Original Paper

Impacts of COVID-19 on Modifiable Lifestyle Behaviors and Associations With Mental Well-Being Among Medical Students and Health Care Workers in Vietnam: Cross-Sectional Online Survey

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Abstract

Background: The COVID-19 pandemic has disrupted daily life and mental health globally; yet, little is known about how multiple modifiable lifestyle behaviors shape psychological outcomes among young health-affiliated populations in low- and middle-income settings such as Vietnam.

Objective: This study aimed to examine changes in modifiable lifestyle behaviors during the COVID-19 pandemic and their associations with depression, anxiety, and perceived stress among medical students and health care workers in Vietnam, most of whom were young people aged 16 to 20 years.

Methods: A cross-sectional online survey was conducted from September to November 2021 among 817 medical students and health care workers recruited through medical universities and health care facilities across Vietnam using snowball sampling. The sample was predominantly young, with 72.5% (591/815) aged 16 to 20 years, and 68.8% (558/811) were female individuals. This period captured the late Delta-driven fourth wave and Vietnam's transition from heterogeneous local restrictions to "safe and flexible adaptation," when daily routines, mobility, online learning/work, and mental well-being remained disrupted. The questionnaire assessed demographics, 14 lifestyle behaviors grouped into positive, diet/media-related, substance use, and violence-related domains, alongside validated Vietnamese-language measures of depression (Patient Health Questionnaire-9 [PHQ-9]), anxiety (Generalized Anxiety Disorder-7 [GAD-7]), and stress (Perceived Stress Scale-4 [PSS-4]). Separate multivariable Tobit regression models were applied to account for bounded-scale outcomes with potential floor effects. Results are reported as unstandardized coefficients with 95% CIs.

Results: High stress was common (n=522, 63.9%; mean PSS-4 6.9, SD 2.2). Mean PHQ-9 and GAD-7 scores were 5.2 (SD 4.7) and 3.1 (SD 3.6), respectively, and participants with higher stress had higher PHQ-9 and GAD-7 scores than those with lower stress (both P<.001). Central and Southern participants reported significantly higher scores than those in the North (Central: coefficient 0.47, 95% CI 0.06-0.87 and Southern: coefficient 0.53, 95% CI 0.17-0.88). Positive behaviors correlated

with lower anxiety (coefficient –0.31, 95% CI –0.59 to –0.03) and stress (coefficient –0.36, 95% CI –0.48 to –0.24). By contrast, diet/media-related negative behaviors were associated with higher depression, anxiety, and stress (coefficient range 0.18-1.10), while violence-related behaviors showed similar adverse associations across all 3 outcomes (coefficient range 0.13-0.56).

Conclusions: Lifestyle behaviors were associated with mental well-being under pandemic conditions among a predominantly young, health-affiliated sample in Vietnam. Because participants were recruited through an online snowball-sampling approach and were largely affiliated with medical universities or health care facilities, the findings should be interpreted as context-specific evidence rather than as estimates for the general Vietnamese adult population. Public health responses, particularly in educational and health-related settings, should incorporate behavior-focused strategies, promoting healthy routines, balanced diets, constructive digital use, and nonviolent coping to strengthen resilience in future crises.

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Introduction

The COVID-19 pandemic has caused profound disruptions in daily routines worldwide, exerting wide-ranging consequences on individual well-being, social habits, and public health. While the primary public health concern focused on reducing viral transmission, the secondary consequences of prolonged lockdowns, physical distancing, and economic uncertainty are increasingly evident in the form of mental distress and disrupted lifestyle behaviors [1,2]. As early as mid-2020, researchers began documenting elevated rates of depression, anxiety, and sleep disorders globally, symptoms no longer confined to those infected, but extending to the general public [3,4]. Those global estimates also suggested that the prevalence of depression and anxiety increased by more than 25% during the first year of the pandemic, with Southeast Asia among the regions most heavily affected. These findings underscore the scale of the crisis and the urgency of identifying behavioral pathways that could mitigate its mental health burden.

Amid these psychological stressors, attention has increasingly turned to modifiable lifestyle behaviors as both mediators and consequences of mental health changes during the pandemic. These behaviors are understood as daily practices that individuals can consciously change, such as physical activity, diet, sleep, media consumption, and substance use. Research from multiple countries indicates that decreases in physical activity, elevated screen time, dietary disruptions, and irregular sleep patterns were closely linked with heightened psychological distress [5,6]. For instance, a cross-sectional study in mainland China revealed that reductions in physical activity and healthy eating were strongly associated with lower levels of subjective well-being [7]. Similarly, data from the English Longitudinal Study of Ageing revealed that composite unhealthy lifestyles, spanning BMI, sleep, smoking, and physical inactivity, exacerbated depressive symptoms and anxiety during lockdowns, particularly among socioeconomically deprived groups [8]. However, these findings largely emerge from high-income, digitally connected nations, potentially limiting their applicability to low- and middle-income countries.

Vietnam presents a markedly different context, one that is epidemiologically, culturally, and demographically distinct. After initial success in suppressing early outbreaks, the country faced a prolonged fourth wave of community transmission. Culturally distinct lifestyle patterns, variable access to digital resources, and evolving urban-rural health disparities may yield different behavioral responses to the same structural disruptions. Despite growing attention to mental health in the Vietnamese context, existing studies have primarily focused on high-risk populations such as health care workers or students [9,10]. However, the research gap remains more specific: limited evidence is available on how multiple modifiable lifestyle behaviors are jointly associated with depression, anxiety, and stress among young health-affiliated populations in Vietnam during the pandemic. Most Vietnamese studies have examined mental health outcomes alone or have focused on selected behavioral factors, such as healthy eating, physical activity, smoking, health literacy, or online learning conditions, rather than applying an integrated behavioral framework covering physical activity, diet, sleep, media use, substance use, and violence-related behaviors [11-13]. Therefore, evidence from young people studying or working in medical universities and health facilities is important for understanding lifestyle-related mental health patterns in a specific health-affiliated population during Vietnam's pandemic response, although such evidence should not be interpreted as representative of the Vietnamese general population. Understanding these behavioral determinants in Vietnam, a lower-middle–income country with unique cultural and demographic characteristics, is critical for designing context-specific interventions and enriching the global discourse on pandemic mental health.

