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ORIGINAL RESEARCH

A study of the prevalence and correlates of suicidal ideation and psychiatric morbidity among undergraduate medical students in Tamil Nadu, India

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Background: Understanding the risk factors for psychiatric morbidity and suicidal ideation among medical undergraduates is gaining importance given the increasing trend in suicides among this population. This study aimed to analyze the prevalence of suicidal ideation, depression, and anxiety among medical undergraduates and to compare their socio-demographic, familial, and behavioral characteristics to identify potential risk factors.

Methods: We performed a cross-sectional online survey among 500 consenting medical undergraduates in Tamil Nadu, South India. Ethical approval was obtained. We used a semi-structured proforma to obtain the socio-demographic, family relationships, and lifestyle information of our participants. The beck depression inventory and the hospital anxiety depression scale were used to quantify depression and anxiety among our students. We performed univariate and multivariate logistic regression analyses and computer-based predictive modelling using Classification and Regression Tree (CART) analysis on our data.

Results: We found a prevalence of 20.2% for suicidal ideation, 35.8% for depression, and 53% for anxiety among our students. Significantly increased odds of having suicidal ideation were observed among students who were from disharmonious families (odds ratio [OR] = 10.80; CI: 9.30–30.15; p = 0.008), had poor satisfaction with maternal love (OR = 2.21; CI: 0.79–3.34; p = 0.03), frequently visited shopping malls (p = 0.05; OR = 5.71; CI: 0.88–17.12) and never exercised (OR = 1.95, CI: 0.81–2.74; p = 0.03). Significantly lower odds of suicidal ideation were observed among students who consumed food with friends in restaurants on weekends (OR = 0.08; CI: 0.01–0.045; p = 0.005). We observed lower odds of anxiety and depression among students who visited religious places (OR = 0.49; CI: 0.04–3.13; p = 0.05) and places of sightseeing (OR = 0.45; CI: 0.07–2.94; p = 0.05), respectively. Among students who reported difficulty in decision-making, CART analysis predicted 36.1% of suicidal ideation, 74.6% of depression, and 80.5% of anxiety. Increased fatiguability, feelings of unattractiveness, and feelings of being punished predicted depression among 49.2% of our students. Ideas of guilt and blaming oneself predicted anxiety among 66.5 and 68.4% of our students, respectively.

Conclusions: One-fifth of medical graduates reported suicidal ideation, one-third experienced depression, and half had anxiety, with risk factors including poor relationships with family and classmates, female gender, academic stress, substance use, and lack of exercise. CART analysis identified depression as the strongest predictor of anxiety and suicidal ideation, with decision-making difficulties and fatigue being significant contributors. CART has demonstrated high accuracy, highlighting its value in clinical research.

Keywords: medical students, depression, anxiety, suicidal ideation, risk factors, prevalence

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Key messages

1. **Mental Health Risks:** Medical graduates face significant mental health challenges, with depression, anxiety, and suicidal ideation prevalent, especially among those who lack exercise, experience academic pressure, or have poor family and social relationships.
2. **Protective Factors:** Engaging in activities like exercising, weekend restaurant food consumption with friends, visiting religious places, and sightseeing can help reduce the risk of suicide, anxiety, and depression, offering simple strategies to improve well-being.
3. **Predictive Insights:** Depression is a strong predictor of both anxiety and suicidal ideation. Decision-making difficulties, increased fatiguability, and feelings of unattractiveness are easily identifiable risk factors for depression.

Introduction

During the past 5 years, not less than 122 medical students have died by suicide, 64 in undergraduate and 58 in postgraduate courses, while 1270 students dropped out (1). In India, 125 medical students, 105 postgraduate residents, and 128 doctors committed suicide between 2010 and 2019 (2). These statistics warrant an urgent need for detailed research into the risk factors associated with suicidal ideation, depression, and anxiety among medical graduates in India.

Suicide is a continuous behavior that includes suicidal ideation followed by plans, attempts, and the act of suicide itself (3). Past research has documented that suicidal ideation is a significant predictor of suicide plans, attempts, and completed suicides (4). According to a national comorbidity survey by Kessler et al. in the United States, 34% of lifetime suicide ideators made a suicide plan, and 72% of them attempted suicide, whereas 26% of suicide ideators attempted suicide without making any prior plans (5).

Depression is defined as the mental state of low mood and aversion to activity. It can manifest as sadness, inability to concentrate, feelings of hopelessness, and an increase or decrease in appetite and sleep (6). Anxiety is an unpleasant emotional state of inner turmoil or feelings of dread over anticipated events, often accompanied by nervous behavior such as pacing, somatic illness, and rumination (7). Anxiety and depression are the most common mental health problems affecting students (8). Depression is the fourth leading and rapidly growing cause of morbidity and accounts for about half of the mental disorders behind suicide attempts (9, 10). Anxiety directly affects the vulnerability to stress and inversely affects the emotional stability of medical students (11). Student distress may adversely influence professional development and academic performance and can also continue into his/her practice, affecting patients, given the correlation between physician distress and a decrease in the quality of healthcare provided on the part of the physician (12, 13).

In a systematic review focused on medical schools in English-speaking countries, Hope et al. (14) have reported a prevalence of 7.7–65.5% for anxiety, 6.0–66.5% for depression, and 12.2–96.7% for psychological distress. Rotenstein et al.'s meta-analysis of studies from 47 countries found that 11.1% of medical students had suicidal ideation and 27.2% had depression (15). A cross-sectional study among medical students in Western Nepal reported a lifetime prevalence of suicidal ideation of 18.4% and suicidal ideation in the past year at 10.7%. Given the importance of depression, anxiety, and their consequences, including suicide, it is important to assess their unfolding during a medical student's undergraduate period to intervene early and alleviate the psychological distress. Past research has identified several risk factors associated with suicidal ideation, depression, and anxiety among medical students. These include poor performance in college, being posted in clinical rotations, a history of substance abuse, parental neglect, being a female student, poor self-image, sleep problems, and mental health problems (5, 16, 17). An investigation into suicidal ideation and its correlates may assist in the prevention of future suicide attempts, both planned and unplanned (18, 19). Despite an increasing interest in this area, to our knowledge, there is a paucity of Indian research analyzing suicidal ideation, depression, and anxiety concurrently among medical students.

Therefore, this study aimed to perform a comprehensive analysis of the prevalence of suicidal ideation, depression, and anxiety among medical students and also to compare the socio-demographic, familial, and behavioral characteristics associated with them. This would enable us to identify the potential risk factors associated with suicidal ideation and to uncover subtle effect pathways leading to suicide attempts or suicide.

Methods

This cross-sectional study was performed in the psychiatry department of a tertiary care medical institution in Southern India for a 6-month period from January 2023 to June 2023. Ethical approval was obtained from our Institutional Ethics Committee. We contacted the deans of 29 medical colleges and provided them with information about our research and requested them to permit their undergraduate students to participate in our study. We also organized online meetings via video conferencing with the faculty advisors and student mentors of the respective medical colleges, elaborating on the pressing need and benefits of this research, and sent them the informed consent forms with a request for onward transmission to their students. We also sought to overcome some of the mental barriers by using informal

consultation and assurance of anonymity and confidentiality. We recruited 746 willing and consenting students by this method. The semi-structured proforma and mental health rating scales were individually mailed to all our consenting participants. Two hundred and 46 students did not complete the survey. Based on previous research work by Rotenstein et al. (15), the prevalence of suicidal ideation was taken as p = 11.1%, precision d = 3%, and a confidence level of 95%; we arrived at a sample size of 421 participants for our study. Expecting a non-response rate of around 20%, we rounded off our sample size to 500.

