

Relationships between Digital Screen Time, Dietary Behaviour, Lifestyle Patterns and Body Mass Index in University Students during the COVID-19 Pandemic  
(*Hubungan antara Masa Skrin Digital, Tingkah Laku Pemakanan, Corak Gaya Hidup dan Indeks Jisim Tubuh dalam Pelajar Universiti semasa Pandemik COVID-19*)

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ABSTRACT

The COVID-19 pandemic has changed individual's dietary habits and lifestyles. University students are at risk of developing weight problems due to changes in eating and lifestyle habits imposed by the switch to online learning. Therefore, this study aimed to determine the relationships between dietary behaviour, lifestyle, digital screen time and body mass index (BMI) among university students during the COVID-19 pandemic. A cross-sectional study was conducted with 253 university students between October and November 2021. Data were collected on sociodemographic, anthropometrics, dietary behaviour, screen time and lifestyle habits using an online questionnaire. Laptop and desktop screen time used for entertainment was significantly lower in students who studied online ( $p < 0.05$ ). Most students skipped main meals (71.9%) but snacked between meals (85.8%). Students who underwent online classes (online students) consumed more fruits and vegetables than students undergoing hybrid learning ( $p = 0.035$ ). Compared to online students, hybrid students dined out more often during the pandemic ( $p < 0.001$ ), bought meals from outside ( $p < 0.001$ ) and ate with friends ( $p < 0.001$ ). There were weak negative relationships between BMI and consumption of fruits and vegetables ( $r = -0.199$ ,  $p < 0.01$ ) and carbohydrate sources ( $r = -0.185$ ,  $p < 0.01$ ) and frequency of physical activity ( $r = -0.194$ ,  $p < 0.01$ ). There was a weak positive correlation between BMI and frequency of dinner consumption ( $r = 0.203$ ,  $p < 0.01$ ) and home-based workouts ( $p < 0.01$ ). In conclusion, dietary behaviour and lifestyle patterns during the pandemic were associated with BMI among Klang Valley university students. These findings suggest that promoting healthy lifestyles among university students is important for improving body weight management and overall well-being.

Keywords: COVID-19, dietary habits, physical activity, screen time, body mass index

ABSTRAK

*Pandemik COVID-19 telah mengubah tabiat pemakanan dan gaya hidup individu. Pelajar universiti berisiko mengalami masalah berat badan kerana perubahan tabiat makan dan gaya hidup yang disebabkan oleh peralihan kepada pembelajaran dalam talian. Oleh itu, kajian ini bertujuan untuk menentukan hubungan antara tingkah laku pemakanan, gaya hidup, masa skrin digital dan indeks jisim tubuh (BMI) dalam kalangan pelajar universiti semasa pandemik COVID-19. Satu kajian keratan rentas telah dijalankan dengan 253 pelajar universiti antara Oktober dan November 2021. Data mengenai sosiodemografi, antropometrik, tingkah laku pemakanan, masa skrin dan tabiat gaya hidup dikumpulkan dengan menggunakan soal selidik dalam talian. Masa skrin komputer riba dan desktop yang digunakan untuk hiburan lebih rendah pada pelajar yang belajar dalam talian ( $p < 0.05$ ). Kebanyakan pelajar tidak makan makanan utama (71.9%) tetapi mengambil snek (85.8%). Pelajar dalam talian mengambil lebih banyak buah-buahan dan sayur-sayuran daripada pelajar hibrid ( $p = 0.035$ ). Berbanding pelajar dalam talian, pelajar hibrid semasa pandemik lebih kerap makan di luar ( $p < 0.001$ ), membeli makanan dari luar ( $p < 0.001$ ) dan makan bersama rakan-rakan ( $p < 0.001$ ). Terdapat hubungan negatif yang lemah antara BMI dan pengambilan buah-buahan dan sayur-sayuran ( $r = -0.199$ ,  $p < 0.01$ ) dan sumber karbohidrat ( $r = -0.185$ ,  $p < 0.01$ ) dan kekerapan aktiviti fizikal ( $r = -0.194$ ,  $p < 0.01$ ). Terdapat hubungan positif yang lemah antara BMI dan kekerapan pengambilan makan malam ( $r = 0.203$ ,  $p < 0.01$ ) dan senaman di rumah ( $p < 0.01$ ). Kesimpulannya, tingkah laku pemakanan dan corak gaya hidup semasa pandemik dikaitkan dengan BMI dalam kalangan pelajar universiti di Klang Valley. Dapatan kajian menunjukkan bahawa menggalakkan gaya hidup sihat dalam kalangan pelajar universiti adalah penting untuk meningkatkan pengurusan berat badan dan kesejahteraan keseluruhan.*

Kata kunci: COVID-19, tabiat pemakanan, aktiviti fizikal, masa skrin, indeks jisim tubuh

## INTRODUCTION

The Severe Acute Respiratory Syndrome (SARS) CoV-2 virus (COVID-19) began spreading worldwide in December 2019, resulting in a pandemic being declared on 11 March 2020. Since the first case was recorded in Malaysia on 4 February 2020, over 4.86 million cases of the virus have been confirmed, with 36,415 documented deaths by 15 October 2022 (Dong et al., 2020). Many educational institutions, including those in Malaysia, have transitioned from traditional face-to-face to online learning in schools and universities to break the chain of transmission of the pandemic (Ibrahim & Rosdi, 2020). As a result, this transition has disrupted students' regular eating and lifestyle habits, which may have a negative impact on their health.