To address these gaps, this study examines the impact of COVID-19 on modifiable lifestyle behaviors and their associations with mental well-being among medical students and health care workers in Vietnam during the fourth COVID-19 wave. Using a composite behavioral framework, we assessed subjective well-being together with depressive and anxiety symptoms to provide a more integrated view of behavioral health during the crisis. By focusing on a predominantly young, health-affiliated sample, this study contributes evidence on a population directly exposed to disrupted training, online learning or work, health-system

pressures, and pandemic-related information during a critical transition period in Vietnam's COVID-19 response. The findings should therefore be interpreted as context-specific evidence from medical students and health care workers rather than as estimates for Vietnamese adults nationwide.

Methods

Study Design and Sampling Methods

This cross-sectional online survey was conducted from September to November 2021, during Vietnam's fourth COVID-19 wave affecting Hanoi, Ho Chi Minh City, and several provinces. The study period was chosen not because lockdowns were uniformly implemented nationwide, but because it represented a particularly relevant transition phase of the pandemic in Vietnam. During this period, many localities were still experiencing the cumulative effects of prolonged distancing measures, while others were gradually shifting toward reopening and risk-based management under the national "safe and flexible adaptation" strategy introduced in October 2021 [14,15]. Therefore, September to November 2021 provided an appropriate window to examine lifestyle and mental health changes under conditions of heterogeneous restrictions, continuing uncertainty, online learning/work, and altered daily routines. Respondents were recruited using snowball sampling. The recruitment setting was online and centered on health-related educational and occupational networks in Vietnam, including medical universities, health care facilities, and professional or youth networks linked to the Vietnam Young Physicians Association (VYPA). The questionnaire was piloted with 15 staff of the VYPA, revised, and then distributed to an initial group of 20 individuals before wider circulation. The initial seeds were purposively selected from the investigators' professional networks and the VYPA, including individuals affiliated with medical universities and health care facilities. All initial seeds received the same online invitation message, which briefly described the study purpose, eligibility criteria, voluntary participation, confidentiality, approximate completion time, and survey link. They were asked to forward this same invitation to eligible peers, students, colleagues, and professional or youth-network contacts who were studying or working in medical universities or health care facilities. Participants who accessed the link reviewed the study information and provided electronic informed consent before completing the questionnaire. Therefore, the snowball process was expected to propagate primarily within health-related networks, which is consistent with the young and health-affiliated composition of the final sample. Because recruitment was web-based and network-driven, this sampling approach may have favored individuals with internet access, digital literacy, and connections to medical universities, health care facilities, youth union networks, or health-professional networks. Therefore, the resulting sample should be interpreted as a nonprobability, predominantly young, health-affiliated sample rather than a representative sample of Vietnamese adults. Completion time averaged 30 minutes, and participants could withdraw at any point. Data were collected and managed through the SurveyMonkey platform.

Participants

Eligibility criteria included the following: (1) age 16 years or older, (2) willingness to provide informed consent, (3) employment or study at medical universities or health facilities nationwide, (4) ability to access the survey link and complete the questionnaire, and (5) familiarity with online communication tools to ensure survey completion.

Among the 817 individuals who accessed the survey, 744 fully completed the questionnaire, resulting in a completion rate of 91.1%.

Measurements

Data were collected using a structured questionnaire that comprised three principal components: (1) sociodemographic characteristics, (2) modifiable lifestyle behaviors, and (3) psychological status, assessed through Vietnamese-language versions of validated tools, including the Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder-7 (GAD-7), and Perceived Stress Scale-4 (PSS-4) scales. All psychological measures were administered in Vietnamese. The Vietnamese PHQ-9 and GAD-7 have been previously translated, culturally adapted, and/or validated in Vietnamese populations, including health-related or clinical samples. For perceived stress, the PSS-4 items were used in Vietnamese, based on the Vietnamese PSS instrument, for which prior psychometric evidence is available. Internal consistency of all 3 psychological measures was further examined in the present sample. The finalized questionnaire was hosted on the SurveyMonkey platform [16], chosen for its accessibility, cost-effectiveness, and suitability for contactless data collection during periods of social distancing.

Variables

Outcome Variables

Modifiable Lifestyle Behaviors

Data on lifestyle practices were collected using 14 items. These items were developed for this study to capture pandemic-related changes in common modifiable behaviors that were considered relevant to mental well-being, based on prior COVID-19 lifestyle and mental health literature and the public health relevance of behaviors such as physical activity, sleep, diet, screen/media use, substance use, and violence-related experiences. The items were not adapted verbatim from a single validated lifestyle inventory; rather, they were designed as a pragmatic behavior-change checklist, reviewed by the research team, and refined after pilot testing with 15 staff members of the VYPA. Participants were asked to report how each behavior changed during the COVID-19 period compared with the prepandemic period. Therefore, the 8-point response scale should be interpreted primarily as a perceived change scale rather than a pure frequency scale. The response options ranged from "never/not practiced" to "increased by more than 50%." In this context, "never" indicated that the participant did not engage in that behavior

during the reference period and was treated as the lowest response category, whereas higher scores indicated greater increases or higher engagement during the pandemic. Items were grouped into 4 domains: positive health-promoting behaviors (5 items), diet- and media-related risks (4 items), substance use (3 items), and violence-related behaviors (2 items). Domain scores ranged from 1 to 8, with higher scores indicating greater frequency or intensity. Reliability was acceptable to good, with Cronbach α values of 0.7428, 0.7503, 0.6352, and 0.7770 for the 4 domains, respectively. The factor structure and reliability results are reported in the *Results* section.

