

Anxiety and Depressive Symptoms among Undergraduate Health Sciences Students at a Rural South African University: Prevalence and Multivariable Correlates



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Abstract:

Introduction/Objective: Health sciences students may experience substantial anxiety and depressive symptoms, yet evidence from rural South African faculties remains limited. This study estimated the prevalence and severity of anxiety and depressive symptoms and examined associated sociodemographic, academic, and health-related characteristics.

Methods: A quantitative cross-sectional survey was conducted among undergraduate students enrolled in six programmes within the Faculty of Health Sciences at a rural South African university in 2024. Of 1,679 eligible students, 848 participated (50.5%). Anonymous questionnaires included the Generalized Anxiety Disorder-7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9). Descriptive, non-parametric, linear, and logistic regression analyses were performed.

Results: At least moderate anxiety symptoms (GAD-7 ≥ 10) were present in 34.0% of participants, while at least moderate depressive symptoms (PHQ-9 ≥ 10) were present in 55.9%. GAD-7 and PHQ-9 scores were strongly correlated (Pearson $r=0.65$, 95% CI 0.61–0.68; $p < 0.001$). In adjusted logistic models, lower household income, trauma history, and previous psychological support were associated ($p \leq 0.05$) with anxiety outcomes. Female sex, non-Medicine programme enrolment, and earlier study year were associated ($p \leq 0.05$) with depressive outcomes, while prior psychiatric history and psychological support showed inverse associations. Nagelkerke R^2 values were 0.12 for anxiety and 0.18 for depressive symptoms.

Discussion: The findings indicate a substantial burden of screening-positive anxiety and depressive symptoms in this rural health sciences cohort. Associations should be interpreted as exploratory, cross-sectional correlates rather than causal determinants or individual-level risk estimates.

Conclusion: Faculty-wide service-linked screening, trauma-informed counselling, first-year support, and coordinated academic, financial aid, and mental health services may help address student needs. Future longitudinal research should assess causal pathways and intervention effectiveness.

Keywords: Health professions education, Student mental health, GAD-7, PHQ-9, South Africa, Substantial anxiety and depressive symptoms.

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1. INTRODUCTION

Health sciences students, including those in medicine, nursing, dentistry, pharmacy and allied health, are widely recognised as facing distinctive academic and professional demands during training [1, 2]. Contemporary work increasingly frames their anxiety, depression, stress and burnout not only as individual welfare concerns but also as workforce and patient-safety issues, given evidence that student mental health influences learning, functioning and professional formation [3-5]. Across this literature, psychological distress is often used as an umbrella construct for co-occurring or non-specific symptom clusters that include anxiety and depression [6, 7]. Distress is typically defined as an uncomfortable emotional response to stressors that, when inadequately managed, manifests as depressive and anxiety symptoms and overlaps with burnout, positioning anxiety and depression within a broader distress spectrum that is frequently reported in health professions training [8, 9]. This conceptualisation supports the interpretation that anxiety and depression among health sciences students rarely occur in isolation; instead, they cluster with academic stress and burnout in mutually reinforcing ways [9, 10].

1.1. Global Evidence on Anxiety and Depression in Health-professions Education

Meta-analytic and synthesis studies consistently report substantial prevalence of depression and anxiety among medical students and broadly similar patterns in other health-profession groups [11-13]. Pooled estimates often suggest that a sizeable minority of medical students meet depression cut-offs, with anxiety affecting around one in three, and that stress, burnout and suicidal ideation are common [9-12]. Reviews also emphasise that by the end of undergraduate medical training, psychological distress levels exceed those of age-matched general-population peers, and that health-profession students overall show higher anxiety, depression and perceived stress than non-health-care peers [10-12]. At the same time, cross-field comparisons are mixed: some studies find higher depression or burnout in medical students, others find no differences or even lower anxiety/depression than in non-medical students, underscoring contextual heterogeneity rather than uniform elevation across all settings [13, 14].

The present study distinguishes anxiety symptoms, depressive symptoms, stress, burnout, psychological distress, and psychiatric disorders. Anxiety symptoms

refer to experiences assessed using the GAD-7, whereas depressive symptoms refer to experiences assessed using the PHQ-9. Stress refers to a perceived response to demands or pressures, while burnout usually describes emotional exhaustion, cynicism, or disengagement related to prolonged academic or occupational demands. Psychological distress is a broader, non-specific construct that may include anxiety, depressive symptoms, and stress, but it was not directly assessed in this study. Psychiatric disorders are clinical diagnoses that require professional assessment; in the present study, prior psychiatric disorder refers only to participants' self-reported history of a diagnosis by a health professional. Accordingly, the primary outcomes are reported as anxiety and depressive symptoms rather than diagnosed anxiety or depressive disorders.

1.2. Discipline-specific Patterns across Health Sciences Programmes

Discipline-specific evidence shows that these concerns extend beyond medicine. Nursing students frequently report very high levels of anxiety, stress and depression, sometimes exceeding those of other students and even working adults [15-18]. Dentistry students face demanding academic and clinical curricula, with some studies reporting higher depression/anxiety/stress than in the general population [19]. Pharmacy students are described as vulnerable to high stress and reduced quality of life, with calls for primary and secondary preventive strategies for depression [5, 20]. Allied health students also show noteworthy stress, burnout, anxiety, and depression, with variation across disciplines and countries but a recurring pattern of substantial symptom burden [21-23]. Collectively, this supports an interprofessional view of anxiety and depression as problems that emerge during training rather than only after entry into practice [4, 23]. Training environments are consistently implicated as central drivers. Intense academic schedules, frequent examinations, high expectations, sleep deprivation, peer competition, and poor work-life balance are repeatedly linked to stress, burnout, depression, and anxiety across health-professions programmes [3, 4, 10, 23, 24]. Clinical workload, emotionally demanding patient care, and financial burdens further contribute to distress [15, 18, 23, 24]. Depressive symptoms often emerge early: first-year students can experience distress linked to environmental and psychosocial changes, and some nursing and medical

studies note that depressive and anxiety symptoms can increase during training, suggesting that education itself may precipitate or exacerbate symptoms in previously healthy students [20, 25, 26].

1.3. The South African Rural University Context and the Contribution of the Study

Rural South African universities often serve students from lower-income, rural or peri-urban communities who may have attended under-resourced schools and depend on bursaries or family support. Financial uncertainty regarding tuition, accommodation, transport, food and learning materials may add to the pressures of demanding health sciences programmes. Although food insecurity, funding delays and prior educational disadvantage were not measured in this study, they are relevant contextual considerations. Access to mental-health support may also be constrained by limited service availability, travel costs, academic or clinical-placement commitments, confidentiality concerns and stigma, which can discourage help-seeking. By focusing on a rural faculty with high proportions of students from low-income households, high bursary reliance, and substantial reported trauma exposure, the study addresses a clear evidence gap and responds to calls for institution-level data to inform mental health promotion in diverse health sciences settings.

The study is novel in that it provides an inter-professional, faculty-wide assessment of anxiety and depression among undergraduate health sciences students at a rural South African university, using validated screening tools (GAD-7, PHQ-9) and multivariable modelling to examine a broad set of socio-demographic, academic and health-related determinants within a single, census-invited cohort. In addition to structural, academic and socioeconomic circumstances, psychological processes may help explain why students exposed to similar stressors experience different levels of anxiety and depressive symptoms.

1.4. Mindfulness and Emotion Regulation as Psychological Mechanisms

Mindfulness and emotion-regulation strategies may help explain why students exposed to similar academic, financial, and interpersonal stressors experience different levels of anxiety, depressive symptoms, and well-being. Mindfulness, non-judgmental, present-moment awareness, may be protective by promoting acceptance and flexible responses to distressing thoughts and emotions [27]. In contrast, adaptive emotion-regulation strategies, such as planning, positive reappraisal and acceptance, may support well-being, whereas self-blame, rumination and catastrophising may prolong distress and contribute to anxiety and depressive symptoms [28]. Evidence among university students indicates that mindfulness is positively associated with well-being, while planning predicts higher well-being and self-blame predicts lower well-being [29]. Although mindfulness and emotion-regulation strategies were not assessed in the present study, they provide a useful framework for understanding variation in student

anxiety and depressive symptoms and identify potentially modifiable targets for future intervention research.

