TITLE: Does depressive and anxiety symptoms associate with the diet quality of university students? An exploratory study during the COVID-19 pandemic in India

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ABSTRACT

Background: This study examines the association of depressive and anxiety symptoms on diet quality while controlling for different demographic and other health and lifestyle factors.

Methods: This cross-sectional study was carried out between April 2021 to June 2021 among a total of 440 (unweighted) university students. Diet quality was assessed using a 10-item mini-dietary assessment index tool. Depressive and anxiety symptoms of participants were measured using the validated Patient Health Questionnaire-9 (PHQ-9), and Generalized anxiety disorder (GAD-7) scale, respectively. Multivariable logistic regression and mediation analyses were performed.

Results: In this study, 61.1% (95% CI: 56.6% to 65.7%) of university students' diet quality was good during the COVID-19 pandemic. Being a post-graduate student, an urban resident, having no depressive (AOR = 2.15, 95% CI: 1.20 to 3.84) and anxiety symptoms (AOR = 1.96, 95% CI: 1.07 to 3.59), no changes or better appetite, and no changes in sleep duration were significantly associated with good diet quality among our study participants. Both depressive and anxiety symptoms had a direct and indirect effect on diet quality while mediated each other.

Limitations: The causal conclusion cannot be drawn due to the cross-sectional design of this study. All data were self-reported that may cause social desirability and recall bias.

Conclusions: Depressive and anxiety symptoms during COVID-19 had a significant effect on diet quality of university students. Future public health policies need to be focused on improving the mental health and well-being of students particularly during pandemic situations to enhance their diet quality.

Keywords: Depression; Anxiety; Diet quality; University students; COVID-19

1. Introduction

After spreading to over 110 countries, Corona virus disease (COVID-19) was declared a pandemic on March 11, 2020, by World Health Organization (WHO) and as of July 13, 2021, over 188 million cases and 4 million deaths have been reported globally (Banna et al., 2020; Kundu et al., 2020; Wang et al., 2020). To control the transmission of COVID-19, many international governments had to take rigorous decisions in form of lock-downs, travel restrictions and suspension of international flights, closing of schools and business organizations, bans on social gathering, among others (Ghazawy et al., 2020). As a result, the most active age group, specifically the university students got directly affected by these restrictive measures, which have a negative impact on their life both physically and mentally (Ghazawy et al., 2020). Moreover, these sudden changes also affected students' learning environment, causing lots of uncertainties, as well as a halt in academic and career plans thus adversely affecting their mental health (Lee et al., 2021).

Mental health problems among students are getting a common prodigy and many similar studies found that approximately half of the university students have some stress-related minor mental health issues including anxiety and depression (Gao et al., 2020). These mental health problems have been reported be associated with detrimental behaviors such as poor diet, smoking, lack of exercise, poor sleep habits (Beiter et al., 2015). Several studies have explored mental health related behaviours such as sleeping hours being associated with both depression and anxiety among Egyptian university students during the COVID-19 pandemic (Ghazawy et al., 2020). In addition, healthy diet has been reported to be associated with health behaviors like smoking, alcohol consumption, physical activity and drug use among adolescents in East London (Jacka et al., 2011).

According to the Diagnostic and Statistical Manual of Mental Disorders V (DSM V), changes in appetite is one of the symptoms of depression, though other symptoms like reduced energy and a lack of interest in activities may influence one's diet quality through lack of energy/motivation to prepare or enjoy meals. This, in turn, could influence the overall diet choices and thus diet quality (Gibson-Smith et al., 2018). The association between depression and anxiety with diet quality is quite complex and it is a bidirectional relationship, given that several studies show that healthier diets are associated with a lower risk for developing depression (Gibson-Smith et al., 2018; Molendijk et al., 2018).

Recent evidence suggests that mental disorders are associated with poor diet quality (Poorrezaeian et al., 2015; Weng et al., 2012), and in both developed and developing countries, depressive disorders are becoming a significant health and economic burden (Quirk et al., 2013). Many shreds of evidence suggest that the onset of depression and anxiety is influenced by diet (Lassale et al., 2019; Li et al., 2017) and some modifiable lifestyle behaviors such as physical inactivity, smoking, among others (Pasco et al., 2011, 2008; Quirk et al., 2013; Sacker and Cable, 2006). Currently, the relationship between nutrition and depressive disorders has become of increasing interest (Jacka et al., 2011) though growing evidence suggested a complex relationship between diet and depressive symptoms (Lopresti et al., 2013; Popa and Ladea, 2012; Rahe et al., 2014).