An active lifestyle and balanced diet are essential for a healthy physique. This is especially important during COVID-19. Fruits and vegetables contain vitamins, minerals and bioactive compounds, which help strengthen the body's resistance to disease and infection (Singh et al., 2023). However, an online cross-sectional study found a decrease in fruit and vegetable consumption among Polish adults who reported having difficulty finding fresh food during the COVID-19 pandemic (Górnicka et al., 2020). At the same time, consumption of ultra-processed foods, including ready meals, snacks and junk food, which are typically high in salt, sugar and fat, increased during the pandemic (Bonaccio et al., 2021; Ruíz-Roso et al., 2020). One possible reason for the increase in the purchase of these products is their longer shelf life, which allows people to shop less frequently to prevent viral infection in the community.

As more people spend most of their working hours indoors instead of going outside, this unaccustomed time may encourage sedentary behaviour and physical inactivity. Several studies have reported a reduction in the duration and intensity of physical activity, while at the same time the amount of time spent sedentary increased significantly during the pandemic (Ammar et al., 2020; Wang et al., 2020). Furthermore, the use of digital devices for work or school has undeniably become necessary due to the COVID-19 pandemic. This is evidenced by recent studies reporting that adults in China and India spend much more time in front of screens than before the pandemic (Hu et al., 2020; Majumdar et al., 2020). In addition, research has shown that 30.9% of Italians reported feeling less refreshed during the pandemic because they slept less well, stayed up longer and took longer naps during the day (Cellini et al., 2020).

Even before the COVID-19 pandemic, university students are at risk of developing weight problems due to their poor eating habits (Bernardo et al., 2017; Elmskini et al., 2024) and unhealthy lifestyle habits (Pengpid et al., 2015; Yahia et al., 2016). Unhealthy dietary and lifestyle patterns during the pandemic may further exacerbate to unnecessary weight gain and increase the prevalence of obesity (Butler & Barrientos, 2020; López-Moreno et al., 2020). Therefore, this study aimed to determine the relationships between dietary behaviours, lifestyle patterns, digital screen time and body mass index (BMI) among Malaysian university students during the COVID-19. This study also made comparisons between dietary behaviours, lifestyle patterns and digital screen time between those on online and hybrid learning modes. Online learning refers to education that is delivered entirely or primarily via the internet. It uses digital technologies such as computers, tablets, smartphones and the internet to facilitate learning. Hybrid learning is a form of education that combines online learning and face-to-face instruction, with students participating in both online and traditional classroom activities.

## MATERIALS AND METHODS

### Study Design and Sample Selection

Data collection for this cross-sectional study started in October 2021 and lasted until the end of November 2021. The link to the online Google Forms was disseminated through social media platforms such as WhatsApp, Facebook and Instagram. All Malaysians studying in public universities in the Klang Valley with internet access were eligible to participate in this survey. The Federal Territory of Kuala Lumpur, Gombak, Hulu Langat, Klang and Petaling are among the five major areas that make up the Klang Valley, which is located in the centre of the west coast of Peninsular Malaysia. Together, these five areas have an area of about 2,832 km<sup>2</sup>. Pregnant or breastfeeding students and those with diagnosed physical and/or mental disabilities were excluded from this study. To calculate the minimum sample size in this study, the Cochran' formula 1963 was used with the desired confidence level of 95% and precision of 0.05. The expected proportion was 0.176 based on the prevalence of obesity among university students in Malaysia obtained from a previous study (Wan Mohamed Radzi et al., 2019). The total sample size required was therefore 248 respondents, allowing for an attrition rate of 10%.

### Ethical Considerations

Ethical approval was granted by the Research Ethics Committee of Universiti Kebangsaan Malaysia under approval number JEP-2021-510. Potential respondents were informed about the study via social media platforms and asked if they would be willing to participate. Informed consent was obtained online before they started answering the questionnaire for the study.