1.5. Study Rationale and Objectives

Despite growing international literature on anxiety and depressive symptoms among health sciences students, African and South African evidence remains limited, particularly for studies that include multiple health sciences programmes within rural university settings. The present study, therefore, provides an interprofessional, faculty-wide assessment of anxiety and depressive symptoms using the GAD-7 and PHQ-9 and examines their cross-sectional socio-demographic, educational and health-related correlates. Previous research has focused disproportionately on medical students, with less attention to pharmacy, allied health, and interdisciplinary cohorts, thereby limiting cross-disciplinary comparisons and the design of tailored interventions [2, 4, 5, 23]. Comparative findings between medical and non-medical students are heterogeneous, and measurement differences, institutional context, and timing (*e.g.*, pre- vs post-COVID-19) appear to influence observed risk patterns [13, 14]. Mindfulness and emotion-regulation strategies may help explain why students exposed to similar academic, financial, and interpersonal stressors experience different levels of anxiety, depressive symptoms, and well-being.

By focusing on a rural faculty with high proportions of students from low-income households, substantial bursary reliance, and notable trauma exposure, this study addresses a clear evidence gap and responds to calls for institution-level data to inform mental-health promotion in diverse health sciences settings. The rationale for conducting the study in South Africa rests on three considerations: (i) documented global concern about high levels of anxiety and depressive symptoms in health-professions students, with emerging but still sparse African and South African data; (ii) the specific socioeconomic and educational context of a rural South African university, where students frequently face financial strain, family disruption and under-resourced schooling, potentially amplifying anxiety and depressive symptoms beyond patterns described in high-income settings; and (iii) the strategic importance of health sciences students as a future workforce in an already constrained health system, making their mental health a workforce and patient-safety issue rather than only an individual welfare concern.

Accordingly, the study objectives were:

- To estimate the cross-sectional prevalence and severity of anxiety and depressive symptoms among undergraduate students across all programmes in the Faculty of Health Sciences.
- To describe how anxiety and depressive symptom levels vary across key socio-demographic, educational and health-related characteristics.
- To examine cross-sectional associations between these characteristics and total GAD-7 and PHQ-9 scores using multivariable linear regression and multivariable logistic

regression, identifying variables that are independently associated with higher or lower anxiety and depressive symptoms.

2. MATERIALS AND METHODS

2.1. Study Design and Population

A quantitative, cross-sectional, descriptive design was used to assess levels of anxiety and depression and their association with socio-demographic, educational, and health-related characteristics. The study was conducted in the Faculty of Health Sciences at a public university located in a rural province of South Africa. The institution is classified as a rural university because it is situated outside major metropolitan centres and predominantly serves students from rural and peri-urban communities. The faculty offers six undergraduate professional programmes: Nursing Sciences, Pharmacy, Medical Sciences, Medicine, Human Nutrition and Dietetics, and Optometry, each structured as full-time, multi-year curricula with a combination of preclinical classroom-based teaching and progressively intensive clinical placements at regional and district hospitals and primary-care facilities. All undergraduate students enrolled in 2024 in Nursing Sciences, Pharmacy, Medical Sciences, Medicine, Human Nutrition and Dietetics, and Optometry formed the study's total population ($N = 1679$). Of the 1,679 eligible students, 848 completed valid questionnaires (overall participation 50.5%). The remaining 831 students were either not present at any data-collection session, declined to participate, or returned incomplete questionnaires. Precise counts by disposition (absent, declined, incomplete) were not systematically recorded, which is a limitation for assessing nonresponse bias.

2.2. Inclusion and Exclusion Criteria

Eligible participants were (i) 18 years of age or older, (ii) currently enrolled as undergraduate students in one of the six Faculty of Health Sciences programmes during the 2024 academic year, and (iii) willing and able to provide written informed consent and complete the study questionnaire. Students were excluded if they (i) were younger than 18 years, (ii) were enrolled only in non-undergraduate programmes (*e.g.* Department of Public Health programmes or postgraduate degrees), or (iii) declined or withdrew consent.

2.3. Data Collection Process and Tools

Data collection took place over four weeks in October 2024, during the second semester, when students were preparing for the examination. This timing is relevant because examination proximity is associated with increased academic pressure and may influence anxiety and depressive symptom reports. On data-collection days, researchers approached classes that met the inclusion criteria, explained the study's purpose and procedures, and distributed a participant information leaflet. Students who agreed to participate signed an informed consent form and completed self-administered questionnaires

privately, with adequate time provided to ensure completion.

The questionnaire comprised three sections. Section A captured socio-demographic and academic information, including age, sex, ethnolinguistic group, year and programme of study, bursary, household income, monthly allowance, family residence, living arrangements, relationship and parental status, and indicators of academic performance and clinical history. Bursary/funding status was captured with a yes/no item asking whether the student received any bursary, scholarship, or external financial aid to support their studies. This indicator does not directly measure financial hardship: bursaries can be awarded on a merit or equity basis, and some funded students may have relatively secure financial circumstances, while some unfunded students may experience substantial financial strain. Moreover, the questionnaire did not assess food insecurity, unmet basic needs, or delays in bursary disbursement. In this study, bursary status is therefore interpreted as an institutional and financial-aid characteristic and a potential marker of funding dependence, but not as a direct measure of financial hardship. Trauma history was captured with a lifetime yes/no item asking whether participants had experienced any event they considered traumatic or very disturbing (*e.g.*, serious accidents, assault, life-threatening violence, sudden bereavement). No specific time frame or diagnostic criteria were imposed. Psychiatric history was assessed by asking whether the student had ever been told by a doctor, psychologist, or other health professional that they had a mental health or psychiatric condition (*e.g.* depression, anxiety disorder, bipolar disorder). Students who reported 'yes' were considered to have a prior psychiatric history. The item did not separately record the exact diagnosis, age at diagnosis, or duration of the condition, and diagnoses were based on self-report rather than verification of clinical records, implying that this variable reflects perceived or recalled prior diagnosis rather than formally confirmed lifetime psychiatric morbidity. Previous psychological support was assessed using a yes/no item asking whether the student had ever received professional psychological or counselling services (*e.g.*, from a psychologist, counsellor, psychiatrist, or university counselling centre) for emotional, behavioural, or mental-health concerns. The question covered any contact before or during university; we did not distinguish between support obtained before enrolment and support received during the current academic year, nor did we collect details on the number of sessions, modality, or setting. This variable therefore identifies students who have had any professional mental-health contact, but does not distinguish intensity, recency, or type of intervention.

Section B assessed depressive symptoms using the Patient Health Questionnaire-9 (PHQ-9), and Section C assessed anxiety using the Generalized Anxiety Disorder-7 (GAD-7) scale. Both instruments are brief, validated screening tools widely used in university populations [30-32] and also in the South African context [33, 34]. The questionnaires were administered in English, the

university's primary language of instruction; items were reviewed for appropriateness in the local context, and the research team provided clarification where needed. In this sample, internal consistency was good (Cronbach's alpha 0.77 for PHQ-9; 0.76 for GAD-7).

The GAD-7 and PHQ-9 were scored and interpreted using standard clinical cut-offs.

For GAD-7, total scores (0-21) were categorised as: 0-4 minimal, 5-9 mild, 10-14 moderate, and 15-21 severe anxiety; a score ≥ 10 indicated at least moderate anxiety. For PHQ-9, total scores (0-27) were categorised as: 0-4 minimal, 5-9 mild, 10-14 moderate, 15-19 moderately severe, and 20-27 severe depression; a score ≥ 10 indicated at least moderate depressive symptoms.

Questionnaires with any missing items on GAD-7 or PHQ-9 were excluded from analyses (only 8 participants) involving that outcome; no imputation or prorating was performed. Given the ethnolinguistic diversity of the faculty, instruments were administered in English with on-site clarification available, and the observed reliability and expected correlates suggest adequate comprehension, although formal equivalence testing across language/cultural groups was not conducted.

The primary outcomes in this study were GAD-7 and PHQ-9 scores, representing anxiety and depressive symptoms, respectively; psychological distress as a broader construct was not assessed using a dedicated instrument.