Depression Severity

PHQ-9 (9 Items)

The PHQ-9 was used to assess depressive symptoms over the past 2 weeks. The Vietnamese-language version was administered in this study. Previous studies have supported the reliability and validity of the Vietnamese PHQ-9 in Vietnamese populations, including medical students and clinical samples [17-19]. This 9-item PHQ-9 was used to assess depressive symptoms over the past 2 weeks. It reflects *DSM-IV* (*Diagnostic and Statistical Manual of Mental Disorders* [Fourth Edition]) criteria and captures both cognitive-affective and somatic dimensions while also screening for suicide risk. Items are rated on a 4-point scale (0=not at all to 3=nearly every day), with total scores ranging from 0 to 27. Higher scores indicate greater severity, and a cut-off of 10 and higher is widely applied to identify major depression, with both sensitivity and specificity of 88% [20]. In this study, internal consistency reliability was high (Cronbach α=0.8951).

GAD-7 Assessment

Anxiety symptoms were measured with the 7-item GAD-7, which screens for generalized anxiety disorder. The Vietnamese-language version was used. Prior evidence from Vietnam has supported the use of the GAD-7 as a valid screening measure for anxiety symptoms in clinical and high-risk populations [18], while the original GAD-7 study demonstrated good reliability and validity for screening generalized anxiety disorder and assessing symptom severity [21]. Items use the same 4-point scale as the PHQ-9, yielding total scores from 0 to 21. Higher scores reflect greater severity. The GAD-7 is also validated in adolescents, distinguishing mild from moderate symptoms [22,23]. Internal reliability in our sample was excellent (Cronbach α=0.9023).

PSS-4

Stress was assessed using the 4-item PSS-4. The Vietnamese-language PSS-4 items were used, based on the Vietnamese PSS instrument. Although Vietnamese psychometric evidence has mainly been reported for the PSS-10, prior work has supported the translation equivalence, construct validity, internal consistency reliability, and test-retest reliability of the Vietnamese PSS-10 [24]. The PSS-4 has also been supported as a brief measure of perceived stress in previous psychometric studies [25,26]. Therefore, the internal consistency of the PSS-4 was additionally evaluated in the present sample. The PSS-4 captures sense of control, ability to handle problems, perception of life events, and feelings of being overwhelmed. Items 1 and 4 were scored from 0 (never) to 4 (very often), while items 2 and 3 were reverse-coded. Total scores range from 0 to 16, with higher values indicating greater stress. For analysis, participants were grouped as low (<6) or high stress (≥6) [27]. Reliability of the PSS-4 in this study was acceptable (Cronbach α=0.7211).

Covariates: Sociodemographic Characteristics

Sociodemographic data included age, sex, marital status, residence (urban, town, or rural), household size, income, and geographic region (Northern, Central, and Southern Vietnam). The geographic variable was analyzed by region rather than by city.

Data Analysis

Statistical Procedures

All analyses were conducted using Stata (version 16; StataCorp). Descriptive analyses were conducted using available observations for each variable, with percentages calculated based on nonmissing responses. Accordingly, denominators varied across sociodemographic characteristics. For multivariable regression analyses, observations with missing data on variables included in the corresponding model were excluded using complete-case analysis (listwise deletion). Continuous variables are summarized as means with SDs, while categorical variables are expressed as frequencies and percentages. Age was categorized a priori into 3 groups: 16 to 20, 21 to 25, and more than 25 years to reflect developmental and educational/occupational stages within this predominantly young, health-affiliated sample. The 16- to 20-year group broadly represented late adolescence and early undergraduate training, while the 21- to 25-year group corresponded to emerging adulthood, a developmental period often characterized by transitions in education, work, autonomy, and health-related behaviors [28,29]. The more than 25-year group was combined because of its smaller size and because participants in this group were more likely to have more established health care roles. Differences between participants with low and high stress levels were examined using chi-square tests for categorical data and Wilcoxon-Mann-Whitney tests for continuous variables.

Reliability

Internal consistency was assessed through Cronbach α, with values of 0.70 and greater were considered acceptable [30]. Additional diagnostics included examination of domain-to-domain, item-to-item, and item-total correlations, as well as recalculated α coefficients after item deletion.

Factorial Structure

Exploratory factor analysis using principal component analysis was performed to evaluate the dimensionality of the modifiable lifestyle behavior scale. Factor retention was guided by scree plots, parallel analysis, eigenvalues, and the

proportion of variance explained [31]. Items with loadings of 0.40 or greater were retained. The final structure supported 4 domains: positive health behaviors (5 items), diet- and media-related risk behaviors (4 items), substance use (3 items), and violence-related behaviors (2 items).

Regression Modeling

To avoid ambiguity, we used separate multivariable Tobit regression models for each dependent variable; the term "multivariable" indicates that each model included multiple covariates, whereas outcomes were modeled separately rather than simultaneously. Potential covariates for models of lifestyle behaviors included individual characteristics, while models examining depression severity considered both individual characteristics and lifestyle behaviors. Multivariable Tobit regression was applied to identify factors associated with domain scores for lifestyle behaviors and with depression severity. It was selected because the dependent variables were bounded-scale scores. The lifestyle behavior domain scores were restricted to the 1 to 8 response range, while the PHQ-9, GAD-7, and PSS-4 scores were restricted to fixed lower and upper limits. These distributions were expected to show floor effects, particularly for anxiety symptoms, where a large proportion of participants were classified as having minimal anxiety. Because these models were intended to estimate associations rather than to develop or compare predictive models, emphasis was placed on regression coefficients, 95% CIs, and statistical significance rather than pseudo R^2 values, which can be difficult to interpret consistently across Tobit models with different bounded outcomes. Stepwise forward selection was used to refine the models, with P value less than .20 as the entry criterion. Statistical significance was set at P less than .05. For consistency between CIs and significance markings, coefficients were considered statistically significant only when the corresponding 95% CI did not include 0 at the 2-sided 5% level. Estimates with 95% CIs crossing 0 were retained in the tables but were not interpreted as statistically significant.