Many systematic reviews and meta-analyses were also conducted to find out the effects of diet quality, dietary patterns, dietary intake on mental health among adults, children, and young people. A meta-analysis conducted by Firth et al. covered the randomized control trial (RCT) and tried to find out the effects of dietary interventions on symptoms of depression and anxiety (Firth et al., 2019), similarly, a systematic review based on observational studies tried to summarize the relationship between dietary patterns and depression in healthy adults (Rahe et al., 2014). Khalid

et al. conducted a systematic review which examined the association between the dietary intake of children and young people and depression and related mental health problems (Khalid et al., 2016), while Quirk et al. summarized the association of both diet quality and dietary pattern with depression among adults (Quirk et al., 2013). On the other hand, high stress and high neuroticism scores were found to be associated with poorer diet quality (Schweren et al., 2021).

Most of the previous literature examined the effect of diet quality on depression and anxiety among children, women, and adults but very few studies have focused on university students. To our knowledge, no study in India has explored the effects of depression and anxiety on diet quality among university students. During this pandemic situation, the available studies have focused on prevalence of mental health problems and their association with demographic and some lifestyle factors but not diet quality. In our study, we tried to focus on university students during this COVID-19 pandemic and hypothesized that university students with high depressive and anxiety symptoms might have poor diet quality. Thus, this study aimed to investigate the effect of depressive and anxiety symptoms on diet quality among university students in India during the COVID-19 pandemic, while controlling for the effects of specific demographic and other health and lifestyle factors.

2. Methods

2.1. Study design and participants

It was a prospective cross-sectional study that was carried out between April 2021 to June 2021 under the Helsinki Declaration ethical guidelines. This study was conducted among both undergraduate and postgraduate students from the University of Mysore (UoM) as well as four affiliated colleges of UoM. The UoM, a public state university, and its affiliated colleges are situated in Mysore city, Karnataka, India (see **Figure 1**).

2.2. Sampling and study procedure

The sample size was calculated using single population proportion formula. Since there is no existing literature that assessed the diet quality of Indian university students, we considered the prevalence of depressive symptoms of a previous study (Nezam et al., 2020) to calculate the sample size. We used OpenEpi Version 3 (<https://www.openepi.com/SampleSize>) with the assumption of 95% confidence level, 5% absolute precision, a design effect of 1.2, and taking 38% prevalence of depressive symptoms among Indian university students (Nezam et al., 2020). After calculating, our final sample size was 435. We used simple random sampling technique to select the participants. All the participants were interviewed face-to-face by trained research staff using a structured questionnaire. The questionnaire was piloted among a sample (n = 30). Preliminary, we invited approximately 500 university students to attain our desire sample, however, a total of 440 participants agreed to participate voluntarily and took part in the interview. The participants were informed that anonymity and confidentiality would be maintained and the data would be used only for research purposes. Written informed consent was also obtained from all participants. The participants only who were willing to participate and filled written consent were interviewed and made the final response rate about 88.0%.

2.3. Measures

2.3.1. Diet quality

A 10-item mini-dietary assessment index tool was used to assess the diet quality of study participants. The mini-dietary assessment tool was used to evaluate overall diet quality based on the Dietary Guidelines for Indians by the National Institute of Nutrition (NATIONAL INSTITUTE OF NUTRITION, 2011). The index comprised four food groups that should be consumed, four food groups that should be consumed at a limited amount, and the other two food groups regarding

meal skipping and regular diet. Responses to food groups of which adequate amounts should be consumed were reported using a 5-point Likert scale where “1” was for seldom, “3” for sometimes, and “5” for always. Responses to food groups that should be consumed in limited quantities were also reported using a 5-point Likert scale where “1” was for always, “3” for sometimes, and “5” for seldom. The maximum possible score for diet quality using this assessment tool was 50. A participants’ diet quality was considered as “good” when his/her total score was greater than or equal to 30, and if the score was below 30, then the diet quality was defined as “poor”. This mini-dietary assessment tool is validated for Koreans (Kim et al., 2003); however, in the present study, the internal consistency of the assessment tool was adequate (Cronbach's $\alpha = 0.82$).

2.3.2. Depressive symptoms

Patient Health Questionnaire (PHQ-9), a 9-item scale, was used to assess the level of depressive symptoms. To measure the depressive symptoms, the PHQ-9 is a validated tool (Kroenke et al., 2001), which was also used in several previous studies among university students (Islam et al., 2020; Kundu et al., 2021). The PHQ-9 scale is composed of 9 individual questions, where the response for each question was coded based on a four-point Likert scale ranging from “Not at all” (0) to “Nearly every day” (3). The total score ranges from 0 to 27, where a higher score indicates more severe depressive symptoms. After summarizing the total score obtained from the responses of the nine items, the summed score was categorized into two groups. Participants with a score of <10 were classified as having no depressive symptoms, and those who made a score of 10 were categorized as having depressive symptoms (Kundu et al., 2021; Manea et al., 2012). The reliability of the scale in the present study was high (Cronbach's $\alpha = 0.83$).