2.4. Bias

Bias in this study was minimised but could not be fully eliminated. The use of a cross-sectional survey and self-administered questionnaires created the potential for selection and response bias, as students who were present in class, willing to participate, and comfortable disclosing psychological symptoms may have differed systematically from those who were absent, declined to participate, or did not complete the questionnaire. Nonresponse bias is an important concern. Only 50.5% of eligible students contributed analysable data, and reasons for non-participation (absence, refusal, incomplete questionnaires) may be related to mental-health status or academic pressures. Students experiencing higher distress might have been more or less likely to participate, and students on clinical rotations or off-campus placements were harder to reach. As a result, prevalence estimates and associations may be conservative or inflated, and the findings should be interpreted with caution regarding generalisability to the full faculty population. Self-report measurement of anxiety and depression using the GAD-7 and PHQ-9 also introduced the possibility of recall and social-desirability bias, with some participants under- or over-reporting symptoms because of stigma or misunderstanding of items. To reduce these biases, the study used anonymous questionnaires and standardised, validated instruments, and invited all eligible students in the faculty to participate during routine teaching sessions to reach a broad range of students.

2.5. Data Capture and Analysis

Completed questionnaires were captured in Microsoft Excel and exported to IBM SPSS Statistics version 30 for analysis. Socio-demographic and academic variables were summarised using frequencies and percentages. PHQ-9 and GAD-7 scores were calculated and categorised into standard severity groups. Normality was assessed using the Shapiro-Wilk test. Group differences in GAD-7 and PHQ-9 scores across categorical variables were examined using non-parametric tests (Mann-Whitney U and Kruskal-Wallis), and correlations between continuous scores were assessed using appropriate correlation coefficients.

Multivariable associations between socio-demographic, educational, and health-related characteristics and total GAD-7 and PHQ-9 scores were examined using multiple linear regression. Because the Total GAD-7 and Total PHQ-9 scores were not normally distributed, we examined linear regression assumptions and model diagnostics. Residual plots were inspected to assess linearity and homoscedasticity, and normal probability plots were used to evaluate the distribution of residuals. Multicollinearity was assessed using variance inflation factors (VIFs) and tolerance values for all predictors. Influential observations were examined using leverage and Cook's distance; we considered Cook's distance values >1 as indicating potentially influential cases. To reduce the impact of any heteroscedasticity, we estimated robust (HC3) standard errors for all regression coefficients. Nominal variables (academic programme, ethnolinguistic group, living arrangement, and others) were entered using dummy coding, with Medicine, Pedi, 22-23 years, final year of study, Christian religion, highest household income and allowance bands, urban family residence, living with both parents, and university residence specified as reference categories. Binary variables were coded 0 = reference category and 1 = comparison category.

In addition to linear regression on continuous GAD-7 and PHQ-9 scores, we conducted multivariable logistic regression analyses using binary outcomes defined by established screening cutoffs: GAD-7 ≥ 10 (at least moderate anxiety) and PHQ-9 ≥ 10 (at least moderate depressive symptoms). These logistic models were treated as the primary analyses because the study emphasises prevalence based on cutoff scores. The same set of socio-demographic, educational, and health-related predictors used in the linear models was included. Results are presented as adjusted odds ratios (aOR) with 95% confidence intervals (CIs). We report Nagelkerke R^2 as an effect-size measure for the logistic models. Given the exploratory nature of the analyses and the number of predictors, we did not apply formal multiple-testing corrections; instead, we emphasise the magnitude and direction of adjusted estimates and their confidence intervals rather than relying solely on p -values.

Analyses were largely exploratory. The covariate set was chosen on theoretical grounds: socio-demographic, educational and clinical/trauma variables have been

repeatedly linked in prior research to student anxiety, depression and broader psychological distress, and were therefore treated as potential correlates and confounders rather than causal determinants. The models were not designed to test causal hypotheses but to characterise cross-sectional patterns of association.

2.6. Ethics

Ethical approval for the study was obtained from the Turfloop Research Ethics Committee (TREC/1494/2024: UG), and written permissions were secured from the university authorities. Participation was voluntary, anonymity and confidentiality were maintained through the use of non-identifiable questionnaires, and all procedures adhered to relevant institutional and national research ethics guidelines. Written informed consent was obtained from all participants prior to data collection. All human research procedures were conducted in accordance with the ethical standards of the institutional research committee and the 1964 Declaration of Helsinki and its later amendments, or with comparable ethical standards.

3. RESULTS

3.1. Socio-demographic, Educational and Health-related Characteristics of the Participants

The sample included 848 students, predominantly female (62.5%) and aged 18-21 years (70.4%). Most participants identified as Pedi (54.7%) and reported Christian affiliation (80.3%). A large proportion came from rural areas (80.1%) and lower- to middle-income

households, with nearly two-thirds earning below ZAR 20,000 per month. Academically, students were drawn from various health science programmes, with the largest groups in Pharmacy (27.0%) and Optometry (20.1%). First-year students comprised the biggest cohort (30.1%). Most participants received bursary support (80.1%), although allowances were generally modest. Academic failure (8.4%) and year repetition (4.6%) were relatively uncommon. Clinically, few participants reported chronic conditions (7.7%) or prior psychiatric diagnoses (4.7%). However, nearly one-third (31.4%) had experienced traumatic events. Despite this, only 15.7% had accessed professional psychological support, suggesting limited utilisation of mental health services (Table 1).

To assess representativeness, the analytic sample was compared with available 2024 Faculty of Health Sciences registration data for gender, programme and year of study. The sample had a similar gender distribution to the faculty population (62.5% female in the sample vs 61.2% in the faculty) and included students from all six programmes. The proportions of students by programme and first-year status (30.1% in the sample vs 28.2% in the faculty) were broadly comparable with faculty registration data. However, because the response rate was 50.5% and information on non-participants’ mental-health symptoms and other individual characteristics was unavailable, selection and nonresponse bias cannot be excluded. The results should therefore be interpreted as reflecting the mental-health profile of students who were present and willing to participate, rather than as a fully representative snapshot of the entire faculty.

Table 1. Sociodemographic, educational, and health-related characteristics (n=848).

Social and Demographic Characteristics			
	Category	Frequency	Percentage
Gender	Male	318	37.5
	Female	530	62.5
Age group (in years)	18-19	314	37.0
	20-21	283	33.4
	22-23	147	17.3
	>24	104	12.3
Ethnolinguistic group	Pedi	464	54.7
	Tsonga	136	16.0
	Venda	103	12.1
	Other	145	17.2
Religious affiliation	Christian	681	80.3
	None/other	167	19.7
Household income category (ZAR)	0-5000	174	20.5
	5001-10000	203	23.9
	10001-20000	173	20.4
	>20000	298	35.1
Usual family residence	Rural	679	80.1
	Urban	169	19.9
Lives with	Single parent	344	40.6
	Both parents	396	46.7
	Relatives/others	108	12.7

(Table 1) contd.....

Social and Demographic Characteristics			
	Category	Frequency	Percentage
Parental status	Yes	66	7.8
	No	782	92.2
Relationship status	In a relationship	274	32.3
	Single	574	67.7
Educational characteristics			
Academic programme	Pharmacy	229	27.0
	Medicine	127	15.0
	Optometry	171	20.1
	Nursing	145	17.1
	Human Nutrition and Dietetics	95	11.2
	Medical Sciences	81	9.6
Current study year	Year 1	255	30.1
	Year 2	215	25.4
	Year 3	169	19.9
	Year 4 or above	209	24.6
Receives bursary/funding	Yes	679	80.1
	No	169	19.9
Monthly allowance (in ZAR)	<500	50	5.9
	501-2000	588	69.3
	>2000	210	24.8
Current accommodation type	In the university Residence	615	72.5
	In a private residence	233	27.5
Failed a module this academic year	Yes	71	8.4
	No	777	91.6
Repeating the academic year	Yes	39	4.6
	No	809	95.4
Health-related characteristics			
Chronic physical condition	Yes	65	7.7
	No	783	92.3
History of traumatic events	Yes	266	31.4
	No	582	68.6
History of psychiatric disorder	Yes	40	4.7
	No	808	95.3
Ever received Professional psychological support	Yes	133	15.7
	No	715	84.3

Note: Data are presented as n (%). Percentages are based on the number of respondents with non-missing data for each variable. Monthly allowance categories are in South African Rands (ZAR). Accommodation type refers to the student's usual place of residence during the academic year.

3.2. Prevalence of Anxiety and Depression among Faculty of Health Sciences Students

Table 2 shows the distribution of GAD-7 anxiety severity by degree programme (n = 848). Mild anxiety was the most common category across most programmes, ranging from 27.1% (Pharmacy) to 59.3% (Medical Sciences). Pharmacy students had the highest proportion with no anxiety (38.0%) and a relatively low proportion with severe anxiety (9.1%). In contrast, Human Nutrition and Dietetics students reported the highest level of severe anxiety (17.9%), while Medical Sciences students had the highest proportion with mild anxiety (59.3%) and very low severe anxiety (2.4%). Medicine, Optometry, and Nursing students showed similar patterns, with more than half in the mild category (55.1%, 36.9%, and 51.8%, respectively)

and substantial proportions in the moderate category (26.0%, 29.2%, and 30.3%, respectively).