This manuscript was prepared with reference to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guideline for cross-sectional studies. The completed STROBE checklist is provided as Checklist 1.

Ethical Considerations

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of1975, as revised in 2000. The study protocol was approved by the Scientific Committee of the Youth Research Institute of the Ho Chi Minh Communist Youth Union (approval code: ĐT.KXĐTN 22-11). As this study involved human participants, the approved protocol covered online recruitment and survey-based data collection. Participation was voluntary. Before accessing the questionnaire, participants reviewed online study information describing the study purpose, eligibility criteria, confidentiality, voluntary participation, approximate completion time, and the right to withdraw before submission. Electronic informed consent was obtained from all participants before survey completion, in accordance with the approved study protocol. All data were anonymized and stored securely, and used exclusively for research purposes. No directly identifying information was included in the analytic dataset, and access to the data was restricted to the research team. Participants received no financial or material compensation for completing the survey.

Results

The study sample was predominantly young and drawn from health-related settings. Of the 817 participants, 72.5% (n=591) were aged 16 to 20 years, and 91.4% (n=745) were single, divorced, or widowed. Given the age distribution, the latter category was likely composed primarily of unmarried participants. Consequently, the findings mainly reflect the experiences of young medical students and health care workers rather than those of the general Vietnamese adult population. Approximately two-thirds of the participants were female. Just over half (434/816, 53.2%) resided in urban areas, while 57.7% (470/815) lived in households of 3 to 4 members. The highest proportion of participants reported both personal income and per capita household income below 5 million VND per month (US $1=VND 23,139 as of November 30, 2021). By region, respondents from the South accounted for the largest share (320/813, 39.4%), followed closely by those from the North (307/813, 37.8%). Table 1 summarizes the sociodemographic characteristics of participants, stratified by lower and higher perceived stress levels.

Table 1. Sociodemographic characteristics of medical students and health care workers in a cross-sectional online survey on COVID-19–related lifestyle behaviors and mental well-being in Vietnam, September to November 2021[a].

Characteristics	Perceived Stress Scale-4			
	Lower stress (n=295), n/N (%)	Higher stress (n=522), n/N (%)	Total (N=817), n/N (%)	*P* value
Age group[b] (y)				.15
16-20	212/295 (71.9)	379/520 (72.9)	591/815 (72.5)	
21-25	46/295 (15.6)	96/520 (18.5)	142/815 (17.4)	
>25	37/295 (12.5)	45/520 (8.7)	82/815 (10.1)	
Sex				.17
Male	83/294 (28.2)	170/517 (32.9)	253/811 (31.2)	
Female	211/294 (71.8)	347/517 (67.1)	558/811 (68.8)	
Marital status				.22
Single/divorced/widowed	264/294 (89.8)	481/521 (92.3)	745/815 (91.4)	
Married	30/294 (10.2)	40/521 (7.7)	70/815 (8.6)	
Living location				.49
Urban areas	165/295 (55.9)	269/521 (51.6)	434/816 (53.2)	
Town	54/295 (18.3)	106/521 (20.3)	160/816 (19.6)	
Rural/mountainous/island	76/295 (25.8)	146/521 (28.0)	222/816 (27.2)	
Family size				.43
1-2 people	60/295 (20.3)	88/520 (16.9)	148/815 (18.2)	
3-4 people	163/295 (55.3)	307/520 (59.0)	470/815 (57.7)	
≥5 people	72/295 (24.4)	125/520 (24.0)	197/815 (24.2)	
Main income per month (VND)				.98
Under 5 million (under US $216.09)	219/262 (83.6)	402/482 (83.4)	621/744 (83.5)	
5-10 million (US $216.09-$432.17)	25/262 (9.5)	45/482 (9.3)	70/744 (9.4)	
10 million or above (US $432.17 or above)	18/262 (6.9)	35/482 (7.3)	53/744 (7.1)	
Monthly household income per capita (VND)				.22
Under 5 million (under US $216.09)	123/284 (43.3)	249/505 (49.3)	372/789 (47.1)	
5-10 million (US $216.09-$432.17)	90/284 (31.7)	151/505 (29.9)	241/789 (30.5)	
10 million or above (US $432.17 or above)	71/284 (25.0)	105/505 (20.8)	176/789 (22.3)	
Region				.10
Northern	116/294 (39.5)	191/519 (36.8)	307/813 (37.8)	
Central	55/294 (18.7)	131/519 (25.2)	186/813 (22.9)	
Southern	123/294 (41.8)	197/519 (38.0)	320/813 (39.4)	

[a]Percentages were calculated using nonmissing observations for each variable within the corresponding stress group. Therefore, denominators vary due to missing responses and may differ from the overall sample size (N=817).
[b]Age groups were defined a priori to reflect developmental and educational/occupational stages relevant to this young health-affiliated sample. The more than 25-year-old group was combined because of the small number of participants in older age ranges.

Table 2 presents the factor structure and internal consistency of the modifiable lifestyle behavior items. Four domains were identified: positive behaviors, diet- and media-related risk behaviors, substance use, and violence-related behaviors. Reliability across these domains was acceptable, with Cronbach α ranging from 0.64 to 0.78. The mean scores for the 4 domains were 5.0 (SD 1.4), 4.4 (SD 1.4), 1.3 (SD 0.8), and 1.7 (SD 1.4), respectively.

