

Comparison of sleep quality, diet quality, and weight change between COVID-19-recovered patients and healthy controls: A matched case-control study

Farha Ainin Sofia Muzaffar¹ | Seok Tyug Tan^{1,2} 

¹Faculty of Health and Life Sciences, Management and Science University, University Drive, Off Persiaran Olahraga, Section 13, Shah Alam, Selangor, Malaysia

²Jeffrey Cheah School of Medicine and Health Sciences, Monash University Malaysia, Jalan Lagoon Selatan, Bandar Sunway, Selangor, Malaysia

Correspondence

Seok Tyug Tan, - Jeffrey Cheah School of Medicine and Health Sciences, Monash University Malaysia, Jalan Lagoon Selatan, Bandar Sunway, Selangor, 47500, Malaysia.
Email: Tan.SeokTyug@monash.edu

Abstract

Background and Aim: Literature suggests that individuals who have recovered from COVID-19 may experience post-COVID conditions, including sleep problems and alterations in smell or taste. Thus, this study aims to compare the sleep quality, diet quality, and weight change between COVID-19-recovered patients and healthy controls.

Methods: A matched case-control study involving young adults aged 18–30 years was conducted in the Klang Valley of Malaysia. The young adults were matched in a 1:1 ratio based on their sociodemographic characteristics, including gender, age, marital status, ethnicity, educational attainment, employment status, and monthly earned income. The Pittsburgh Sleep Quality Index was utilized to evaluate sleep quality, and the Diet Quality for Malaysia was used to determine the diet quality of all young adults. The young adults retrospectively recalled their prepandemic body weight in February 2020, while their current body weight in February 2023 was measured using a TANITA HD-314 digital weighing scale.

Results: Emerging findings suggest that sleep quality and weight change were comparable between COVID-19-recovered patients and healthy controls. However, healthy controls were reported to have a more diversified diet than COVID-19-recovered patients. Nevertheless, no significant main effects or interaction effects of sleep and diet quality on weight change were observed in COVID-19-recovered patients or healthy controls. In this study, young adults also reported suffering from sleep deprivation and deficiency due to the pandemic.

Conclusion: Intervention programs that emphasize avoiding stimulants before bedtime for healthy controls, promoting the importance of having a diversified and balanced diet among the COVID-19-recovered patients, and achieving an ideal body weight for all young adults should be conducted after the COVID-19 pandemic.

KEYWORDS

COVID-19-recovered patients, diet quality, healthy controls, sleep quality, weight change

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1 | INTRODUCTION

Globally, the total number of reported COVID-19 cases had exceeded 763 billion as of April 2023.¹ Like many other countries, the federal government of Malaysia implemented three nationwide lockdowns from 2020 to 2021 to curb the spread of COVID-19. In parallel with this effort, the MySejahtera mobile application was unveiled in April 2020 to keep the nation informed of the pandemic situation in the country, record an individual's whereabouts, and assist in close contact tracing. For COVID-19-confirmed cases, it is used to issue Home Surveillance Orders (HSO), record clinical staging of illness, and monitor the signs and symptoms of the patients on a daily basis.²

In Malaysia, COVID-19 confirmed cases are categorized into five clinical stages based on the severity of the infection. Patients in Stage 1 are often asymptomatic and without pneumonia, while patients in Stages 2–5 commonly present symptoms such as fever, cough, flu, and fatigue. Despite having mild symptoms of COVID-19, patients in Stage 2 typically do not show signs of pneumonia. In contrast, patients in Stages 3–5 not only have more severe symptoms but also present clear evidence of pneumonia.³ Another health concern worth mentioning is that individuals who have contracted the virus may experience long COVID or post-COVID conditions that can last for weeks, months, or years.⁴ While typical symptoms of long COVID-19 may include shortness of breath, fatigue, and cognitive dysfunction (such as the presence of brain fog), some COVID-19-recovered patients may also experience sleep problems and alterations in smell or taste.^{4,5} Despite those mentioned previously, a narrative review by Park and Lee⁶ showed that long COVID-19 symptoms may be alleviated through the supplementation of zinc, vitamin C, vitamin D, and polyphenols.

