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THE ASSOCIATION BETWEEN CHRONONUTRITION BEHAVIOUR AND CONSUMPTION LEVELS WITH THE OCCURRENCE OF CENTRAL OBESITY AMONG BUMN OFFICE EMPLOYEES IN CIANJUR

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Abstract

Central obesity is considered more harmful because it is associated with an increased risk of disease. In Indonesia, the prevalence of central obesity almost doubled from 18.8% in 2007 to 31% in 2018, while in Cianjur Regency it increased from 15.7% in 2007 to 23.8% in 2013. BUMN office workers represent one of the groups with the highest prevalence of central obesity (50.1%). Factors influencing central obesity include sex, education level, macronutrient intake, and chrononutrition behaviour. Objective: To examine the association between chrononutrition behaviour and consumption levels with central obesity. Methods: This quantitative cross-sectional study involved 60 participants selected using simple random sampling. Data were collected through waist circumference measurement, Chrononutrition Profile Questionnaire (CPQ), and 2×24-hour dietary recalls. Data analysis was performed using IBM SPSS Statistics 21 with the Chi-square test. Results: Breakfast skipping and short evening latency were significantly associated with central obesity ($p < 0.05$), while eating window, evening eating, night eating, and largest meal showed no significant association ($p \geq 0.05$). Energy and carbohydrate intake levels were significantly associated with central obesity ($p < 0.05$), whereas protein and fat intake levels were not ($p \geq 0.05$). Conclusion: Office employees are encouraged to avoid skipping breakfast, limit late-night eating, and maintain balanced energy and carbohydrate intake to reduce the risk of central obesity.

Keywords : Central Obesity, Chrononutrition Behaviour, Circadian Rhythm, Consumption Level

Introduction

The development of nutritional problems has become increasingly complex with the emergence of the double burden of malnutrition, a condition in which undernutrition and overnutrition coexist [1]. Obesity represents a major form of overnutrition. In 2022, the World Health Organization reported that 43% of adults aged ≥18 years were overweight, with 16% classified as obese [2]. The World Obesity Federation projected that global obesity prevalence would increase from 14% in 2020 to 24% by 2035 [3], indicating that obesity requires serious public health attention.

Central obesity is considered more hazardous due to its strong association with an increased risk of cardiovascular diseases, as abdominal fat accumulation is located closer to vital organs, including the heart [4]. Data from the Indonesian Basic Health Research (Riskesdas) show that the prevalence of central obesity among individuals aged ≥15 years did not decline over an 11-year period, increasing from 18.8% in 2007 to 31% in 2018. In West Java Province, the prevalence reached 32%, exceeding the national average [5]. In Cianjur Regency, the prevalence of central obesity increased from 15.7% in

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2007 to 23.8% in 2013 and slightly decreased to 22.8% in 2018. Employees of BUMN were reported to have one of the highest prevalences of central obesity, reaching 50.1% [6].

Several factors influence the occurrence of central obesity among workers, including sex, educational level, physical activity, sleep quality, dietary patterns, macronutrient intake levels, and chrononutrition behaviours such as eating window and meal timing [7–10]. In recent years, chrononutrition has emerged as a novel approach to understanding eating behaviour by emphasizing meal timing and regularity in accordance with the body's circadian rhythm [11]. Chrononutrition highlights the importance of meal timing in health outcomes. Eating at times that are misaligned with the circadian rhythm, such as late-night or irregular eating, may disrupt metabolic processes and increase obesity risk [12]. Cunha et al, reported that consuming dinner after 9:00 p.m. was associated with a higher risk of central obesit [7]. Similarly, Longo-Silva et al., found that workers who consumed a greater proportion of daily energy intake at night had a higher risk of obesity compared to those whose energy intake was concentrated in the morning [13].

Appropriate meal timing should be accompanied by adequate intake levels. Office workers often experience irregular eating patterns due to workload and occupational stress, which may lead to excessive food consumption as a coping mechanism [14]. Excessive energy intake, particularly from high-fat and refined carbohydrate foods, contributes to visceral fat accumulation and increases the risk of central obesity [15]. Energy, protein, fat, and carbohydrate intake play important roles in the development of central obesity. Faridi et al. reported that higher energy and fat intake levels were significantly associated with central obesity [16]. Hasanizadeh et al. further demonstrated that high carbohydrate intake increased the risk of central obesity, whereas higher protein intake was associated with a reduced risk [9].