2.3.3. Anxiety symptoms

The Generalized Anxiety Disorder (GAD-7) tool, a 7-item scale, was used to assess the anxiety symptoms level of study participants, a valid and reliable tool for screening anxiety symptoms in epidemiological studies (Islam et al., 2020). The GAD-7 scale includes seven items responded on a four-point Likert scale ranging from 0 (Never) to 3 (Nearly every day). The total score ranges from 0 to 21, where a higher score indicates more severe anxiety symptoms. In this study, those scoring ≥ 10 were defined as having the existence of anxiety symptoms (Islam et al., 2020; Spitzer et al., 2006). The reliability of the scale in the present study was sufficient (Cronbach's $\alpha = 0.79$).

2.3.4. Other health and lifestyle characteristics

The smoking status during the COVID-19 lockdown was assessed by asking whether they don't smoke or currently quit smoking, or smoke more, less, or about the same compared to before the lockdown. The level of physical activity (PA) during the COVID-19 lockdown was assessed using a fixed-choice question: on the average time spend actively, where the respondents chose one of three following categories describing their activity time: (1) Low PA (<0.5 h a day); (2) Moderate PA (0.5–2 h a day), and (3) High PA (>2 h a day). Changes in physical activity level during lockdown were assessed using a single fixed-choice question: 'During the COVID-19 lockdown, my average physical activity level a day was: (1) Decreased, (2) Not changed, (3) Increased' (Górnicka et al., 2020).

We estimated the total sleep duration a day of study participants by asking the following question: "How many hours a night on average did you sleep during the past 4 weeks? We categorized sleep duration into long (more than 8 h), normal (7 and 8 h), and short (6 h or less) to identify the effect of short or long sleep duration vs. "normal" sleep duration on the diet quality of participants. Previous studies conducted among university students also used these categories to define sleep duration (Islam et al., 2020; Kundu et al., 2021; Sayeed et al., 2020). Changes in average sleep

duration a day were assessed using a single fixed-choice question: ‘During the COVID-19 lockdown, my average sleep duration a day was: (1) Decreased, (2) Not changed, (3) Increased’.

Changes in meal size during the COVID-19 lockdown were assessed by asking a close-ended question: ‘During the COVID-19 lockdown, on average my meal size was: (1) Decreased, (2) Not changed, (3) Increased’. Similarly, the changes in appetite were also measured using a fixed-choice question: ‘During the COVID-19 lockdown, on average my appetite was: (1) Worse than before, (2) Poorer than before, (3) Not changed, (4) Better than before, and (5) Don’t know’.

2.4. Data analysis

Frequencies and percentages were used to interpret the descriptive characteristics of study participants. A Chi-square test was performed to identify the association between outcome and independent variables. In the univariable analyses, the effect of the independent variables on the diet quality of university students was estimated by simple logistic regression analysis (Block-0). Multivariable logistic regression models were also employed using three Blocks. In Block-1 (demographic characteristics), we included sex, age, education level, study course, residence, and living situation during the lockdown. In Block-2 (health and lifestyle characteristics), we included smoking status, physical activity level and change during the lockdown, average sleep time a day and its changes during the lockdown, alcohol use, changes in meal size, and appetite. In Block-3, all the demographic variables, living situation, health and lifestyle characteristics, and their changes during the COVID-19 lockdown were included. The crude and adjusted odds ratios are demonstrated with 95% confidence interval (95% CI). Multicollinearity among variables for each model was checked using variance inflation factors (VIF) and tolerance values. We also performed mediation analysis to identify the indirect effect of depressive symptoms on diet quality through anxiety symptoms as well as the indirect effect of anxiety symptoms on diet quality through

depressive symptoms. The mediation pathway has been shown in **Figure 2**. For data analysis, we used the statistical package STATA (version 16.0) and SPSS (version 23.0).

2.5. Ethical approval

The study was conducted in accordance with the guidelines of the Helsinki declaration. The study protocol was reviewed and approved by the Institutional Human Ethics Committee (IHEC) of the University of Mysore (Approval no: IHEC–UOM No. 80/M.Sc./2020-21).

3. Results

A total of 440 university students were included in this study. Of the total participants, the majority were females (54.8%), aged between 18 to 25 years (96.4%), postgraduate students (63.2%), and were studying business and law courses (52.3%). Moreover, the majority resided in semi-urban and urban areas (71.4%), lived with their families (80.5%). In the present study, we found that 61.1% (95% Confidence Interval [95% CI]: 56.6% to 65.7%) of university students had good diet quality, as shown in **Table 1**.

Regarding health and lifestyle characteristics, the majority of the respondents were non-smokers (88.2%) and did not drink alcohol (73.2%). More than half of the respondents were engaged in moderate physical activity (58.2%) and 51.4% reported a change in their physical activity during the COVID-19 lockdown. Almost half of the participants (49.1%) reported that their average sleep duration was long (> 8 hours a day) and 44.3% reported an increase in their average sleep duration. Most of the participants (73.2%) never used alcohol and about 30.2% of students reported that their meal sizes were decreased during the lockdown period. In the present study, 26.8% of respondents had depressive symptoms, while 22.9% of participants were found to have anxiety symptoms (**Table 2**).

