 (1.50)	4.75 (1.50)	**<0.01**[a]
Afternoon latency (hr)	3.5–12.29	7.50 (2.08)	7.50 (2.50)	7.50 (2.50)	**<0.01**[a]
Evening latency (hr)	1.00 –15.71	5.29 (4.57)	5.75 (6.5)	3.50 (2.0)	**0.01**[a]
Evening eating (hh:mm)	17:00–1:17	20:30 (1:43)	20:30 (2:00)	20:30 (2:00)	**<0.01**[a]
Frequency variable					
Breakfast skipping (day/week)	0–7	1.0 (4)[b]			
Largest meal					
Breakfast		17 (8.1)[c]			
Lunch		149 (71.0)[c]			
Dinner		41 (19.5)			
Supper		3 (1.4)[c]			
Nighttime snacking (day/week)	0–7	3.0 (3)[b]			
Night eating (day/week)	0–7	0.0 (2)[b]			
Total chrononutrition profile score	0–9	4.0 (2)[b]			

[a]*p*-value between the work day and free day was tested using Spearman's correlation; [b]Data between groups were reported as median (IQR); [c]Data were reported as n (%)

Table 3. Association between chrononutrition behaviors and body mass index categories

Chrononutrition behaviors	n	Cut off	Total	BMI categories			*p*
				Under weight n (%)	Normal n (%)	Overweight/ Obese n (%)	
Evening eating[a]	210	Good	45 (21.4)	0 (0.0)	30 (14.3)	15 (7.1)	
		Fair	145 (69.0)	5 (2.4)	89 (42.4)	51 (24.3)	0.471
		Poor	20 (9.5)	0 (0.0)	16 (7.6)	4 (1.9)	
Evening latency[a]	206	Good	87 (42.2)	1 (0.5)	52 (25.2)	34 (16.5)	
		Fair	99 (48.1)	3 (1.5)	68 (33.0)	28 (13.6)	0.331
		Poor	20 (9.7)	1 (0.5)	14 (6.8)	5 (2.4)	
Eating window[b]	210	Good	201 (95.7)	5 (2.4)	128 (61.0)	68 (32.4)	
		Fair	9 (4.3)	0 (0.0)	7 (3.3)	2 (1.0)	0.776
		Poor	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Breakfast skipping[a]	210	Good	110 (52.4)	3 (1.4)	71 (33.8)	36 (17.1)	
		Fair	45 (21.4)	0 (0.0)	32 (15.2)	13 (6.2)	0.639
		Poor	55 (26.2)	2 (1.0)	32 (15.2)	21 (10.0)	
Night eating[a]	210	Good	157 (74.8)	3 (1.4)	95 (45.2)	59 (28.1)	
		Fair	35 (16.7)	2 (1.0)	24 (11.4)	9 (4.3)	0.064
		Poor	18 (8.6)	0 (0.0)	16 (7.6)	2 (1.0)	
Largest meal[a]	210	Good	17 (8.1)	1 (0.5)	8 (3.8)	8 (3.8)	
		Fair	149 (71.0)	2 (1.0)	97 (46.2)	50 (23.8)	0.179
		Poor	44 (21.0)	2 (1.0)	30 (14.3)	12 (5.7)	

[a]Data between the groups were tested using the Fisher exact test and reported as n (%); [b]Data between the groups were analyzed using the Kruskal-Wallis and reported as median (IQR)

Table 4. Association between chrononutrition behaviors and sleep quality

Chrononutrition behaviors	n	Cut off	Total	Sleep quality		*p*
				Good n (%)	Poor n (%)	
Evening eating[a]	210	Good	45 (21.8)	26 (12.6)	19 (9.2)	
		Fair	141 (68.4)	55 (26.7)	86 (41.7)	**0.004**
		Poor	20 (9.7)	3 (1.5)	17 (8.3)	
Evening latency[a]	202	Good	85 (42.1)	37 (18.3)	48 (23.8)	
		Fair	98 (48.5)	41 (20.3)	57 (28.2)	0.632
		Poor	19 (9.4)	6 (3.0)	13 (6.4)	
Eating window[b]	206	Good	197 (95.6)	83 (40.3)	114 (55.3)	
		Fair	9 (4.4)	1 (0.5)	8 (3.9)	0.086
		Poor	0 (0)	0 (0)	0 (0)	
Breakfast skipping[a]	206	Good	108 (52.4)	48 (23.3)	60 (29.1)	
		Fair	44 (21.4)	20 (9.7)	24 (11.7)	0.151
		Poor	54 (26.2)	16 (7.8)	38 (18.4)	
Night eating[a]	206	Good	154 (74.8)	70 (34.0)	84 (40.8)	
		Fair	34 (16.5)	7 (3.4)	27 (13.1)	**0.028**
		Poor	18 (8.7)	7 (3.4)	11 (5.3)	
Largest meal[a]	206	Good	16 (7.8)	7 (3.4)	9 (4.4)	
		Fair	146 (70.9)	59 (28.6)	87 (42.2)	0.967
		Poor	44 (21.4)	18 (8.7)	26 (12.6)	