Central obesity increases the risk of degenerative diseases, including type 2 diabetes mellitus, hypertension, and cardiovascular disease [17–19]. In addition to its health impact, central obesity among office workers negatively affects work productivity. Khoiroh et al. reported a significant association between central obesity and work-related fatigue, with workers experiencing central obesity having a 2.78-fold higher risk of fatigue, leading to decreased productivity [20].

Given the high prevalence of central obesity among office workers and the limited research on chrononutrition behaviour in Indonesia, further investigation is necessary. Preliminary observations at the Perum Perhutani KPH Cianjur Office indicated that 15% of employees experienced central obesity, and no previous studies on this topic had been conducted at the site. Therefore, this study aims to analyze the relationship between chrononutrition behaviour and intake levels and the incidence of central obesity among BUMN office employees in Cianjur.

Method

This study employed a cross-sectional research design and was conducted at the Perum Perhutani KPH Cianjur Office, Cianjur District, Cianjur Regency from October 2024 to April 2025. The study population comprised all office employees at the Perum Perhutani KPH Cianjur Office, totaling 255 participants. The sample size was determined using the Lemeshow formula (1997) with an additional 10% to account for potential dropouts, resulting in a total of 60 participants. The sampling method applied was probability sampling using a simple random sampling technique. The inclusion criteria were office employees at Perum Perhutani KPH Cianjur who were willing to participate in the study and provided written informed consent. The exclusion criterion was female employees who were pregnant at the time of data collection.

Data were collected through direct interviews using structured questionnaires. The collected data included subject characteristics, waist circumference measurements, and chrononutrition behaviour. Central obesity was assessed by measuring waist circumference using a measuring tape.

Chrononutrition behaviour was assessed using the Chrononutrition Profile–Questionnaire (CP-Q). The CP-Q has been tested for validity and reliability in a study conducted by Veronda et al [21]. The association between variables was examined using the Chi-Square test. This research was reviewed by the Ethics Committee of Universitas Negeri Malang and was declared ethically appropriate with approval number 07.02.03/UN32.14.2.8/LT/2025.

Result

An overview of chrononutrition behaviours, including eating window, breakfast skipping, evening latency, evening eating, night eating, and largest meal, in this study is presented in Table 1.

Table 1 Characteristics of the Study Subjects (n=60)

Variable	n (%)[a]	Mean ($\bar{x}$ ± SD)
Central Obesity		
1. Central obesity	35 (58,3) [b]	
2. Non-central obesity	25 (41,7)	
Age Group		
1. Early adulthood	10 (16,7)	
2. Middle adulthood	19 (31,7)	
3. Late adulthood	31 (51,7) [b]	44,45 ± 8,538
Sex		
1. Male	53 (88.3)[b]	
2. Female	7 (11.7)	
Educational Level		
1. Senior high school or equivalent	38 (63.3)[b]	
2. Higher education	22 (36,7)	
Income		
1. High (> IDR 5,000,000)	35 (58.3)[b]	
2. Low (≤ IDR 5,000,000)	25 (41.7)	4.850.000 ± 1.972.909
Household Size	58	4,05 ± 1,048

[a]Frequency (percentage); [b]Largest percentage

Based on Table 1, the majority of respondents (58.3%) experienced central obesity, with a mean age of 44.45 years. Most respondents were classified as late adulthood (46–65 years), accounting for 51.7% of the sample. The majority were male (88.3%) and had completed senior high school or its equivalent as their highest level of education (63.3%). More than half of the respondents (58.3%) had high income levels, with a mean monthly income of IDR 4,850,000. In addition, the average household size was four persons. An overview of chrononutrition behaviour among the respondents is presented in Table 2. This overview includes eating window, evening latency, breakfast skipping, evening eating, night eating, and the timing of the largest meal.