Kessler et al. have reported that about 90% of unplanned and 60% of planned first suicide attempts occurred within 1 year of having a suicidal ideation (5). Based on this research finding, we assessed suicidal ideation among our participants with the question "Did you have thoughts about killing yourself in the past year?" and asked them to choose the statement that best described them—"I don't have any thoughts of killing myself"; "I have such thoughts, but I would not carry them out"; "I would kill myself if I had the chance." Smoking and drinking behavior were assessed with the questions "Do you smoke any tobacco products or other substances?" and "Do you consume alcoholic drinks?" The frequency of consumption of junk food was assessed with the question "How often do you consume junk/outside/ordered food?" The frequency of performing physical exercise was obtained with the question—"How often do you exercise or take part in sports (>30 minutes)?"

Materials

Semi-structured proforma

We used a self-designed, semi-structured proforma to obtain information regarding the socio-demographic characteristics like age, gender, monthly family income, monthly living expenses, number of friends, and relationship with classmates. We also obtained information regarding family relationships, parental marital status, satisfaction with paternal and maternal love, family history of psychiatric illness, history of psychiatric illness, and history of using substances. Information regarding consumption of junk food, frequency of physical exercise, academic pressure, and leisure activities was also obtained.

Beck's depression inventory (BDI)

Beck's depression inventory (BDI) is a 21-question inventory created by Aaron T. Beck and is one of the most widely used psychometric tests for measuring the severity of depression. It uses a 4-point Likert scale, with each question scored from 0 to 3. The total score ranges from 0 to 63, with scores <11 considered normal. 11–16 indicates a mild mood disturbance, while 17–20 indicates borderline clinical depression. Scores of 21–30 signify moderate depression, and >30 is indicative of severe depression (20).

Hospital anxiety depression scale (HADS)

The Hospital Anxiety Depression Scale (HADS) is a 14-item scale developed by Zigmond and Snaith and has seven questions related to anxiety alternating with seven questions related to depression, with a score ranging between 0 and 21 for the anxiety and depression subscales. A score of ≤7 corresponds to "no depression or anxiety," a score of 8–10 is a minor depression/anxiety, and a score of >10 is a moderate to severe depression/anxiety (21).

Statistical analysis

We used the Statistical Package for the Social Sciences software (SPSS Version 24.0, IBM SPSS, IBM Corp., Armonk, NY, USA) to perform univariate logistic analyses to examine the correlation and identify potential risk factors for suicidal ideation, depression, and anxiety. Variables that were found to be significant were included in a forward stepwise multivariate logistic regression. Additionally, the independent variables were analyzed by using a classification and regression tree (CART) analysis and recursive partition algorithms called RPART (22), which examines all possible predictors, finds the most optimal split, and automatically creates two homogenous subgroups that are most different in terms of the dependent variable. This process of binary splitting continues until it can no longer divide any further. CART analysis exhaustively searches all independent variables, thereby enabling us to explore complex relationships that may exist among multiple risk factors. We took a value of $p < 0.05$ to be statistically significant.

Results

Table 1 summarizes the details of psychiatric morbidity, the socio-demographic profile, and family factors associated with suicidal ideation. The mean age of our sample was 21.9 ± 2.8 years. 57.4% (n = 287) of our study participants were female. The mean monthly family income of our participants was Rs. 66,550 ± 30,192. Their mean monthly expenditure was Rs. 5890 ± 2683. 30% (n = 150) of the respondents stated that they had a neutral family relationship. While 4.2% (n = 21) of our students had a disharmonious family, 65.8% (n = 329) had a harmonious family relationship. 18.2% (n = 91) of the respondents' parents frequently quarreled, 2.2% (n = 11) were separated, and 1.2% (n = 6) were divorced. 12.2% (n = 61) of subjects had a history of psychiatric illness in their family.

TABLE 1 | Psychiatric morbidity and socio-demographic profile, family relationships.

Demographic variables	Sample	Suicidal ideation	Depression	Anxiety
	Cr[a]% (n)	Pr[a]% (n)	Pr[a]% (n)	Pr[a]% (n)
	100 (500)	**20.2 (101)**	**35.8 (179)**	**53.0 (265)**
Gender				
Male	42.6 (213)	14.6 (31)	32.9 (70)	49.8 (106)
Female	57.4 (287)	24.4 (70)	38.0 (109)	55.4 (159)
Age				
17–18	8.6 (43)	18.6 (8)	32.6 (14)	41.9 (18)
19–20	57 (285)	19.3 (55)	35.1 (100)	53.0 (151)
21–22	30 (150)	24.0 (36)	40.0 (60)	58.7 (88)
23–24	3.6 (18)	11.1 (2)	27.8 (5)	33.3 (6)
25 and above	0.8 (4)	0	0	50.0 (2)
Monthly family income in Rs.				
20,000–50,000	25.6 (128)	18.8 (24)	35.2 (45)	50.8 (65)
50,001–75,000	18.6 (93)	22.6 (21)	43.0 (40)	54.8 (51)
75,001–1,00,000	19.8 (99)	19.2 (19)	32.3 (32)	51.5 (51)
above 1 lakh	36 (180)	20.6 (37)	34.4 (62)	54.4 (98)
Monthly living expense in Rs.				
less than 5000	25 (125)	17.6 (22)	31.2 (39)	48.0 (60)
5000–7500	35.4 (177)	26.0 (46)	39.0 (69)	59.9 (106)
7501–10,000	18.6 (93)	18.3 (17)	35.5 (33)	49.5 (46)
above 10,000	21 (105)	15.2 (16)	36.2 (38)	50.5 (53)
Family relationship				
Very harmonious	24.6 (123)	8.9 (11)	17.9 (22)	37.4 (46)
Harmonious	41.2 (206)	20.4 (42)	37.4 (77)	55.3 (114)
Neutral	30 (150)	26.0 (39)	44.7 (67)	58.7 (88)
Disharmonious	3.2 (16)	37.5 (6)	68.8 (11)	87.5 (14)
Highly disharmonious	1 (5)	60.0 (3)	40.0 (2)	60.0 (3)
Parental relationship				
Harmony	78.4 (392)	15.8 (62)	30.4 (119)	48.2 (189)
Frequent quarrel	18.2 (91)	35.2 (32)	57.1 (52)	69.2 (63)
Separation	2.2 (11)	45.5 (5)	72.7 (8)	100.0 (11)
Divorce	1.2 (6)	33.3 (2)	0	33.3 (2)
Family history of psychiatric illness				
No	87.8 (439)	19.4 (85)	34.6 (152)	53.1 (233)
Yes	12.2 (61)	26.2 (16)	44.3 (27)	52.5 (32)
Satisfaction with paternal love				
1 – very dissatisfied	2.8 (14)	28.6 (4)	21.4 (3)	42.9 (6)
2 – somewhat dissatisfied	3.4 (17)	58.8 (10)	70.6 (12)	70.6 (12)
3 – neutral	12.4 (62)	29.0 (18)	56.5 (35)	71.0 (44)
4 – somewhat satisfied	22 (110)	21.8 (24)	40.9 (45)	66.4 (73)
5 – fully satisfied	59.4 (297)	15.2 (45)	28.3 (84)	44.8 (133)
Satisfaction with maternal love				
1 – very dissatisfied	1 (5)	40.0 (2)	40.0 (2)	60.0 (3)
2 – somewhat dissatisfied	2 (10)	50.0 (5)	80.0 (8)	80.0 (8)
3 – neutral	6.8 (34)	41.2 (14)	61.8 (21)	70.6 (24)
4 – somewhat satisfied	19.4 (97)	32.0 (31)	46.4 (45)	62.9 (61)
5 – fully satisfied	70.8 (354)	13.8 (49)	29.1 (103)	47.7 (169)

