

Research Article

Predictors of Poor Sleep Quality among Vegetarians: Insights from a Study in Kuala Lumpur and Selangor, Malaysia

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ABSTRACT

This study aimed to examine the prevalence of poor sleep quality and its predictors among Malaysian vegetarians. The present cross-sectional study was conducted among 200 vegetarians in Malaysia. Data on socio-demographic characteristics, lifestyle behaviours, psychological distress and sleep quality were collected using a set of self-administered questionnaires. A three-day dietary recall was employed to examine the dietary intake of vegetarians. The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality in vegetarians, with a score above five indicating poor sleep quality. A multiple logistic regression model was used to determine how socio-demographic characteristics, lifestyle behaviours (smoking, alcohol consumption and physical activity level), psychological distress (depression, anxiety, and stress) and specific dietary macronutrient intakes (carbohydrate, protein and fat) predicted poor sleep quality. The mean sleep duration was 6.0 ± 1.4 hours among vegetarians. The mean PSQI score was 5.4 ± 3.1 , with 40.5% of vegetarians experiencing poor sleep quality. Multiple logistic regression found that vegetarians with depression (OR=4.56, 95% CI: 1.62–12.83) and stress (OR=3.07, 95% CI: 1.14–8.31) had higher odds of poor sleep quality ($p < 0.05$). About two in five (40.5%) vegetarians reported poor sleep quality with depression and stress as significant predictors. Effective sleep education programs are essential for improving sleep hygiene awareness. Psychological screening and mental health interventions for vegetarians with depression and stress are necessary to improve their sleep health.

INTRODUCTION

Sleep is an imperative physiological process required to regulate and maintain an individual's health status. An appropriate sleep duration for adults and older adults is between 7 to 9 hours and 7 to 8 hours, respectively (Hirshkowitz *et al.* 2015). Contrary to sleep duration, sleep quality refers to «the degree of excellence in sleep»

(Lee *et al.* 2020). It captures the sleep duration and other aspects such as sleep latency, the number of arousals and depth or restfulness of sleep simultaneously (Buysse *et al.* 1989). Poor quality of sleep is increasingly a public health problem with a significant impact on physical, mental and emotional well-being. It involves difficulty falling or remaining asleep, frequent awakening or non-restorative sleep (Buysse

et al. 1989). Ongoing lack of quality sleep has been associated with high-risk cardiovascular diseases, weakened immune systems and cognitive decline. To date, the prevalence of poor sleep quality among the population has been reported in different regions globally (Lee *et al.* 2020). In Malaysia, the prevalence of poor sleepers reached up to 59.4% (Aye & Lee 2024). Insufficient sleep and low sleep quality can lead to several health-related problems. Consequently, it is important to identify predictors of poor sleep quality in response to improving overall health and preventing future health complications. It is crucial to identify the predictors of poor sleep quality, since the latter may create a risk to general well-being and health complications later in life, especially among populations with different lifestyle habits such as vegetarians.

Several factors including diet, lifestyle behaviours and mental health influence sleep quality while the interactions between these factors may influence sleep quality and overall health differently. For instance, sleep functionality is interrelated with social-demographic factors, lifestyle behaviours and psychological factors (Lee *et al.* 2020; Sutanto *et al.* 2020). In terms of socio-demographic characteristics, individuals with lower levels of education and lower income were more likely to develop poor sleep quality (Lee *et al.* 2020). Lack of education may affect health literacy and knowledge of sleep habits. Financial difficulties may lead to stress as well as inadequate health care services. Regarding lifestyle behaviours, regular tobacco and alcohol consumption and being inactive in daily life result in poor sleep quality (Park & Suh 2019; Lee *et al.* 2020). Tobacco and alcohol can affect sleep by altering the neurotransmitter and the normal sleep architecture of the body. For physical inactivity, it may increase the risk of sleep problems by affecting the state of physical fatigue and metabolic control (Park & Suh 2019; Lee *et al.* 2020; Sutanto *et al.* 2020).