Table 2 Characteristics of Chrononutrition Behaviour

Chrononutrition Behaviour		Category	n	%
Eating Window	Weekdays	Poor (>02:00 PM)	16	26,7
		Good (≤02:00 PM)	44	73,3[b]
	Weekends	Poor (>02:00 PM)	14	23,3
		Good (≤02:00 PM)	46	76,7[b]
Evening Latency	Weekdays	Poor (≤2:00 AM)	29	48,3
		Good (>2:00 AM)	31	51,7[b]
	Weekends	Poor (≤2:00 AM)	30	50
		Good (>2:00 AM)	30	50
Breakfast Skipping		Poor (≥4 days/week)	17	28,3
		Good (<4 days/week)	43	71,7[b]
Evening Eating		Poor (≥11:00 PM)	2	3,3
		Good (<11:00 PM)	58	96,7[b]
Night Eating		Poor (≥4 days/week)	3	5
		Good (<4 days/week)	57	95[b]
Largest Meal		Dinner	11	18,3
		Breakfast/Lunch	49	81,7[b]

[b]Largest percentage

The descriptive analysis presented in Table 2 shows that most subjects had a favorable eating window (≤02:00 PM), both on weekdays (73.7%) and weekends (76.7%). Approximately half of the subjects had a favorable evening latency (≤02:00 AM), both on weekdays (51.7%) and weekends (50%). In this study, the majority of subjects demonstrated favorable chrononutrition behaviours, including breakfast skipping (<4 days/week) (71.7%), evening eating (<11:00 PM) (96.7%), and night eating (<4 days/week) (95%). Furthermore, most subjects consumed their largest meal during breakfast or lunch (81.7%). The consumption levels of the respondents in this study, as presented in Table 3.

Tabel 3 Characteristics of Consumption Levels

Consumption Levels	Weekdays		Weekends		Average Consumption Levels
	n (%) [a]	Mean ($\bar{x}$ ± SD)	n (%) [a]	Mean ($\bar{x}$ ± SD)	($\bar{x}$ ± SD)
Energy					
1. Excessive (>110%)	20 (33,3)	2.322,2 ± 766,4	18 (30)	2.288,3 ± 818,9	2.305,3 ± 694,6
2. Not Excessive (≤110%)	40 (66,7) [b]		42 (70)[b]		
Protein					
1. Excessive (>110%)	30 (50)	73,3 ± 29,2	34 (56,7) [b]	75,4 ± 26,4	74,3 ± 23,4
2. Not Excessive (≤110%)	30 (50)		26 (43,3)		
Fat					
1. Excessive (>110%)	33 (55)[b]	80,6 ± 34,9	30 (50)	80,9 ± 43,3	80,7 ± 29,5
2. Not Excessive (≤110%)	27 (45)		30 (50)		
Carbohydrate					
1. Excessive (>110%)	18 (30)	337,7 ± 123,9	17 (28,3)	326,9 ± 135,7	332,3 ± 121,6
2. Not Excessive (≤110%)	42 (70)[b]		43 (71,7) [b]		

[a]frequency (percentage); [b]largest percentage

The descriptive analysis in Table 3 shows that the majority of respondents had adequate energy intake both on weekdays (66.7%) and weekends (70.0%). However, excessive protein intake tended to increase on weekends (56.7%) compared to weekdays (50.0%). During weekdays, more than half of the respondents (55.0%) consumed fat in excessive amounts, while on weekends the proportion of excessive fat intake decreased to 50.0%. Carbohydrate intake remained relatively stable between weekdays (70.0%) and weekends (71.7%), with most respondents classified as having adequate intake.

Furthermore, the descriptive analysis indicates that the mean energy intake was slightly higher on weekdays (2,322.2 kcal) than on weekends (2,288.3 kcal). Protein intake was higher on weekends (75.4 g) compared to weekdays (73.3 g), while fat intake remained almost the same across both periods. Carbohydrate intake tended to be slightly lower on weekends (326.9 g) than on weekdays (337.7 g). The analysis was then continued with bivariate analysis, as presented in Table 4.