Table 3 shows the distribution of PHQ-9 depression severity by degree programme (n = 848). Moderate depression was the most common category overall, with Medicine (48.8%) and Medical Sciences (59.3%) students showing the highest proportions. Pharmacy students had the lowest levels of more severe depression, with only 3.1% in the moderately severe category and 0.8% in the severe category. In contrast, Nursing students exhibited the highest proportion of moderately severe depression (32.4%), followed by Optometry (24.0%) and Human Nutrition and Dietetics (15.8%). Severe depression was most prevalent among Human Nutrition and Dietetics students (13.7%), while Medical Sciences students had the lowest proportion (1.2%).

Table 2. GAD-7 anxiety severity by health sciences degree programme (n = 848).

Degree Programme	GAD-7 Categories				
	None (%) CI (lower; upper)	Mild (%) CI (lower; upper)	Moderate (%) CI (lower; upper)	Severe (%) CI (lower; upper)	Total
Pharmacy	87 (38.0%) [31.70;44.28]	62 (27.1%) [21.32; 32.83]	59 (25.8%) [20.10;21.43]	21 (9.1%) [5.43; 12.91]	229
Medicine	16 (12.6%) [6.83;18.37]	70 (55.1%) [46.47; 63.77]	33 (26.0%) [18.36; 33.61]	8 (6.3%) [2.07; 10.52]	127
Optometry	40 (23.4%) [17.05; 29.74]	63 (36.9%) [29.61; 44.07]	50 (29.2%) [22.42; 36.08]	18 (10.5%) [5.93; 15.13]	171
Nursing	20 (13.8%) [8.18; 19.41]	75 (51.8%) [43.59; 59.86]	44 (30.3%) [22.86; 37.83]	6 (4.1%) [0.90; 7.38]	145
Human Nutrition and Dietetics	31 (32.6%) [23.20; 42.06]	26 (27.4%) [18.40; 36.33]	21 (22.1%) [13.76; 30.45]	17 (17.9%) [10.19; 25.60]	95
Medical Sciences	22 (27.2%) [17.47; 36.85]	48 (59.3%) [48.56; 69.96]	9 (11.1%) [4.27; 17.96]	2 (2.4%) [0.00; 5.85]	81

Note: Data are presented as n (% within programme). 95% confidence intervals (CIs) for proportions were calculated using the Wilson method.

Table 3. PHQ-9 depression severity by health sciences degree programme (n = 848).

Degree Programme	PHQ-9 Categories					Total
	None (%) CI (lower; upper)	Mild (%) CI (lower; upper)	Moderate (%) CI (lower; upper)	Moderately Severe (%) CI (lower; upper)	Severe (%) CI (lower; upper)	
Pharmacy	63 (27.5%) [21.73; 33.29]	85 (37.1%) [30.86; 43.38]	49 (21.4%) [16.09; 26.71]	% [6.88; 14.96]	7 (3.1%) [0.83; 5.29]	229
Medicine	10 (7.9%) [3.19; 12.56]	36 (28.4%) [20.51; 36.18]	62 (48.8%) [40.13; 57.51]	15 (11.8%) [6.20; 17.42]	4 (3.1%) [0.11; 6.19]	127
Optometry	32 (18.7%) [12.87; 24.56]	38 (22.2%) [15.99; 28.45]	53 (31.0%) [24.06;37.93]	41 (24.0%) [17.58; 30.38]	7 (4.1%) [1.12; 7.06]	171
Nursing	6 (4.1%) [0.90; 7.38]	34 (23.4%) [16.55; 30.34]	53 (36.6%) [28.71; 44.39]	47 (32.4%) [24.8; 40.03]	5 (3.5%) [0.48; 6.42]	145
Human Nutrition and Dietetics	20 (21.1%) [12.85; 29.25]	29 (30.5%) [21.27; 39.79]	18 (18.9%) [11.07; 26.83]	15 (15.8%) [8.46; 23.2]	13 (13.7%) [6.77; 20.60]	95
Medical Sciences	4 (4.9%) [0.22; 9.66]	17 (21.0%) [12.12;29.86]	48 (59.3%) [48.56; 69.96]	11 (13.6%) [6.12; 21.04]	1 (1.2%) [0.00; 3.64]	81
Total	135	239	283	154	37	848

Note: Data are presented as n (% within programme). 95% confidence intervals (CIs) for proportions were calculated using the Wilson method.

Total GAD-7 and Total PHQ-9 scores were strongly and positively correlated. The Pearson correlation coefficient was $r = 0.65$ (95% CI 0.61–0.68, $p < 0.001$), indicating a large linear association between higher anxiety and higher depressive symptoms. The Spearman rank correlation was $\rho = 0.62$ (95% CI 0.58–0.66, $p < 0.001$), confirming that this association was robust to the non-normal distribution of scores.

3.3. Group Differences in GAD-7 and PHQ-9 Scores across Socio-demographic, Educational and Health-related Characteristics

Table 4 presents non-parametric comparisons of GAD-7 and PHQ-9 scores across sociodemographic, educational, and health-related characteristics (n = 848). For anxiety, significant differences were observed by age group ($p = 0.007$), ethnolinguistic group ($p = 0.009$), academic programme ($p = 0.001$), current study year ($p = 0.001$), bursary status ($p = 0.012$), monthly allowance ($p = 0.001$), parental status ($p = 0.038$), history of traumatic events ($p = 0.037$), history of psychiatric disorder ($p <$

0.001), and prior psychological support ($p < 0.001$). Students aged 22–23 years had the lowest median anxiety scores (median = 7), while those with a history of psychiatric disorder reported the highest (median = 13). Pharmacy students had the lowest median anxiety score (7), compared with Nursing students (9).

For depression, significant differences were found by gender ($p = 0.017$), age group ($p = 0.001$), ethnolinguistic group ($p = 0.026$), usual family residence ($p = 0.006$), academic programme ($p = 0.001$), current study year ($p = 0.001$), failed module status ($p < 0.001$), repeating the academic year ($p = 0.016$), chronic physical condition ($p = 0.037$), history of psychiatric disorder ($p < 0.001$), and prior psychological support ($p < 0.001$). Female students had higher median depression scores than males (11 vs 9), and students who had failed a module reported higher scores than those who had not (13 vs 10). Those with a history of psychiatric disorder had the highest median depression scores (15.5), while Medical Sciences students had the highest programme-specific median (12).

Table 4. Non-parametric group differences in GAD-7 and PHQ-9 scores across socio-demographic, educational and health-related characteristics (n=848).

