



Changes in physical activity, dietary behaviours, and BMI among undergraduate health students before, during, and after the COVID-19 lockdown: a follow-up study

Samya Varadarajan¹, Akila Govindarajan Venguidesvarane¹, Muthukumar Rajamohan^{1,*}, Saranya Varadarajan², Thodur Madapusi Balaji³

¹ Sri Ramachandra Medical College; Sri Ramachandra Institute of Higher Education and Research. Department of Community Medicine, Porur, Chennai, India.

² Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University Chennai. Department of Oral Pathology and Microbiology, Tamil Nadu, India.

³ Tagore Dental College and Hospital, Near Vandalur, Melakkotiayur Post, Rathinamangalam, Tamil Nadu 600127, India.

*Corresponding author: Muthukumar Rajamohan.

Assistant Professor. Sri Ramachandra Medical College; Sri Ramachandra Institute of Higher Education and Research. Department of Community Medicine, Porur, Chennai, India.

E-mail: muthukumar.r@sriramachandra.edu.in

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Abstract

Introduction: India reported over 30 million confirmed COVID-19 cases and nearly 400000 deaths. The nationwide lockdown beginning on March 25, 2020, and prolonged campus closures led to remote-learning, restricted mobility, and limited access to healthy foods among students. Understanding these lifestyle changes in health-professional students who will guide future patients is essential. **Objective:** To assess changes in physical activity, dietary behaviours, and body mass index (BMI) among undergraduate health students before, during, and after the COVID-19 lockdown.

Methods: A follow-up observational study was conducted among final-year MBBS, BDS, BPT, and BPharm students at a tertiary medical university in South India. All eligible students (N=550) were approached; 470 consented. Pre-lockdown weight and height were obtained by recall, while weight and height were measured during lockdown and weight re-measured after lockdown (September 2021 onwards). Physical activity was assessed using the International Physical Activity Questionnaire–Short Form (IPAQ-SF), and dietary behaviours with a pre-tested semi-structured questionnaire. Descriptive statistics, paired t-tests, repeated measures ANOVA, and multiple linear regression were performed. **Results:** Mean BMI remained unchanged from pre- to during lockdown but

decreased significantly afterwards, while still slightly exceeding baseline values ($p < 0.001$). Physical activity (MET-min/week) declined significantly during lockdown compared with baseline (mean difference -364.78 , $p < 0.001$). Stress eating (40%), night-time eating (34.3%), and increased junk food intake (24.9%) were reported. Regression analysis identified physical activity change ($\beta = -0.252$, $p < 0.001$) and fitness app use ($\beta = -0.219$, $p = 0.017$) as protective against BMI gain, whereas increased meal frequency predicted higher BMI ($\beta = 0.088$, $p = 0.048$). Model explained 8.7% of variance in BMI change. **Conclusion:** COVID-19 lockdown led to reduced physical activity and altered dietary behaviours among health-professional students, producing modest but sustained BMI increases. Student-focused health-promotion strategies and digital tools to maintain activity are warranted.

Keywords: COVID-19. Lockdown. Physical activity. Diet. Eating behaviour. Body mass index. Undergraduate students. India.

Introduction

The COVID-19 pandemic and the nationwide lockdowns imposed to contain its spread caused

profound disruptions to daily life. Following the detection of the first COVID-19 case in January 2020 [1], India experienced successive waves of infection, exceeding 30 million confirmed cases by mid-2021 [2]. In response, authorities implemented a nationwide lockdown beginning March 25 2020, with gradual “unlock” phases extending through the subsequent year [3]. Closure of educational institutions and transition to online mode of education led to restrictions on mobility which altered the students’ physical activity levels, eating habits and social interactions [4-6]. As life style behaviours are established during the young adulthood, these changes may influence the risk of non-communicable diseases (NCDs) [7].