Table 2. Factor loadings and reliability of modifiable lifestyle behavior domains among medical students and health care workers in Vietnam, September to November 2021[a].

Items	Positive behaviors	Negative behaviors related to diet and using media	Using substance use	Behaviors related to violence
Smoking	—[b]	—	0.6779	—
Drinking alcohol	—	—	0.4705	—
Substance abuse (drugs, cocaine, balloons, etc)	—	—	0.7024	—

Items	Positive behaviors	Negative behaviors related to diet and using media	Using substance use	Behaviors related to violence
Exercise moderate to vigorous intensity at least 4 times/week, 30 minutes each time	0.5198	—	—	—
Housework	0.6742	—	—	—
Relax	0.7193	—	—	—
Eat 5 servings of green vegetables/fruits per day	0.564	—	—	—
Eat, drink fast food	—	0.5495	—	—
Eat, drink foods that contain added sugar	—	0.8022	—	—
Eat and drink foods that contain added salt	—	0.7245	—	—
Sleep 6-8 hours/day	0.5242	—	—	—
Using TV, computer, or phone	—	0.429	—	—
Fighting, hitting colleagues or family members	—	—	—	0.7283
Being a victim of violence	—	—	—	0.6942
Cronbach α	0.7428	0.7503	0.6352	0.7770
Mean (SD)	5.0 (1.4)	4.4 (1.4)	1.3 (0.8)	1.7 (1.4)

[a]Lifestyle behavior items assessed perceived changes during the COVID-19 period compared with the prepandemic period. The lowest response category, "never/not practiced," indicated no engagement in the behavior during the reference period; higher scores indicated greater increases or higher engagement during the pandemic. Because most participants were young, the loading of housework in the positive behavior domain should be interpreted as participation in daily routines or minor household tasks rather than as overall household-management responsibility.
[b]The factor loading was not reported for the corresponding domain; only loadings for the assigned factors are presented.

Table 3 shows factors associated with lifestyle behaviors. Participants who were older than 25 years reported greater substance use than those aged 16 to 20 (coefficient 0.52, 95% CI 0.34-0.70). Female participants scored higher on positive (coefficient 0.24, 95% CI 0.02-0.46) and diet/media-related negative behaviors (coefficient 0.22, 95% CI 0.00-0.43) but lower on substance use (coefficient –0.23, 95% CI –0.35 to –0.11) than male participants. Town residents reported higher positive and violence-related behaviors (both coefficients 0.28, 95% CIs 0.01-0.56 and 0.01-0.55, respectively) compared with urban residents. Higher monthly income (≥10 million VND) was linked to fewer diet/media-related risks (coefficient –0.58, 95% CI –1.00 to –0.17) but more violence-related behaviors (coefficient 0.42, 95% CI 0.02-0.81), while higher household income per capita (≥10 million VND) was associated with more positive behaviors (coefficient 0.50, 95% CI 0.24-0.76). Respondents from the Central and Southern regions also showed higher positive behaviors (both coefficients 0.31, 95% CIs 0.03-0.58 and 0.07-0.54, respectively) than those in the North.

Table 3. Factors associated with modifiable lifestyle behavior domains among medical students and health care workers in Vietnam, September to November 2021.

Factors	Positive behaviors, coefficient (95% CI)	Negative behaviors related to diet and using media, coefficient (95% CI)	Using substance use, coefficient (95% CI)	Behaviors related to violence, coefficient (95% CI)
Socioeconomic				
Age group (vs 16-20 y old: reference)				
21-25	—[a]	—	0.10 (–0.05 to 0.25)	—
More than 25	—	—	0.52[b] (0.34 to 0.70)	—
Sex (female vs male: reference)	0.24[c] (0.02 to 0.46)	0.22[c] (0.00 to 0.43)	–0.23[b] (–0.35 to –0.11)	—
Marital status (married vs single/divorced/widowed: reference)	–0.65[b] (–1.01 to –0.29)	—	—	—
Living location (vs urban areas: reference)				
Town	0.28[c] (0.01 to 0.56)	—	—	0.28[c] (0.01 to 0.55)
Rural/mountainous/island	0.23[d] (–0.02 to 0.48)	—	—	0.06 (–0.18 to 0.30)
Family size (vs 1-2 people)				
3-4 people	—	—	0.20[b] (0.06 to 0.35)	—
5 people or more	—	—	0.24[b] (0.07 to 0.41)	—
Main income/month (vs <5 million VND: reference)				
5-10 million VND (US $216.09-$432.17)	—	–0.09 (–0.44 to 0.26)	—	0.21 (–0.14 to 0.56)

Factors	Positive behaviors, coefficient (95% CI)	Negative behaviors related to diet and using media, coefficient (95% CI)	Using substance use, coefficient (95% CI)	Behaviors related to violence, coefficient (95% CI)
10 million VND or above (US $432.17 or above)	—	–0.58[b] (–1.00 to –0.17)	—	0.42[c] (0.02 to 0.81)
Monthly household income per capita (vs <5 million VND: reference)				
5-10 million (US $216.09-$432.17)	0.40[b] (0.16 to 0.64)	0.14 (–0.09 to 0.38)	—	—
10 million or above (US $432.17 or above)	0.50[b] (0.24 to 0.76)	0.24[d] (–0.03 to 0.51)	—	—
Region (vs Northern: reference)				
Central	0.31[c] (0.03 to 0.58)	—	–0.05 (–0.19 to 0.10)	—
Southern	0.31[c] (0.07 to 0.54)	—	–0.19[b] (–0.32 to –0.06)	—

[a]The variable was not included in the final regression model for the corresponding outcome.
[b]*P*<.01.
[c]*P*<.05.
[d]*P*<.10.