Literature has consistently reported that the COVID-19 pandemic has significantly impacted the quality of sleep and diet among various populations. In the Netherlands, a study conducted by Kocevskaja et al.⁷ indicated that one-fifth of the population who had decent sleep before the pandemic suffered a decline in sleep quality during the lockdown measures. Similarly, a local study involving university students indicated that 77% experienced poor sleep quality during the pandemic lockdown.⁸ Fear of COVID-19 infection, social isolation, financial stress, and pandemic-related uncertainties are among the contributing factors to poor sleep quality.^{7,8} Concerning the changes in diet quality, a recent local study by Ahmad et al.⁹ showed that the COVID-19 pandemic resulted in better adherence to the Malaysian Dietary Guidelines compared to the prepandemic period.

A recent cross-sectional study by Alharbi and Barakat¹⁰ examined the relationships between sleep quality, diet quality, and body mass index among Arabian adults during the COVID-19 pandemic. Despite the findings suggesting that adults who did not adhere to a healthy dietary pattern during the COVID-19 pandemic were at heightened risk of having poor sleep quality, no significant association was observed between sleep quality and body mass index of the adults. To the authors' knowledge, there remains a shortage of

studies comparing the sleep quality, diet quality, and weight change between COVID-19-recovered patients and healthy controls. Thus, this study aims to determine the possible interaction effects of sleep quality, diet quality, and weight change- in COVID-19-recovered patients and healthy controls during the transition to the endemic phase of the pandemic.

2 | METHODS

2.1 | Study design and population

A matched case-control study was carried out in the Klang Valley of Malaysia from February 2, 2023 through March 3, 2023. Young adults aged 18–30 years, able to comprehend Bahasa Melayu or English, free from physical disabilities (such as mobility impairments) and mental disabilities (such as psychological disorders or cognitive impairments), not clinically diagnosed with sleep disorders (such as insomnia or sleep apnea) and eating disorders (such as anorexia nervosa, bulimia nervosa or binge eating disorder), and not participating in any weight loss intervention programs during the data collection period were enrolled in this study using convenience sampling. A printed questionnaire with informed consent and inclusion criteria on the cover page was distributed to potential young adults. Participants were required to grant informed consent and confirm that they fulfilled the inclusion criteria before beginning to answer the survey.

Klang Valley (Kuala Lumpur, Selangor, and Putrajaya) was chosen as the study location due to its record of the highest number of confirmed COVID-19 cases among all states in Malaysia.¹¹ The sample size was calculated using epiR sample size for matched case-control studies (<https://shiny.vet.unimelb.edu.au/epi/sample.size.mccs/>). Assuming that 32.3% of the general population experienced sleep problems during the COVID-19 pandemic,¹² an odds ratio of 4.45¹² and a correlation coefficient of 0.2 between exposure for matched cases and controls, this study would require a minimum sample size of 36 COVID-19-recovered patients and 36 healthy controls to detect a significant difference between the two groups with a margin of error of 5% and a desired power of 80%.

2.2 | Sociodemographics

All young adults were required to report their age, gender, marital status, ethnicity, educational attainment, employment status, and monthly earned income (RM).

2.3 | The diagnosis status and clinical staging of COVID-19

Young adults were required to self-report whether they had been previously infected with COVID-19 between April 2020 and March

2023. Those who had recovered from COVID-19 were asked to disclose the frequency of diagnosis and clinical staging of their illness as registered in the MySejahtera mobile application.

2.4 | Assessment of sleep quality

The Pittsburgh Sleep Quality Index (PSQI) was utilized to assess the sleep quality of young adults over a 1-month time interval. This study instrument consists of seven components: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction, and each component was rated between 0 (*no difficulty*) and 3 (*severe difficulty*). The overall PSQI score is calculated by adding the scores from the seven components of the PSQI, resulting in a possible range of 0–21. The higher the score, the poorer the overall sleep quality. In this study, the global PSQI score was also dichotomized into good sleep quality (score of 0–4) and poor sleep quality (score of 5–21), with the latter indicating a higher likelihood of experiencing sleep problems or disorders.¹³

2.5 | Diet quality assessment

The Diet Quality Questionnaire (DQQ) for Malaysia was used to evaluate all foods and drinks consumed by young adults in the previous 24 h.¹⁴ It has 29 food groups with a binary response (no/yes), where one point was assigned to young adults who conferred a yes response to any of the food groups. To create a 10-point Dietary Diversity Score (DDS), 17 food groups from the DQQ were combined into 10 healthy food groups (refer to Table 4).^{15,16} The DDS ranges between 0 and 10, wherein a high score indicates greater diversity in the consumption of foods from different food groups.