*Cr – Constituent ratio; Pr – Prevalence ratio.

70.8% (n = 354) and 59.4% (n = 297) of students expressed complete satisfaction with their maternal love and paternal love, respectively.

Table 2 shows the psychiatric morbidity and behavioral characteristics of our sample. 20.2% (n = 101) of students reported instances of suicidal ideation within the past 12 months, of which 2.8% (n = 14) expressed an intent to carry them out. The prevalence of suicidal ideation among males and females was 14.6% (n = 31) and 24.4% (n = 70), respectively. On the BDI, mild mood disturbances were seen in 23% (n = 115), borderline clinical depression in 11.4% (n = 57), moderate depression in 16.6% (n = 83), and severe depression in 7.8% (n = 39) of the students. On the HADS, 21% (n = 105) of the students had mild anxiety, and 32% (n = 160) of the students had moderate to severe anxiety.

Table 3 shows that 35.2% (n = 176) of the students had a good relationship with their classmates. While 21.6% (n = 108) had 1–3 friends, 2.4% (n = 12) of our students had no friends. 44% (n = 220) were able to manage well with their academic schedule, whereas 9.2% (n = 46) felt severely overwhelmed and 30% (n = 150) felt moderately overwhelmed. 39.2% (n = 196) of our participants frequently visited restaurants. While 51.2% (n = 256) of our study subjects consumed outside food on weekends, 15.4% (n = 77) consumed it daily. 26.8% (n = 134) of our sample performed physical exercise daily, 22.2% (n = 111) exercised weekly, 40.4% (n = 202) exercised rarely, and 10.6% (n = 53) never exercised. 17.6% of our students (n = 88) consumed alcohol, 7.8% (n = 39) smoked tobacco, and 7% (n = 35) gave us a history of psychiatric treatment in the past.

The univariate analysis of various factors associated with suicidal ideation, depression, and anxiety is presented in **Table 4**. We found that female undergraduates had a significantly higher chance (odds ratio [OR] = 1.68; CI: 0.84–2.10; $p < 0.05$) of having suicidal ideation. Suicidal ideation was significantly higher in students who said that their parents had frequent quarrels (OR = 2.08; CI: 0.93–2.53; $p < 0.005$), those who were dissatisfied with their paternal love (OR = 3.12; CI: 0.82–5.94; $p < 0.05$) and those who were not fully satisfied with their maternal love (OR = 2.21; CI: 0.79–3.34; $p < 0.05$). Students who never performed physical exercise (OR = 1.95; CI: 0.81–2.74; $p < 0.05$) and those who gave a history of psychiatric treatment (OR = 2.31; CI: 0.83–3.42; $p < 0.05$) had significantly higher suicidal ideation. We also observed significantly higher depression in students with frequent parental quarrels (OR = 1.84; CI: 1.01–2.55; $p < 0.01$) and less than full satisfaction with their paternal love (OR = 1.72; CI: 0.89–1.62; $p < 0.05$). Individuals who had few friends (<3) (OR = 1.74; CI: 0.89–2.62; $p < 0.01$) and students who felt overwhelmed by academic pressure (OR = 1.99; CI: 0.95–3.39; $p < 0.05$) had greater odds of being depressed. Children of parents who had separated were found to have significantly higher (OR = 1.93; CI: 1.20–2.65; $p < 0.001$) anxiety.

We performed a multivariate logistic regression analysis in an effort to identify the significant variables that are associated with suicidal ideation, depression, and anxiety. **Table 5** shows a summary of this analysis. We observed that children from highly disharmonious families had significantly higher odds (OR = 10.80; CI: 9.30–30.15; $p < 0.01$) of having suicidal ideation. Students with anxiety had a significantly higher suicidal ideation (OR = 10.4; CI: 1.88–57.19; $p < 0.01$) and depression (OR = 9.16; CI: 7.88–16.31; $p < 0.001$). Similarly, participants who reported having suicidal ideation had significantly higher odds of being depressed (OR = 4.09; CI: 3.72–9.54; $p < 0.001$) and of being anxious (OR = 3.45; CI: 2.90–7.37; $p < 0.005$). Participants who had anxiety disorder (OR = 8.88; CI: 7.19–16.55; $p < 0.001$) and those who had a history of psychiatric treatment (OR = 3.12; CI: 2.93–5.20; $p = 0.04$) also had a significantly higher chance of depression. Students who often visited shopping malls (OR = 5.71; CI: 0.88–17.12; $p = 0.05$) and spent Rs. 5000–7500 per month (OR = 3.03; CI: 2.53–4.80; $p = 0.05$) had a significantly higher chance of suicidal ideation.

We performed predictive modeling using a computer-based CART. **Figure 1** represents the important correlates of suicidal ideation among our student participants. 73.3% of individuals with suicidal ideation had depression. Amongst these depressed subjects, 60.4% of individuals had expressed less than full satisfaction with the maternal love they received. Among the 26.7% of students who were not depressed but suicidal, 23.8% had expressed that they cried more than usual, and 18.8% revealed that they had lost more than 4 kg of their weight. We also observed that 15.8% of individuals belonging to this group had difficulty in making decisions and 11.8% had around 10 friends.

Figure 2 depicts the risk factors for depression shown by our predictive model. Among the 179 depressed students, 63.1% reported difficulty in making decisions. 53.1% of the students also felt unattractive, and 50.8% reported having feelings of being punished. In addition, 49.2% of these students also reported feeling too tired to do anything.

TABLE 2 | Psychiatric morbidity.

Suicidal ideation	Depression - Beck's depression inventory	Anxiety - hospital anxiety depression scale (HADS)
20.2% (n = 101)	**35.8% (n = 179)**	**53.0% (n = 265)**
No suicidal ideation 79.8 (399)	Normal 40.2 (201)	Normal 47 (235)
Suicidal ideation 17.4 (87)	Mild mood disturbance 23 (115)	Borderline abnormal 21 (105)
Suicidal plan 2.8 (14)	Borderline clinical depression 11.4 (57)	Abnormal (case) 32 (160)
	Moderate depression 16.6 (83)	
	Severe depression 7.8 (39)	

TABLE 3 | Behavioral characteristics.