A recent systematic review found that macronutrients such as a high proportion of dietary protein may improve sleep quality in adults (Sutanto *et al.* 2020). Nutrient intakes can affect neurotransmitters that play a critical role in sleep regulation including serotonin and melatonin, both vital to good quality sleep, as well as one's circadian rhythm (Kautz *et al.* 2024). In addition to earlier factors, a growing of evidence showed that psychological distress such

as anxiety, depression and stress were associated with poor sleep quality across the population worldwide (Lee *et al.* 2020). These mental health conditions can disrupt sleep patterns by raising the level of cortisol, a hormone that is associated with stress, increasing the level of arousal and preventing the body from relaxing and getting the restful sleep it needs (Thompson *et al.* 2022).

Though existing studies have examined the associations of the factors mentioned above with sleep quality among the general population (Lee *et al.* 2020; Sutanto *et al.* 2020), the associations of these factors with sleep quality remain unknown among vegetarians. Vegetarians are different from the general population in lifestyle and psychological characteristics, which can affect their health and quality of life. In particular, a well-planned vegetarian diet is nutritionally adequate for optimising human health. Nonetheless, an improper planned vegetarian diet can contribute to notable variations in macronutrients intake, particularly the protein and essential amino acid balance as compared to a non-vegetarian diet (Soh *et al.* 2025). For instance, a research points out that vegetarians may experience lower levels of specific indispensable amino acids such as leucine and lysine (Soh *et al.* 2025). Low levels of leucine and lysine may affect the sleep-regulating hormones such as serotonin and melatonin, and overall sleep quality. Therefore, it is essential for vegetarians to ensure a balanced amino acid intake through appropriate dietary protein sources, such as legumes and pulses, for improving sleep quality (Soh *et al.* 2025). Likewise, vegetarian diets may exhibit distinct carbohydrate and fat intake, such as higher fibre and different fatty acid composition derived from plant-based sources. For instance, a diet high in fiber may promote sleep quality by stabilizing blood sugar, whereas a diet high in refined carbohydrate and saturated fat but low in omega-3 fatty acids (EPA and DHA) may impact sleep health. Considering a vegetarian diet typically features high fibre but low EPA and DHA intake (Neufingerl & Eilander 2022), there is a necessity for further investigation into how a vegetarian diet may influence sleep quality. Moreover, a recent study found that vegetarians have a greater risk of depression, which aligns with findings derived from systematic reviews and meta-analyses highlighting lower rates of depression among non-vegetarians than vegetarians (Chen *et al.* 2024; Iguacel *et al.* 2023; Dobersek *et al.*

2021). These special factors make it important to investigate how lifestyle and psychological state influence sleep quality among vegetarians. Previous studies conducted among the general population probably included respondents with diverse dietary patterns, which may significantly impact the overall findings (Park & Suh 2019; Lee *et al.* 2020; Sutanto *et al.* 2020). It is believed that most of the conclusions have been made based on the general population. Currently, no data has been published comparing sleep quality risk factors for the vegetarian population although increasing scientific publications relevant to vegetarianism (Ching *et al.* 2020; Ching 2023). This research gap suggests that there is more research to be conducted specifically for vegetarians to understand the underlying factors influencing the sleep quality of vegetarians. Therefore, the current study aimed to examine sleep quality and its predictors among vegetarians in Malaysia. By understanding these factors, healthcare professionals can reduce the incidence of chronic illnesses related to poor sleep, which may reduce the financial cost to the healthcare system.

METHODS

Design, location, and time

A cross-sectional study design was used in the present study. Data collected as conducted at nine out of the 31 community centres that were randomly selected from Kuala Lumpur (capital of Malaysia) and Selangor (the state in Malaysia with the highest population density). The data collection was carried out in year 2017. Ethical approval was obtained from the Ethics Committee for Research involving Human Subjects, Universiti Putra Malaysia (JKEUPM) [Reference number: FPSK (FR16) P023]. All vegetarians gave their written informed consent after being briefed on the study.

Sampling

Vegetarians who fulfilled the study inclusion criteria namely more than 18 years old, practising vegetarianism for more than two years, currently not pregnant or lactating were invited to participate in the present study. A total of 200 vegetarians from nine out of the 31 community centres that were randomly selected from Kuala Lumpur (capital of Malaysia) and Selangor (the state in Malaysia with the highest population density) were recruited. Out of the 273

vegetarians who consented to participate in the study, 200 (34.5% male and 65.5% female) had complete data and were included in the analysis.