2.6 | Weight change of young adults

To determine the prepandemic body weight, young adults were asked to retrospectively recall their body weight in February 2020 (in kg). Conversely, the current body weight (in kg) was quantified using a TANITA HD-314 digital weighing scale and recorded to the nearest 0.1 kg. Weight change of young adults was subsequently sorted into three categories: no weight change (0 kg), weight gain (gained ≥ 1 kg from the prepandemic body weight), and weight loss (lost ≥ 1 kg from the prepandemic body weight).

2.7 | Statistical analysis

Data analysis was conducted using IBM Statistical Package for the Social Sciences (SPSS) version 29 (IBM Corp.). Case-control matching was carried out based on the sociodemographic characteristics (gender, age, ethnicity, marital status, educational attainment, employment status, and monthly earned income) of the young adults in a

1:1 ratio. Descriptive statistics were used to describe variables when applicable. The mean difference in sleep quality, diet quality, and weight change of COVID-19-recovered patients and healthy controls were analyzed using the independent-samples *t* test. In the study of weight change, multicollinearity is a concern due to the high correlations between the predictor variables. To address this issue, mean centering was applied to the predictors of weight change.¹⁷ Two individual linear regression models were then used to examine the correlation between sleep quality, diet quality, and weight change in COVID-19-recovered patients and healthy controls. Statistically significant was considered at a *p* value of less than 0.05 ($p < 0.05$).

3 | RESULTS

A total of 332 young adults responded to the survey, with 108 successfully matched into two equal groups based on their socio-demographic characteristics: 54 COVID-19-recovered patients and 54 healthy controls. Of the 108 young adults, the majority were female ($n = 80$, 74.1%), aged 21–24 years ($n = 72$, 66.7%), Malay ($n = 68$, 63.0%), still in school with no income ($n = 104$, 96.3%). With regard to marital status and educational attainment, all young adults ($n = 108$, 100.0%) are single and are either currently pursuing or have completed tertiary education (Table 1). Of the 54 recovered patients, 45 (83.3%) were diagnosed with COVID-19 only once. Concerning the clinical staging of COVID-19 among recovered patients, 52 (96.3%) fell into Stage 1 ($n = 20$, 37.1%) and Stage 2 ($n = 32$, 59.2%) (Table 2).

Table 3 compares the sleep quality between COVID-19-recovered patients and healthy controls. The findings of this study indicated that COVID-19-recovered patients had similar scores to healthy controls across all components, except for sleep latency ($t = 2.543$, $p = 0.012$). Specifically, COVID-19-recovered patients (1.04 ± 0.91) attained a lower sleep latency score than healthy controls (1.48 ± 0.91). Furthermore, additional analysis revealed that COVID-19-recovered patients had a shorter duration of falling asleep each night (21.81 ± 21.14 min) than healthy controls (31.19 ± 30.98 min). The average sleep duration per night was similar between COVID-19-recovered patients (6.12 ± 1.83 h) and healthy controls (6.11 ± 1.59 h), with no significant difference observed ($t = -0.028$, $p = 0.98$). Although healthy controls (7.74 ± 2.97) recorded a slightly higher global PSQI score than those recovered from COVID-19 (7.28 ± 3.54), the mean difference was not statistically significant ($t = 0.736$, $p = 0.46$). The proportion of those with poor sleep quality was slightly higher in healthy control ($n = 46$, 85.2%) than in COVID-19-recovered patients ($n = 41$, 75.9%).

Table 4 compares the diet quality between COVID-19-recovered patients and healthy controls. The findings indicated that healthy controls (6.63 ± 2.12) attained a significantly higher ($t = 2.404$, $p = 0.018$) DDS than COVID-19-recovered patients (5.63 ± 2.20). Subsequent analysis revealed that COVID-19-recovered patients achieved significantly lower scores in meat, poultry, and fish ($t = 2.259$, $p = 0.026$), as well as other vegetables ($t < 0.001$, $p = 0.039$)

TABLE 1 Sociodemographic characteristics of the young adults.