Globally, NCDs account for more than 70% of deaths, and physical inactivity is a major modifiable risk factor identified by the World Health Organization [8,9]. In India, the rapid epidemiological transition has led to a rising prevalence of obesity, diabetes, and cardiovascular disease at younger ages [10]. Health-professional students represent a critical group because their lifestyle behaviours formed during training often persist into adulthood and influence their ability to model and promote healthy practices among patients. Previous studies among medical and health science students have shown low levels of physical activity, irregular eating habits, and a tendency toward unhealthy coping behaviours under stress. The lockdown period likely amplified these risks by restricting opportunities for outdoor exercise, disrupting meal routines, and increasing reliance on sedentary activities [11,12].

Despite recognition of these risks, evidence on how the lockdown affected lifestyle behaviours among university students remains inconsistent. Evidence from different countries has suggested a decline in physical activity and mixed dietary changes among university students during the COVID-19 lockdown [13-15]. Yet, most of these investigations were cross-sectional or relied on single time-point surveys, limiting the ability to determine whether such behavioural changes persisted or reversed after restrictions were lifted. Longitudinal follow-up data among health-professional students in India are particularly scarce. Addressing this gap is crucial to understand the sustained impact of lockdown measures on physical activity, diet, and body weight in young adults who represent future healthcare providers.

Against this background, we conducted a follow-up study among undergraduate health students at a tertiary medical university in South India. We aimed to assess changes in physical activity, dietary behaviours, and body mass index (BMI) across three time points:

before lockdown (recall), during lockdown (measured), and after lockdown (measured at follow-up). Findings from this study were intended to inform the development of evidence-based strategies to promote healthy lifestyle behaviours among young adults during future public health emergencies.

Methods

Study design and setting

We conducted a follow-up observational study among undergraduate students of Sri Ramachandra Institute of Higher Education and Research (SRIHER), Chennai, India. Data were collected at three time points:

1. Pre-lockdown (baseline): Data were obtained retrospectively through participant recall.
2. During lockdown (2020–2021): Data were collected prospectively while students were attending classes in a hybrid format (partly online and partly in-person, on an alternateday/weekly basis).
3. After lockdown (from September 2021 onwards): Data were collected prospectively when regular in-person classes resumed.

Study population

Participants included final-year undergraduate students from MBBS, BDS, BPT, and BPharm programs.

- Inclusion criteria: Final-year students who were willing to participate.
- Exclusion criteria: Students undergoing internship or unwilling to participate.

Sample size:

All final-year students from four undergraduate health programs at SRIHER were eligible: MBBS (250), BDS (100), BPT (100), and BPharm (100), giving a total target frame of 550 students. We adopted a census approach where all eligible students were approached. Of these, 470 students consented to participate (overall response rate: 85.5%) and were included in the analysis. Non-participation was due to absence on campus during data collection or refusal.

Although no a priori sample-size calculation were performed, the achieved sample size provides good statistical precision:

- For proportion estimates, the margin of error is approximately $\pm 4.5\%$ at 95% confidence.
- For continuous variables (e.g., BMI, SD ≈ 4.0), the margin of error for mean estimates is ± 0.36 units.
- For regression analyses, with five predictors, the study retained >90 observations per predictor, exceeding common stability recommendations

(≥10–15 per predictor).

Thus, the sample size was adequate for the planned analyses and enhances the reliability of findings.

Data collection

- ✓ **During lockdown:** Because students attended classes partly online and partly in-person, data collection was logistically challenging. Students who attended on-campus sessions were approached individually during lunch or break periods. Trained investigators conducted face-to-face interviews to complete the semi-structured questionnaire and simultaneously measured height and weight using standardized equipment.
- ✓ **After lockdown:** From September 2021, when regular in-person classes resumed, only body weight was measured due to institutional restrictions; height was carried forward from the during-lockdown measurement.
- ✓ **Pre-lockdown:** Weight and height were obtained through participant recall. BMI was computed as weight/height² (kg/m²).