Data collection

Socio-demographic characteristics and lifestyle behaviours. Socio-demographic characteristics such as age, sex, ethnicity, educational background, employment status, total household income and marital status were reported by vegetarians. Information on alcohol consumption was collected through the adapted questions relating to alcohol consumption in the National Health and Nutrition Examination Survey Food Frequency Questionnaire. The Global Adult Tobacco Survey was used to assess the smoking status of vegetarians and classified them into smokers, past smokers and non-smokers, respectively. The physical activity level of vegetarians was assessed using the Global Physical Activity Questionnaire with vegetarians were classified into three categories (insufficient physical activity, moderately active and highly active).

Dietary practice. A three-day dietary recall consisting of two weekdays and one weekend was employed to examine the dietary intake of vegetarians. The total energy and selected macronutrients such as carbohydrate, protein and total fat were analysed using the Nutritionist Pro Software Version 4.0.0. The USDA Food Database and the Singapore Food Composition Guide were used to complement the Malaysian Food Composition Database.

Psychological distress. Depression, Anxiety, and Stress Scale-21 (DASS-21) was used to assess the psychological distress of vegetarians. The DASS-21 is a 21-item psychological tool that can assess the emotional state of depression, anxiety and stress over the past week. Each of the questions used a four-point Likert scale. The total scores of each subscale were multiplied by two and categorised into five levels, namely normal, mild, moderate, severe and extremely severe.

Sleep quality. Sleep quality of the vegetarians was assessed using the Pittsburgh Sleep Quality Index (PSQI) for the previous month (Buysse *et al.* 1989). The PSQI consists of 19 items from seven sleep domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication and daytime dysfunction. PSQI consisted of 19 items to assess the sleep

quality of an individual. Each item in the self-administered questionnaire was rated using a four-point Likert scale. Vegetarians with a total final score of more than five were classified as poor-quality sleepers or vice versa.

Data analysis

Data were entered and analysed using IBM SPSS Statistics 26.0 software (SPSS Inc., Chicago, IL, USA). All data were checked and only cases with no missing values were included in the analysis. First, the normality of continuous variables such as age, total energy and macronutrients (carbohydrate, protein and fat) intake, sleep duration, sleep disturbance composite score, daytime dysfunction, and total mean PSQI score was checked. Variables that fell within skewness ± 2 Standard Deviation (SD) were considered normally distributed. Sleep quality was determined using the PSQI, which divided vegetarians into poor and good sleep quality categories. The roles of socio-demographic characteristics, lifestyle behaviours (smoking, alcohol consumption and physical activity level), psychological distress (depression, anxiety and stress) and specific dietary macronutrients intake (carbohydrate, protein and fat) as potential predictors were examined using the univariate logistic regression model. Multicollinearity among the predictors were checked based on variance inflation factor less than 10 with those predictors more than 10 were excluded. A univariate logistic regression model was first used to determine the likelihood (odds ratio) of poor sleep quality for each predictor. Upon completing the univariate logistic regression analyses, all predictors with $p < 0.25$ in the univariate logistic regression were included in the multiple logistic regression. Multiple logistic regression analysis was used to determine the odds ratio of factors associated with poor sleep quality of vegetarians. The Odds Ratios (ORs) and 95% Confidence Intervals (CIs) were determined. The acceptance level of statistical significance for all tests was set at $p < 0.05$.

RESULTS AND DISCUSSION

Characteristics of respondents

The present study comprised of 200 vegetarians with their characteristics are displayed in Table 1. More than half of vegetarians were female (65.5%), Chinese (63.0%) and married

vegetarians (57.0%). In terms of lifestyles, a high proportion of them were non-smokers (95.5%), and non-alcohol users (90.5%). The mean carbohydrate, protein and fat intake were 264.9 ± 74.7 g/day, 49.3 ± 15.1 g/day and 57.1 ± 19.7 g/day. The prevalences of vegetarians with depression, anxiety and stress were 15.5%, 37.0% and 16.0%, respectively, as determined using the DASS-21 questionnaire.

Sleep quality of respondents

As depicted in Table 2, the mean sleep duration was 6.0 ± 1.4 hours with about one in ten vegetarians (11.0%) sleeping for less than 5 hours per night. Nearly half (47.5%) of vegetarians had less than 15 minutes of sleep latency duration. More than half (69.5%) of the vegetarians had a habitual sleep efficiency of more than 85.0%. A majority of the vegetarians (97.0%) did not use sleep medicine during the night. Overall, the mean PSQI score was 5.4 ± 3.1 , with about two in five vegetarians (40.5%) of the vegetarians had poor sleep quality.