Table 4 describes depression severity. Of the 817 participants, nearly half of participants (n=402, 49.2%) fell into the minimal-to-none PHQ-9 category, while 36.1% (n=295) reported mild symptoms. For GAD-7, 72.6% (n=593) of participants were classified as having minimal anxiety and 22.0% (n=180) as having mild anxiety. The mean PHQ-9, GAD-7, and PSS-4 scores were 5.2 (SD 4.7), 3.1 (SD 3.6), and 6.9 (SD 2.2), respectively. Participants with higher stress reported significantly elevated PHQ-9 and GAD-7 scores compared with those experiencing lower stress (*P*<.01).

Table 4. Depression, anxiety, and perceived stress among medical students and health care workers in Vietnam, September to November 2021.

Characteristics	Perceived Stress Scale-4			
	Lower stress	Higher stress	Total	*P* value
Total, n (%)	295 (36.1)	522 (63.9)	817 (100)	—[a]
PHQ-9[b] severity, n (%)				<.001
None/minimal	191 (64.7)	211 (40.4)	402 (49.2)	
Mild	94 (31.9)	201 (38.5)	295 (36.1)	
Moderate	7 (2.4)	68 (13.0)	75 (9.2)	
Moderately severe	3 (1.0)	36 (6.9)	39 (4.8)	
Severe	0 (0)	6 (1.1)	6 (0.7)	
GAD-7[c] severity, n (%)				<.001
Minimal anxiety	265 (89.8)	328 (62.8)	593 (72.6)	
Mild anxiety	28 (9.5)	152 (29.1)	180 (22.0)	
Moderate anxiety	2 (0.7)	31 (5.9)	33 (4.0)	
Severe anxiety	0 (0)	11 (2.1)	11 (1.3)	
PHQ-9 score (range 0-27), mean (SD)	3.6 (3.2)	6.2 (5.1)	5.2 (4.7)	<.001
GAD-7 score (range 0-21), mean (SD)	1.7 (2.1)	3.9 (4.0)	3.1 (3.6)	<.001
PSS-4[d] score (range 0-16), mean (SD)	4.6 (1.5)	8.2 (1.2)	6.9 (2.2)	<.001

[a]Not applicable.
[b]PHQ-9: Patient Health Questionnaire-9.
[c]GAD-7: Generalized Anxiety Disorder-7.
[d]PSS-4: Perceived Stress Scale-4.

Table 5 presents factors linked to depression severity. Only estimates with 95% CIs that did not include 0 were interpreted as statistically significant at the 2-sided 5% level. Estimates with CIs crossing 0 were retained in the table for transparency but were interpreted cautiously and not described as statistically significant. Participants older than 25 years had lower PHQ-9 scores than those aged 16 to 20 (coefficient –1.94, 95% CI –3.28 to –0.61). Married participants had lower anxiety (GAD-7: coefficient –2.02, 95% CI –3.32 to –0.72) and stress (PSS-4: coefficient –0.73, 95% CI –1.27 to –0.18) than those classified as single, divorced, or widowed; however, this finding should be interpreted cautiously because only 8.6% (70/817) of participants were married and most participants were aged 16 to 20 years. A household income of 5 to 10 million VND was associated with higher anxiety (coefficient 0.88, 0.05-1.72), while a household income of 10 million VND and higher was associated with lower stress (coefficient –0.41, 95% CI –0.81 to –0.02). Stress was higher in the Central (coefficient 0.47, 95% CI 0.06-0.87) and Southern

regions (coefficient 0.53, 95% CI 0.17-0.88) compared with the Northern region. Lifestyle behaviors also played a strong role: positive behaviors reduced anxiety (coefficient –0.31, 95% CI –0.59 to –0.03) and stress (coefficient –0.36, 95% CI –0.48 to –0.24), whereas negative diet/media habits and violence-related behaviors were consistently associated with higher PHQ-9, GAD-7, and PSS-4 scores.

Table 5. Associations of sociodemographic characteristics and lifestyle behavior domains with depression, anxiety, and perceived stress among medical students and health care workers in Vietnam, September to November 2021[a].

Factors	PHQ-9[b] score, coefficient[c] (95% CI)	GAD-7[d] score, coefficient[c] (95% CI)	PSS-4[e] score, coefficient[c] (95% CI)
Socioeconomic			
Age group (vs 16-20 y: reference)			
21-25	0.97[f] (–0.07 to 2.01)	—[g]	—
>25	–1.94[h] (–3.28 to –0.61)	—	—
Sex (female vs male: reference)	—	—	–0.22 (–0.54 to 0.11)
Marital status (married vs single/divorced/widowed: reference)	—	–2.02[h] (–3.32 to –0.72)	–0.73[h] (–1.27 to –0.18)
Monthly household income per capita (vs <5 million VND: reference)			
5-10 million (US $216.09-$432.17)	0.64 (–0.29 to 1.57)	0.88[i] (0.05 to 1.72)	–0.20 (–0.56 to 0.16)
10 million or above (US $432.17 or above)	–0.33 (–1.36 to 0.69)	0.07 (–0.85 to 1.00)	–0.41[i] (–0.81 to –0.02)
Region (vs northern: reference)			
Central	—	—	0.47[i] (0.06 to 0.87)
Southern	—	—	0.53[h] (0.17 to 0.88)
Modifiable lifestyle behaviors			
Positive behaviors	—	–0.31[i] (–0.59 to –0.03)	–0.36[h] (–0.48 to –0.24)
Negative behaviors related to diet and using media	1.10[h] (0.80 to 1.40)	0.98[h] (0.69 to 1.27)	0.18[h] (0.06 to 0.30)
Using substance use	0.51[f] (–0.01 to 1.04)	—	—
Behaviors related to violence	0.43[h] (0.13 to 0.72)	0.56[h] (0.31 to 0.82)	0.13[i] (0.02 to 0.24)

[a]Separate multivariable Tobit regression models were fitted for PHQ-9, GAD-7, and PSS-4 scores. Estimates whose 95% CIs included 0 were not considered statistically significant at the 2-sided 5% level and were not marked with significance symbols.
[b]PHQ-9: Patient Health Questionnaire-9.
[c]Unstandardized Tobit regression coefficient.
[d]GAD-7: Generalized Anxiety Disorder-7 assessment.
[e]PSS-4: Perceived Stress Scale-4.
[f]$P<.10$.
[g]The variable was not included in the final regression model for the corresponding outcome.
[h]$P<.01$.
[i]$P<.05$.