Study variables

- ✓ **Anthropometry and BMI:** Height and weight were measured as above; BMI calculated.
- ✓ **Physical Activity:** Physical activity was assessed using the International Physical Activity Questionnaire – Short Form (IPAQ-SF) [16,17]. As per IPAQ scoring protocol, weekly MET-minutes were calculated by assigning values of 3.3 METs for walking, 4.0 METs for moderate activity, and 8.0 METs for vigorous activity. Total physical activity was obtained by summing across domains. Results were expressed both as continuous scores (MET-min/week) and categories (low, moderate, high activity) according to standard cut-offs
- ✓ **Dietary Behaviours:** Dietary behaviours were assessed using a pre-tested, semi-structured questionnaire developed by the investigators based on prior literature and expert input. The questionnaire was pilot-tested among 20 students (not included in the final sample) to ensure clarity, relevance, and face validity. It included items on changes in eating habits during lockdown (e.g., meal frequency, diet type adopted, junk food intake, night-time eating, stress eating, and supplement use). Responses were collected in categorical form (e.g., increased / decreased / no change) and summarized as proportions.

- ✓ **Lifestyle Factors:** Additional items on fitness app use, sleep duration, and daily meal frequency.

Statistical Analysis

Data were checked for completeness. As missing values were <1% for anthropometry and negligible for questionnaire items, no imputation was performed; analyses were based on available cases. Data were analyzed in SPSS v29. Descriptive statistics: mean, SD, skewness, kurtosis. Paired-sample t-tests for time-point comparisons. Repeated measures ANOVA (with Greenhouse–Geisser correction) for BMI trends. Linear regression to assess predictors of BMI change (gender, physical activity, sleep, meals, fitness app use). Significance level: p < 0.05.

Ethical Approval

Ethical approval was obtained from the Institutional Ethics Committee reference number IEC-NI/20/OCT/76/94. Participation was voluntary with electronic informed consent. Confidentiality was maintained.

Results

Among 470 students, mean height was 1.66 ± 0.10 m (N=469). Mean body weight showed a small decline from 65.97 ± 12.94 kg (before) to 65.25 ± 12.86 kg (after); corresponding BMI means shifted from 23.996 ± 3.96 to 23.712 ± 3.81. Physical activity decreased between during and after lockdown (IPAQ MET-min/week 1599.77 ± 1478.36 to 1234.99 ± 1109.10) (Table 1).

Table 1. Background variables.

7	Variable	N	Mean	Median	Mode	SD	Skewness	Kurtosis	Range
1	Height (m)	469	1.6565	1.65	1.60	0.0951	-0.373	-1.746	1.91 - 1.40
2	Weight (kg) - Before Lockdown	470	65.97	65.00	65.00	12.94	0.785	0.990	38.49 - 15.09
	Weight (kg) - During Lockdown	470	65.87	65.00	65.00	13.47	0.860	1.152	41.50 - 15.09
	Weight (kg) - After Lockdown	470	65.25	64.00	65.00	12.86	0.851	1.494	38.82 - 15.09
3	BMI Before Lockdown	470	23.996	23.51	21.48	3.96	0.828	1.042	38.58 - 15.09

	BMI During Lockdown	470	23.945	23.46	21.48	4.10	0.954	1.588	41.50
	BMI After Lockdown	470	23.712	23.40	24.22	3.81	0.915	1.732	38.82
4	IPAQ MET During Lockdown	470	1599.77	1255.00	1255.00	1478.36	1.744	4.177	—
	IPAQ MET After Lockdown	470	1234.99	933.00	933.00	1109.10	1.490	3.240	—

Abbreviations: BMI, body mass index; MET, metabolic equivalent of task. Source: Own authorship.

Gender differences

Male students were significantly taller than female students (1.74 ± 0.06 m vs. 1.59 ± 0.05 m, $p < 0.001$) and consistently weighed more across all three time points ($p < 0.001$ for each). However, BMI did not differ significantly by gender at any time point (all $p > 0.1$). In terms of physical activity, males reported higher IPAQ-MET scores both during lockdown (1981.56 ± 1679.89 vs. 1355.95 ± 1192.10 , $p < 0.001$) and after lockdown (1447.98 ± 1170.72 vs. 1090.32 ± 1015.38 , $p < 0.001$).

Life style and eating behaviours

Self-reported behaviours during the lockdown revealed several lifestyle changes. About one-third of students (34.0%) reported using fitness apps. Nearly half (45.3%) indicated a change in eating habits; of these, 23.0% adopted intermittent fasting, while smaller proportions tried ketogenic (7.7%) or Atkins diets (6.2%). The majority (56.8%) reported no dietary change.