Characteristics	Frequency, n (%)	Mean \pm standard deviation
Gender		
Male	28 (25.9)	—
Female	80 (74.1)	
Age		
18–20	36 (33.3)	21.06 \pm 1.37
21–24	72 (66.7)	
Ethnicity		
Malay	68 (63.0)	—
Chinese	10 (9.2)	
Indian	22 (20.4)	
Others (Bumiputra of Sabah and Sarawak or mixed race)	8 (7.4)	
Marital status		
Single	108 (100)	—
Educational attainment		
Tertiary	108 (100)	—
Employment status		
Still schooling	104 (96.3)	—
Employed	4 (3.7)	
Monthly income (RM)		
No income	104 (96.3)	—
Less than RM2000	4 (3.7)	900.00 \pm 692.82

TABLE 2 The frequency and clinical staging of COVID-19 diagnoses among the recovered patients as registered in the MySejahtera mobile application ($n = 54$).

Frequency of COVID-19 diagnosis	Clinical staging of COVID-19, n (%)		
	Stage 1	Stage 2	Stage 3
1	17 (31.5)	26 (48.1)	2 (3.7)
2	2 (3.7)	6 (11.1)	0
3	1 (1.9)	0	0
Total	20 (37.1)	32 (59.2)	2 (3.7)

and other fruits ($t = 0.003$, $p = 0.011$), compared to healthy controls. Figure 1 shows the changes in body weight of all young adults throughout the COVID-19 pandemic. Of the 108, slightly more than half of the young adults (COVID-19-recovered patients = 32 and healthy controls = 36) gained weight after the pandemic. Among young adults who gained weight throughout the COVID-19

pandemic, healthy controls (6.03 ± 6.12 kg) weighed 1.2 kg heavier than those who had recovered from COVID-19 infection (4.83 ± 3.17 kg). Despite those mentioned above, the magnitude of weight gain between these two groups was not statistically significant ($t = 1.025$, $p = 0.31$).

Two linear regression analyses were carried out to examine the main and interaction effects of sleep quality and diet quality on the weight change of young adults (Table 5). In COVID-19-recovered patients, the main effects of sleep quality ($\beta = -0.008$, $p = 0.96$, 95% confidence interval [CI] = -0.42 to 0.40) or diet quality ($\beta = -0.081$, $p = 0.57$, 95% CI = -0.84 to 0.47) on weight change were not statistically significant. The interaction effect of sleep and diet quality on weight change of COVID-19 recovered patients was also not statistically significant ($\beta = 0.063$, $p = 0.66$, 95% CI = -0.16 to 0.27). A similar trend of observation was also noted among the healthy controls, wherein no significant main effects were observed between sleep quality ($\beta = 0.181$, $p = 0.22$, 95% CI = -0.37 to 1.59) or diet quality ($\beta = 0.131$, $p = 0.36$, 95% CI = -0.72 to 1.96) on weight change. The interaction effect between sleep and diet quality on the weight change of healthy controls ($\beta = -0.136$, $p = 0.34$, 95% CI = -0.73 to 0.26) was also not statistically significant.

4 | DISCUSSION

Before the COVID-19 outbreak in Malaysia, ischemic heart diseases were the primary cause of mortality in the country.¹⁸ The mortality due to COVID-19 infection, however, has surpassed ischemic heart diseases and emerged as the leading cause of death in 2021.¹⁹ As of April 2023, Malaysia has recorded more than 5 million confirmed cases of COVID-19 and 37,000 deaths from the virus.²⁰ Despite those mentioned earlier, a local systematic review by Ng et al.²¹ revealed that the majority of confirmed cases (32.0%) fell in Stage 2, with Stage 1 following closely at 27.8%. The findings of this study also revealed a similar trend, with slightly over half (59.2%) of the confirmed cases falling in Stage 2, followed by one-third (37.1%) in Stage 1.

Two former local studies conducted before the COVID-19 pandemic revealed that 63.9%²² and 70.6%²³ of Malaysian undergraduates (the typical age range of undergraduates in Malaysia is 18–24 years old) had poor sleep quality. The global PSQI scores reported in the same studies were 6.27²² and 7.12,²³ respectively. Comparatively, a higher proportion of young adults with poor sleep quality (80.6%) was observed in this study. In addition, the global PSQI scores among COVID-19-recovered patients (7.28 ± 3.54) and healthy controls (7.74 ± 2.97) in this study were slightly higher than those reported in the literature mentioned above. These findings suggest that young adults experienced poorer sleep quality due to the pandemic. Over the past 3 years of the pandemic, the sleep quality of young adults may have been affected by changes in sleep schedule, increased screen time, more time spent on social media, and increased psychological distress.^{24–26}

TABLE 3 Comparison of sleep quality between COVID-19-recovered patients and healthy controls.