Sleep accounts for about one-third of the human life span to facilitate physical, mental and emotional well-being (Hirshkowitz *et al.* 2015). In the current study, it was found that poor sleep quality is a common issue among vegetarians. Although the prevalence of poor sleepers in the present study was 40.5%, which is lower than elderly (59.4%) in Malaysia (Aye & Lee 2024), it remains a significant concern. The prevalent issue of poor sleep quality among vegetarians in Malaysia highlights the need to implement targeted sleep intervention programs for the vegetarian population.

Most vegetarians in the present study did not achieve the recommended sleep duration, which is relatively higher than the former study conducted in North America (Tonstad *et al.* 2009). It is noteworthy that short sleep duration alters the circulating levels of neuroendocrine, leading to a reduction in leptin and an increment in ghrelin that causes additional weight gain or obesity. Earlier study showed that improper sleep hygiene practices contributed to poor sleep health, such as sleep deprivation. Sleep education program has demonstrated their effectiveness in improving individuals' knowledge of sleep, facilitating sleep health (Tucker *et al.* 2021). Therefore, the government can modify the sleep education program according to the general population's needs. Such modified versions of sleep education

Table 1. Characteristics of vegetarians

Variables	Total (n=200)
Age (year) (Mean±SD)	48.3±13.2
Sex (n (%))	
Male	69 (34.5)
Female	131 (65.5)
Ethnicity (n (%))	
Chinese	126 (63.0)
Indians	74 (37.0)
Education background (n (%))	
Below primary level	30 (15.0)
Secondary level	114 (57.0)
Tertiary level	56 (28.0)
Employment status (n (%))	
Unemployed	89 (44.5)
Employed	111 (55.5)
Total household income (n (%))	
<RM2,300	68 (34.0)
RM2,300–5,599	72 (36.0)
≥RM5,600	60 (30.0)
Marital status (n (%))	
Married	114 (57.0)
Divorced or widowed	22 (11.0)
Unmarried	64 (32.0)
Alcohol drinkers (n (%))	
Yes	19 (9.5)
No	181 (90.5)
Cigarette smoking (n (%))	
Past smokers	9 (4.5)
No	191 (95.5)
Physical activity level (n (%))	
Insufficient	99 (49.5)
Moderate	71 (35.5)
High	30 (15.0)
Total energy intake (kcal/day) (Mean±SD)	1,736±450
Carbohydrate intake (g/day) (Mean±SD)	264.9±74.7
Protein intake (g/day) (Mean±SD)	49.3±15.1
Fat (g/day) (Mean±SD)	57.1±19.7
Depression (n (%))	
No	169 (84.5)
Yes	31 (15.5)
Anxiety status (n (%))	
No	126 (63.0)
Yes	74 (37.0)
Stress status (n (%))	
No	168 (84.0)
Yes	32 (16.0)

RM: Ringgit Malaysia

programs can be added to the television show to help the public develop and maintain healthy sleep habits. Health care professionals can share the importance and steps to maintain good sleep habits with the public through an online or physical public seminar. It is assumed that the sleep quality of individuals can be improved following sleep education programs.

Table 2. Descriptions of vegetarians according to PSQI components

PSQI components	Total (n=200)
Subjective sleep quality rating (n (%))	
Good sleep quality	160 (80.0)
Poor sleep quality	40 (20.0)
Sleep latency (n (%))	
Good (≤15 minutes)	95 (47.5)
Moderate (16–30 minutes)	70 (35.0)
Fair (>60 minutes)	35 (17.5)
Sleep duration (Mean±SD)	6.0±1.4
Sleep duration category (n (%))	
>7 hours	33 (16.5)
6–7 hours	97 (48.5)
5–6 hours	48 (24.0)
<5 hours	22 (11.0)
Habitual sleep efficiency (n (%))	
>85	139 (69.5)
75–84	38 (19.0)
<74	23 (11.5)
Sleep disturbance composite score (Mean±SD)	1.1±0.5
Use of medication (n (%))	
Yes	6 (3.0)
No	194 (97.0)
Daytime dysfunction (Mean±SD)	0.8±0.9
Total PSQI score (Mean±SD)	5.4±3.1
Good sleeper (%)	59.5
Poor sleeper (%)	40.5