Table 3 represents the detailed results of four different blocks of logistic regression. The unadjusted model has been shown in Block-0, where sex, study course, residence, change in sleep duration, change in meal size, change in appetite, depressive symptoms and anxiety symptoms were the initial factors significantly associated with good diet quality. While only the socio-demographic factors were adjusted in Block-I, study course and residence have remained as significant factors. When the variables related to health and lifestyle and their changes during the COVID-19 lockdown were adjusted in Block-2, change in sleep duration, change in appetite, depressive and anxiety symptoms were found to be significant factors associated with good diet quality. These were just to present the variables that were significant in Block-1 and Block-2, to estimate how those variables are modified to each other in the final model (Block-3; **Table 3**).

In the final model (Block-3), all the variables (socio-demographic, health, and lifestyle characteristics) were included at the same time. After adjusting all the variables, education level, study course, residence, change in sleep duration, change in appetite, depressive symptoms, and anxiety symptoms were found to be significant factors associated with good diet quality. Postgraduate students were 42% less likely to have good diet quality (adjusted odds ratio [AOR] = 0.42, 95% Confidence Interval [CI]: 0.24 to 0.73) compared to undergraduate students. Participants from arts/social science, and other courses were 35% (AOR = 0.35, 95% CI: 0.16 to 0.81) and 18% (AOR = 0.18, 95% CI: 0.07 to 0.49), respectively, less likely to have good diet quality compared to their counterparts from science/engineering courses. Compared to participants residing in rural areas, those in urban areas were 93% more likely to have good diet quality (AOR = 1.93, 95% CI: 1.13 to 3.31), while those with no change in their sleep duration were 2.45 times more likely to have good diet quality compared to those with decreased sleep duration (AOR = 2.45, 95% CI: 1.26 to 4.77). Similarly, participants with no change in their appetite and those with

better-than-before appetite were 7.53 times (AOR = 7.53, 95% CI: 2.56 to 16.34) and 12.98 times (AOR = 12.98, 95% CI: 5.63 to 18.0), respectively, more likely to have good diet quality compared to those with worse appetite than before. Lastly, participants with no depressive (AOR = 2.15, 95% CI: 1.20 to 3.84) and anxiety symptoms (AOR = 1.96, 95% CI: 1.07 to 3.59) were 2.15 times and 1.96 times higher odds of having good diet quality compared to those who had depressive and anxiety symptoms, respectively (**Table 3**).

Table 4 shows the results of mediation analysis among depressive symptoms, anxiety symptoms, and diet quality of the study participants. Depressive symptoms ($p = 0.003$) and anxiety symptoms ($p = 0.042$) had significant direct effect on diet quality. Similarly, there were significant indirect effects of depressive symptoms mediating through anxiety symptoms ($p = 0.045$), and that of anxiety symptoms mediating through depressive symptoms ($p = 0.004$). Total effects of depressive symptoms and anxiety symptoms on diet quality were also found to be significant ($p < 0.001$) in the mediation analysis.

4. Discussion

Due to COVID 19 mental health has been impacted globally among all people. Eating behaviors like over and under-eating and others are being triggered by stress, anxiety, and depression (Coakley et al., 2021). Our study aimed to identify the association of depressive and anxiety symptoms with diet quality.

We found that about 61.1% of the students have had good diet quality during the COVID-19 pandemic, and this was further associated with urban residents, postgraduate students, and doing arts/social science courses. Our result is consistent with the literature as postgraduate, older students, and living in urban areas are more likely to be informed, have better living conditions, and have greater access to food. Due to greater disruptions to their university routines, spending

more than the usual time at home younger students and undergraduates are more likely to have moderate or severe anxiety as compared to older postgraduate students, resulting in anxiety and stress, as compared to their postgraduate counterparts, who were able to still complete some level of work during the lockdown (Antunes et al., 2020; Deci and Ryan, 2000). The transition from in-person lectures to online classes, postponement of semesters, not having access to academic institution libraries, new methods of assessment, adjusted examinations, and alternate communication mediums for administrative and lecturer support further compounded the academic life of undergraduate students that heavily influenced their emotional wellbeing and mental health (Cao et al., 2020; Gonzalez et al., 2020; Kamarianos et al., 2020). As students were studying at home, they were less likely to skip meals, ate proper home-cooked meals, had time to eat more healthily, and therefore escaped the food insecurity at college (Son et al., 2020; Wattick et al., 2018).