Component	Mean \pm standard deviation		t-value (p value)
	COVID-19-recovered patients (n = 54)	Healthy controls (n = 54)	
Component 1: Subjective sleep quality	1.35 \pm 0.73	1.32 \pm 0.61	-0.286 (0.78)
Component 2: Sleep latency	1.04 \pm 0.91	1.48 \pm 0.91	2.543 (0.012)*
Component 3: Sleep duration	1.28 \pm 1.02	1.30 \pm 0.96	0.097 (0.92)
Component 4: Sleep efficiency	0.85 \pm 1.19	0.91 \pm 1.10	0.252 (0.80)
Component 5: Sleep disturbance	1.44 \pm 0.54	1.26 \pm 0.52	-1.818 (0.072)
Component 6: Use of sleep medication	0.15 \pm 0.45	0.33 \pm 0.82	1.448 (0.151)
Component 7: Daytime dysfunction	1.17 \pm 0.86	1.15 \pm 0.90	-0.109 (0.91)
Global PSQI score	7.28 \pm 3.54	7.74 \pm 2.97	0.736 (0.46)

Abbreviation: PSQI, Pittsburgh Sleep Quality Index.

*Significance was considered at $p < 0.05$.

TABLE 4 Comparison of diet quality between COVID-19-recovered patients and healthy controls.

Food groups	Mean \pm standard deviation		t value (p value)
	COVID-19-recovered patients (n = 54)	Healthy controls (n = 54)	
Grains, white roots and tubers, and plantains	0.96 \pm 0.19	0.96 \pm 0.19	<0.001 (>0.99)
Pulses (beans, peas and lentils)	0.33 \pm 0.48	0.37 \pm 0.49	0.428 (0.69)
Nuts and seeds	0.22 \pm 0.42	0.32 \pm 0.47	1.081 (0.28)
Dairy	0.59 \pm 0.50	0.63 \pm 0.49	0.391 (0.70)
Meat, poultry, and fish	0.83 \pm 0.38	0.96 \pm 0.19	2.259 (0.026)*
Eggs	0.70 \pm 0.46	0.78 \pm 0.42	0.873 (0.39)
Dark green leafy vegetables	0.46 \pm 0.50	0.50 \pm 0.51	0.382 (0.70)
Other vitamin A-rich fruits and vegetables	0.46 \pm 0.50	0.63 \pm 0.49	0.088 (0.083)
Other vegetables	0.59 \pm 0.50	0.78 \pm 0.42	<0.001 (0.039)*
Other fruits	0.46 \pm 0.50	0.70 \pm 0.46	0.003 (0.011)*
Dietary diversity score (DDS)	5.63 \pm 2.20	6.63 \pm 2.12	2.404 (0.018)

*Significance was considered at $p < 0.05$.

In a sample of Iraqi adults, COVID-19-recovered patients had a significantly longer sleep duration (6.90 h) and a significantly higher global PSQI score (8.77) than those in the control group of the same age and sex (sleep duration = 6.44 h and global PSQI score = 8.14). In addition, the COVID-19-recovered patients (29.01 min) were found to have a shorter duration of falling asleep compared to the control group (33.52 min).²⁷ Regardless of the COVID-19 diagnosis status, young adults in this study had shorter sleep durations (COVID-19 recovered patients = 6.12 \pm 1.83 h and healthy controls = 6.11 \pm 1.59 h) and lower global PSQI scores (COVID-19 recovered patients = 7.28 \pm 3.54 and healthy controls = 7.74 \pm 2.97) compared to Iraqis. Despite having a shorter sleep duration than Iraqis, the young adults in this study still had better sleep quality overall. Consistent with Al-

Ameri, Hameed, and Maroof,²⁷ this study supports the notion that healthy controls (31.19 \pm 30.98 min) had a longer sleep latency than the COVID-19-recovered patients (21.81 \pm 21.14 min). Nevertheless, further exploration is needed to understand the underlying reasons for this phenomenon.