Table 4 The Association Between Chrononutrition Behaviour and Central Obesity

Chrononutrition Behaviour	Central Obesity n (%)	Non-Central Obesity n (%)	Total (n = 60)	p-value
Eating Window				
1. Poor			15 (100)	0,096
2. Good	12 (80)	3 (12)	45 (100)	
	23 (51,1)	22 (48,9)		
Breakfast Skipping				
1. Poor			17 (100)	0,037[c]
2. Good	14 (82,4)	3 (17,6)	43 (100)	
	21 (48,8)	22 (51,2)		
Evening Latency				
1. Poor			33 (100)	0,025[c]
2. Good	24 (72,7)	9 (27,3)	27 (100)	
	11 (40,7)	16 (59,3)		
Evening Eating				
1. Poor	2 (100)	0 (0)	2 (100)	0,506
2. Good	33 (56,9)	25 (43,1)	58 (100)	
Night Eating				
1. Poor	2 (66,7)	1 (33,3)	3 (100)	1,000
2. Good	33 (57,9)	24 (42,1)	57 (100)	
Largest Meal				
1. Dinner			11 (100)	1,000
2. Breakfast/Lunch	6 (54,5)	5 (45,5)	49 (100)	
	29 (59,2)	20 (40,8)		

[a]frequency (percentage); [c]significance p-value < 0,05

Based on Table 4, more than half of the respondents (51.1%) with a good eating window were found to have central obesity. In contrast, more than half of the respondents (51.2%) with good breakfast skipping habits did not have central obesity. The majority of respondents (72.7%) with poor evening latency had central obesity. In addition, half of the respondents with good evening eating and night eating habits were also found to have central obesity. More than half of the respondents (59.2%) whose largest meal was consumed at breakfast or lunch had central obesity.

Based on Table 4, the results of the Chi-square statistical test indicate that chrononutrition behaviour variables, specifically breakfast skipping and evening latency, were significantly associated

with the occurrence of central obesity (p-value < 0.05). Meanwhile, eating window, evening eating, night eating, and largest meal were not significantly associated with central obesity (p-value > 0.05).

Tabel 5 The Association Between Consumption Levels and Central Obesity

Consumption Levels	Central Obesity n (%)	Non-Central Obesity n (%)	Total (n = 60)	p-value
Energy				
1. Excessive (>110%)	17 (85)	3 (15)	20 (100)	0,007[c]
2. Not Excessive (≤110%)	18 (45)	22 (55)	40 (100)	
Protein				
1. Excessive (>110%)	19 (61,3)	12 (38,7)	31 (100)	0,827
2. Not Excessive (≤110%)	16 (55,2)	13 (44,8)	29 (100)	
Fat				
1. Excessive (>110%)	20 (62,5)	12 (37,5)	32 (100)	0,662
2. Not Excessive (≤110%)	15 (53,6)	13 (46,4)	28 (100)	
Carbohydrate				
1. Excessive (>110%)	18 (90)	2 (10)	20 (100)	0,001[c]
2. Not Excessive (≤110%)	17 (42,5)	23 (57,5)	40 (100)	

[a]frequency (percentage); [c]significance p-value < 0,05

Based on Table 5, half of the respondents with non-excessive energy intake (55%) and carbohydrate intake (57.5%) tended not to have central obesity. However, more than one quarter of respondents with excessive protein intake (38.7%) and excessive fat intake (37.5%) did not experience central obesity. The results of the Chi-square statistical test indicate that energy intake level and carbohydrate intake level were significantly associated with the incidence of central obesity (p value < 0.05). In contrast, protein intake level and fat intake level were not significantly associated with the incidence of central obesity (p value > 0.05).

Discussion

a. Association Between Chrononutrition Behavior and Central Obesity

The results of the Chi-square statistical test showed that breakfast skipping was significantly associated (p-value < 0.05) with the incidence of central obesity. This finding is consistent with observational results, in which half of the respondents with good breakfast habits (≤4 days/week) did not experience central obesity. This phenomenon can be explained by several factors influencing breakfast habits among office workers. Office workers tend not to skip breakfast because they recognize the importance of breakfast in providing sufficient energy to remain productive throughout the day and generally have structured morning routines, making breakfast an integral part of their daily lifestyle [22]. A study by Wiguna & Stefani in 2023 [23], reported that breakfast improves concentration and work performance, encouraging workers to maintain regular breakfast consumption. Therefore, regular breakfast habits may reduce the risk of central obesity [24,25].