### Data Collection Procedure

The online questionnaire consisted of five sections: sociodemographic data, anthropometric data, weekly screen time, dietary behaviour and lifestyle patterns. The sociodemographic section collected data on age, gender, ethnicity, year of study, course of study, mode of learning, current living situation and daily food expenditure. The second part of the questionnaire asked for self-reported anthropometric data such as height (cm) and weight (kg) to calculate BMI. To calculate total digital screen time, respondents were asked to indicate the total amount of time they spent per week using various screen-based devices (e.g., laptops, desktops, tablets and smartphones) for learning and entertainment purposes. The questions in this section were adapted from the screen time questionnaire developed by Vizcaino et al. (2019). The Eating Behaviour Questionnaire (EBQ) was used in this study to assess respondents' eating behaviour (Chin & Taib, 2009). The EBQ has been used in many previous studies to examine the eating habits of adolescents and university students in Malaysia (Bakar et al., 2016; Gan et al., 2011; Ho et al., 2021). Information was obtained on frequency of consumption of food groups, intake of pure water, place of consumption and food sources. Lifestyle habits were assessed by asking respondents about the type of activities and frequency of at least 30 minutes of moderate and vigorous physical activity, sleep duration and quality in the past week.

### Statistical Analysis

Statistical analysis was performed using the software IBM SPSS Statistics version 25.0 (Chicago, IL, USA). Descriptive statistics were expressed as mean and standard deviation (SD) for normally distributed continuous data, and as median and interquartile range (IQR) for non-normally distributed continuous data. Categorical data were reported as frequency and percentage. To compare digital screen time, dietary behaviour and lifestyle patterns between learning

modes, the Chi-square test or Fisher's exact test was used. In addition, Spearman's Rho correlation or Chi-square test was used to determine the associations between dietary behaviour, lifestyle, digital screen time and BMI. Statistical significance was assumed at  $p < 0.05$ .

## RESULTS

Table 1 shows the sociodemographic data and BMI of the respondents. A total of 253 students from five public universities were included in this study. More than half of the respondents were female (65.6%,  $n=166$ ), with a mean age of  $21.2 \pm 1.5$  years. The proportion of Malay respondents was 43.9% and the proportion of Chinese respondents was 47.4%. Most of the respondents were from health science programmes (85.3%,  $n=215$ ). One third of the respondents (33.6%,  $n=85$ ) were in their final year of study (year 4). In addition, 51.0% ( $n=129$ ) of respondents were living at home and 50.2% ( $n=127$ ) were living with family members at the time of data collection. Half of the respondents were learning online (50.2%) while the other half were learning in a hybrid mode. They spent a median of RM8.00 [interquartile range (IQR): RM15.00] daily on food. In terms of body weight status, majority of the respondents had a normal BMI (64.0%,  $n=162$ ), with 20.6% ( $n=52$ ), 8.3% ( $n=21$ ) and 6.7% ( $n=17$ ) being underweight, overweight and obese, respectively.

Table 2 shows the total weekly screen time based on the learning modes of the respondents. Laptops and desktops were used more frequently for learning purposes (median=23.0 hours/week) than smartphones and tablets (median=10.0 hours/week). On the other hand, smartphones and tablets were used more often for entertainment purposes (median=20.0 hours/week). When comparing screen time between online and hybrid learning modes, there was no significant difference, except for the use of laptops and desktops for entertainment purposes ( $p < 0.05$ ).

Table 3 shows the frequency of consumption of main meals and snacks according to the different learning modes. Although the majority of respondents reported eating lunch (75.9%,  $n=192$ ) and supper (74.3%,  $n=188$ ) every day, 71.9% ( $n=182$ ) admitted to skipping one or more main meals during the pandemic COVID-19. There was no significant difference in the frequency of eating the main meal between online and hybrid students. Regarding snacks, half of the respondents (52.2%,  $n=132$ ) did not have morning tea, but about two-thirds (63.6%,  $n=161$ ) ate supper at least once a week. When comparing snacking

TABLE 1. Sociodemographic data and anthropometric indices of the participants

Characteristics	n (%)	Mean $\pm$ SD / Median [IQR]
Age (years)		21.2 $\pm$ 1.5
Gender		
Male	87 (34.4)	
Female	166 (65.6)	
Ethnicity		
Malay	111 (43.9)	
Chinese	120 (47.4)	
Indian	15 (5.9)	
Others <sup>1</sup>	7 (2.8)	
Study year		
Year 1	48 (19.0)	
Year 2	74 (29.2)	
Year 3	44 (17.4)	
Year 4	85 (33.6)	
Year 5	2 (0.8)	
Course of study		
Health science programme	215 (85.0)	
Non-health science programme	37 (14.6)	
No response	1 (0.4)	
Current living situation		
Living with family	127 (50.2)	
Living with friends	71 (28.1)	
Living alone	55 (21.7)	
Place of living		
At home	129 (51.0)	
At campus	103 (40.7)	
Rent outside of the campus	21 (8.3)	
Daily food expenditure (RM)		8.0 [15.0]
Learning mode		
Online	127 (50.2)	
Hybrid	126 (49.8)	
BMI category (kg/m <sup>2</sup> )		20.8 [4.6]
Underweight (<18.5)	52 (20.6)	
Normal (18.5-24.9)	162 (64.0)	
Overweight (25.0-29.9)	21 (8.3)	
Obese ( $\geq$ 30.0)	17 (6.7)	