Regarding food behaviours, 24.9% reported increased junk food consumption, 30.6% decreased, and 44.5% no change. Night-time eating was reported by 34.3%, while 40.0% engaged in stress-related eating. Supplement use was reported by 27.7% of students, with Ayurveda/kabasura products (27.7%) and multivitamins (14.9%) being the most common choices (Table 2).

Table 2. Lifestyle and behaviour changes.

S No	Variable	Category	n (%)
1	Fitness App Use	Yes	160 (34.0%)
		No	310 (66.0%)
2	Change in Eating Habits	Yes	213 (45.3%)
		No	257 (54.7%)
3	Diet Change Type	No change	267 (56.8%)
		Intermittent fasting	108 (23.0%)
		Keto	36 (7.7%)
		Atkins	29 (6.2%)
		Other	30 (6.4%)

4	Junk Food Intake	Increased	117 (24.9%)
		Decreased	144 (30.6%)
		Same	209 (44.5%)
5	Night-time Eating	Yes	161 (34.3%)
		No	309 (65.7%)
6	Stress Eating	Yes	188 (40.0%)
		No	282 (60.0%)
7	Supplement Use	Yes	130 (27.7%)
		No	340 (72.3%)
8	Type of supplements (n=130)	Green tea	12 (9.6%)
		Ayurveda/ kabasura	36 (27.7%)
		Iron and folic acid supplements	2 (1.7%)
		Multivitamins	19 (14.9%)

Source: Own authorship.

Changes in different time points Body Mass Index (BMI)

BMI showed a small, non-significant increase from before to during lockdown (mean difference = 0.051, $p = 0.266$). Following lockdown, BMI decreased significantly compared with the lockdown period (mean difference = 0.233, $p < 0.001$). However, BMI at follow-up remained slightly but significantly higher than baseline (mean difference = 0.284, $p < 0.001$). Thus, although BMI peaked modestly during lockdown and declined afterwards, it did not fully return to pre-lockdown levels (Table 3, Figure 1).

Physical activity

Physical activity declined significantly during lockdown, with mean IPAQ MET-min/week decreasing by -364.78 ($p < 0.001$) compared with pre-lockdown levels.

Other behaviours

Students reported shorter sleep duration during lockdown compared with before (mean decrease = 1.40 hours, $p < 0.001$). Similarly, the number of meals/snacks per day also decreased (mean difference = -0.71 , $p < 0.001$).

Table 3. Paired comparisons of BMI, physical activity, and lifestyle factors (N = 470).

Comparison	Mean Difference \pm SD	95% CI	p-value
BMI Before vs During Lockdown	0.051 \pm 0.991	-0.039 to 0.141	0.266
BMI During vs After Lockdown	0.233 \pm 1.441	0.102 to 0.363	< 0.001
BMI Before vs After Lockdown	0.284 \pm 0.896	0.231 to 0.336	< 0.001
IPAQ MET before vs during Lockdown	-364.78 ± 1518.29	227.16 to 502.40	< 0.001
Sleep Duration	1.40 \pm 1.77	1.24 to 1.56	< 0.001

before vs during Lockdown			
Meals/Snacks per Day before vs during lockdown	0.71 ± 1.50	0.57 to 0.84	< 0.001

Abbreviations: BMI, body mass index; MET, metabolic equivalent of task. Source: Own authorship.

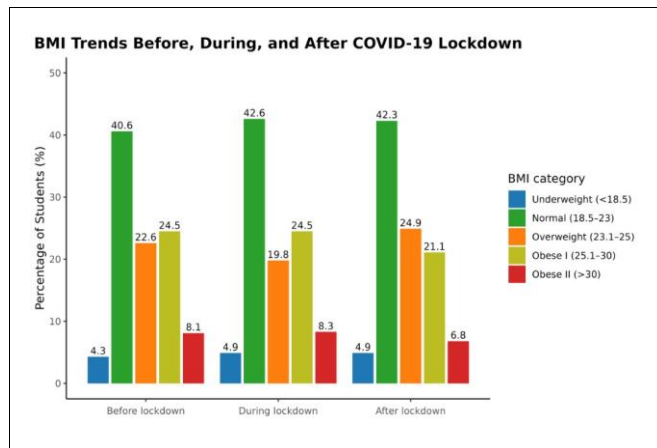


Figure 1. BMI trends before, during, and after lockdown. *Description:* The proportion of students with normal BMI (~42%) remained stable across the study period. After lockdown, obesity prevalence declined slightly, accompanied by a small increase in overweight status. Source: Own authorship.