Behavioral variables	Sample Cr[a]% (n)	Suicidal ideation Pr[a]% (n)	Depression Pr[a]% (n)	Anxiety Pr[a]% (n)
	100 (500)	**20.2 (101)**	**35.8 (179)**	**53.0 (265)**
Relationship with classmates				
1 – very poor	2.8 (14)	50.0 (7)	57.1 (8)	78.6 (11)
2 – poor	7.2 (36)	30.6 (11)	66.7 (24)	86.1 (31)
3 – neutral	28.2 (141)	24.1 (34)	46.1 (65)	61.0 (86)
4 – good	35.2 (176)	19.3 (34)	15.3 (27)	50.0 (88)
5 – very good	26.6 (133)	11.3 (15)	18.8 (25)	36.8 (49)
Number of good friends				
0	2.4 (12)	33.3 (4)	41.7 (5)	75.0 (9)
1–3	21.6 (108)	25.9 (28)	53.7 (58)	69.4 (75)
4–6	40 (200)	22.0 (44)	36.5 (73)	55.5 (111)
7–9	18.4 (92)	16.3 (15)	25.0 (23)	42.4 (39)
10 and above	17.6 (88)	11.4 (10)	22.7 (20)	35.2 (31)
Places visited often				
Gym	19.4 (97)	11.3 (11)	28.9 (28)	41.2 (400
Shop	11 (55)	27.3 (15)	30.9 (17)	56.4 (31)
Religious	16.2 (81)	16.0 (13)	32.1 (26)	45.7 (37)
Food	39.2 (196)	23.0 (45)	41.8 (82)	59.7 (117)
Sightseeing	14.2 (71)	23.9 (17)	36.6 (26)	56.3 (40)
Smoking				
Daily	1.2 (6)	33.3 (2)	66.7 (4)	66.7 (4)
Weekly	0.8 (4)	50.0 (2)	50.0 (2)	75.0 (3)
Monthly	0.2 (1)	100.0 (1)	0.0	100.0 (1)
Rarely	5.6 (28)	28.6 (8)	28.6 (8)	57.1 (16)
Never	92.2 (461)	19.1 (88)	35.8 (165)	52.3 (241)
Drinking				
Daily	0.2 (1)	100.0 (1)	100.0 (1)	100.0 (1)
Weekly	1.4 (7)	42.9 (3)	57.1 (4)	71.4 (5)
Monthly	2.6 (13)	23.1 (3)	46.2 (6)	46.2 (6)
Rarely	13.4 (67)	31.3 (21)	35.8 (24)	59.7 (40)
Never	82.4 (412)	17.7 (73)	35.0 (144)	51.7 (213)
Exercise				
Daily	26.8 (134)	11.2 (15)	27.6 (37)	41.0 (55)
Weekly	22.2 (111)	20.7 (23)	32.4 (36)	53.2 (59)
Rarely	40.4 (202)	21.8 (44)	39.1 (79)	56.9 (115)
Never	10.6 (53)	35.8 (19)	50.9 (27)	67.9 (36)
Junk food				
Daily	15.4 (77)	20.8 (16)	35.1 (27)	54.5 (42)
Weekends	51.2 (256)	19.1 (49)	37.9 (97)	55.5 (142)
Fortnightly	10.4 (52)	26.9 (14)	44.2 (23)	59.6 (31)
Monthly	13 (65)	15.4 (10)	26.2 (17)	46.2 (30)
Rarely	10 (50)	24.0 (12)	30.0 (15)	40.0 (20)
Pressure of studies				
1 – none	4.8 (24)	12.5 (3)	25.0 (6)	29.2 (7)
2 – low	12 (60)	21.7 (13)	25.0 (15)	38.3 (23)
3 – able to cope	44 (220)	15.0 (33)	25.5 (56)	44.1 (97)
4 – high	30 (150)	26.7 (40)	48.0 (72)	68.0 (102)
5 - overwhelming	9.2 (46)	26.1 (12)	65.2 (30)	78.3 (36)
History of psychiatric treatment				
Yes	7 (35)	42.9 (15)	60.0 (21)	65.7 (23)
No	93 (465)	18.5 (86)	34.0 (158)	52.0 (242)

TABLE 4 | Univariate analyses of factors associated with suicidal ideation, depression, and anxiety.

Variables for suicidal ideation	Odds ratio (OR)	95% CI	p-value
Male	0.60	0.48–1.21	0.03
Female	1.68	0.84–2.10	0.03
Very harmonious family relationship	0.38	0.31–1.17	0.004
Parents with harmonious relationship	0.44	**0.40–0.98**	0.001
Parents with frequent quarrels	2.08	0.93–2.53	0.004
Dissatisfied with paternal love	3.12	0.82–5.94	0.02
Full satisfaction with paternal love	0.55	0.47–1.12	0.007
Not fully Satisfaction with maternal love	2.21	0.79–3.34	0.03
Fully satisfied with maternal love	0.39	**0.38–0.92**	0.001
Good Relationship with classmates	0.48	0.38–1.23	0.02
Frequently visit gym	0.51	0.36–1.38	0.05
Never consume alcohol	0.56	0.45–1.20	0.02
Physical exercise daily	0.48	0.38–1.22	0.01
Never exercised	1.95	0.81–2.74	0.03
Able to manage academic pressure	0.62	0.49–1.22	0.04
Positive History of psychiatric treatment	2.32	0.83–3.42	0.02
No history of psychiatric treatment	0.43	0.34–1.21	0.01
Variables for Depression			
Very harmonious family relationship	0.43	**0.36–0.99**	0.001
Parents with harmonious relationship	0.55	**0.41–0.98**	0.007
Parents with frequent quarrel	1.84	**1.01–2.55**	0.01
Not fully Satisfied with paternal love	1.72	0.89–2.62	0.05
Fully Satisfied with paternal love	0.60	0.49–1.03	0.008
Fully satisfied with maternal love	0.56	**0.44–0.98**	0.004
Good Relationship with classmates	0.33	**0.32–0.80**	0.001
1–3 friends	1.74	0.98–2.34	0.01
More than 10 friends	0.59	0.42–1.23	0.05
Able to manage academic pressure	0.58	0.48–1.02	0.005
Overwhelmed by academic pressure	1.99	0.95–3.39	0.03
Variables for anxiety			
Very harmonious family relationship	0.64	0.46–1.06	0.04
Parental separation	1.93	1.20–2.65	0.001
Fully Satisfied with paternal love	0.69	0.48–1.01	0.05
Good Relationship with classmates	0.63	0.45–1.02	0.03
More than 10 friends	0.62	0.42–1.10	0.05

Figure 3 represents the important correlates and predictors of anxiety in our sample. Among the 265 individuals who were suffering from anxiety, 58.5% were found to be depressed. Of these, 22.6% reported having experienced sadness most of the time, although 14.7% of them had around 10 friends. Among this group of graduates, we observed that 10.2% of students had feelings of guilt. Among the 155 individuals with depressive symptoms, our model showed that 35.9% were suicidal, 21.5% had a poor appetite, 18.9% had difficulty in decision-making, and around 17% of students had self-blame even though all of these individuals did not express feeling sad on most days.