<sup>1</sup>Including the inhabitants of Sabah and Sarawak

BMI: Body Mass Index; IQR: Interquartile range; SD: Standard deviation

TABLE 2. Weekly screen time (hours) based on online and hybrid learning modes

Screen time (hours/week)	Total (n = 253)	Online (n = 127)	Hybrid (n = 126)	p-value
	Median [IQR]	Median [IQR]	Median [IQR]	
<b>Learning purposes</b>				
Laptop/desktop	23.0 [24.0]	22.0 [24.0]	23.5 [20.0]	0.443
Smartphone/tablet	10.0 [12.0]	10.0 [10.0]	10.0 [14.0]	0.678
<b>Entertainment purposes</b>				
Laptop / desktop	7.0 [11.0]	6.0 [10.0]	7.5 [11.0]	0.011*
Smartphone / tablet	20.0 [20.0]	19.5 [18.0]	20.0 [20.0]	0.662

Significant difference at \* $p < 0.05$  by Mann-Whitney U test. IQR: Interquartile range

behaviour between the different learning modes, there was a significant difference ( $p=0.045$ ) in morning tea consumption. However, the difference was not significant after conducting a post hoc analysis.

Table 4 shows the different eating habits, including food sources, eating locations and food companions, according to two different learning modes. About two-thirds of the respondents either cooked their meals at home (62.5%,  $n=158$ ) or bought their food from a cafeteria, restaurant, stall or fast-food outlet (60.9%,  $n=154$ ). However, a higher proportion of online respondents ate meals prepared at home than hybrid respondents, who were more likely to eat at cafeterias, restaurants, food stalls or fast-food places ( $p < 0.001$ ). Many respondents (65.2%,  $n=165$ ) eat at home, followed by eating at a cafeteria, restaurant, stall or fast-food outlet (25.7%,  $n=65$ ) and eating at other places such as dormitories (9.1%,  $n=23$ ). The proportion of online respondents who ate at home was much larger than that of hybrid respondents, while the proportion of hybrid respondents who ate out was significantly higher ( $p < 0.001$ ). While hybrid respondents were more likely to eat with friends during the pandemic, online respondents were more likely to eat meals with family members ( $p < 0.001$ ).

Majority of the respondents reported consuming fat, oil, sugar and salt (61.7%,  $n=156$ ), protein sources such as meat, chicken, fish, eggs and legumes (66.8%,  $n=169$ ) and carbohydrate-rich foods (56.9%,  $n=144$ ) two to three times a day (Table 5). In addition, 22.1% of respondents reported not drinking milk or dairy products during the pandemic COVID-19, while 57.3% ( $n=145$ ) did so once a day. Although half of the respondents reported eating fruits and vegetables at least twice a day, about half of the respondents reported eating only one or less fruits and vegetables during the pandemic.

Regarding the consumption of foods high in sugar, fat and salt, more than half of the respondents (56.9%) consumed less than twice a week of these. In this study, a statistically significant difference ( $p < 0.05$ ) was found in the consumption of fruits and vegetables between the different learning modes, with online respondents more likely to eat fruits and vegetables more than five times a day compared to hybrid respondents.

During the COVID-19, 81.4% ( $n=206$ ) of the respondents spent their time sitting (watching TV, reading, writing and other sedentary activities), 71.5% ( $n=181$ ) spent their time walking and 58.1% ( $n=147$ ) doing household chores (Table 6). Compared to online respondents, hybrid respondents went jogging or running more often ( $p < 0.001$ ). On the other hand, online respondents did chores more often ( $p=0.036$ ). About one third of the respondents (34.4%,  $n=87$ ) participated in at least 30 minutes of moderate and vigorous physical activities one or two days per week. However, 20.6% ( $n=52$ ) of respondents reported engaging in physical activity less than once a week or not at all during the pandemic. About two-thirds of respondents reported having fair quality sleep during the pandemic, with an average sleep duration of  $6.6 \pm 1.3$  hours per day.

Table 7 shows the relationships between digital screen time, dietary behaviour, lifestyle habits and BMI categories (underweight, normal, overweight and obese). The results showed that dinner frequency was positively associated with BMI ( $r=0.203$ ,  $p < 0.01$ ). There were also weak negative correlations between BMI and intake of fats, oils, sugars and salts ( $r=-0.140$ ,  $p < 0.05$ ), fruits and vegetables ( $r = -0.199$ ,  $p < 0.01$ ) and carbohydrate intake ( $r=-0.185$ ,  $p < 0.01$ ). Home workouts such as yoga, strength training and strengthening exercises were also significantly associated with BMI ( $p < 0.01$ ). A weak negative correlation was found

TABLE 3. Frequency of consumption of main meals and snacks based on online and hybrid learning modes