Repeated measures ANOVA

A repeated measures ANOVA was conducted to assess BMI changes across the three time points (before, during, after lockdown). The assumption of sphericity was violated (Mauchly's $W = 0.821$, $p < 0.001$), so Greenhouse–Geisser correction was applied. The effect of time on BMI was statistically significant, $F(1.70, 795.76) = 14.34$, $p < 0.001$, partial $\eta^2 = 0.030$.

Pairwise comparisons with Bonferroni adjustment showed

- No significant difference between baseline and during lockdown (mean difference = 0.051, $p = 0.798$).
- A significant increase in BMI from baseline to after lockdown (mean difference = 0.284, $p < 0.001$).
- A significant decrease in BMI from during to after lockdown (mean difference = 0.233, $p = 0.002$), although BMI after lockdown remained modestly higher than baseline.

Predictors of BMI Change

A multiple linear regression analysis was performed to identify predictors of BMI change between pre- and during-lockdown periods (Table 4). The model was statistically significant, $F(5, 464) =$

8.871, $p < 0.001$, explaining 8.7% of the variance (Adjusted $R^2 = 0.077$).

- Physical activity (MET change): Higher activity was associated with lower BMI ($\beta = -0.252$, $p < 0.001$).
- Fitness app use: Protective effect, linked to reduced BMI gain ($\beta = -0.219$, $p = 0.017$).
- Meals/snacks: Increase in meal frequency predicted BMI increase ($\beta = 0.088$, $p = 0.048$).
- Sleep duration change and gender were not significant predictors.
- No evidence of multi-collinearity (VIF range: 1.01–1.04).

Table 4. Predictors of BMI change: multiple linear regression results.

Predictor	β (Unstd)	Std. Error	Beta (Std.)	t	pvalue	95% CI (Lower–Upper)	VIF
Constant	0.628	0.238	–	2.634	0.009	0.159 – 1.096	–
MET change	0.000	0.000	-0.252	-5.629	<0.001	0.000 – 0.000	1.02
Sleep change	-0.036	0.025	-0.065	-1.466	0.143	-0.085 – 0.012	1.01
Meals change	0.058	0.029	0.088	1.984	0.048	0.001 – 0.116	1.01
Gender (Male)	-0.149	0.092	-0.073	-1.625	0.105	-0.329 – 0.031	1.03
Fitness app use	-0.219	0.092	-0.108	-2.389	0.017	-0.399 – -0.039	1.04

Abbreviations: MET, metabolic equivalent of task; SE, standard error; VIF, variance inflation factor. Source: Own authorship.

Discussion

Our study was done as a follow-up of 470 undergraduate students where we attempted to assess the changes in physical activity levels, diet, BMI across the phases during the lockdown due to COVID-19. It was found that BMI values did not change significantly between pre-lockdown and during lockdown, but the mean values decreased after lockdown period, and remained slightly higher than the pre-lockdown period. Physical activity levels significantly reduced during lockdown period. We also found that stress-eating, night-time eating and junk food consumption were reported by most students during lockdown. Regression analysis indicated that increased physical activity and fitness app use were protective against BMI gain, while increased meal frequency was associated with higher BMI.

The findings of our study is consistent with many international studies that has reported a reduced physical activity and altered eating behaviours among university students during lockdowns [18,19]. Similarly, IPAQ-MET scores significantly declined in

Italian medical students (from a median of 1,588 to 960 MET-min/week during lockdown), yet time spent in moderate-to-vigorous activity actually increased even as walking declined—suggesting compensation via home-based exercise [20].