[a]Data between the groups were analyzed using the Chi-square test ; [b]Data between the groups were analyzed using the Fisher exact test

Table 5. Association between chrononutrition behaviors and stress levels

Chrononutrition behaviors	n	Cut off	Total	Stress level			*p*
				Low stress n (%)	Moderate stress n (%)	High perceived stress n (%)	
Evening eating[a]	210	Good	45 (21.4)	21 (10.0)	24 (11.4)	0 (0)	
		Fair	145 (69.0)	57 (27.1)	88 (41.9)	0 (0)	**0.051**
		Poor	20 (9.5)	3 (1.4)	17 (8.1)	0 (0)	
Evening latency[a]	206	Good	87 (42.2)	33 (16.0)	54 (26.2)	0 (0)	
		Fair	99 (48.1)	38 (18.4)	61 (29.6)	0 (0)	0.836
		Poor	20 (9.7)	9 (4.4)	11 (5.3)	0 (0)	
Eating window[b]	210	Good	201 (95.7)	81 (38.6)	120 (57.1)	0 (0)	
		Fair	9 (4.3)	0 (0)	9 (4.3)	0 (0)	**0.014**
		Poor	0 (0)	0 (0)	0 (0)	0 (0)	
Breakfast skipping[a]	210	Good	110 (52.4)	44 (21.0)	66 (31.4)	0 (0)	
		Fair	45 (21.4)	20 (9.5)	25 (11.9)	0 (0)	0.348
		Poor	55 (26.2)	17 (8.1)	38(18.1)	0 (0)	
Night eating[a]	210	Good	157 (74.8)	69 (32.9)	88 (41.9)	0 (0)	
		Fair	35 (16.7)	7 (3.3)	28 (13.3)	0 (0)	**0.019**
		Poor	18 (8.6)	5 (2.4)	13 (6.2)	0 (0)	
Largest meal[a]	210	Good	17 (8.1)	5 (2.4)	12 (5.7)	0 (0)	
		Fair	149 (71.0)	55 (26.2)	94 (44.8)	0 (0)	0.312
		Poor	44 (21.0)	21 (10.0)	23 (11.0)	0 (0)	

[a]Data between the groups were analyzed using the Chi-square test ; [b]Data between the groups were analyzed using the Fisher exact test

and BMI. Similarly, a study among adults with obesity or overweight showed no significant association between eating window and BMI (Popp *et al.* 2021). Typically, an eating window is defined as the time between the first and last eating events; however, this definition is prone to misreport actual mealtimes and unlogged (missed) meals (Popp *et al.* 2021). Ninety-five point seven percent (95.7%) of our samples had a good eating window, meaning their eating window was 12 hours or less. The inconsistent working hours of military personnel may affect their eating time and patterns. Eating habits were also substantially influenced by the modern lifestyle, which cause a prolonged eating phase of more than 14 hours daily (Gill & Panda 2015). The eating and fasting phases influence peripheral clocks and thus metabolism, which contributes to the development and progression of chronic disease (Heilbronn & Regmi 2020; Regmi & Heilbronn 2020).

II. Night eating. Night eating in this study is the days per week in which participants wake up at night to eat (Veronda *et al.* 2020). One population-based study among German adults reported a positive association between night eating and BMI among individuals aged 31 to 60, but only among younger or older adults within this age range (Meule *et al.* 2014). Consequently, in younger cohorts such as students, the relationships between night eating and weight may either be absent or only marginally apparent. In our study, there was no association between night eating and BMI, which could be attributed to the participant's age, as most of participants were young adults with a median age of 27.5.

III. Evening eating. Evening eating is the last eating event of the day (Veronda *et al.* 2020). We found no significant association between evening eating and BMI categories (p=0.471). Similarly, a study among Korean adults found that evening eating was not associated with obesity (Ha & Song 2019). Another study found that having late dinner and bedtime snack were associated with a higher risk of being overweight (Okada *et al.* 2019). Through chrononutrition, the evening is regarded as the time when one can quickly gain weight, but not in our study.