Variables	Total	Online	Hybrid	<i>p</i> -value
	(n = 253) n (%)	(n = 127) n (%)	(n = 126) n (%)	
<b>Breakfast</b>				
Every day	94 (37.2)	53 (41.7)	41 (32.5)	0.525
4-6 days /week	65 (25.7)	28 (22.0)	37 (29.4)	
2-3 days /week	54 (21.3)	27 (21.3)	27 (21.4)	
1 day /week	25 (9.9)	11 (8.7)	14 (11.1)	
0 day /week	15 (5.9)	8 (6.3)	7 (5.6)	
<b>Lunch</b>				
Every day	192 (75.9)	92 (72.4)	100 (79.4)	0.638
4-6 days /week	41 (16.2)	23 (18.1)	18 (14.3)	
2-3 days /week	14 (5.5)	9 (7.1)	5 (4.0)	
1 day /week	3 (1.2)	2 (1.6)	1 (0.8)	
0 day /week	3 (1.2)	1 (0.8)	2 (1.6)	
<b>Dinner</b>				
Every day	188 (74.3)	94 (74.0)	94 (74.6)	0.790
4-6 days /week	42 (16.6)	21 (16.5)	21 (16.7)	
2-3 days /week	16 (6.3)	9 (7.1)	7 (5.6)	
1 day /week	5 (2.0)	3 (2.4)	2 (1.6)	
0 day /week	2 (0.8)	0 (0.0)	2 (1.6)	
<b>Morning tea</b>				
Every day	32 (12.6)	21 (16.5)	11 (8.7)	0.045*
4-6 days /week	29 (11.5)	17 (13.4)	12 (9.5)	
2-3 days /week	32 (12.6)	20 (15.7)	12 (9.5)	
1 day /week	28 (11.1)	10 (7.9)	18 (14.3)	
0 day /week	132 (52.2)	59 (46.5)	73 (57.9)	
<b>Afternoon tea</b>				
Every day	18 (7.1)	10 (7.9)	8 (6.3)	0.444
4-6 days /week	37 (14.6)	22 (17.3)	15 (11.9)	
2-3 days /week	71 (28.1)	36 (28.3)	35 (27.8)	
1 day /week	23 (9.1)	8 (6.3)	15 (11.9)	
0 day /week	104 (41.1)	51 (40.2)	53 (42.1)	
<b>Supper</b>				
Every day	10 (4.0)	5 (3.9)	5 (4.0)	0.763
4-6 days /week	35 (13.8)	19 (15.0)	16 (12.7)	
2-3 days /week	69 (27.3)	31 (24.4)	38 (30.2)	
1 day /week	47 (18.6)	22 (17.3)	25 (19.8)	
0 day /week	92 (36.4)	50 (39.4)	42 (33.3)	
<b>Skipping main meals</b>				
Yes	182 (71.9)	89 (70.1)	93 (73.8)	0.509
No	71 (28.1)	38 (29.9)	33 (26.2)	
<b>Snacking between meals</b>				
Yes				0.738
No	217 (85.8)	108 (85.0)	109 (86.5)	
	36 (14.2)	19 (15.0)	17 (13.5)	

Significant difference at \* $p < 0.05$  by Chi-square test

TABLE 4. Different eating behaviour based on online and hybrid learning modes

Variables	Total	Online	Hybrid	p-value
	(n = 253) n (%)	(n = 127) n (%)	(n = 126) n (%)	
<b>Food Source<sup>1</sup></b>				
Home-prepared meals	158 (62.5)	104 (81.9)	54 (42.9)	<0.001***
Buy directly from cafeteria/restaurant/ stall/fast-food outlet	154 (60.9)	52 (40.9)	102 (81.0)	<0.001***
Buy directly from food delivery apps	67 (26.5)	31 (24.4)	36 (28.6)	0.453
<b>Eating location</b>				
At home	165 (65.2)	111 (87.4)	54 (42.9)	0.001***
At cafeteria/restaurant/ stall/fast-food outlet	65 (25.7)	14 (11.0)	51 (40.5)	
Others <sup>2</sup>	23 (9.1)	2 (1.6)	21 (16.7)	
<b>Food companion<sup>1</sup></b>				
Alone	117 (46.2)	55 (43.3)	62 (49.2)	0.347
Family members	126 (49.8)	95 (74.8)	31 (24.6)	<0.001***
Friends	100 (39.5)	18 (14.2)	82 (65.1)	<0.001***

<sup>1</sup>More than one answer was allowed, and the percentage of cases is shown

<sup>2</sup>Other location includes a dormitory

Significant difference at \*\*\* $p < 0.001$  by Chi-square test followed by post hoc analysis

between frequency of physical activity and BMI ( $r = -0.194$ ,  $p < 0.01$ ).