Our model showed a sensitivity of 85%, a specificity of 45%, a negative predictive value of 85%, and a positive predictive value of 45%.

Discussion

"Put on your own oxygen mask before assisting others."

- Randy Pausch

In India, the process of gaining admission into medical colleges is very rigorous and challenging, often demanding exceptional dedication and hard work on the part of the

TABLE 5 | Multivariate logistic regression analysis.

Multivariate factors	Standard error (SE)	p-value	OR	95% CI
Suicidal ideation				
Monthly living expense Rs. 5001–7500	0.289	0.04	3.03	2.53–4.80
Highly disharmonious family relationship	3.448	0.008	10.80	9.30–30.15
Satisfaction with maternal love	0.479	0.01	0.29	0.11–0.75
Junk food weekends	0.917	0.005	0.08	0.01–0.45
Places visited often - shopping	0.955	0.05	5.71	0.88–17.12
Anxiety	0.871	0.007	10.37	1.88–27.19
Depression				
Relationship with classmates	0.145	0.03	0.73	0.65–4.01
Number of good friends	0.198	0.02	0.63	0.10–4.16
Places visited often - sightseeing (beach)	0.423	0.05	0.45	0.07–2.94
History of psychiatric treatment	0.549	0.04	3.12	2.93–5.20
Anxiety	0.308	0.001	9.16	7.88–16.31
Suicidal intent	0.340	0.001	4.09	3.72–9.54
Anxiety				
Relationship with classmates	0.139	0.05	0.76	0.17–3.61
Places visited often - religious	0.363	0.05	0.49	0.04–3.13
Depression	0.298	0.001	8.88	7.19–16.55
Suicidal intent	0.395	0.002	3.45	2.90–7.37

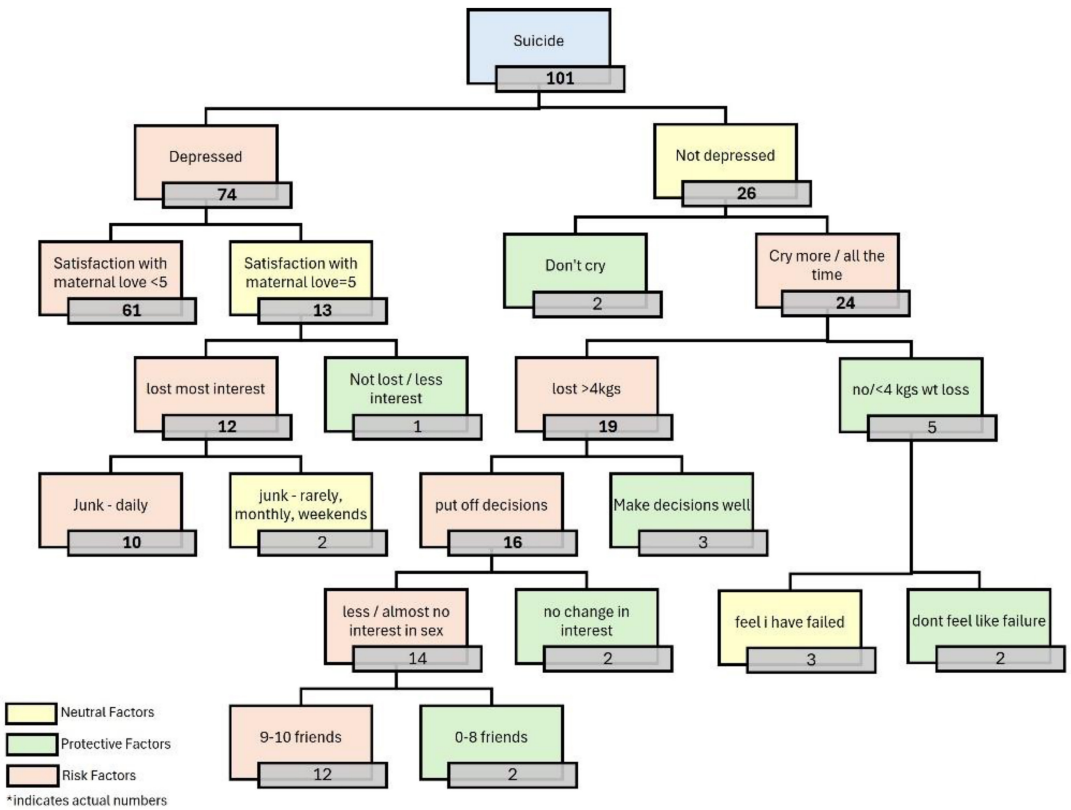

FIGURE 1 | Classification and regression tree (CART) analysis of variables affecting suicidal ideation.

students. It marks the beginning of an arduous career path often influenced by personal ambition or familial pressure while taking on the role of future healers. Students can also have an identity crisis as they transition from being top achievers to competing among equally skilled peers. Medical training presents the students with continuous

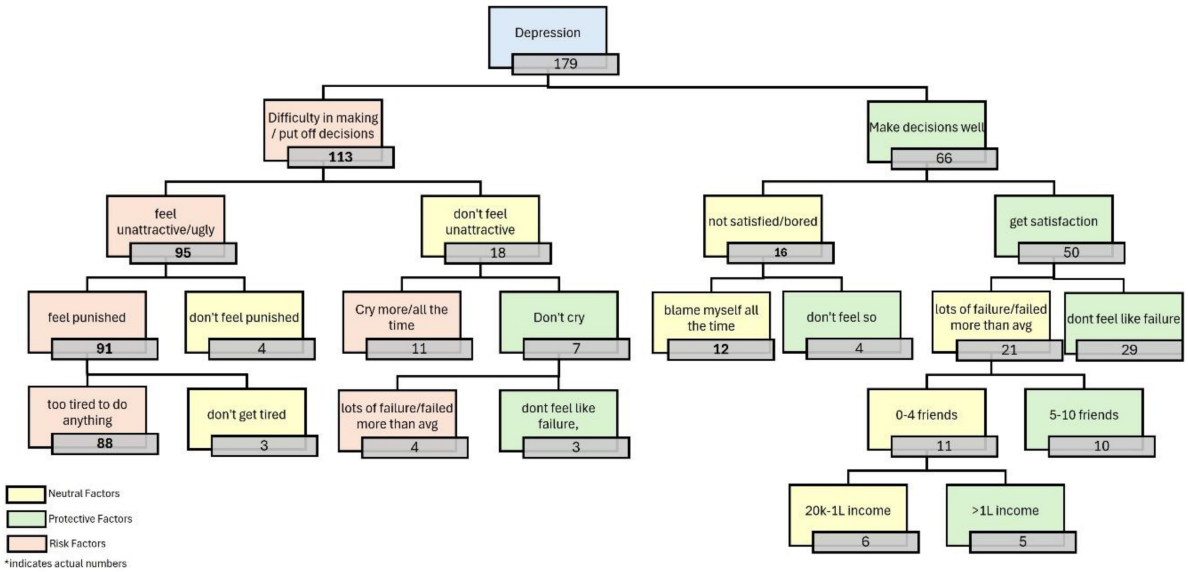

FIGURE 2 | CART analysis of variables affecting depression.