Sociodemographic, Educational, and Health-related Characteristics		GAD-7						PHQ-9					
		Median	IQR Low	IQR High	Test Statistic	Effect Size	p-value	Median	IQR Low	IQR High	Test Statistic	Effect Size	p-value
Gender	Male	8	5	12	77884.0	0.075	0.063	9	5	14	76092.5	0.097	0.017
	Female	9	6	12				11	7	14			
Age group (in years)	18-19	9	6	12	11.947	0.010	0.007	12	7	16	37.810	0.004	<0.001
	20-21	9	5.5	12				11	7	13			
	22-23	7	4	11				8	4	12			
	>24	9	5	12.25				8	5	14			
Ethnolinguistic group	Pedi	9	6	12	11.412	0.009	0.009	11	7	14	9.197	0.007	0.026
	Tsonga	7	4	10				9	5	13			
	Venda	10	6	12				10	7	14.5			
	Other	8	6	11				11	7	15			
Religious affiliation	Christian	9	6	12	58950.5	-0.036	0.461	11	6	14	62060.0	-0.091	0.066
	None/other	9	5	12				10	6	13			
Household income category (ZAR)	0-5000	8	5	14	8.182	0.006	0.004	10	6	13	2.766	-0.001	0.429
	5001-10000	8	5	11				10	6	13			
	10001-20000	8	5	12				12	6	15			
	>20000	9	6	12				10	7	14			
Usual family residence	Rural	9	5	12	56456.5	0.016	0.746	10	6	14	49664.0	0.134	0.006
	Urban	9	5	12				12	8	15			
Lives with	Single parent	9	6	12	3.848	0.002	0.145	11	7	14.25	8.823	0.008	0.012
	Both parents	8	5	12				10	6	14			
	Relatives/others	8	5	11				8	4	13			
Parental status	Yes	9	7	14	29756.5	-0.153	0.038	8	5.25	12	28490.5	-0.104	0.159
	No	8	5	12				9	5	12			
Relationship status	In a relationship	8	5.25	12	77788.0	0.010	0.798	11	6	14	76979.5	0.021	0.618
	Single	9	5	12				10	7	14			
Academic programme	Pharmacy	7	4	12	19.954	0.017	0.001	7	4	11	72.545	0.079	<0.001
	Medicine	9	7	11				11	8	14			
	Optometry	10	6	12				11	7	15			
	Nursing	9	6	11				13	9	16			
	Human Nutrition and Dietetics	9	5	14				9	5	16.5			
	Medical Sciences	7	5	9				12	9	13			
Current study year	Year 1	9	6	12	2.724	-0.001	0.436	11	8	15.5	54.083	0.060	<0.001
	Year 2	8	6	12				12	8	15			
	Year 3	10	6	12				10	7	13			
	Year 4 or above	8	5	12				7	4	11			
Receives bursary/funding	Yes	8	5	12	50257.0	0.124	0.012	10	6	14	54041.0	0.058	0.241
	No	10	6	12				11	7	14			
Monthly allowance (in ZAR)	<500	10.5	6.25	14.75	14.080	0.014	<0.001	10	8	13.75	0.349	-0.001	0.839
	501-2000	8	5	11.25				10	6	14			
	>2000	10	6	12				10.5	6	15			
Current accommodation type	In the university Residence	9	5	12	74515.5	-0.040	0.366	10	6	14	68530.5	0.043	0.326
	In a private residence	9	6	11				11	6	14			
Failed a module this academic year	Yes	9	6	12	28558.0	-0.035	0.621	13	9	16.5	34954.5	-0.267	<0.001
	No	9	5	12				10	6	14			
Repeating the academic year	Yes	9	7	12.5	17703.0	-0.122	0.196	13	11	14.5	19353.5	-0.226	0.016
	No	8	5	12				10	6	14			

(Table 4) contd....

Sociodemographic, Educational, and Health-related Characteristics		GAD-7						PHQ-9					
		Median	IQR Low	IQR High	Test Statistic	Effect Size	p-value	Median	IQR Low	IQR High	Test Statistic	Effect Size	p-value
Chronic physical condition	Yes	9	7	11	26832.0	-0.054	0.464	12	8	15	29391.0	-0.154	0.037
	No	9	5	12				10	6	14			
History of traumatic events	Yes	10	6	13	29391.0	-0.154	0.037	11	6	15	79458.0	-0.026	0.534
	No	8	5	11				10	6	14			
History of psychiatric disorder	Yes	13	10	16	24337.5	-0.506	<0.001	15.5	11.75	18	23302.0	-0.441	2.248
	No	8	5	12				10	6	14			
Ever received Professional psychological support	Yes	11	7	14	61666.5	-0.296	<0.001	12	9	16	56501.0	-0.188	<0.001
	No	8	5	11				10	6	14			

Note: Group differences in Total GAD-7 and Total PHQ-9 scores were examined using Mann-Whitney U tests for two-level variables and Kruskal-Wallis H tests for variables with more than two categories. Effect sizes are reported as r for Mann-Whitney tests and eta-squared (η^2) for Kruskal-Wallis tests. IQR, interquartile range. Statistically significant p -values ($p < 0.05$) are shown in bold.

3.4. Association between Socio-demographic, Educational and Health-related Characteristics with Total GAD-7 and PHQ-9 Scores

Regression diagnostics did not indicate serious violations of model assumptions. VIF values ranged from 1.02 to 2.35 (tolerance 0.43-0.98), indicating no problematic multicollinearity. Cook's distance values were all < 0.20 , and no observation exceeded the conventional threshold of 1, indicating no highly influential cases. Visual inspection of residuals suggested approximate linearity and no major departures from homoscedasticity for both the Total GAD-7 and Total PHQ-9 models. Table 5 reports robust HC3 standard errors to account for any remaining heteroscedasticity.

Table 5 presents the results of multiple regression analyses examining sociodemographic, educational, and health-related predictors of GAD-7 anxiety and PHQ-9 depression symptom scores ($n = 848$). For Total GAD, the model including all predictors was significant ($F(21, 826) = 4.29, p < 0.001$), with an R^2 of 0.098 and an adjusted R^2 of 0.075, indicating that these variables together accounted for about 8-10% of the variability in GAD-7 scores. For anxiety, five predictors were statistically significant. Students in other age bands (compared with 22-23 years) had significantly lower anxiety scores ($\beta = -0.624, p = 0.007$), whereas those receiving a bursary had higher anxiety scores than those without a bursary ($\beta = 0.891, p = 0.023$). A history of psychiatric disorder was associated with substantially lower anxiety scores ($\beta = -2.821, p = 0.002$), as was a history of traumatic events ($\beta = -0.974, p = 0.005$), and prior professional psychological support ($\beta = -1.532, p < 0.001$).

For Total PHQ, the equivalent model showed stronger explanatory power ($F(21, 826) = 8.57, p < 0.001; R^2 = 0.179$, adjusted $R^2 = 0.158$), suggesting that the same predictors explained approximately 16-18% of the variance in PHQ-9 scores. For depression, six predictors were statistically significant. Students in earlier study years had significantly lower depression scores than those in their final year ($\beta = -0.776, p = 0.001$). In contrast,

students in non-Medicine programmes had higher depression scores than Medicine students ($\beta = 0.663, p < 0.001$). Non-Christian religious affiliation was associated with lower depression scores ($\beta = -0.988, p = 0.027$), and students living with single parents or other relatives had lower scores than those living with both parents ($\beta = -0.560, p = 0.032$). A history of psychiatric disorder was associated with substantially lower depression scores ($\beta = -3.184, p = 0.002$), as was having failed a module in the current academic year ($\beta = -1.455, p = 0.027$), and prior professional psychological support ($\beta = -1.274, p = 0.013$).

3.5. Sociodemographic, Educational, and Health-related Predictors of Probable Anxiety and Depression: Multivariable Logistic Regression Analyses

Table 6 presents the results of multivariable logistic regression analyses examining sociodemographic, educational, and health-related predictors of anxiety (GAD-7) and depression (PHQ-9) symptoms ($n = 848$). For anxiety, four predictors were statistically significant. Students in lower household income bands had higher odds of anxiety compared with those in the highest income band ($OR = 1.173, 95\% CI: 1.028-1.339, p = 0.017$). A history of psychiatric disorder was associated with substantially lower odds of anxiety ($OR = 0.286, 95\% CI: 0.125-0.654, p = 0.002$), as was a history of traumatic events ($OR = 0.601, 95\% CI: 0.436-0.829, p = 0.001$), and prior professional psychological support ($OR = 0.425, 95\% CI: 0.279-0.646, p < 0.001$). The model explained a modest proportion of variance (Nagelkerke $R^2 = 0.12$).

For depression, seven predictors were statistically significant. Female students had higher odds of depression compared with males ($OR = 1.621, 95\% CI: 1.191-2.207, p = 0.002$). Students in earlier study years had lower odds of depression than those in their final year ($OR = 0.739, 95\% CI: 0.609-0.895, p = 0.002$), while students in non-Medicine programmes had higher odds than Medicine students ($OR = 1.287, 95\% CI: 1.171-1.413, p < 0.001$). Students living with single parents or other relatives had

lower odds of depression than those living with both parents (OR = 0.719, 95% CI: 0.575–0.899, $p = 0.003$). A history of psychiatric disorder was associated with substantially lower odds of depression (OR = 0.184, 95% CI: 0.070–0.481, $p = 0.001$), as was repeating the

academic year (OR = 0.306, 95% CI: 0.132–0.710, $p = 0.005$), and prior professional psychological support (OR = 0.554, 95% CI: 0.354–0.866, $p = 0.009$). The depression model showed stronger explanatory power (Nagelkerke $R^2 = 0.18$).

Table 5. Socio-demographic, educational and health-related predictors of anxiety and depression symptoms scores among health sciences students (n=848).