IV. Evening latency. Evening latency is the duration of time between the last eating event and sleep onset time (Veronda *et al.* 2020). The range for evening latency in this study was 1 hour to 15 hours 43 minutes. In this study, the association between evening latency and BMI categories was not significant (p=0.331). A significant correlation between eating dinner within three hours of going to bed and BMI was discovered by Watanabe *et al.* (2014). In our study, because some of the participants did not sleep during the workday, our findings for evening latency may be inaccurate due to circadian disrupting working hours.

V. Largest meal. Individuals that ate the most at breakfast were classified as exhibiting good chrononutrition behavior, those who ate the most at lunch were categorized as having fair chrononutrition behavior, and those who ate the most at dinner or supper were labeled with poor chrononutrition behavior. Our study found that most of the participants 149 (71.0%) had their largest meal during lunch. The association between the largest meal and BMI categories was not significant (p=0.179). To compare, a study on the timing of energy intake found no association between morning energy intakes with BMI (Wang *et al.* 2014). The study found that eating more of the total daily caloric intake at midday is linked to a lower risk of being overweight/obese while eating more at night is connected to a higher risk.

VI. Breakfast skipping. In this study, breakfast skipping was the frequency of days the breakfast is skipped, and good breakfast skipping behavior is for one or fewer days/week, fair for two to three days/week, and poor for four or more days/week. No association was found between breakfast skipping and BMI. However, a study by Watanabe *et al.* (2014) reported that skipping breakfast was associated with a higher prevalence of obesity. Another study on breakfast skipping but with a different population also found an association between breakfast skipping and obesity among older people (Otaki *et al.* 2017).

Association between sleep quality and chrononutrition behaviors

Sleep quality may affect health; however, in the population of military personnel, it does not appear to be a driver of weight gain since most poor sleepers have normal BMI. Poor sleep quality and inadequate sleep are viewed as 'normal' and 'unavoidable' among military personnel due to the nature of military operations and special missions that often require shift work, long-term field training, and fast deployment across multiple time zones (Yarnell & Deuster

2016). In our study, only evening eating and night eating were significantly associated with sleep quality. Similarly, the frequency of snacking and irregularity of night eating among Korean military service members were associated with poor sleep quality (Choi *et al.* 2022). In another study, late dinner was positively associated with poor sleep quality (Lopes *et al.* 2019).

Association between stress & chrononutrition behaviors

Military personnel can experience stress as a result of military exercises, continuous training, humanitarian missions, peacekeeping activities, interpersonal relationship tension, military rank issues, separation from family, and sleep problems (Sareen *et al.* 2007; Adams *et al.* 2013; Rigs & Rigs 2011; Don Richardson *et al.* 2014), as cited in Chou *et al.* (2016). We found more than half (n=129, 61.4%) of participants with moderate stress, while 81 (38.6%) with low stress.

Surprisingly, none of them had high perceived stress despite working in military service, which was ranked as one of the most stressful professions in 2018 (Jayne *et al.* 2020).Consistent with a study among United States Army, the mean perceived stress score of military personnel in the sample was in the moderate range, probably due to the many unique sources of stress faced by many soldiers (Jayne *et al.* 2020). A study among young male military recruits in compulsory service reported that 75% of the participants were low-stress and only 25% were higher-stress (Tonon *et al.* 2020).

It was reported that people who perceived themselves as more vulnerable to stress had fewer eating occasions (Barrington *et al.* 2014) and the presence of higher stress hormones was found in the person who eats later in the evening (Lucassen *et al.* 2013). Our study reveals a significant association between evening eating, night eating, and eating window with stress levels aligning with the findings of Tan & Chow (2014) that heightened stress levels were linked to increased eating dysregulation and emotional eating.

CONCLUSION

In summary, no association was found between chrononutrition behaviors and the BMI of military personnel. Chrononutrition behaviors were associated with sleep quality and stress level but not body mass index in military personnel. Sleep quality was not associated with evening latency, eating window, breakfast skipping, and the largest meal. Evening eating and night eating were found to be associated with sleep quality. Among all chrononutrition behaviors, evening eating, eating window, and night eating were significantly associated with stress levels.

Our findings highlight the importance of considering the timing of intake relative to sleep and stress when studying the associations of meal timing with obesity. We encourage future research to examine the effects of meal timing on body mass index by using an experimental design, particularly randomized trials, to minimize bias. Based on our findings, future trials should consider other body composition measurements, as BMI may not accurately reflect the body fat and its distribution.

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DECLARATION OF CONFLICT OF INTERESTS

The authors have no conflict of interest.

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