PSQI: Pittsburgh Sleep Quality Index; SD: Standard Deviation

Predictors of poor sleep quality

Table 3 shows predictors of poor sleep quality in the present study. From the univariate logistic regression analysis, ethnicity, marital status, alcohol consumption, physical activity level, depression, anxiety and stress were identified as potential factors ($p<0.25$). These variables were further included in the multiple logistic regression. In the multiple logistic regression, depression (OR=4.56, 95% CI:1.62–12.83, $p=0.004$) and stress (OR=3.07, 95% CI: 1.14–8.31, $p=0.027$) were identified as predictors of poor sleep quality.

Understanding the reasons behind poor sleep quality will help provide necessary interventions to help these individuals maintain an adequate sleep schedule. To the best of our knowledge, there is a notable lack of studies determining predictors of sleep quality among vegetarians, which highlights the critical need to an analysis within the vegetarian population. Vegetarianism is gaining popularity globally for various reasons such as health benefits, religious beliefs, ethical considerations and environmental concerns. The growing trend of vegetarianism across the globe highlights the need to establish

Table 3. Predictors of poor sleep quality

Variables (n=200)	Univariate logistic regression		Multiple logistic regression	
	OR (95% CI)	<i>p</i>	OR (95% CI)	<i>p</i>
Age	0.99 (0.97–1.01)	0.472	-	-
Sex				
Male	1.00	1.00	-	-
Female	0.84 (0.46–1.52)	0.556	-	-
Ethnicity ^a				
Chinese	1.00	1.00	1.00	1.00
Indians	0.64 (0.35–1.16)	0.139	0.51 (0.24–1.06)	0.071
Education background				
Below primary level	1.00	1.00	-	-
Secondary level	1.35 (0.58–3.15)	0.484	-	-
Tertiary level	1.61 (0.64–4.06)	0.311	-	-
Employment status				
Unemployed	1.00	1.00	-	-
Employed	1.29 (0.73–2.29)	0.378	-	-
Total household income				
<RM2,300	1.00	1.00	-	-
RM2,300–5,599	1.02 (0.52–2.00)	0.953	-	-
≥RM5,600	0.89 (0.44–1.81)	0.743	-	-
Marital status ^a				
Unmarried	1.00	1.00	1.00	1.00
Married	0.77 (0.41–1.42)	0.399	0.67 (0.33–1.34)	0.257
Divorced or widowed	0.33 (0.11–1.01)	0.053	0.33 (0.09–1.21)	0.094
Alcohol consumption ^a				
No	1.00	1.00	1.00	1.00
Yes	2.18 (0.84–5.69)	0.111	1.45 (0.49–4.32)	0.500
Physical activity level ^a			1.00	1.00
Insufficient	1.00	1.00	0.61 (0.30–1.25)	0.177
Moderate	0.59 (0.31–1.11)	0.099	0.62 (0.23–1.71)	0.354
High	0.67 (0.29–1.55)	0.345	-	-
Carbohydrate (g/day)	0.99 (0.99–1.01)	0.457	-	-
Protein (g/day) ^a	0.98 (0.97–1.01)	0.133	0.99 (0.96–1.01)	0.192
Fat (g/day)	1.00 (0.99–1.01)	0.975	-	-
Depression ^a				
No	1.00	1.00	1.00	1.00
Yes	5.50 (2.32–13.07)	<0.001	4.56 (1.62–12.83)	0.004*
Anxiety ^a				
No	1.00	1.00	1.00	1.00
Yes	2.04 (1.13–3.66)	0.017	1.16 (0.55–2.42)	0.701
Stress ^a				
No	1.00	1.00	1.00	1.00
Yes	4.85 (2.11–11.16)	<0.001	3.07 (1.14–8.31)	0.027*

^aVariables with $p < 0.25$ in univariate logistic regression were entered into the multiple logistic regression; *Indicates a significant difference at $p < 0.05$ in multiple logistic regression; RM: Ringgit Malaysia

evidence-based findings that investigate the underlying predictors of poor sleep quality among vegetarians. The present study can serve this purpose by exploring the roles of different predictors towards sleep quality within vegetarian population, which is important for future sleep health intervention for this vegetarian population. Moreover, vegetarians often exhibit different dietary patterns, lifestyle behaviours and psychological status when compared to the non-vegetarian population. These differences

may complicate the roles of these factors in sleep quality. Therefore, the identification of specific predictors of poor sleep quality within this growing population may provide a particular framework for developing recommendations to improve their sleep health.