Sociodemographic, Educational, and Health-related Characteristics		GAD-7					PHQ-9				
Predictor	Category/coding (reference)	β	SE	t	95% CI	p	β	SE	t	95% CI	p
Constant		23.553	3.147	7.484	17.376; 29.731	<0.001	33.570	3.573	9.395	26.556; 40.583	<0.001
Gender	Female vs Male (0 = male, 1 = female)	0.271	0.321	0.846	-0.358; 0.901	0.398	0.559	0.364	1.534	-0.156; 1.274	0.125
Ethnolinguistic group	Non-Pedi vs Pedi (0 = Pedi, 1 = other ethnolinguistic groups)	-0.112	0.135	-0.828	-0.377; 0.154	0.408	-0.136	0.154	-0.885	-0.437; 0.165	0.377
Age group (in years)	Other age bands vs 22–23 years (0 = 22–23, 1 = other)	-0.624	0.231	-2.704	-1.077; -0.171	0.007	-0.471	0.262	-1.799	-0.985; 0.043	0.072
Current study year	Earlier year vs final year (0 = final year, 1 = earlier years)	0.044	0.201	0.220	-0.350; 0.438	0.826	-0.776	0.228	-3.406	-1.223; -0.329	0.001
Academic programme	Non-Medicine vs Medicine (0 = Medicine, 1 = other programmes)	0.121	0.097	1.251	-0.069; 0.310	0.211	0.663	0.110	6.046	0.448; 0.878	<0.001
Receives bursary/funding	Receives bursary vs No bursary (0 = no, 1 = yes)	0.891	0.389	2.287	0.126; 1.655	0.023	0.209	0.442	0.472	-0.659; 1.076	0.637
Religious affiliation	Non-Christian vs Christian (0 = Christian, 1 = other religions)	-0.160	0.393	-0.406	-0.931; 0.612	0.685	-0.988	0.446	-2.214	-1.865; -0.112	0.027
Household income category (ZAR)	Lower vs highest income band (0 = highest band, 1 = lower bands)	0.136	0.142	0.954	-0.143; 0.415	0.340	0.172	0.162	1.062	-0.145; 0.489	0.288
Monthly allowance (in ZAR)	Lower vs highest allowance band (0 = >20000, 1 = lower bands)	-0.158	0.309	-0.510	-0.765; 0.450	0.610	-0.204	0.351	-0.581	-0.894; 0.485	0.561
Usual family residence	Rural vs urban (0 = urban, 1 = rural)	-0.294	0.396	-0.744	-1.072; 0.483	0.457	0.368	0.449	0.819	-0.514; 1.250	0.413
Lives with	Single parent/other vs both parents (0 = both parents, 1 = other)	-0.395	0.230	-1.719	-0.847; 0.056	0.086	-0.560	0.261	-2.144	-1.072; -0.047	0.032
Relationship status	In relationship vs not (0 = not, 1 = in relationship)	0.034	0.338	0.101	-0.630; 0.698	0.920	0.142	0.384	0.370	-0.612; 0.896	0.711
Parental status	Has children vs none (0 = no children, 1 = ≥ 1 child)	-0.755	0.616	-1.227	-1.964; 0.453	0.220	-0.736	0.699	-1.053	-2.108; 0.636	0.293
History of psychiatric disorder	Yes vs No (0 = no previous psychiatric disorder, 1 = yes)	-2.821	0.892	-3.161	-4.572; -1.069	0.002	-3.184	1.013	-3.143	-5.172; -1.195	0.002
Chronic physical condition	Yes vs No (0 = no chronic condition, 1 = ≥ 1 chronic condition)	-0.042	0.589	-0.071	-1.198; 1.114	0.943	-0.171	0.668	-0.256	-1.484; 1.141	0.798
Current accommodation type	Private residence vs university residence (0 = university residence, 1 = private residence)	-0.078	0.357	-0.219	-0.778; 0.622	0.827	0.322	0.405	0.794	-0.473; 1.117	0.427
History of traumatic events	Yes vs No (0 = no trauma history, 1 = ≥ 1 traumatic event)	-0.974	0.349	-2.789	-1.659; -0.289	0.005	-0.278	0.396	-0.701	-1.056; 0.500	0.483
Failed a module this academic year	Yes vs No (0 = no module failed, 1 = ≥ 1 module failed in current year)	0.368	0.577	0.638	-0.764; 1.500	0.524	-1.455	0.655	-2.223	-2.740; -0.170	0.027
Repeating the academic year	Yes vs No (0 = not repeating, 1 = repeating module/year)	-0.334	0.749	-0.445	-1.804; 1.137	0.656	-1.067	0.851	-1.255	-2.737; 0.602	0.210
Ever received Professional psychological support	Yes vs No (0 = no previous professional psychological support, 1 = yes)	-1.532	0.450	-3.406	-2.415; -0.649	<0.001	-1.274	0.511	-2.494	-2.276; -0.271	0.013

Note: Nominal variables were entered using dummy coding with Medicine (programme), Pedi (ethnolinguistic group), 22–23 years (age), final year of study, Christian religion, highest household income and allowance bands, urban family residence, living with both parents, and university residence as reference categories. Binary variables were coded 0 = reference and 1 = comparison. Diagnostics: VIF range, 1.02–2.35; tolerance range, 0.43–0.98; maximum Cook's distance, 0.20. Residual plots indicated approximate linearity and homoscedasticity, and normal probability plots indicated approximate normality of residuals. Robust HC3 standard errors were used to account for heteroscedasticity. β , unstandardised regression coefficient; SE, standard error. CI = 95% confidence interval. Statistically significant p -values ($p < 0.05$) are shown in bold. The GAD-7 model: $F(21,826) = 4.29$, $p < 0.001$, adjusted $R^2 = 0.075$; PHQ-9 model: $F(21,826) = 8.57$, $p < 0.001$, adjusted $R^2 = 0.158$.

Table 6. Multivariable logistic regression of anxiety and depressive symptoms on sociodemographic, academic and clinical predictors.

Sociodemographic, Educational, and Health-related Characteristics		GAD-7				PHQ-9			
		β	OR	CI (lower; upper)	<i>p</i>	β	OR	CI (lower; upper)	<i>p</i>
Constant		3.362	28.857	1.579; 527.366	0.023	7.935	2793.513	98.353; 79343.683	<0.001
Gender	Female vs Male (0 = male, 1 = female)	0.110	1.116	0.828; 1.505	0.468	0.483	1.621	1.191; 2.207	0.002
Ethnolinguistic group	Non-Pedi vs Pedi (0 = Pedi, 1 = other ethnolinguistic groups)	-0.069	0.932	0.821; 1.058	0.280	-0.062	0.939	0.825; 1.070	0.348
Age group (in years)	Other age bands vs 22-23 years (0 = 22-23, 1 = other)	-0.149	0.861	0.692; 1.070	0.178	-0.105	0.899	0.721; 1.122	0.349
Current study year	Earlier years vs final year (0 = final year, 1 = earlier years)	-0.017	0.982	0.814; 1.186	0.855	-0.302	0.739	0.609; 0.895	0.002
Academic programme	Non-Medicine vs Medicine (0 = Medicine, 1 = other programmes)	-0.015	0.984	0.900; 1.077	0.735	0.252	1.287	1.171; 1.413	<0.001
Receives bursary/funding	Receives bursary vs No bursary (0 = no, 1 = yes)	0.344	1.411	0.986; 2.019	0.059	-0.047	0.953	0.655; 1.385	0.802
Religious affiliation	Non-Christian vs Christian (0 = Christian, 1 = other religions)	-0.055	0.946	0.656; 1.365	0.767	-0.362	0.695	0.477; 1.014	0.059
Household income category (ZAR)	Lower vs highest income band (0 = highest band, 1 = lower bands)	0.160	1.173	1.028; 1.339	0.017	0.024	1.024	0.894; 1.174	0.722
Monthly allowance (in ZAR)	Lower vs highest allowance band (0 = highest band, 1 = lower bands)	-0.034	0.966	0.725; 1.287	0.814	0.015	1.015	0.752; 1.371	0.919
Usual family residence	Rural vs urban (0 = urban, 1 = rural)	-0.067	0.934	0.643; 1.356	0.722	0.338	1.403	0.950; 2.072	0.088
Lives with	Single parent/other vs both parents (0 = both parents, 1 = other)	-0.112	0.893	0.720; 1.108	0.307	-0.328	0.719	0.575; 0.899	0.003
Relationship status	In relationship vs not (0 = not, 1 = in relationship)	0.209	1.233	0.897; 1.693	0.195	0.029	1.030	0.742; 1.428	0.859
Parental status	Has children vs none (0 = no children, 1 = ≥ 1 child)	0.021	1.022	0.567; 1.842	0.941	-0.338	0.712	0.379; 1.339	0.292
History of psychiatric disorder	Yes vs No (0 = no previous psychiatric disorder, 1 = yes)	-1.248	0.286	0.125; 0.654	0.002	-1.690	0.184	0.070; 0.481	0.001
Chronic physical condition	Yes vs No (0 = no chronic condition, 1 = ≥ 1 chronic condition)	0.438	1.550	0.874; 2.747	0.133	0.100	1.105	0.609; 2.004	0.741
Current accommodation type	Off-campus vs university residence (0 = university residence, 1 = other)	-0.026	0.974	0.698; 1.358	0.878	0.014	1.015	0.721; 1.428	0.931
History of traumatic events	Yes vs No (0 = no trauma history, 1 = ≥ 1 traumatic event)	-0.508	0.601	0.436; 0.829	0.001	0.272	1.312	0.934; 1.843	0.116
Failed a module this academic year	Yes vs No (0 = no module failed, 1 = ≥ 1 module failed in current year)	0.0001	1.001	0.585; 1.708	0.999	-0.489	0.612	0.337; 1.111	0.107
Repeating the academic year	Yes vs No (0 = not repeating, 1 = repeating module/year)	-0.029	0.970	0.485; 1.941	0.932	-1.182	0.306	0.132; 0.710	0.005
Ever received Professional psychological support	Yes vs No (0 = no previous professional psychological support, 1 = yes)	-0.855	0.425	0.279; 0.646	<0.001	-0.589	0.554	0.354; 0.866	0.009