While literature indicates that students from the arts/social sciences performed better academically during the pandemic than those in science/engineering due to theoretical lessons replaced by written documents and multimedia classes as compared to science/engineering that faced difficulty in terms of practical sessions that were predominantly lab-based and required hands-on learning (Aristovnik et al., 2020; Gonzalez et al., 2020), our study also found the similar findings. This may be due to students in science and engineering having greater exposure to nutrition-related information as part of their work. Evidence from previous studies (Lipson et al., 2016; Odrizola-González et al., 2020) indicated that students from the arts had a substantial tendency to develop mental illnesses as compared to students studying engineering and business. This also is attributed to students not having any previous experience that could have been used as a reference as part of the learning process. Thus, they worked through their learning challenges to not miss any

important work and assessment as they were afraid of the COVID-19 pandemic confinement halting their academic year and work schedule (Gonzalez et al., 2020).

Regarding health and lifestyle, without any changes in sleep duration, meal size, appetite, the residence(urban/rural) and anxiety or depression all were associated with a good diet quality. The link between mental health and dietary intake is consistent in various studies (Meegan et al., 2017; Ohmori et al., 2017; Stefańska et al., 2014), with lower healthy food intake and higher food insecurity rates indicating an increase in anxiety and depression. Those with greater stress and anxiety levels tend to not follow careful food selection, eat larger quantities and more than they need to, thus regulating emotions via food (Braden et al., 2018; Schneider et al., 2012). As previously mentioned, those spending more time at home are more likely to make informed food choices, had adequate time for cooking, and did not have to skip meals (Son et al., 2020; Wattick et al., 2018). Thus, if diet was well maintained, it would more likely impact mood and state of mind positively.

Students in urban areas are more likely to have greater access to food and digital platforms as compared to their rural counterparts. In the transition from onsite to virtual learning, the infrastructure required for home studying possess a challenge for students in rural areas as they have limited study space at the home, with limited or no access to the internet (Adnan and Anwar, 2020; Owusu-Fordjour et al., 2020). This highlights the major differences in digital equipment availability and acquiring of computer skills between students from developed and developing countries, especially in rural areas, due to the very quick transition to virtual learning, that did not allow students without experience to have the confidence and assistance to gain such skills (Demuyakor, 2020; Owusu-Fordjour et al., 2020).

Regarding sleep duration, our study is consistent with the literature that indicates sleep patterns being maintained (Antunes et al., 2020; Son et al., 2020). This may be attributed to students staying and learning at home and not having to travel out. Creating their own learning and work schedules also allowed students to maintain sleep habits (Antunes et al., 2020). Furthermore, the sleep-wake-cycle and quality of sleep is related to meal timing. If meals are eaten at regular intervals, with correct food choices, it is more likely to impact the quality of sleep positively as metabolic and physiological processes respond accordingly based on the circadian rhythm (Hawley et al., 2020; Theodoro et al., 2021).

The association between mental health and diet is well established (Stevenson, 2017). Lower depressive and anxiety symptoms have been linked to healthier diets. In contrast, western diets have been closely associated with greater risks of anxiety and depression (Dipnall et al., 2015; Nanri et al., 2013). Depressed individuals are more likely to consume a greater amount of calories, have poorer quality of diet, and have a higher body mass index (BMI) (Flórez et al., 2015). The increasing level of mental health disorders in college students is a global concern. The majority of the students are undergraduates, who are more prone to mental health disorders. The undergraduate stage is a critical stage of transition as they become more independent, take on more responsibility, and are involved in decision-making. Due to academic demands, increased workloads, self-directed learning, as well as combined environmental, social, and academic changes, undergraduates, as well as postgraduates have faced the greater challenge of stress, anxiety, and depression (Aluh et al., 2020). Food intake can impact the regulation of emotions and mood, thereby affecting food choices, resulting in a bidirectional influence on diet quality. A mutual connection exists between poor nutrition and low mood, and vice versa. The quality of the diet can be impacted by different psychological states or stressful conditions. Therefore, the link between

diet quality and mental health outcomes offers an evidence base for the prevention of anxiety and depression through targeted dietary interventions (Lassale et al., 2019).

5. Limitations

The first limitation of this study is its cross-sectional nature in design; thus, any causal relationship cannot be identified, and the study was conducted at one academic institution and its affiliated colleges. Hence, the longitudinal study can investigate the long-term impact of the pandemic on anxiety and depression with diet quality. To extend and generalize the findings, large-scale surveys should be conducted in various universities in India. All data were self-reported, and a systematic clinical evaluation would provide a better assessment of anxiety and depression. Self-reporting may include social desirability and recall bias, whereby under-and overestimation occurred regarding participant perception of some lifestyle aspects during the COVID-19 pandemic.