## DISCUSSION

In this study, we discovered that the dietary habits and lifestyle of university students in the Klang Valley during the COVID-19 were weakly associated with BMI. Specifically, BMI was positively associated with frequency of dinner and doing workout activity at home, but negatively associated with consumption of fruits and vegetables, carbohydrate-rich foods, and frequency of at least 30 minutes of moderate and vigorous physical activity. In addition, students who studied online consumed more fruits and vegetables than students who studied with the hybrid learning style.

The majority of students in the current study had a normal BMI, with a slightly higher proportion of underweight than overweight and obese. This result is similar to a previous study conducted in several universities in Selangor, Malaysia (Hakim et al., 2012). Our findings showed that online students tend to eat meals prepared at home, while hybrid students tend to eat outside the home. This is because most online students live at home and are therefore more likely to eat meals prepared at home. Most hybrid students, on

the other hand, live on campus where cooking is not allowed in the dormitories. Therefore, food sold in the cafeteria and at the food stalls served as primary food sources. There were similar results for eating location. Online students were more likely to eat at home as their meals were mostly prepared by family members, while students who were far from home were forced to eat outside. Most online students tended to eat with family members, while hybrid students tended to eat with peers. Our findings are consistent with those of a local study by Pung et al. (2021) who examined the eating habits of 122 university students and found that more than half of the online students ate their meals with family members.

Our results show that a higher percentage of students (66.8%) consumed protein sources 2-3 times daily compared to these previous studies where only 13.1% of United Arab Emirates (UAE) participants consumed 2-3 times daily (Cheikh Ismail et al., 2020) and only 3.1% of Poles consumed more than once daily during the pandemic (Sidor & Rzymiski, 2020). Our result shows that some students did not follow the recommendations for two servings of milk and dairy products per day (National Coordinating Committee on Food and Nutrition, 2021). In addition, almost half of the respondents in our study consumed fruits and vegetables 2-3 times a day, which is higher than the findings of a similar study from the UAE (Cheikh

TABLE 5. Food intake by food groups in online and hybrid learning modes

Variables	Total	Online	Hybrid	<i>p</i> -value
	(n = 253) n (%)	(n = 127) n (%)	(n = 126) n (%)	
<b>Fats, oil, sugars &amp; salts</b>				
Never	1 (0.4)	1 (0.8)	0 (0.0)	0.240
Once a day	55 (21.7)	21 (16.5)	34 (27.0)	
2-3 times/day	156 (61.7)	81 (63.8)	75 (59.5)	
4-5 times/day	24 (9.5)	14 (11.0)	10 (7.9)	
> 5 times/day	17 (6.7)	10 (7.9)	7 (5.6)	
<b>Protein sources (meat, chicken, fish, eggs and legumes)</b>				
Never				0.173
Once a day	0 (0.0)	0 (0.0)	0 (0.0)	
2-3 times/day	47 (18.6)	17 (13.4)	30 (23.8)	
4-5 times/day	169 (66.8)	92 (72.4)	77 (61.1)	
> 5 times/day	15 (5.9)	7 (5.5)	8 (6.3)	
	22 (8.7)	11 (8.7)	11 (8.7)	
<b>Milk, yoghurt and cheese</b>				
Never	56 (22.1)	23 (18.1)	33 (26.2)	0.410
Once a day	145 (57.3)	73 (57.5)	72 (57.1)	
2-3 times/day	35 (13.8)	20 (15.7)	15 (11.9)	
4-5 times/day	8 (3.2)	5 (3.9)	3 (2.4)	
> 5 times/day	9 (3.6)	6 (4.7)	3 (2.4)	
<b>Fruits and vegetables</b>				
Never	14 (5.5)	7 (5.5)	7 (5.6)	0.035*
Once a day	91 (36.0)	35 (27.6)	56 (44.4)	
2-3 times/day	117 (46.2)	65 (51.2)	52 (41.3)	
4-5 times/day	15 (5.9)	8 (6.3)	7 (5.6)	
> 5 times/day	16 (6.3)	12 (9.4)	4 (3.2)	
<b>Carbohydrate sources</b>				
Never	3 (1.2)	1 (0.8)	2 (1.6)	0.230
Once a day	68 (26.9)	32 (25.2)	36 (28.6)	
2-3 times/day	144 (56.9)	77 (60.6)	67 (53.2)	
4-5 times/day	18 (7.1)	5 (3.9)	13 (10.3)	
> 5 times/day	20 (7.9)	12 (9.4)	8 (6.3)	
<b>Foods/drinks high in sugars, fats and salts (burgers, potato chips, soft drinks &amp; etc.)</b>				
Never				0.957
< 2 times/week				
2-3 times/week	26 (10.3)	12 (9.4)	14 (11.1)	
4-5 times/week	144 (56.9)	73 (57.5)	71 (56.3)	
> 5 times/week	65 (25.7)	34 (26.8)	31 (24.6)	
	12 (4.7)	5 (3.9)	7 (5.6)	
	6 (2.4)	3 (2.4)	3 (2.4)	