Note: Multivariable logistic regression models examined associations between predictors and screening-positive anxiety (GAD-7 ≥ 10) and depression (PHQ-9 ≥ 10). Nagelkerke R^2 : 0.12 (for GAD-7) and 0.18 (for PHQ-9). Nominal variables were entered using dummy coding with the same reference categories as in Table 5. Binary variables were coded 0 = reference and 1 = comparison. β , unstandardised regression coefficient; OR, adjusted odds ratio; CI, confidence interval. Statistically significant *p*-values (*p* < 0.05) are shown in bold.

4. DISCUSSION

In this rural South African Faculty of Health Sciences, clinically significant anxiety (GAD-7 ≥ 10) affected 34.0% of students, and at least moderate depressive symptoms (PHQ-9 ≥ 10) affected 55.9%. These figures indicate a substantial burden of psychological distress within this single faculty, with more than one in three students screening positive for anxiety and more than one in two for depression. The strong correlation between GAD-7 and

PHQ-9 scores ($r = 0.65$) further suggests that anxiety and depression co-occur as part of a broader distress syndrome rather than as isolated problems. Our data, collected in 2024 from a rural South African university with high bursary dependence and substantial trauma exposure, therefore extend the literature by showing that even outside the pandemic period and in a low-resource setting, health sciences students continue to report high levels of anxiety and depression.

The high prevalence of anxiety and depressive symptoms observed in this health sciences cohort aligns with extensive evidence that health-professions students frequently report substantial mental health symptom burdens across training pathways. Observational data indicate that depression symptom rates among medical, nursing, pharmacy, and allied health students commonly exceed general-population benchmarks, with prevalence estimates ranging from 12% to 60% across various distress measures, depending on discipline and year [35-38]. While these prevalence estimates fall within the wide range reported for health-professions students internationally (approximately 12-60% across studies), direct numerical comparisons are limited by heterogeneity in instruments, cutoff scores, sampling frames, timing (including pre- vs post-pandemic cohorts), disciplines included, and national contexts. This convergence across regions and disciplines strengthens the conclusion that health sciences students exhibit elevated anxiety and depression relative to non-health peers and general populations [39, 40].

4.1. Gender Differences in Depressive Symptoms

The finding that female students experience higher rates of depression than male students is robustly supported across multiple countries, study designs, and measurement instruments. This pattern is documented across Ethiopia [41], Bangladesh [42], Oman [43], Nigeria [44], Spain [45, 46], China [47], and Malaysia [48], with odds ratios ranging from 1.74 to 5.56 for greater depression risk among females. The mechanisms underlying this disparity are multifactorial, encompassing biological, psychological, and social dimensions [43, 46]. Health sciences students face a compounding burden due to the inherently stressful nature of their academic and clinical training [46, 47]. These findings collectively underscore the urgent need for gender-sensitive mental health interventions within health sciences educational settings.

4.2. Programme Differences in Depressive Symptoms

A notable finding of this study was that students enrolled in non-Medicine programmes had significantly higher odds of depression compared with Medicine students, despite the widespread perception that medical students bear the greatest mental health burden. The evidence synthesised here robustly supports the finding that non-Medicine health sciences programmes do not confer protection against depression; in many instances, students in dentistry, applied medical sciences, pharmacy, physiotherapy, and allied health disciplines report depression prevalence rates comparable to or exceeding those of medical students [17, 21, 49]. Anxiety and depression profiles differ meaningfully across programmes, shaped by discipline-specific stressors, clinical training demands, gender composition, and academic pressures [17, 21, 49-51]. Dentistry students consistently emerge as a particularly high-risk group [49], while allied health and physiotherapy students have been shown to have worse mental health-related quality of life

than medical and dental students in some contexts [21]. Programme-level differences should be interpreted cautiously. Although symptom distributions varied across programmes in the analytic sample, the study was not designed to classify programmes as 'high risk.' Programme-specific response rates were not available, and participation may have varied with attendance, clinical placement schedules, or willingness to complete the questionnaire. These descriptive differences may reflect variation in respondent composition, curriculum stage, gender distribution, financial circumstances or unmeasured contextual factors, rather than programme effects. The findings identify student characteristics and academic contexts that warrant further investigation and may help guide inclusive, programme-sensitive mental-health support. They do not identify definitive high-risk programmes or permit prediction of individual student risk.

4.3. Psychiatric History and Prior Psychological Support

The counterintuitive finding that a history of psychiatric disorder and prior psychological support are associated with lower odds or scores for current depressive symptoms in multivariate models can be explained through a convergence of theoretical and empirical mechanisms. These include survivor bias among currently enrolled students [52], increased help-seeking efficacy and reduced stigma following prior treatment [17, 53], the development of functional coping strategies and psychological resilience through prior therapeutic engagement [54, 55], and the protective role of social support networks cultivated through prior psychological contact [56, 57]. The distinction between current and historical psychiatric illness is critical, as current illness is consistently associated with higher odds of current symptoms, while resolved prior episodes may confer net protective benefits through the mechanisms described above [50, 58, 59]. These findings underscore the importance of careful interpretation of multivariate regression outputs in mental health research and highlight the need for longitudinal study designs to disentangle the complex temporal relationships among prior psychiatric history, treatment engagement, and current symptomatology.

4.4. Socioeconomic Factors and Financial Stress

The finding that low household income is associated with higher odds of anxiety among health sciences students is robustly supported by a convergence of theoretical and empirical evidence. Financial burden is consistently identified as one of the primary sources of distress in higher education [60], and socioeconomic factors are recognised correlates of anxiety and depression among health sciences students [17]. Bursary-dependent students face a distinctive form of financial anxiety stemming from the conditional and precarious nature of their funding, which compounds the ordinary stressors of health sciences education [61, 62]. The mechanisms linking low income to anxiety include

material deprivation, academic performance pressure associated with funding conditionality, social isolation and reduced access to coping resources, and barriers to accessing mental health services [17, 56, 59, 61]. Addressing this association requires both structural interventions, including adequate, unconditional financial support and institutional wellness programmes that are accessible to students regardless of their financial circumstances.

4.5. Living Arrangement and Family Structure

In the present study, university students who lived with a single parent reported lower levels of depressive symptoms. While the provided literature does not establish a universal protective effect of single-parent living arrangements on depression, it does provide a defensible evidence base to contextualise why co-residing with a parent (even one parent) could be associated with lower depressive symptoms in some university settings, particularly when co-residence increases access to family support and reduces exposure to stressors linked to independent living [60, 63]. Importantly, evidence also emphasises that “family” effects on depression are often better explained by family environment and functioning (*e.g.*, cohesion, conflict, control, and parental relationship quality) rather than family structure alone [47]. The clinical significance of this depressive symptom burden should be considered in relation to students’ social and economic circumstances. Social support may buffer depressive symptoms through emotional and practical assistance, whereas financial vulnerability may compound academic pressures and restrict access to care. Consistent with this interpretation, a Nigerian study of young adults found that depression was positively associated with suicidal ideation, while social support and socioeconomic status were negatively associated with suicidal ideation. Although that study focused on suicidal ideation, it reinforces the need to address depressive symptoms through both accessible mental-health care and interventions that strengthen peer, family, and financial support [64]. Taken together, these sources support interpreting our finding as potentially reflecting context-specific protective processes (*e.g.*, supportive co-residence, greater cohesion, or reduced family conflict in the relevant comparison group), rather than implying that single-parent living arrangements are universally protective across settings.