6. Conclusions

The study collected data on a university population that is often left out despite the associated risks for poor health, access to nutritious food, high levels of stress, anxiety, and/or depression, as well as low socio-economic status. Our study results indicated that change in sleep duration, appetite, residence, study course, education level, depressive symptoms and anxiety symptoms were significantly associated with diet quality. The results indicate that good diet quality is a modifiable factor closely associated with mental health and improving such factors (diet and lifestyle) can result in good mental health. Furthermore, psychological factors play a significant role in the wellbeing and quality of life of this population group. It is therefore imperative that intervention strategies are developed and implemented for the promotion of wellbeing and quality of life during the pandemic so that diet quality is maintained. The study findings call for greater collaboration between higher education and other stakeholders, with context-specific and targeted interventions,

paying careful attention to this vulnerable, and often missed population group. There is also a need for the provision of mental health support services during times of confinement so that good diet quality can be maintained. The study findings are important for university students in general, and encourages more studies within the local context for the promotion of good diet and mental health in young adults.

CRedit authorship contribution statement

Satyajit Kundu: Conceptualization, methodology, writing manuscript, formal analysis, and critical review & editing; **Najneen Rejwana:** literature search, writing manuscript, review & editing; **Joseph Kawuki:** original draft writing, review & editing; **Susmita Ghosh:** Literature search, writing manuscript, review & editing; **Najim Z. Alshahrani:** Review and editing, validation; **Subarna Kundu:** Literature search, writing manuscript; **Natisha Dukhi:** Critical review, editing and writing manuscript; **Md. Hasan Al Banna:** Analyze and interpretation of data, critical review, editing and writing manuscript during revision; **Suttur S Malini:** Conceptualization, review & editing. All authors gave final approval of the version to be published.

Declaration of Competing Interest

None.

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Table 1: *Distribution of diet quality across different socio-demographic characteristics of study participants during the COVID-19 pandemic in India (N = 440)*

Characteristics	Categories	Total; n (%)	Diet quality		p values
			Poor; n (%)	Good; n (%)	
Sex	Male	199 (45.2)	67 (33.7)	132 (66.3)	0.042
	Female	241 (54.8)	104 (43.2)	137 (56.9)	
Age in years	18-21	228 (51.8)	100 (43.7)	128 (56.1)	0.037*
	22-25	196 (44.6)	68 (34.7)	128 (65.3)	
	> 25	16 (3.6)	3 (18.8)	13 (81.2)	
Education level	Under-graduate	162 (36.8)	60 (37.0)	102 (63.0)	0.548
	Post-graduate	278 (63.2)	96 (34.5)	182 (65.5)	
Study course	Science/engineering	115 (26.1)	40 (34.8)	75 (65.2)	0.009
	Arts/social science	68 (15.5)	35 (51.5)	33 (48.5)	
	Business and law	230 (52.3)	80 (34.8)	150 (65.2)	
	Others [#]	27 (6.1)	16 (59.3)	11 (40.7)	
Residence	Rural	126 (28.6)	63 (50.0)	63 (50.0)	0.010
	Semi-urban	87 (19.8)	31 (35.6)	56 (64.4)	
	Urban	227 (51.6)	77 (33.9)	150 (66.1)	
Living situation during lockdown	Alone	21 (4.8)	8 (38.1)	13 (61.9)	0.970
	With partner	27 (6.1)	11 (40.7)	16 (59.3)	
	With family	354 (80.5)	136 (38.4)	218 (61.6)	
	With friends/others	38 (8.6)	16 (42.1)	22 (57.9)	
Diet quality	Poor	171 (38.9)	-	-	-
	Good	269 (61.1)	-	-	
# Others included humanity and education					
* p-value was obtained from Fisher’s Exact test					
- Bolded p values indicate the statistical significance					

Table 2: Health and lifestyle characteristics and their changes during the COVID-19 lockdown of study participants ($N = 440$)