Significant at \* $p < 0.05$  by Chi-square test and subsequent post hoc analysis



TABLE 6. Activity and sleep patterns based on online and hybrid learning modes

Variables	Total (n=253)	Online (n = 127)	Hybrid (n = 126)	p-value
<b>Activity<sup>1</sup></b>				
Walking	181 (71.5)	91 (71.7)	90 (71.4)	0.968
Jogging/running	76 (30.0)	26 (20.5)	50 (39.7)	0.001**
Cycling	21 (8.3)	13 (10.2)	8 (6.3)	0.263
Home workout (yoga, strength training, push-up and others)	89 (35.2)	43 (33.9)	46 (36.5)	0.659
Hiking	10 (4.0)	3 (2.4)	7 (5.6)	0.216
Household chores	147 (58.1)	82 (64.6)	65 (51.6)	0.036*
Sitting down (watching TV, reading, writing and other)	206 (81.4)	107 (84.3)	99 (78.6)	0.245
Others <sup>2</sup>	31 (12.3)	15 (11.8)	16 (12.7)	0.830
<b>Frequency of at least 30 minutes of moderate and vigorous physical activity</b>				
Every day	21 (8.3)	9 (7.1)	12 (9.5)	
5-6 days/week	39 (15.4)	14 (11.0)	25 (19.8)	
3-4 days/week	54 (21.3)	29 (22.8)	25 (19.8)	0.103
1-2 days/week	87 (34.4)	42 (33.1)	45 (35.7)	
Never/less than once per week	52 (20.6)	33 (26.0)	19 (15.1)	
Sleep duration (hour/day)	6.6 ± 1.3	6.7 ± 1.3	6.6 ± 1.3	0.795
<b>Sleep quality</b>				
Very good	62 (24.5)	33 (26.0)	29 (23.0)	0.108
Fair	159 (62.8)	73 (57.5)	86 (68.3)	
Poor	32 (12.6)	21 (16.5)	11 (8.7)	

<sup>1</sup>More than one answer was allowed, and the percentage of cases is shown

<sup>2</sup>Other activities include badminton, skipping, netball, table tennis, volleyball, basketball, futsal, swimming, Zumba, football, dancing and Frisbee

Significant difference at \* $p < 0.05$  and \*\* $p < 0.01$  by Chi-square test

Ismail et al., 2020). The finding in this study that most students did not consume 5 or more servings of fruits and vegetables is consistent with the findings of the National Health & Morbidity Survey (NHMS) 2019 that 94.9% of Malaysian adults do not consume adequate servings of fruits and/or vegetables (Institute for Public Health, 2020). In addition, online students were more likely to consume fruits and vegetables than hybrid students. This is because students who live with their families tend to practise healthier eating habits by consuming fruits and vegetables more frequently than students who do not live at home (El Ansari et al., 2012; Seguin et al., 2016). The availability of fruits and vegetables in their homes could also contribute to their higher consumption of this food group. In contrast to previous studies that suggested more frequent consumption of unhealthy foods during the pandemic,

such as eating sugary foods at least once a day and regularly eating salty foods (Cheikh Ismail et al., 2020), our study showed that foods high in sugar, fat and salt were not frequently consumed by most subjects. While the exact reason for this is unclear, the majority of the students in our study were studying for a bachelor's degree in health sciences, so their health awareness may have been higher.

This study found that most students were not sufficiently active because they spent most of their time sitting, walking and doing housework. This is not surprising given that most people spent most of their time indoors during the pandemic. However, a previous cross-sectional study reported that Malaysian university students showed higher engagement in walking and sedentary activities compared to Indonesian students (Tan et al., 2021). In addition, we found that hybrid

TABLE 7. Relationships between digital screen time, dietary behaviour, lifestyle patterns and BMI categories

Variables	BMI Categories <sup>1</sup>	
	$\chi^2 / r$	<i>p</i> -value
Screen time (hours/week)	0.107	0.091
Breakfast (times/week)	0.054	0.396
Lunch (times/week)	0.073	0.250
Dinner (times/week)	0.203	0.001**
Morning tea (times/week)	0.081	0.199
Afternoon tea (times/week)	0.069	0.276
Supper (times/week)	0.069	0.272
Fats, oil, sugars & salts (times/day)	-0.140	0.026*
Protein sources (times/day)	-0.076	0.227
Milk & dairy products (times/day)	-0.032	0.614
Fruits & vegetables (times/day)	-0.199	0.001**
Carbohydrate sources (times/day)	-0.185	0.003**
Foods high in sugars, fats & salts (times/day)	0.107	0.091
Plain water (glasses/day)	-0.068	0.286
Walking (yes or no)	1.685	0.640
Jogging/running (yes or no)	4.318	0.229
Cycling (yes or no)	0.284	1.000
Home workout (yes or no)	11.564	0.009 <sup>††</sup>
Hiking (yes or no)	1.079	0.789
Household chores (yes or no)	1.182	0.757
Sitting down (yes or no)	3.992	0.257
Others (yes or no)	3.209	0.365
Frequency of at least 30 minutes of moderate and vigorous physical activity (times/week)	-0.194	0.002**
Sleep duration	-0.046	0.464
Sleep quality (Very good or fair or poor)	-0.001	0.988