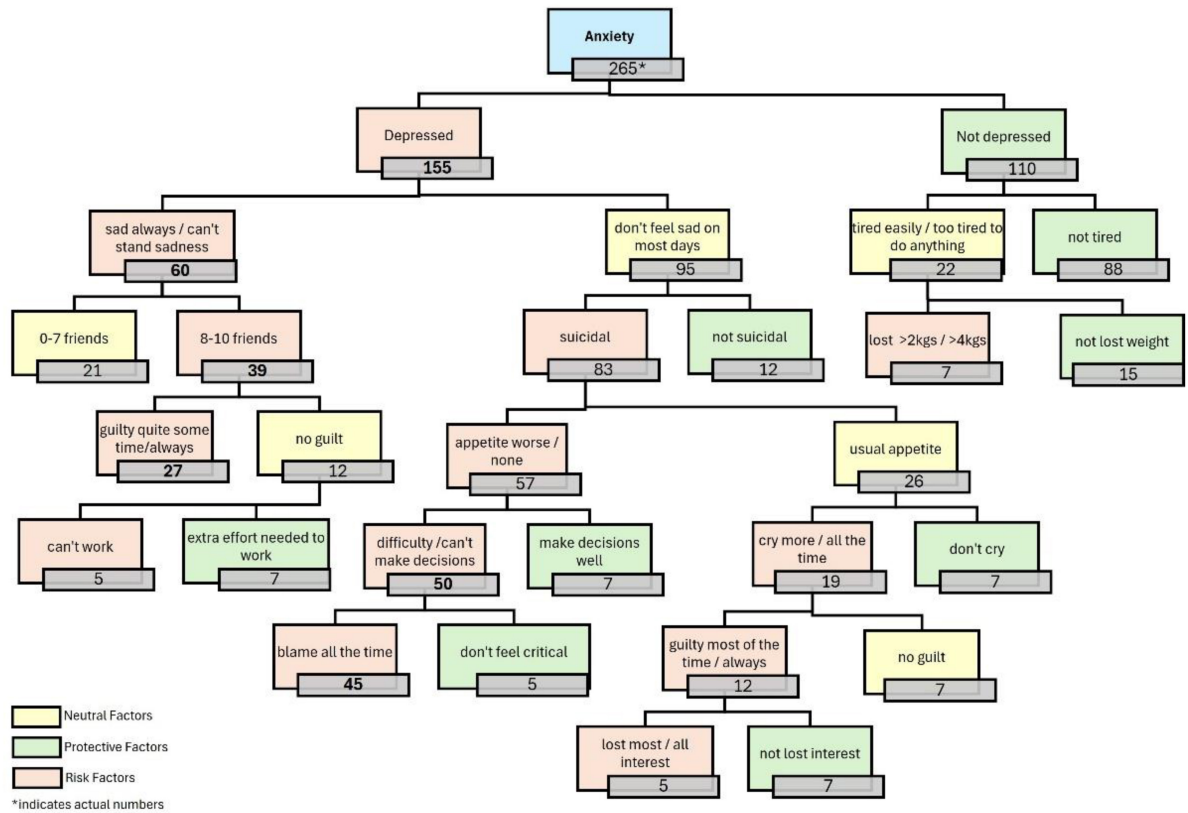

FIGURE 3 | CART analysis of variables affecting anxiety.

tests of endurance and personal sacrifice, including intense competition, emotional and interpersonal conflicts, heavy workload, limited personal time, and lack of adequate support systems, thereby creating a fertile breeding ground conducive to the development of mental health problems. While many do survive, a few may tragically succumb. Past research has clearly documented the universally higher prevalence and rising trend of mental health problems among medical students when compared to the general population. Indian research evidence broadly divides the risk factors for the above into academic (examination failure, excessive clinical work, and burnout) and non-academic (relationship and family issues) factors. There is a paucity of Indian research focusing on the subtle and not-so-obvious

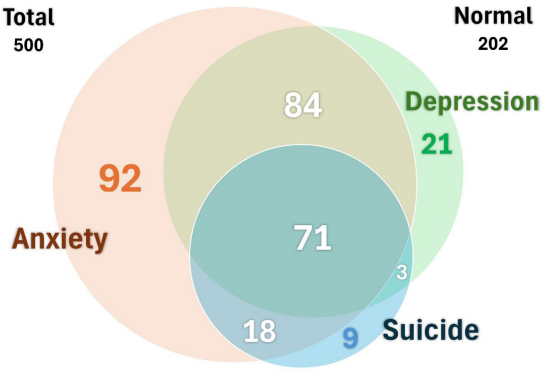

FIGURE 4 | Prevalence of suicidal ideation, anxiety, and depression among undergraduates in Tamil Nadu.

risk factors and behavioral traits that may be helpful in the early recognition and management of mental health problems. Computer-based information systems (CBIS) is one of the newest analytical methods that has been used in medical research and has proved to be a valid, sensitive, and reliable method (23–25). To our knowledge, there are very few Indian studies that have employed this newest analytical tool to discover previously unknown patterns and relationships in data sets. In our study, we have used computer-based predictive modeling in an attempt to uncover and understand hitherto unrecognized risk factors and protective factors and their effect pathways that lead to suicide, depression, and anxiety.

We found a prevalence rate of 20.2% for suicidal ideation, 35.8% for depression, and 53% for anxiety among our subjects. We observed that 14.2% of our students had concurrent anxiety, depression, and suicidal ideation, as summarized in **Figure 4**. This is significant because the presence of two or more of these comorbid conditions can lead to a drastic deterioration in the mental well-being of a student. The complex interplay between these mental health variables and their bearing on the student's psychological well-being is succinctly captured in **Figure 5**.

Sarkar et al., in their systematic review using data from 44 Indian studies, reported that the pooled prevalence rate of depression was 39.2% (26). Kumar et al., in their study from Mysore, South India, have reported a prevalence rate of 37.3% for depression and 50.6% for anxiety (27). Another cross-sectional study by Garg et al. among medical students of Northern India has reported lifetime rates of suicidal ideation, plans, and attempts as 20.3, 10.3, and 2.3%, respectively (28). Our prevalence rates are consistent with these Indian studies. Despite the cultural diversity of the Indian student population and the fact that we included students only from Tamil Nadu, our study found a surprising consistency with the results of the above-mentioned Indian studies.

Jahrami et al., in their umbrella review using 32 meta-analyses, revealed a pooled prevalence rate of 8.9% for suicidal ideation and 32.5% for depression and anxiety (29). Overall, one-third of our medical graduates were found to be depressed, a figure that is very similar to international reports. In contrast, we found that close to half of our students are having anxiety, and slightly less than a quarter of our graduates are having suicidal ideation. These higher levels of anxiety and suicidal ideation among Indian medical students could be explained by the higher levels of competitiveness to gain medical admissions, the intensive medical curriculum without appropriate learning resources, high levels of expectations from the students' families, and the lack of adequate mental health support systems for the students.