Characteristics	Categories	Total; n (%)	Diet quality		p values
			Poor; n (%)	Good; n (%)	
Smoking status	More than before	21 (4.8)	7 (33.3)	14 (66.7)	0.926*
	Less than before	15 (3.4)	7 (46.7)	8 (53.3)	
	Same as before	7 (1.6)	3 (42.9)	4 (57.1)	
	Quit smoking	9 (2.1)	4 (44.4)	5 (55.6)	
	Don't smoke	388 (88.2)	150 (38.7)	238 (61.3)	
Level of physical activity	Low (0.5 h/day)	126 (28.6)	53 (42.1)	73 (57.9)	0.641
	Moderate (0.5–2 h/day)	256 (58.2)	95 (37.1)	161 (62.9)	
	High (> 2 h/day)	58 (13.2)	23 (39.7)	35 (60.3)	
Changes in physical activity	Decreased	109 (24.8)	39 (35.8)	70 (64.2)	0.739
	No change	214 (48.6)	86 (40.2)	128 (59.8)	
	Increased	117 (26.6)	46 (39.3)	71 (60.7)	
Sleep duration	Short (< 6 h/day)	43 (9.8)	16 (37.2)	27 (62.8)	0.277
	Normal (6–8 h/day)	181 (41.1)	63 (34.8)	118 (65.2)	
	Long (> 8 h/day)	216 (49.1)	92 (42.6)	124 (57.4)	
Changes in sleep duration	Decreased	95 (21.6)	45 (47.4)	50 (52.6)	0.023
	No change	150 (34.1)	46 (30.7)	104 (69.3)	
	Increased	195 (44.3)	80 (41.0)	115 (59.0)	
Alcohol use	Never	322 (73.2)	131 (40.7)	191 (59.3)	0.433
	Monthly or less	68 (15.5)	23 (33.8)	45 (66.2)	
	≥ 2 times a month	50 (11.4)	17 (34.0)	33 (66.0)	
Meal size	Decreased	133 (30.2)	60 (45.1)	73 (54.9)	0.017
	No change	210 (47.7)	67 (31.9)	143 (68.1)	
	Increased	97 (22.1)	44 (45.4)	53 (54.6)	
Appetite	Worse than before	14 (3.2)	11 (78.6)	3 (21.4)	0.000
	Poorer than before	88 (20.0)	47 (53.4)	41 (46.6)	
	No change	204 (46.4)	66 (32.4)	138 (67.6)	
	Better than before	90 (20.5)	25 (27.8)	65 (72.2)	
	Don't know	44 (10.0)	22 (50.0)	22 (50.0)	
Depressive symptoms	Yes	118 (26.8)	66 (55.9)	52 (44.1)	0.000
	No	322 (73.2)	105 (32.6)	217 (67.4)	
Anxiety symptoms	Yes	101 (22.9)	56 (55.5)	45 (44.5)	0.000
	No	339 (77.1)	115 (33.9)	224 (66.1)	
* p-value was obtained from Fisher's Exact test Bolded p values indicate the statistical significance					

Table 3: *Different models of regression analysis showing the factors associated with good diet quality of study participants*

Variables	Block-0	Block-1	Block-2	Block-3
	COR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Socio-demographic characteristics				
Sex				
Male	1.50* (1.01, 2.21)	1.29 (0.83, 1.99)		1.21 (0.72, 2.04)
Female	Ref	Ref		Ref
Age in years				
18-21	Ref	Ref		Ref
22-25	1.47 (0.99, 2.18)	1.52 (0.97, 2.41)		1.72 (1.03, 2.87)
> 25	3.39 (0.94, 12.20)	3.28 (0.85, 12.68)		3.59 (0.80, 16.09)
Education level				
Under-graduate	Ref	Ref		Ref
Post-graduate	1.89 (1.59, 2.32)	1.62 (1.38, 2.01)		1.42** (1.24, 2.73)
Study course				
Science/engineering	Ref	Ref		Ref
Arts/social science	0.50* (0.27, 0.93)	0.51 (0.26, 1.02)		0.35* (0.16, 0.81)
Business and law	1.0 (0.63, 1.60)	0.89 (0.52, 1.50)		0.92 (0.51, 1.68)
Others [#]	0.37* (0.16, 0.86)	0.29** (0.12, 0.71)		0.18** (0.07, 0.49)
Residence				
Rural	Ref	Ref		Ref
Semi-urban	1.81* (1.03, 3.16)	1.52 (0.83, 2.78)		1.42 (0.72, 2.82)
Urban	1.95** (1.25, 3.04)	1.74* (1.08, 2.80)		1.93* (1.13, 3.31)
Living situation				
Alone	Ref	Ref		Ref
With partner	0.90 (0.28, 2.88)	1.48 (0.42, 5.13)		1.63 (0.39, 6.84)
With family	0.99 (0.40, 2.44)	1.35 (0.51, 3.56)		1.27 (0.41, 3.92)
With friends/others	0.85 (0.28, 2.52)	0.84 (0.27, 2.62)		1.47 (0.39, 5.60)
Health and lifestyle characteristics and their changes during the COVID-19 lockdown				
Smoking status				
More than before	Ref		Ref	Ref
Less than before	0.57 (0.15, 2.23)		0.46 (0.10, 2.10)	0.36 (0.07, 1.81)
Same as before	0.67 (0.12, 3.84)		0.60 (0.09, 4.02)	0.39 (0.05, 2.72)
Quit smoking	0.63 (0.13, 3.09)		0.66 (0.11, 3.81)	0.48 (0.08, 3.01)
Don't smoke	0.79 (0.31, 2.01)		0.99 (0.36, 2.80)	0.90 (0.29, 2.76)
Level of physical activity				
Low (0.5 h/day)	Ref		Ref	Ref
Moderate (0.5–2 h/day)	1.23 (0.80, 1.90)		0.90 (0.54, 1.48)	1.19 (0.69, 2.06)
High (> 2 h/day)	1.10 (0.59, 2.08)		1.04 (0.50, 2.15)	1.22 (0.56, 2.66)
Changes in physical activity				
Decreased	Ref		Ref	Ref
No change	0.83 (0.51, 1.34)		0.84 (0.49, 1.43)	0.95 (0.54, 1.68)
Increased	0.86 (0.50, 1.47)		0.69 (0.37, 1.27)	0.67 (0.35, 1.29)
Sleep duration				
Short (< 6 h/day)	Ref		Ref	Ref