While there is minimal data available regarding the role of macronutrients and sleep quality among vegetarians, the present study found no associations of macronutrients with sleep quality. In contrast, a diet comprising a

lower intake of carbohydrates was found to be associated with better sleep quality among the general population with higher protein intake may improve sleep quality (Yi *et al.* 2020). Besides the amount of carbohydrates, the type of carbohydrate or glycemic index of foods may impact sleep quality (Katagiri *et al.* 2014). Proteins derived from different food sources may have discrete metabolic effects on the human body (Wojcik *et al.* 2016), which may affect sleep quality. Since vegetarians substituted animal protein foods with plant protein foods such as soy-based products or legumes, the inconsistent findings on macronutrients and sleep quality may be due to different macronutrients consumed by vegetarians.

Previous studies conducted among the general population demonstrated socio-demographic characteristics such as sex, ethnicity, age, marital status, education background, employment status and total household income were associated with sleep quality (Wu *et al.* 2018; Lee *et al.* 2020), this was not observed in the present study. It was hypothesised lower socioeconomic status may contribute to poor quality of life and higher susceptibility to stress, leading to poor sleep quality (Lee *et al.* 2020). On the other hand, the difference in hormone secretion may be attributed to the different sleep quality patterns between females and males (Wu *et al.* 2018). A possible explanation to explain the result disparities is due to the different characteristics of the study population. Previous studies comparing socio-demographics between vegetarians and non-vegetarians observed that vegetarians were more likely to be female, younger and tended to obtain higher education levels as well as higher socioeconomic status (Allès *et al.* 2017). On the other hand, the present study found that the distributions of vegetarians are generally different in terms of sex ratio, age, and education levels from the previous studies (Wu *et al.* 2018; Lee *et al.* 2020), with a majority of the vegetarians were female, aged more than 50 years and attained secondary school level. Since the present study is the first published data to determine the association of socio-demographic factors with sleep quality among vegetarians, additional study is needed to delineate the findings.

Though previous studies have demonstrated the associations between lifestyle behaviours such as smoking behaviour and alcohol consumption

with poor sleep quality, these associations were not found in the present study. One of the possible reasons to explain this phenomenon may be the low proportion of smokers and alcohol drinkers in the present study. Religious belief appeared as the main reason for vegetarians to practice vegetarianism in the present study. As religious belief motivates their followers to adopt healthy lifestyles such as cigarette cessation and alcohol restriction, a low proportion of smokers and alcohol drinkers is expected. In terms of physical activity level, although the prevalence of poor sleepers in the present study was slightly higher among individuals with insufficient physical activity level as compared to those with moderate physical activity level and high physical activity level, the differences were not statistically significant. This result was inconsistent with a study conducted in Korea (Park & Suh 2019). Unidentified associations may be due to subjective measures of physical activity that may be subjected to recall bias as compared to objective measures such as accelerometers.

Depression and stress were significant predictors of poor sleep quality among vegetarians. These findings were consistent with previous studies conducted among the general population in international settings (Lee *et al.* 2020). A plausible reason to explain the association between depression and poor sleep quality is the rapid decrease of monoamines such as serotonin, norepinephrine and dopamine, increasing in cholinergic tone, which regulates the onset of rapid eye movement in sleep (Fang *et al.* 2019). A dysfunction in this neurotransmitter activity (serotonin, norepinephrine and dopamine) may affect an individual's mood as well as the sleep-wake cycle. For instance, a drop in serotonin concentration is likely to reduce the synthesis of melatonin, which is vital for sleep. Likewise, decreased levels of norepinephrine and dopamine are likely to cause disrupted sleep patterns, difficulty falling asleep, and increased nighttime rest interruptions. In addition, depression has been associated with increased cholinergic tone, which modulates the onset and control of Rapid Eye Movement (REM) sleep. Such an imbalance can also cause people suffering from depression to experience enhanced REM sleep blocks, abbreviated sleep, and reduced overall sleep efficacy (Tonon *et al.* 2021).