This study is consistent with research conducted by Wicherski et al. (2021), which demonstrated that breakfast skipping is associated with central obesity [26]. Breakfast plays an important role in regulating appetite, improving postprandial glucose response, and enhancing insulin sensitivity at subsequent meals. In contrast, breakfast skipping is associated with altered appetite regulation, impaired insulin sensitivity, and reduced satiety, which may lead to overeating at later meals [27,28]. A study by Ruddick-Collins et al. (2021) indicated that breakfast plays a crucial role in regulating appetite-related hormones such as ghrelin and leptin [29]. Ghrelin, known as a hunger-stimulating hormone, tends to

increase in individuals who skip breakfast, while leptin levels, which promote satiety, tend to be lower. This hormonal imbalance encourages excessive caloric intake at subsequent meals, ultimately increasing the risk of central obesity [30].

Breakfast skipping may impair insulin sensitivity, which is the body's ability to regulate blood glucose effectively in response to insulin [31]. Disruption of circadian rhythms related to glucose metabolism reduces insulin responses after meals, leading to persistently elevated postprandial blood glucose levels. Over time, this condition increases the risk of insulin resistance, a key factor in the development of central obesity and type 2 diabetes [28]. In addition, BaHammam & Pirzada reported that breakfast skipping may promote obesity through genetic mechanisms by altering the expression of circadian and metabolic genes (Per1, Cry1, Rorβ, Sirt1, and Clock), which affect circadian hormone secretion and increase postprandial glycemia, thereby contributing to central obesity [32].

The Chi-square test results also showed that evening latency was significantly associated (p-value < 0.05) with central obesity. This finding aligns with observational results, in which the majority of respondents with poor evening latency (≤2 hours before bedtime) experienced central obesity. Characteristics of adulthood and office work may explain why the interval between dinner and bedtime is often very short. Workload, high professional demands, and work-related stress among office workers contribute to irregular meal timing, resulting in late dinners that occur close to bedtime, thereby increasing the risk of central obesity [33,34].

This finding is consistent with research by Gong et al. in 2021, which demonstrated that the interval between dinner time and bedtime is significantly associated with central obesity [35]. Additionally, O'Connor et al. reported a significant association between evening latency and overweight/obesity [36]. Individuals with an evening latency of less than 3 hours have a 2.61-fold higher risk of developing central obesity compared to individuals with an evening latency of more than 5 hours [35]. Another study by Gong et al in 2025, showed that evening latency of less than 4 hours was associated with increased waist circumference [37]. An interval of ≤2 hours between dinner and bedtime is considered detrimental to health [21].

Several mechanisms explain how short evening latency contributes to central obesity. Metabolically, circadian rhythms influence factors involved in energy metabolism and balance, such as the thermic effect of food, which affects calorie processing and storage [11,29]. During sleep, basal metabolic rate decreases, so eating close to bedtime limits energy utilization and promotes fat storage, particularly visceral fat [38]. From a hormonal perspective, studies have shown that postprandial blood glucose levels are higher at night than in the morning [11]. This condition is exacerbated by increased melatonin levels occurring approximately 2–3 hours before sleep, as melatonin is known to suppress insulin secretion [39]. As a result, eating too close to bedtime disrupts glucose regulation. Excess glucose that is not properly metabolized is more readily stored as visceral fat, contributing to central obesity [40]. Eating near bedtime is also associated with reduced leptin levels, increasing hunger and the risk of overeating [41].

The study results indicated that eating window was not significantly associated (p value > 0.05) with central obesity. Adults with obesity typically have longer eating windows exceeding 14 hours per day. However, in this study, several respondents with good eating windows still experienced central obesity [42]. This condition may be attributed to the quality of food consumed during the eating period. Diets high in calories, saturated fat, and sugar can still result in energy surplus despite restricted eating times, thereby contributing to central obesity [10,43]. This finding is supported by Jamshed et al., who stated that time-restricted eating without additional interventions such as balanced food selection is insufficient to prevent obesity [44].