Discussion

Principal Findings

This study examined perceived changes in modifiable lifestyle behaviors and their associations with depression, anxiety, and perceived stress among medical students and health care workers in Vietnam during the fourth COVID-19 wave. Psychological distress was common, with 63.9% (522/817) of participants classified as having high perceived stress. Positive behaviors were associated with lower anxiety and stress, whereas diet- and media-related risk behaviors, as well as violence-related behaviors, were linked to poorer mental health outcomes. Participants from Central and Southern Vietnam also reported higher perceived stress than those from the Northern region. Given the predominantly young, health-affiliated sample, these findings should be interpreted as context-specific evidence rather than population-level estimates for Vietnamese adults.

The focus on September to November 2021 was intentional because this period captured the late phase of Vietnam's Delta-driven fourth wave and the transition from strict containment measures to the national strategy of "safe and flexible adaptation" to COVID-19 [14,15]. Although lockdowns and mobility restrictions were not applied uniformly across all provinces during this period, such heterogeneity was highly relevant to lifestyle and mental health research. Participants may have experienced different combinations of prolonged distancing, gradual reopening, online learning or work, reduced social interaction, uncertainty about local restrictions, and increased exposure to COVID-19-related information. For medical students and health-affiliated participants, these disruptions may have been particularly salient because their academic, clinical, and social routines were closely linked to pandemic control measures and health-system pressures. Given that most participants were aged 16 to 20 years and that eligibility required studying or working in medical universities or health facilities, the findings should not be interpreted as

representative of Vietnamese adults nationwide. Rather, they primarily reflect the experiences of young medical students and health-related participants during prolonged pandemic restrictions. The external validity of the findings is, therefore, limited by the combined effects of nonprobability snowball sampling, web-based recruitment, eligibility restricted to medical universities or health care facilities, and the marked overrepresentation of participants aged 16 to 20 years. These findings should be interpreted as context-specific evidence for a young health-affiliated population, not as population-level estimates for Vietnamese adults. Previous research in Vietnam mainly examined psychological distress in specific groups such as health workers or students, while our findings highlight how daily routines, digital practices, and coping behaviors converged under prolonged restrictions [6,32].

Nearly two-thirds (522/817, 63.9%) of the participants reported high levels of perceived stress, as measured by the PSS-4. This widespread psychological strain was not uniform: individuals in the Central (coefficient 0.47, 95% CI 0.06-0.87) and Southern (coefficient 0.53, 95% CI 0.17-0.88) regions reported significantly higher stress levels than those in the Northern region. Similar regional disparities in mental health burden during the pandemic have been reported elsewhere, often driven by differences in resource allocation, lockdown severity, and access to health infrastructure [4]. In Vietnam, this finding may also reflect the geographically heterogeneous implementation and relaxation of COVID-19 control measures during September to November 2021, rather than the effect of a single uniform national lockdown. Comparable findings have also been observed in Vietnam: research among university students showed rates of depressive symptoms ranging from 30% to 40% [10]. Still, caution is needed when extrapolating these estimates to the broader Vietnamese population because older adults, non–health care workers, rural residents with limited internet access, and married adults were underrepresented.

Importantly, lifestyle behavior domains revealed distinct and consistent associations with mental health outcomes. Diet-, media-, and violence-related risk behaviors were consistently associated with poorer mental health outcomes. The association between increased domestic conflict and psychological distress has been well documented in both high-income and low-resource settings during the COVID-19 [33]. Excessive digital media exposure, particularly doomscrolling and unstructured screen time, has also been linked to heightened anxiety and poor sleep hygiene [34]. In the context of our sample, these associations may be particularly relevant to young students and early-career health-related participants, who may have experienced prolonged online learning, increased screen exposure, disrupted peer interaction, and heightened concern about COVID-19 due to their connection with health-related institutions.

By contrast, individuals who engaged in positive behaviors, including physical activity, healthy eating, and maintaining routines, were more likely to report lower stress and anxiety levels. In our data, positive behaviors had a mean score of 5.0 (SD 1.4) and were significantly associated with lower GAD-7 scores (coefficient –0.31, 95% CI –0.59 to –0.03) and PSS-4 scores (coefficient –0.36, 95% CI –0.48 to –0.24). In this predominantly young sample, housework within the positive behavior domain likely reflected structured daily activity or minor household tasks rather than the household-management burden more commonly experienced by older adults or primary caregivers. This aligns with growing international evidence suggesting that behavioral resilience is a critical buffer against mental deterioration in times of crisis [35,36]. However, because the present study was dominated by younger participants, these protective associations should be understood primarily within a youth and health-training context rather than as evidence of equivalent effects across all age and occupational groups in Vietnam.