To the authors' knowledge, no prior studies have compared diet quality between individuals who have recovered from COVID-19 and those who have never been infected with the virus. The findings in the current study revealed that healthy controls had a more diversified diet (DDS = 6.63 \pm 2.12) compared to COVID-19-recovered patients (DDS = 5.63 \pm 2.20). Furthermore, healthy controls were more likely to consume complete proteins (meat, poultry, and fish) and phytochemical-rich fruits and vegetables than COVID-

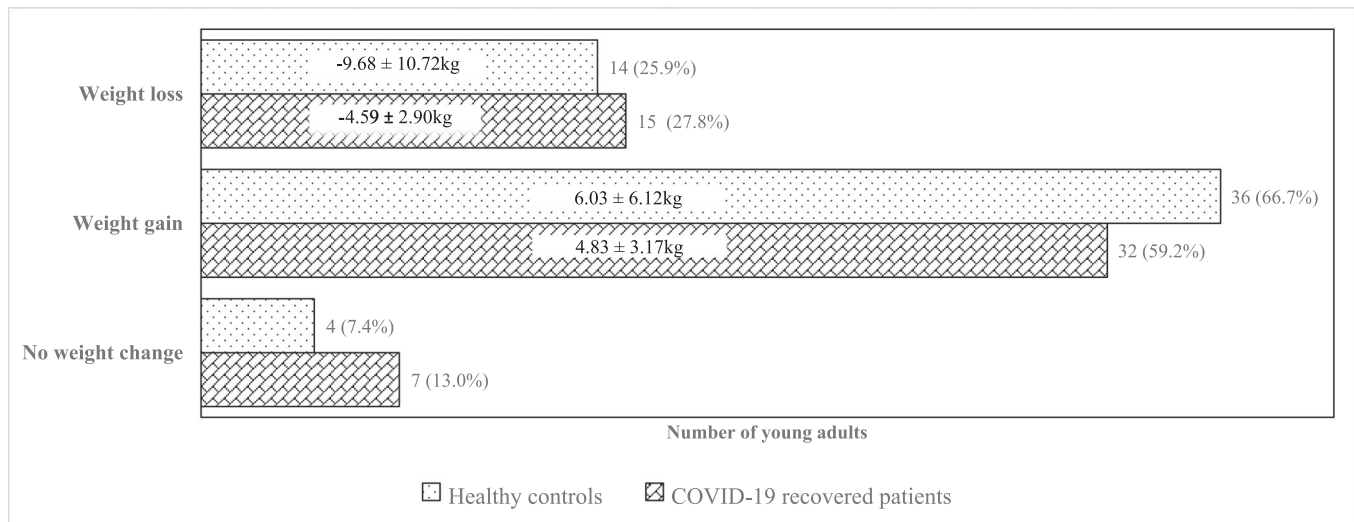


FIGURE 1 Changes in body weight throughout the COVID-19 pandemic.

TABLE 5 The main and interaction effects of sleep quality and diet quality on the weight change of young adults.

COVID-19-recovered patients				
Predictor	B	β	95% CI	p value
Sleep quality	-0.011	-0.008	-0.42 to 0.40	0.96
Diet quality	-0.186	-0.081	-0.84 to 0.47	0.57
Sleep quality × Diet quality	0.046	0.063	-0.16 to 0.26	0.66
Healthy controls				
Sleep quality	0.610	0.181	-0.37 to 1.59	0.22
Diet quality	0.619	0.131	-0.72 to 1.96	0.36
Sleep quality × Diet quality	-0.235	-0.136	-0.73 to 0.26	0.34

Abbreviation: CI, confidence interval.

19-recovered patients. Emerging findings are in accordance with a prospective cohort study conducted in the United Kingdom and the United States, which found that individuals with a high-quality diet had a lower risk of COVID-19 infection.²⁸ Eating a well-balanced diet promotes a stronger immune system, which can subsequently lower an individual's susceptibility to and severity of COVID-19.²⁹

Despite factors such as body mass index, recent weight changes, end-digit preferences, and current cognitive ability may potentially affect the accuracy of self-reported body weight,³⁰ a former study by Yoong et al.³¹ indicated that there was no significant difference between self-reported body weight and height and their measured values in Australia. This suggests that self-reported body weight and height can be a reliable alternative when anthropometric measurement could not be carried out, such as in the emergence of the COVID-19 pandemic. A recent study by Tan et al.³² demonstrated

that 50.6% of young adults in Malaysia gained an average of 3.41 kg in body weight due to the unprecedented pandemic. The current findings indicate that more than half of COVID-19-recovered patients (59.2%) and healthy controls (66.7%) weighed more during the transition to the endemic phase of the pandemic. The proportion of those who experienced weight gain in this study is comparable to that mentioned earlier in the literature. Regardless of COVID-19 diagnosis status, young adults who gained weight in this study recorded greater weight gain (COVID-19-recovered patients = 4.83 ± 3.17 kg and healthy controls = 6.03 ± 6.12 kg) than those reported in the literature mentioned above. Reduced physical activity, increased screen time, changes in dietary patterns and emotional eating arising from increased psychological distress may have contributed to substantial weight gain during the pandemic.³²⁻³⁵