Meanwhile, the positive association between stress and poor sleep quality could be due

to decrease in wave sleep, REM in sleep, sleep efficiency and increases in awakenings triggered by stress factors (Kalmbach *et al.* 2018). There may be many physiological and psychological mechanisms that explain this. Stress mobilizes the hypothalamic-pituitary-adrenal axis, resulting in the accelerated synthesis and secretion of cortisol. Higher levels of cortisol at night can lead to the suppression of circadian rhythms that may trigger post-sleep onset latency, which in turn affects overall sleep quality (Yap *et al.* 2024). Furthermore, stress results in autonomic nervous system hyperarousal, which raises sympathetic tone with the subsequent elevation of heart rate (Riemann *et al.* 2023). These body factors make it hard to relax and sleep. In addition, stress can generate certain sleep interference during the REM stage, which is important for emotional regulation (Halonen *et al.* 2024).

The current results reflect that nurses working in collaboration with nutritionists, dietitians, and mental health professionals are required to assess the sleep health of vegetarians as their routine with the added attention being directed towards the vegetarians who are suffering from depression and stress. Improperly planned vegetarian diets may lead to low levels of tryptophan, and omega-3 fatty acids, which are important for mood regulation. When vegetarians experience depression or stress, these conditions may reduce their ability to maintain a healthy diet and cause dysregulation of appetite that leads to under-eating or craving unhealthy foods. In addition, depression and stress may also reduce the motivation to plan and prepare nutritious and balanced meals, which increases the chance of consuming convenience foods that are usually low in nutritional quality. Routine assessment of sleep health among vegetarians should be added with nutritional status evaluations together with psychological status screening. Therefore, nurses may work with nutritionists, dietitians as well as with psychiatric professionals to perform early psychological status screening, followed by interventions that could positively improve the quality of sleep such as mindfulness-based therapies, cognitive-behavioural approaches and behavioural changes designed to improve sleep. Besides, future research should explore the efficacy of these types of interventions with nutritionists, dietitians, nurses, and mental health professionals. These aspects can also be worked out toward sleep habit promotion in educating

vegetarians with a better understanding of good sleep habits. The program of collaborative work with mental health may also extend support toward comprehensive care. The roles of the nutritionists, dietitians, nurses, and mental health professionals will be crucial in not only preventing future health dilemmas but also in preventing vegetarians from suffering any long-term complications caused by poor sleep quality.

The present study is subject to several limitations. The present study unable to establish causal relationships due to its cross-sectional design. A longitudinal study is needed to affirm the associations of studied factors and sleep quality. Besides, the absence of a non-vegetarian group limits the ability to decide whether the observed predictors are specific to vegetarians or applicable to the broader population. The present study may be subjected to recall bias due to self-administered questionnaires. Meanwhile, the present study examined vegetarians as a single group without stratifying them into different categories such as ovo-vegetarians, lacto-vegetarians, lacto-ovo vegetarians and vegans. Considering the potential impacts of various types of vegetarian diets on nutritional profiles that could affect sleep quality, there is a need for future studies to stratify vegetarians into different subgroups. Despite these limitations, the present study is the first to depict poor sleep quality issue among Malaysian vegetarians. It also successfully identified depression and stress as key predictors of poor sleep quality. This may serve as a reference for healthcare professionals to design targeted psychological interventions for vegetarians with depression and stress.

CONCLUSION

Poor sleep quality was common among vegetarians in Malaysia with most of them not meeting the sleep duration. The present study found that about two in five vegetarians (40.5%) of the vegetarians had poor sleep quality based on the PSQI together with the presence of depression (15.5%), anxiety (37.0%) and stress (16.0%), highlighting a double burden of poor sleep quality and psychological distress in this population. In the present study, depression and stress were identified as predictors of poor sleep quality among vegetarians in Kuala Lumpur and Selangor, which highlights the need to establish psychological intervention programs.

Management of depression and stress at an early stage may reduce their exacerbated influence on sleep quality. Healthcare professionals are encouraged to work together to assess the sleep health of vegetarians through psychological screening, followed by mindfulness-based therapies, cognitive-behavioural approaches and behavioural changes, especially for vegetarians with depression and stress.

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DECLARATION OF CONFLICT OF INTEREST

The authors have no conflict of interest.

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