Based on the study results, evening eating and night eating were not significantly associated (p value > 0.05) with central obesity. These findings are consistent with Longo-Silva et al. in 2022, who reported no significant association between evening eating and central obesity, noting no statistically

significant differences between early and late dinner timing [13]. Similarly, a study by El-Ela et al (2022), found no association between night eating and waist circumference [45]. Field observations revealed that respondents who engaged in evening eating before 11:00 p.m. and night eating less than four days per week (classified as good) still experienced central obesity. The caloric content and nutrient composition of foods consumed at night may explain this phenomenon. Even when dinner timing is not excessively late, consuming large portions of staple foods such as rice, low in fiber and high in fat and sugar, increases the risk of central obesity [46].

Metabolic activity tends to decline at night due to circadian rhythms, resulting in lower energy expenditure efficiency compared to daytime. Consequently, excess energy is more readily stored as visceral fat [47]. Low physical activity after dinner and poor sleep quality further disrupt metabolic regulation [48]. Sedentary behaviors after dinner, such as going directly to sleep or prolonged sitting, contribute to reduced energy expenditure and increased visceral fat storage [49]. This finding supports the present study, showing that evening latency is significantly associated with central obesity, and that appropriate dinner timing alone is insufficient without adequate intervals before sleep.

Another explanation is compensatory overeating earlier in the day, such as excessive lunch intake or frequent snacking outside main meals, which may not be captured as evening or night eating. This is supported by findings showing that respondents whose largest meal occurred at breakfast or lunch still experienced central obesity, while the timing of the largest meal was not significantly associated with central obesity (p-value > 0.05). Higher activity intensity in the morning and afternoon often leads to more frequent food and snack consumption, particularly among office workers who snack to delay hunger or manage work-related stress [50,51]. This pattern may result in daily energy imbalance and increased risk of central obesity, even when the largest meal occurs in the morning or afternoon [52].

b. Association Between Consumption Level and Central Obesity

The Chi-square test results showed that energy intake level and carbohydrate intake level were significantly associated (p value < 0.05) with central obesity. These findings are consistent with observational results indicating that respondents with non-excessive energy and carbohydrate intake (≤110% of requirements) tended not to experience central obesity. This condition may be attributed to appropriate daily caloric intake that does not exceed basal metabolic requirements. Adequate energy and carbohydrate intake are optimally utilized by the body to support physiological functions and daily activities, thereby minimizing fat accumulation [53,54].

Non-excessive consumption patterns typically reflect better-controlled eating behaviors, including portion size, meal frequency, and food choices. Individuals with such patterns generally have better nutritional awareness influenced by knowledge and education [55]. Most respondents in this study had relatively high educational backgrounds, having completed senior high school or higher education. Higher education levels are generally associated with better nutritional knowledge, enabling individuals to make healthier food choices, understand their energy requirements, and apply balanced nutrition principles in daily life [56], thereby reducing the risk of excessive energy intake that may lead to central obesity [57].

This study aligns with Faridi et al. (2024), who reported a significant association between energy intake and central obesity [16]. Most respondents with excessive energy intake in this study experienced central obesity, likely due to high fat consumption. Based on 2×24-hour dietary recalls, fried foods were commonly consumed daily at the workplace, contributing substantially to total energy intake because of their high caloric density [58]. Persistent energy surplus promotes fat accumulation, and when subcutaneous fat storage is exceeded, excess fat is deposited in visceral adipose tissue, leading to central obesity[59].

The findings of Hu et al. (2022) support this study, indicating that higher dietary energy density is associated with increased waist circumference, with each 1 kcal/g increase in energy density

associated with a 0.09 cm/year increase in waist circumference [60]. Data from this study also reinforce that the majority of respondents with excessive carbohydrate intake experienced central obesity. This finding aligns with the study by Nurhasanah et al. (2022), which reported a significant association between carbohydrate intake and central obesity, noting that high carbohydrate consumption was more prevalent among individuals with central obesity than those without [61].

This condition occurs due to alterations in metabolic mechanisms triggered by excessive carbohydrate intake. Glucose not utilized as energy is stored as glycogen in the liver and muscles. However, because glycogen storage capacity is limited, excess glucose is converted through glycolysis into pyruvate and glycerol [62]. Glycerol is required only in small amounts for normal metabolism, while excess pyruvate is converted into acetyl-CoA. Under conditions of energy surplus, acetyl-CoA is diverted from the Krebs cycle toward lipogenesis, resulting in the formation of fatty acids and storage as triglycerides in adipose tissue, particularly in the abdominal region. Thus, excessive carbohydrate intake physiologically promotes fat accumulation in the abdominal area [63,64].