Our study showed a transient increase in BMI during lockdown which was followed by reduction later. This is consistent with findings from Chinese and Japanese studies, which suggest that lifestyle changes during lockdown is due to the restrictions which may lead to recovery after lift of lockdown, but may not be back to the baseline levels [21-24]. The high prevalence of stress-related eating in our study (40%) is comparable with many Indian studies and global reports, which shows that there is psychological impact which happens during lockdown on young adults [25].

In terms of dietary changes, it is noteworthy that almost a quarter of students adopted intermittent fasting, while smaller proportions reported experimenting with ketogenic or Atkins diets. These trends reflect the growing popularity of restrictive dietary patterns among young adults, often influenced by social media and peer networks rather than medical advice [26]. While intermittent fasting has shown potential benefits for weight loss and metabolic health, its long-term safety and sustainability in young populations remain uncertain, especially in the absence of professional guidance [27].

Similarly, ketogenic and Atkins diets are highly restrictive and may pose risks of nutrient deficiencies, impaired concentration, and adverse gastrointestinal effects when adopted without supervision [28]. For students who are involved in tight academic sessions, following restrictive diet patterns may compromise their cognition and their energy levels during the day [29]. The fact that students follow these diets, infer their level of awareness on health and weight management which in the long term could promote healthier evidence based dietary choices. Future studies should be aimed to explore the long term effects of dietary practices among young adults.

The results reveal that the medical and allied health student's lifestyle has been disrupted during the pandemic period. Although the changes in BMI across the study phases were statistically significant, the absolute differences were minimal (mean change ~0.28 kg/m² from baseline to post-lockdown). But still, levels of physical activity significantly reduced and most of the students engaged in unhealthy eating behaviours. This could predispose to long term risk for non-communicable diseases if such behaviours persist. The protective role of fitness app use suggests that digital tools may be effective in sustaining activity levels during restricted conditions [30,31].

These findings emphasize the need for targeted health promotion initiatives, including structured physical activity programs, digital wellness interventions, and nutrition counselling, tailored to student populations. Beyond these findings, this study possesses notable methodological strengths. It included a large sample size with a high response rate and analysed at three different time periods, before, during and after lock-down using anthropometric measurements. This longitudinal approach strengthens the validity of the observed behavioural trends.

Limitations

The results should be interpreted with caution as it was from a single centre in South India and restricted to final year students of only medical and allied health sciences group. As these students may have greater health awareness, the results cannot be generalised to all students. However, we can generalise the results to similar medical and allied health students in similar settings. The details of pre-lock down period is subjected to recall bias. The questions used to examine diet was semi-structured and categorical which could not capture the quantitative details of diet intake. The regression model accounted for only 8.7% of the variance in BMI change. This indicates that the included predictors of BMI (physical activity, fitness apps, meals frequency) could explain only part of the outcome. There could be influence of other factors like socio-economic status, stress etc. This underscores the complex nature of weight regulation and the need for broader models in future studies.

Conclusion

The COVID-19 lockdown was associated with reduced physical activity and shifts in dietary habits among health-professional students, leading to a modest, sustained BMI increase. Encouraging balanced diets, regular exercise, and the use of digital wellness tools may help young adults maintain healthier lifestyles during future disruptions.

CRedit

Author contributions: Conceptualisation: AGV, SV1,MR; Methodology: AGV, SV1, MR; Data Collection / Fieldwork: AGV, SV1, MR; Data Curation: AGV, SV1, SV2; Formal Analysis: AGV, SV1, MR; Resources: SV2, MR; Writing – Original Draft: SV1; Writing – Review & Editing: SV2, AGV, MR; Supervision: MR, AGV. All authors have read and approved the final manuscript.

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Ethical Approval

Ethical approval was obtained from the Institutional Ethics Committee reference number IEC-NI/20/OCT/76/94. Participation was voluntary with electronic informed consent. Confidentiality was maintained.

Informed Consent

Not applicable.

Funding

Not applicable.

Data Sharing Statement

The datasets generated and analysed during the current study are available from the corresponding author upon reasonable request. Individual participant data have been deidentified to protect confidentiality.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate®.

Application of Artificial Intelligence (AI)

Not applicable.

Peer Review Process

It was performed.

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