Normal (6–8 h/day)	1.11 (0.56, 2.21)		0.99 (0.46, 2.15)	1.29 (0.56, 2.96)
Long (> 8 h/day)	0.80 (0.41, 1.57)		0.83 (0.38, 1.82)	1.14 (0.49, 2.68)
Changes in sleep duration				
Decreased	Ref		Ref	Ref
No change	2.03** (1.20, 3.46)		1.96* (1.06, 3.64)	2.45** (1.26, 4.77)
Increased	1.29 (0.79, 2.12)		1.39 (0.77, 2.50)	1.61 (0.86, 3.00)
Alcohol use				
Never	Ref		Ref	Ref
Monthly or less	1.34 (0.77, 2.32)		1.39 (0.75, 2.56)	1.03 (0.52, 2.03)
≥ 2 times a month	1.33 (0.71, 2.49)		1.34 (0.64, 2.81)	0.82 (0.37, 1.83)
Meal size				
Decreased	Ref		Ref	Ref
No change	1.75* (1.12, 2.75)		0.85 (0.47, 1.56)	0.78 (0.41, 1.49)
Increased	0.99 (0.59, 1.67)		0.67 (0.35, 1.28)	0.59 (0.29, 1.17)
Appetite				
Worse than before	Ref		Ref	Ref
Poorer than before	3.20 (0.83, 12.26)		2.88 (0.67, 12.36)	3.73 (0.78, 17.74)
No change	7.67** (2.07, 10.41)		6.44* (2.47, 11.18)	7.53* (2.56, 16.34)
Better than before	9.53** (5.45, 17.05)		9.73** (5.18, 17.47)	12.98** (5.63, 18.0)
Don't know	3.67 (0.90, 14.97)		3.18 (0.68, 14.90)	2.91 (0.57, 14.72)
Depressive symptoms				
Yes	Ref		Ref	Ref
No	2.62*** (1.70, 4.04)		1.82* (1.07, 3.10)	2.15** (1.20, 3.84)
Anxiety symptoms				
Yes	Ref		Ref	Ref
No	2.42*** (1.54, 3.81)		1.79* (1.02, 3.12)	1.96* (1.07, 3.59)
Goodness-of-fit test				
LR chi ² (p value)		29.71 (0.003)	57.98 (0.000)	95.72 (0.000)
Hosmer-Lemeshow chi ² (p-value)		3.30 (0.914)	7.41 (0.116)	13.53 (0.095)
<p>*p<0.05; **p<0.01; ***p<0.001</p> <p># Others included humanity and education</p> <p>Bolded values indicate the statistical significance</p> <p>Note. COR=Crude Odds Ratio; AOR=Adjusted Odds Ratio; CI=Confidence Interval</p>				

Table 4: *Result of the mediation analysis (N = 440)*

Effect of the factors	Coefficient	SE	z	p	95% CI
Direct effect					
Direct effect of depressive symptoms on diet quality (a path)	0.18	0.06	3.00	0.003**	0.06, 0.29
Direct effect of anxiety symptoms on diet quality (b path)	0.13	0.06	2.04	0.042*	0.004, 0.25
Direct effect of depressive symptoms on anxiety symptoms (c path)	0.46	0.04	11.69	0.000***	0.38, 0.54
Direct effect of anxiety symptoms on depressive symptoms (e path)	0.51	0.04	11.69	0.000***	0.43, 0.60
Indirect effect					
Indirect effect of depressive symptoms on diet quality through anxiety symptoms (cd path)	0.06	0.03	2.01	0.045*	0.001, 0.11
Indirect effect of anxiety symptoms on diet quality through depressive symptoms (ef path)	0.09	0.03	2.91	0.004**	0.03, 0.15
Total effect					
Total effect of depressive symptoms on diet quality	0.23	0.05	4.55	0.000***	0.13, 0.33
Total effect of anxiety symptoms on diet quality	0.22	0.05	3.96	0.000***	0.11, 0.32
*p<0.05; **p<0.01; ***p<0.001 Note. SE=Standard Error; CI=Confidence Interval

Figure 1: *Geographical location of the study area*

Figure 2: Mediation analysis of depressive and anxiety symptoms on diet quality of participants.

a = Direct effect of depressive symptoms on diet quality

b = Direct effect of anxiety symptoms on diet quality

cd = Indirect effect of depressive symptoms on diet quality through anxiety symptoms (cd path)

ef = Indirect effect of anxiety symptoms on diet quality through depressive symptoms (ef path)