Based on 2×24-hour dietary recall observations, respondents most frequently consumed rice and granulated sugar, both sources of simple carbohydrates. Granulated sugar was commonly consumed through beverages such as coffee, which was consumed daily. In this study, most respondents with central obesity were male and tended to habitually consume sweetened coffee. Wong et al. (2021) reported that the global prevalence of sugar-sweetened beverage consumption contributes to increased caloric intake and may lead to central obesity [65]. A study by Mellisa et al. (2023) further supports the significant association between sugar consumption and central obesity [66].

The results of this study indicated that protein intake level and fat intake level were not significantly associated with central obesity. This finding is supported by Purwaningtyas et al. (2023), who reported no significant association between protein and fat intake levels and central obesity. This discrepancy may be explained by several factors [67]. Some respondents with excessive protein and fat intake did not experience central obesity, possibly due to better metabolic capacity. Individuals with more efficient metabolism can burn excess calories from protein and fat more effectively, reducing fat storage [68]. High-protein diets increase total energy expenditure and fat oxidation, contributing to negative energy balance and reduced body fat [69]. A study by Kayar (2021) also reported that higher protein intake is associated with lower central obesity [70].

In addition to quantity, the type and quality of protein and fat consumed greatly influence metabolic responses. Plant-based protein sources exhibit different metabolic effects compared to animal-based protein sources [71]. Plant proteins tend to contain fiber and phytonutrients that help regulate insulin levels and blood lipids [72]. Consumption of plant protein sources is associated with better health outcomes than animal protein sources [71]. Animal protein consumption has more adverse effects on obesity compared to plant protein [73]. In addition, healthy fats such as monounsaturated (MUFA) and polyunsaturated fatty acids (PUFA) contribute to improved fat metabolism and insulin sensitivity and may provide protective effects against genetic susceptibility to central obesity [74].

This study also showed that respondents with non-excessive protein and fat intake still experienced central obesity. One factor explaining this phenomenon is low physical activity due to sedentary lifestyles common among office workers. Physical activity among office workers is often limited to light movements, with most time spent sitting in front of computers [75]. Even with adequate protein and fat intake, insufficient physical activity reduces total daily energy expenditure. When energy intake exceeds expenditure, excess calories are stored as fat, particularly in the abdominal region [76]. Therefore, sedentary lifestyles represent a significant risk factor for central obesity. Maulani & Djuwita (2023) reported a significant correlation between physical activity and central obesity [77].

One limitation of this study is the use of the food recall method to assess nutrient intake, which relies heavily on respondents' ability to remember and estimate the types and amounts of foods and beverages consumed, potentially leading to information bias. To address this limitation, visual aids such

as food models or portion size booklets may improve portion estimation accuracy. With more accurate portion sizes, the collected data would better reflect actual intake, improving the accuracy and representativeness of consumption level variables.

Another limitation is that obesity status was assessed solely using waist circumference to represent central obesity. Future studies are recommended to assess obesity status not only by waist circumference but also by incorporating Body Mass Index (BMI) to obtain a more comprehensive nutritional status assessment. Additionally, this study did not consider other variables such as smoking status and stress factors. Future research is expected to include relevant variables such as smoking status and stress, as these factors are known to potentially influence eating behavior, metabolism, and fat distribution [10,78].

Conclusion

Based on the results of the study on the association between chrononutrition behaviour and consumption level with the incidence of central obesity among BUMN office employees at the Perum Perhutani KPH Cianjur Office, it can be concluded that breakfast skipping, evening latency, energy intake level, and carbohydrate intake level were significantly associated with the incidence of central obesity among BUMN office employees at the Perum Perhutani KPH Cianjur Office. Meanwhile, the variables eating window, evening eating, night eating, largest meal, protein intake level, and fat intake level did not show a significant association with the incidence of central obesity among BUMN office employees at the Perum Perhutani KPH Cianjur Office.

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