Consistent with the reports of Sarkar et al. (26), our female respondents had reported higher scores of depression, anxiety, and suicidal ideation when compared to their male counterparts. We observed that females had two times higher odds of having suicidal ideation than males. This predisposition of female medical graduates to depression may be due to the interaction of multiple factors like genetically determined vulnerability, effects of fluctuating hormonal levels on brain systems, gender-specific victimization, and internalization coping style.

We observed that the odds of having suicidal ideation were higher among students whose parents had frequent quarrels and also among graduates who said they were not fully satisfied with either maternal or paternal love. The family as a functional unit has attracted the attention of researchers to determine the role of dysfunctional parent and family experiences in the causation of behavioral problems. Johnson et al. (30) in a longitudinal study, have reported that maladaptive parental behavior in the form of constant parental quarreling and deprivation of child needs like love, attention, praise, and money was found to substantially mediate the development of psychiatric disorders during adolescence or early adulthood. Our findings are consistent with these studies.

Friends can be an important source of social, emotional and financial support to buffer the impact of potential external stressors. This could explain our observation that as the quality of relationship with one's classmates improved, there was also a decrease in anxiety, depression and suicidal ideation. Zhao et al., in their study looking at family, social relationships and coping styles amongst Chinese medical undergraduates observed that students who had bad relationships with their classmates or friends showed higher depression and anxiety scores (31). An interesting observation was that one-third of the students with few or no friends had suicidal ideation, a figure which was significantly higher than the overall prevalence of 20.2%. Poor social interactions can make students prone to poor mental resilience and contribute to negative attitudes while close, personal and enduring relationships foster a sense of security and connectedness. Therefore, medical students should be encouraged to join college clubs/groups to improve their overall mental health, thereby preventing suicide.

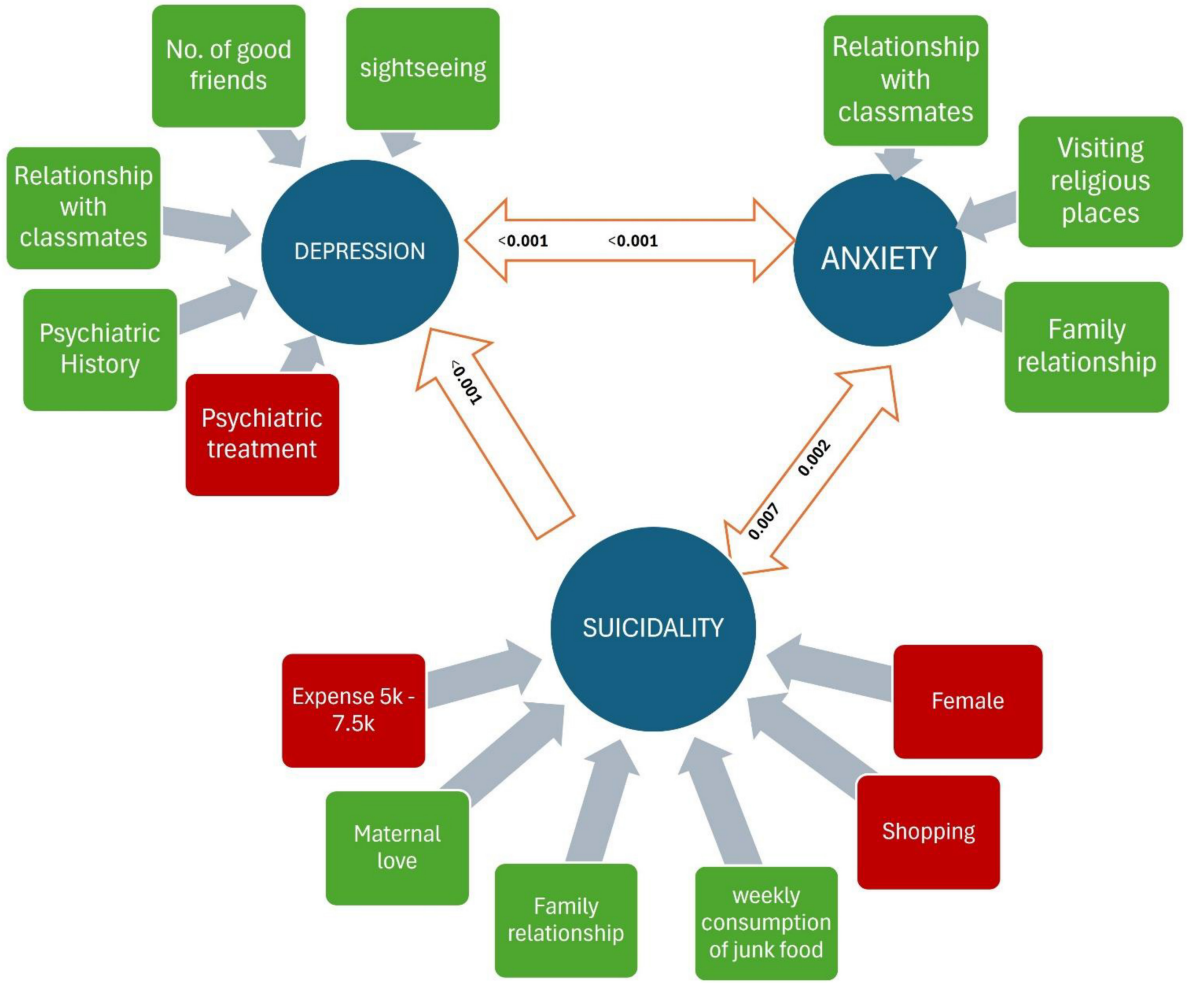

FIGURE 5 | Interrelationship of variables affecting suicidal ideation, depression, and anxiety in medical students.

About one-fifth of our students had reported consuming alcohol, and slightly less than one-tenth had used tobacco. Our findings are similar to the results of a systematic review by Roncero et al., who have reported 24% alcohol consumption and 17.2% tobacco use among medical students (32). Pradeep Kumar et al. have made a similar observation of higher substance use among professional college students, especially medical students (17.15–60.26%), compared to general college students (31.3–31.8%) (33). For many medical graduates, alcohol consumption and smoking tobacco may be a maladaptive way of coping with academic pressure and heavy clinical workload, while for others it is part of a prevailing medical student culture. Both these substances are legal, easily available, and associated with considerable underreporting. In keeping with past literature, our study has demonstrated that students who gave a history of weekly consumption of alcohol had significantly higher suicidal ideation (42.9%) when compared to those who never consumed alcohol (17.7%). Therefore, focusing on medical college-specific cultural factors that drive students to increase their consumption of psychoactive substances may be an important point of early intervention in improving their mental health and preventing future suicides.