<sup>1</sup>BMI categories (underweight, normal, overweight and obese)

Significant correlation at \**p*<0.05 and \*\**p*<0.01 by Spearman's Rho

Significant association at <sup>††</sup>*p*<0.01 by Chi-square test

students were more likely to run or jog compared to online students. This is consistent with a previous Canadian study (n=1098) which found that running was among the most popular activities in the active group (Lesser & Nienhuis, 2020). Hybrid students have to travel to campus or labs for academic reasons; therefore, they are more physically active than online students. The online students in this study, on the other hand, were more likely to do chores than the hybrid students. This could be due to the fact that those who stayed largely indoors during the pandemic spent more time

on low-intensity physical activities such as housework (Villani et al., 2021). According to the World Health Organization's physical activity guidelines, adults are recommended to engage in at least 150 minutes of physical activity per week to reduce their risk of chronic disease (World Health Organization, 2020). However, the current study found that the majority of students did not exercise frequent to meet the recommendations (5 days per week). This is consistent with previous studies that reported that the majority of participants were only physically active 1-3 times per week (Cheikh Ismail et

al., 2020; Sánchez-Sánchez et al., 2020).

Similar to a cohort study in Japan, where researchers reported that low frequency of dinner intake was associated with overweight or obesity (Yamamoto et al., 2021), we discovered a positive correlation between BMI and dinner intake. The high prevalence of skipping meals, especially breakfast, which may lead to higher calorie intake later in the day (Pung et al., 2021), may be the reason for the positive correlation found in the current study. In addition, a negative correlation was found between fat intake and BMI in our study. The perception of overweight and obese subjects that motivates them to change their eating habits or eat healthy to lose weight (Lee & Wan Muda, 2019) is one reason that could explain the results of the current study. In addition, most of the participants in this study were also health science students, so their level of knowledge and awareness of nutrition and health might be higher than students who do not study science. Yahia et al. (2016) have shown that science students tend to consume less total fat than non-science students due to their higher health awareness. In addition, fruits and vegetables were also negatively correlated with BMI. In general, fruits and vegetables are considered foods that do not contribute to weight gain because they are naturally low in calories and fat. Therefore, this result was consistent with a previous study from Poland, which found a significant negative correlation between BMI and frequency of fruit and vegetable consumption (Sidor & Rzymiski, 2020). Our results suggest that carbohydrate intake is also negatively correlated with BMI, which is consistent with a previous local study that included adults aged 20–65 years. The researchers also found a negative association between carbohydrate intake and BMI (Lee & Wan Muda, 2019). This could be because people who eat more carbohydrates tend to consume more fibre, fruit and vegetables, while consuming less saturated fat, which is good for controlling their weight (Merchant et al., 2009).

This study discovered a positive relationship between home workouts and BMI. The higher BMI could be due to increased muscle mass after home training, as also shown in a previous study where 12 weeks of resistance training increased lean body mass and led to higher body weight without changing total fat mass (Van Der Heijden et al., 2010). In addition, a negative correlation was found between frequency of physical activity and BMI. This confirmed the findings of previous studies that high BMI was associated with low physical activity during the pandemic (Robinson et al., 2021; Zachary et al., 2020). This is because a person's body weight can increase due to excessive fat accumulation from lack of physical activity (Narici et

al., 2021).

This study has several limitations that need to be highlighted. First, the results of this study do not necessarily apply to all Malaysian university students as this study only included students from five public universities in the Klang Valley. Since the body weight and height were based on self-report, there is a possibility of self-report bias. Due to the cross-sectional nature of this study, no causal relationship between variables can be established. However, this study was the first to compare dietary behaviour, lifestyle habits and BMI between online and hybrid students during the pandemic COVID-19. Should a pandemic occur in the future, policy makers or relevant authorities can use this study to develop strategies to improve the dietary and lifestyle habits of Malaysian university students to avoid unnecessary weight gain.

## CONCLUSION

During the pandemic COVID-19, majority of university students in Klang Valley practised skipping meals and snacking. While hybrid students were more likely to buy food from outside, online students were more likely to consume home-cooked meals. There were notable differences in fruit and vegetable intake between the online and hybrid student groups. The majority of participants were not sufficiently physically active. There was an inverse relationship between BMI and dinner consumption. On the other hand, negative associations were found between BMI and consumption of fats, oils, sugars, salts, fruits and vegetables, carbohydrates and physical activity. Therefore, promoting a healthy lifestyle among university students is important for improving body weight control and general well-being.

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