Participants in the Central and Southern regions showed higher engagement in both positive behaviors and violence-related behaviors, highlighting a behavioral paradox. This duality suggests that individuals may not fit neatly into “resilient” or “vulnerable” categories, as some may increase exercise and healthy eating while simultaneously experiencing elevated interpersonal strain [37]. The higher anxiety observed among participants with a household income of 5 to 10 million VND, compared with those reporting lower household income, may reflect a transitional financial position. In this young sample, the lowest-income group may have included many students who were still living with or financially supported by their families, which could buffer immediate financial worries despite low reported income. By contrast, those in the middle-income group may have been more likely to face emerging financial responsibilities, tuition or living-cost concerns, employment uncertainty, or family income disruption during the pandemic, while not having the same material buffer as the highest-income group. The lower stress observed among participants with household income of 10 million VND and more may therefore reflect greater financial security and household resilience during prolonged restrictions. Nevertheless, marital-status findings should be interpreted cautiously because 91.4% (745/815) of participants were classified as single, divorced, or widowed, a distribution likely driven by the predominance of participants aged 16 to 20 years, with only 8.6% (70/817) married. Marital status was included as a sociodemographic covariate, but it does not capture living arrangements, coresiding generations, household roles, or perceived family support. Therefore, the apparent protective association of marriage may reflect age, role, life-stage differences, social-support mechanisms, or the demographic composition of the sample rather than necessarily indicating a protective effect of family systems.

These findings highlight the need to move from crisis-driven messaging toward sustainable, behavior-focused strategies. For the population most directly represented in this study, interventions may be especially relevant within medical universities, health professional training programs, and health care–linked youth networks. A behavioral health framework should prioritize support for nonviolent communication, mindful digital engagement, and balanced nutrition. Such a framework should not only provide information but also equip communities with tools, routines, and

services adapted to their realities [2]. Because this study did not directly measure household composition, coresiding generations, or perceived family support, implications related to family systems should be framed cautiously and require further study using household-level variables.

Implications of these findings are multifaceted. First, they call for embedding behavioral health into routine public health programming, ensuring that interventions addressing diet, sleep, and media use are not only crisis-driven but also long-term investments in resilience. Second, policymakers should consider integrating digital literacy and psychosocial support into national emergency preparedness plans, thereby reducing the mental health toll of misinformation and maladaptive coping. However, given the nonprobability online sampling strategy and the concentration of young, health-affiliated participants, these policy implications should be regarded as hypothesis-generating and most directly applicable to youth, students, and health-related settings. Broader national recommendations require confirmation through population-based studies that include a more balanced representation by age, marital status, occupation, education, and internet access. Future research should use probability-based or quota-based sampling to ensure a broader representation of Vietnamese adults and should conduct stratified analyses comparing medical students, health care workers, and non–health-related populations.

Limitations

Several limitations should be considered. First, the cross-sectional design precludes causal inference; therefore, the findings should be interpreted as associations based on self-reported data. Although Tobit regression was used to account for bounded and floor-affected scale scores, the models were intended to estimate associations rather than to assess prediction or model performance. Self-reported measures may also be subject to recall and social desirability biases.

Second, although Vietnamese-language versions of the PHQ-9, GAD-7, and PSS-4 were used and showed acceptable to excellent internal consistency in this sample, this study did not assess test-retest reliability, measurement invariance, or responsiveness to change over time. These instruments should therefore be interpreted as measures of symptom severity at a single time point.

Third, the online snowball-sampling approach may have introduced selection bias and limited external validity. Recruitment through medical universities, health care facilities, youth union contacts, and health-professional networks likely contributed to the predominance of young, health-affiliated participants, with 72.5% (591/815) aged 16 to 20 years and 91.4% (745/815) classified as single, divorced, or widowed. Thus, the findings should not be generalized to Vietnamese adults nationwide, particularly older adults, non–health-related populations, or individuals with limited internet access or digital literacy.

Fourth, marital status was included as a sociodemographic covariate but should not be interpreted as a direct measure of family support, living arrangements, or multigenerational household structure, as these household-level variables were not collected.

Finally, the lifestyle behavior checklist was developed for this study rather than adapted from a fully validated inventory. Although it was informed by previous literature, reviewed by the research team, piloted, and found to be internally consistent, it should be interpreted as a pragmatic measure of perceived pandemic-related behavioral change.

Conclusions

This study shows that modifiable lifestyle behaviors were associated with mental well-being during Vietnam's fourth COVID-19 wave among a predominantly young, health-affiliated sample. Violence-related behaviors and unhealthy diet- and media-related behaviors were linked to poorer mental health outcomes, while positive routines were associated with lower anxiety and stress. Given the online snowball-sampling approach and the predominance of participants recruited through medical universities and health care facilities, the findings should not be generalized to all Vietnamese adults. These results support the integration of behavioral health promotion, digital literacy, and psychosocial support into pandemic preparedness and recovery strategies, particularly for students, young people, and health-related settings.

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Generative AI Use

During manuscript revision, the authors used ChatGPT (OpenAI) to support language editing, improve clarity, and refine the organization of selected sections of the manuscript. ChatGPT was not used for data collection, statistical analysis, the generation of results, or the creation of tables or figures. All AI-assisted content was reviewed, edited, and verified by the authors, who take full responsibility for the accuracy, integrity, and final content of the manuscript.

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Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Authors' Contributions

Conceptualization: HTN, DCN, CL
Data curation: PA, GTV
Formal analysis: DCN, HD
Methodology: TTN, HTN, CL, GF
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Supervision: LB, CSHH
Validation: GF, HD, PA
Writing – original draft: HTN, TTN
Writing – review & editing: TTN, HD, LB, GTV, CSHH
All authors read and approved the final manuscript.

Conflicts of Interest

None declared.

Checklist 1

STROBE checklist.
[DOCX File (Microsoft Word File), 34 KB-Checklist 1]

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Abbreviations

***DSM-IV*:** *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition)
GAD-7: Generalized Anxiety Disorder-7
PHQ-9: Patient Health Questionnaire-9
PSS-4: Perceived Stress Scale-4
STROBE: Strengthening the Reporting of Observational Studies in Epidemiology
VYPA: Vietnam Young Physicians Association

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