4.6. Study Year and Academic Progression

In the present study, students in earlier years of study had significantly lower odds of depression compared with those in their final year. In a cross-sectional study of health professions students in Saudi Arabia, a statistically significant association was found between year of study and the presence/severity of depressive symptoms, and it specifically reported that the third year for all schools and the fifth year for medicine and dentistry have the highest association with depressive symptoms [49]. Because the final year corresponds to a senior stage of training in those programmes, this result provides direct support for

the plausibility of a final-year elevation in depression risk in some health-professions curricula, aligning directionally with our finding. Complementing this, evidence from allied-health education indicates that mental health outcomes can vary systematically across academic progression and training intensity. In a large multi-major allied health student study, mental health-related quality of life was significantly associated with “weekly clinical training hours” and “university year,” among other factors, indicating that stage of training and training load are meaningfully connected to mental health outcomes in this population [21]. However, other studies show different year-of-study gradients, including patterns in which earlier years appear more vulnerable. For example, among nursing students in Cameroon, the “level of studies” was identified as an independent correlate of depression, reporting that the odds of being depressed decreased as students moved from lower to higher years [65]. These findings indicate that the association between academic year and depression is not uniform across settings or programmes; therefore, our “final-year highest risk” result should be framed as a context-specific pattern, albeit supported by at least some evidence from the health professions.

In the adjusted logistic model, repeating the academic year was associated with lower odds of screening-positive depressive symptoms. This counterintuitive cross-sectional association should not be interpreted as evidence that academic repetition reduces depressive symptoms. Students who repeat may differ from non-repeaters in unmeasured ways, including access to support, prior adaptation to academic demands, selective continuation in the programme, or timing of symptoms. Longitudinal studies are needed to clarify the temporal relationship between academic repetition and depressive symptoms.

4.7. Interventions and Policy Implications

The findings have important implications for student-support policy and health-professions education. The substantial prevalence of screening-positive anxiety and depressive symptoms, together with the strong correlation between GAD-7 and PHQ-9 scores, supports a faculty-wide approach to mental-health promotion rather than reliance on reactive or individually focused services. Given the substantial proportion of students reporting traumatic experiences, mental-health interventions should include a trauma-informed component alongside universal screening and targeted academic and financial support. Faculty and university services should provide confidential, accessible, and culturally responsive care, with clear referral and crisis management pathways.

The associations with household income and bursary status highlight the need to integrate financial aid, academic advising, and mental health services, while the higher depressive symptom burden observed among female students, students in non-Medicine programmes, and senior students supports proportionate, programme-sensitive, and gender-responsive support. The low proportion of students reporting previous psychological

support also suggests possible unmet need and the importance of reducing barriers to confidential help-seeking. Because this was a cross-sectional study using self-reported screening measures, these correlates should not be interpreted as causal determinants or as definitive indicators of individual risk. Future longitudinal and intervention studies should evaluate the effectiveness, accessibility, and equity of integrated mental health and student support services in rural health sciences settings. At the policy level, universities and the government should strengthen national student mental health policies and invest in evidence-based interventions that are culturally responsive and scalable within the South African context.

4.8. Limitations

The findings should be interpreted in light of several limitations. First, the cross-sectional design precludes any causal inference: associations between socio-demographic, academic, and clinical factors and anxiety/depression scores cannot be interpreted as directional pathways, and reverse, or bidirectional effects (*e.g.*, depression contributing to academic failure or bursary status) remain plausible. Second, the study relied on self-administered questionnaires and self-report screening tools (GAD-7, PHQ-9), which are vulnerable to selection bias (only students present and willing to participate were included) and response biases such as under- or over-reporting due to stigma, misunderstanding of items, or current mood state, meaning that prevalence estimates and effect sizes may be conservative or inflated. Third, the use of a single-faculty, single-institution sample from a rural South African university limits generalisability to other faculties, urban universities and non-South African settings, where socio-economic profiles, curricula and support structures differ. Fourth, data collection took place over four weeks in October 2024, during the second semester and close to the examination-preparation period. This timing may have coincided with heightened academic demands, potentially increasing reported anxiety and depressive symptoms. Consequently, the prevalence estimates may not reflect symptom levels at other points in the academic year. Fifth, the participation rate was 50.5% (848 of 1 679 eligible undergraduate students), creating a potential for nonresponse bias. Absent students, those who declined to participate, or those who submitted incomplete questionnaires may have differed from participating students in anxiety or depressive symptoms, academic engagement, clinical placement commitments, or other unmeasured characteristics. As separate counts for absence and refusal were not recorded, including by programme and year of study, the extent and direction of nonresponse bias cannot be determined. The findings should therefore be interpreted as representing students who were present and willing to participate rather than the entire Faculty of Health Sciences student population. Sixth, although a wide range of predictors were included, unmeasured confounding is likely (*e.g.*, detailed data on coping styles, personality traits, social support quality, and concurrent life stressors were not collected), and the multivariable models explained a modest proportion of

variance, indicating that important determinants of symptoms were not captured. Seventh, the operationalisation of trauma history, psychiatric history, psychological support, and bursary status relied on brief self-report items, without detailed information on event type, timing, source of diagnosis, treatment characteristics, or direct indicators of financial hardship, such as food insecurity or delayed bursary payments. As a result, these variables should be interpreted as broad correlates or risk markers, and future studies should incorporate more fine-grained measures to disentangle specific pathways. Finally, the use of standard screening cut-offs without clinical diagnostic interviews means that “cases” reflect probable anxiety and depressive symptomatology rather than confirmed disorders, so comparisons with diagnostic prevalence studies should be made cautiously.

CONCLUSION

This study documents a substantial burden of anxiety and depression among South African health sciences students, with marked variation across academic programmes, gender, and socioeconomic groups. Female students, those in non-Medicine programmes, and final-year students exhibited elevated odds of depressive and anxiety symptoms, while students with a psychiatric history and prior psychological support had lower current symptom levels, highlighting the protective value of early identification and sustained treatment engagement. These findings challenge assumptions about which student groups are most vulnerable and underscore the need for comprehensive, multi-level mental health strategies that combine universal mental health literacy with targeted interventions for high-risk populations. Health sciences faculties and policymakers must prioritise enhanced financial support, programme-specific wellbeing initiatives, gender-sensitive approaches, and strengthened mental health services to foster student wellbeing, academic success, and the development of resilient healthcare professionals. Future longitudinal research should clarify the temporal pathways linking psychiatric history, treatment engagement, and mental health outcomes to inform evidence-based intervention design.

AUTHORS' CONTRIBUTIONS

The authors confirm their contributions to the paper as follows: R.V.: Conceptualisation, methodology, supervision, investigation, data curation, visualisation, formal analysis, writing—original draft, writing—review and editing; L.M.: Conceptualisation, methodology, supervision, investigation, writing—review and editing; M.M.: Conceptualisation, visualisation, formal analysis, writing—review and editing; W.G.: Conceptualisation, methodology, supervision, investigation, writing—review and editing; N.P.: Conceptualisation, formal analysis, writing—review and editing. All authors approved the final version of the manuscript.

LIST OF ABBREVIATIONS

CI	= Confidence Interval
GAD-7	= Generalized Anxiety Disorder-7
PHQ-9	= Patient Health Questionnaire-9
SPSS	= Statistical Package for the Social Sciences
ZAR	= South African Rand

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Turfloop Research Ethics Committee, University of Limpopo, South Africa, under reference number TREC14942024UG. Written permission was also obtained from the relevant university authorities.

HUMAN AND ANIMAL RIGHTS

All procedures involving human participants were conducted in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2013.

CONSENT FOR PUBLICATION

Written informed consent was obtained from all participants prior to data collection.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of this article are available from the corresponding author [R.V.] upon reasonable request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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