Our multivariate analysis revealed approximately five times higher suicidal ideation among graduates who reported visiting shopping malls often. In contrast, students who went to religious places often had significantly lower anxiety, while students who went sightseeing had significantly lower depression. Shopping behavior has been linked with impulsivity and sensation seeking. Some individuals may take to shopping as a means of relieving themselves from negative emotions and experiences. Greenberg et al. have similarly observed that adolescents with problematic shopping had 3.43-fold higher odds of endorsing self-injurious behavior (34). Students who frequently visited religious places were found to have lower odds of anxiety. In a review of 35 studies on religion, spirituality and mental health, Koenig et al. have reported lower fear and anxiety among the more religious (35). In a cross-sectional study done on 285 Iranian medical students for association(s) between religiosity, anxiety, and depression, Vasegh et al. have found a significant negative association between religious beliefs and anxiety (36). Religious beliefs

such as greater faith in God, secure religious attachment, and intrinsic religious motivation can increase the sense of control, enhance feelings of security, and boost confidence. In the light of the research evidence presented above, and in the backdrop of 81% religiosity of the Indian population (37), spirituality can play an important role in improving the mental health of our medical graduates.

We also observed lower odds of depression among graduates reporting regular sightseeing (visiting beaches, parks, and other places of nature). Over the past four decades, countries have trialed a wide range of public health programs aimed at increase participation in outdoor activities, including visits to parks (38). Previous research by Toda et al. have established that travel, even in the form of short trips, can bring about a reduction in perceived stress and can improve positive mental health (39). In particular, exposure to nature provides a significant and varied set of mental health benefits (40). Our research findings are in line with these reports. Therefore, encouraging graduate students to embark on nature trips and outdoor excursions would greatly improve their mental health and well-being. Our surprising finding of significantly lower suicidal ideation among students consuming junk food weekly, a finding that is contrary to previous research by Jacob et al. (41) among adolescents, can also be explained by the improved socialization and chances for going off campus that these outings provide.

Similar to Bitonte et al. (42) we found a slightly more than two times chance of having suicidal ideation, depression, and anxiety among the graduates who never exercised. There is a large body of evidence in favor of exercise as a cost-effective remedy for bolstering both the physical and mental health of an individual (43). We believe that our research findings lay a firm ground for recommending the incorporation of a regular exercise schedule into the medical school curriculum, thereby ensuring adequate physical activity for all students.

Students who felt overwhelmed due to academic pressure were found to have twice the chance of having depression and higher odds of having anxiety and suicidal ideation. Steare et al., in their systematic review of 52 studies, have found a positive association in 48 studies between academic pressure and at least one mental health outcome, the most common being mixed anxiety and depression (44). 39.2% of our graduates reported academic stress. In a cross-sectional study in western India by Desai et al., half of the students had identified academic burden as a significant life stressor (45). Some of the important factors that contribute to academic stress in the Indian context include intense pressure to excel academically, which may be coupled with fear of failure, and a mismatch between the curricular load and the available study time.

Understanding the complex interrelationships underlying the variables of mental health and assessing the relevance of each of these risk factors can be a very challenging task for researchers. We therefore generated a CART using 41 independent variables identified during the preliminary data analysis, which were fed into this model.

74% of individuals who had suicidal thoughts and 60% of individuals who were anxious had depression. Thus, we observed that depression was the strongest risk factor for anxiety and suicidal ideation. Our findings are consistent with those of a meta-analysis by Seo et al. who have reported that medical students with comorbid depression are more likely to engage in suicidal ideation (8 studies, OR = 6.87, $p < 0.00001$) (46). We found that slightly more than half of our participants who had expressed dissatisfaction with maternal love had also reported suicidal ideation in the past year compared to 13.8% with full satisfaction of maternal love. Similar to our observation, Seo et al. have also reported a significantly higher risk of suicidal ideation among medical students who had a previous experience of being neglected by parents (4 studies, OR = 2.53, p = 0.03) or demanding parents (3 studies, OR = 2.04, p = 0.0001). Our model predicted that 36% of individuals who felt like crying most of the time, 27.7% who had lost >4 kg of body weight, and 36.8% those who had difficulty in making decisions were at significant risk for having suicidal ideation, even if they had not reported having other symptoms of depression.

Difficulty in decision-making was identified by our model as a significant predictor for suicidal ideation, anxiety, and depression. We observed that our analysis was able to correctly identify 36.1% of those with suicidal ideation, 74.6% of those with depression, and 80.5% of those with anxiety among those individuals who had reported difficulty in decision-making. Past research by Leykin et al. has established the fact that depression is strongly associated with maladaptive decision-making (47). Students who are depressed are likely to underestimate their ability and maintain a pessimistic portfolio of themselves. These individuals often have a reduced engagement in reward-seeking behaviors and a risk-averse approach to life. Delayed decision-making is likely to lead to many negative outcomes, the accumulation of which can further cause a reduced expectation of positive events and can therefore predispose these individuals to increased anxiety and suicidal ideation.

Our model has also identified increased fatiguability as predictive of depression among 49.2% of our students. Silva et al. have similarly reported that fatigue was the most prevalent symptom (55.9–74%) in medical students with depression (48). Our analysis also revealed feelings of unattractiveness and feelings of being punished as predictors of depression. 71% of those who expressed feelings of unattractiveness and 67.4% of those who felt punished were depressed. Consistent with these findings, research by Noles et al. have shown that depressed subjects were less satisfied with their bodies and saw themselves as less physically attractive when compared to nondepressed subjects (49).

91% of students who attempted suicide had anxiety and/or depression. Ideas of guilt and blaming oneself predicted anxiety among 66.5 and 68.4% of our graduates, respectively.

There is a growing body of research showing that guilt is an important feature of various psychological problems, including anxiety disorders (50).

All the above-mentioned risk factors are easy to identify and can be used for the early identification of students with mental health problems. Our model showed good sensitivity and moderate specificity, which may make it useful in a clinical setting where the identification of at-risk students takes priority over identifying healthy ones. Future researchers may want to pay particular attention to developing questionnaire items incorporating the predictors identified by our model.

Limitations

Inherent to any cross-sectional study, the model cannot accurately predict causation and future behaviors. Self-report questionnaires are also subject to self-selection bias, recall bias, response bias, and differences in participant insight. Despite these shortcomings, our study provides preliminary evidence to the existence of subtle and clinically identifiable predictors for suicidal ideation, depression, and anxiety among medical students in India. We therefore recommend future longitudinal studies to track the unfolding of these symptoms over the entire period of medical education.

Conclusion

Around one-fifth of our medical graduates had suicidal ideation, one-third had depression, and half had anxiety. Significantly higher suicidal ideation was associated with female gender, poor satisfaction with maternal love, disharmonious family, poor relationship with classmates, substance abuse, and frequent visits to shopping malls. The risk of having suicidal ideation, depression, and anxiety doubles among graduates who never exercised. Two-fifths of our graduates reported academic stress, and overwhelming academic pressure was found to double the chances of having depression. While visiting religious places was found to lower the odds of having anxiety, regular sightseeing resulted in a lesser risk of depression among our graduates. Our CART analysis predicted depression as the strongest risk factor for anxiety and suicidal ideation. Around one-third of students who felt like crying and those who had lost more than 4 kg of body weight were at significant risk for having suicidal ideation. Difficulty in decision-making emerged as a significant predictor for suicidal ideation (one-third of students) and anxiety and depression (three-fourths of students). Increased fatiguability, feelings of being unattractive, and feelings of being punished predicted depression in around half of our students. Ideas of guilt and blaming oneself predicted anxiety in two-thirds of our students. CART analysis has shown high sensitivity and specificity, making it a valuable tool in clinical research settings.

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Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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