Literature has consistently shown poor sleep and diet quality are associated with higher body weight.^{36,37} A review by Geiker et al.³⁷ claimed that sleep deprivation causes individuals to consume a greater amount of energy-dense foods and sugar-sweetened beverages due to dysregulation in appetite-regulating hormones. Furthermore, a 4-year population-based cohort study conducted in the Netherlands revealed that young adults with poor diet quality are more likely to gain weight compared to those adhering to a high-quality diet. Among those with poor diet quality, the magnitude of average weight gain is more pronounced in men (with an average weight gain of 1.3 kg) than in women (with an average weight gain of 1.0 kg).³⁸ Regardless of those mentioned above, the current study did not observe any significant associations between sleep quality, diet quality, and weight change among COVID-19-recovered patients and healthy controls. Future studies should take into consideration other factors such as physical activity levels, time devoted to sedentary behavior, dietary patterns, and psychological distress, as these may also impact body weight change.

The findings presented in the current study should be interpreted in light of its limitations. First, while data was collected among

young adults aged 18–30 years, only those between 18 and 24 years were successfully matched based on their sociodemographic characteristics. As a result, the generalizability of this study's findings to young adults in Malaysia may be limited. Second, since the DQQ only records food intake for a single day, it may not accurately represent the typical dietary habits of young adults. Third, this study may have introduced recall bias, as young adults were required to recall their body weight before the pandemic retrospectively. Fourth, the lack of significant difference in sleep quality and weight change between COVID-19-recovered patients and healthy controls in this study could be attributed to the fact that almost all (96.3%) of the COVID-19-recovered patients were in Stages 1 or 2, which do not typically involve COVID pneumonia. Given that the COVID-19 diagnosis status was according to the participants' registration in the MySejahtera mobile application, future studies may conduct a SARS-CoV-2 antibody test to accurately determine their diagnosis status before data collection.³⁹ To better understand the associations between sleep quality, diet quality, and weight change, future studies could include patients with more severe COVID-19 infections. Lastly, future studies should also consider the potential confounding effects of physical activity levels, psychological distress, dietary supplement intakes and the period of infection (for the COVID-19-recovered patients) when explaining the relationships between the variables under study.^{40–43} Despite the limitations mentioned earlier, this study is the first to compare sleep quality, diet quality, and weight change among COVID-19-recovered patients and healthy controls in Malaysia.

5 | CONCLUSION

Although the PSQI scores attained by the COVID-19-recovered patients and healthy controls were comparable, the current study indicated that healthy controls took longer to fall asleep each night compared to the COVID-19-recovered patients. Healthy controls were also found to have a more diversified diet compared to the COVID-19-recovered patients. This study also observed that a noticeable proportion of young adults gained weight throughout the COVID-19 pandemic, irrespective of their COVID-19 diagnosis status. Intervention programs that emphasize avoiding stimulants before bedtime for healthy controls, promoting the importance of having a diversified and balanced diet among the COVID-19-recovered patients and achieving an ideal body weight for all young adults should be conducted after the COVID-19 pandemic.

AUTHOR CONTRIBUTIONS

Farha Ainin Sofia Muzaffar: Data curation; data analysis; writing the original manuscript draft. **Seok Tyug Tan:** Conceptualization; methodology; supervision; validation; reviewing; writing; editing of the original draft. All authors have read and approved the final version of the manuscript. Seok Tyug Tan had full access to all of the data in this study and takes complete responsibility for the integrity of the data and the accuracy of the data analysis.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are accessible within the article.

ETHICS STATEMENT

Ethical approval was obtained from the Research Ethics Committee of Management and Science University with the reference number EA-LI-01-FHLS-2022-11-0010. Informed consent was obtained from all participants before answering the survey.

TRANSPARENCY STATEMENT

The lead author Seok Tyug Tan affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

ORCID

Seok Tyug Tan  <https://orcid.org/0000-0003-2492-063X>

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