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RESEARCH ARTICLE **OPEN ACCESS**

Predicting Determinants of Mental Health Status in Malaysian Undergraduate Students Using the Association Rule Mining Technique

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Abstract:

Background: Mental health issues pose a major challenge to the well-being and academic success of undergraduate students. Identifying key determinants of mental health is crucial for developing targeted interventions. This study employs association rule mining (ARM) to explore the relationships between educational and personal factors and students' mental health status.

Methods: A validated survey was administered to 1,394 undergraduate students (409 males and 985 females) from six Malaysian public universities. The Apriori algorithm was applied with minimum support of 0.1, confidence of 0.7, and lift of > 1 to extract meaningful associations. Data preprocessing included handling missing values, categorical encoding, and outlier detection.

Results: The analysis identified ten key association rules, revealing that female students were more likely to face learning difficulties (support = 0.188, confidence = 0.852, and lift = 1.134) but were also more uncertain about their mental health status. Interestingly, financial problems did not strongly predict mental health issues (support = 0.175, confidence = 0.707, and lift = 1.142).

Conclusion: These findings underscore the need for universities to reduce academic pressures, combat loneliness and isolation, and provide mental health services to support struggling students. With targeted interventions, universities can create healthier learning environments where students can thrive both academically and emotionally.

Keywords: Undergraduate students, Mental health, Stressors, Learning challenges, Association rule mining.

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1. INTRODUCTION

Mental health concerns among college students have gained increasing attention in the academic literature, reflecting a global awareness of the profound impact of psychological well-being on academic success and overall life satisfaction [1, 2]. The unique challenges faced by students in higher education, ranging from academic pressures to social and financial stressors, contribute to an environment where mental health issues can manifest and persist [3, 4]. Research analyzing assignment submission patterns further highlights these challenges, linking submission timing and academic engagement with factors affecting mental health and commitment to coursework [5].

In Malaysia, as in many other countries, the prevalence of mental health issues among undergraduate students is a growing concern [5, 6]. The Malaysian higher education landscape is known for its high academic standards and societal expectations [7]. However, these expectations can lead to a range of stressors that can impact the mental well-being of students [8]. To address this complex issue, it becomes imperative to delve into the specific determinants that influence the mental health status of Malaysian undergraduate students across genders.

Recent advancements in data mining techniques have opened new avenues for understanding complex phenomena in mental health. Association rule mining (ARM), in particular, has gained traction for its ability to uncover hidden patterns in large datasets. For instance, Hassan *et al*. (2023) utilized ARM to detect humans' suicidal behaviour, demonstrating its utility in detecting high-risk groups based on different lifestyle stressors [9]. Similarly, Olivera *et al*. (2023) explored the relationship between academic stress and mental health among undergraduate university students, revealing a strong correlation between elevated academic stress and the likelihood of experiencing languishing mental health, underscoring the need for targeted interventions to address self-imposed pressures and mitigate their negative effects [10]. From another perspective, previous investigators reported that emotional factors could significantly impact the mental health of language teachers and learners advocating for multidisciplinary innovative approaches for addressing mental health concerns in the educational environment [11].

Despite the challenging Malaysian academic environment, there are resources available to help students cope with stress. Universities in Malaysia offer counselling services, mental health support, and other resources to help students manage their mental health. However, mental health-related issues of the students continue to rise. While studies have explored mental health in the context of higher education globally, there is a lack of research focusing on the Malaysian setting, particularly employing advanced analytical techniques to uncover complex associations between various factors and mental health outcomes. This study seeks to bridge this gap by utilizing association rule mining, a powerful data mining technique, to unravel intricate patterns and associations within a dataset encompassing educational and personal variables related to mental health.

While previous research on student mental health has identified various risk factors, most studies rely on traditional statistical models, which often fail to capture the complex, non-linear interactions between multiple determinants of mental well-being. This study introduces an innovative approach by employing ARM, a data-driven technique that uncovers hidden patterns and relationships between different educational and personal factors affecting mental health. Unlike conventional regression-based methods, ARM allows for multi-factorial analysis, identifying interrelated stressors that contribute to mental health challenges among undergraduate students.

1.1. Research Objectives

The objectives of this study are as follows:

1.1.1. OBJ1

To understand the determinants of mental health among Malaysian undergraduate students.

1.1.2. OBJ2

To identify specific stressors and risk factors unique to Malaysian undergraduate students.

1.2. Research Questions

The research questions are as follows:

1.2.1. RQ1

What are the key determinants of mental health among Malaysian undergraduate students?

1.2.2. RQ2

What are the specific stressors and risk factors affecting the mental health of Malaysian undergraduate students?

1.2.2.1. Hypothesis

The following hypotheses were tested in this study:

1.2.2.1.1. H1

Some determinants of mental health could influence the mental well-being of students.

1.2.2.1.2. H2

There is a significant association between certain stressors and risk factors among Malaysian undergraduate students.

2. MATERIALS AND METHODS

Before the commencement of this study, students were informed about the purpose of the study and a verbal agreement was obtained from the study through briefing at the beginning of the data collection *via* their various course coordinators. Approval to carry out the study was obtained from the departmental ethics committee of Universiti Malaysia Terengganu (UMT/PPAL/500-32 JILID), and all students provided consent to participate in the study. It is worth highlighting that the study was carried out anony-

mously. As such no personal information of the student was disclosed. The following steps were taken to address the research aims.

2.1. Participants

In the current investigation, a descriptive cross-sectional survey design with a stratified sampling approach was employed to ensure representation from different academic levels, genders, and fields of study. The final sample size, determined through Gpower analysis, comprised 1394 undergraduate students (409 males and 985 females) (SAGER guidelines were followed), within the age range of 18 to 25 years old, who voluntarily participated in the study. The sample was undergraduate students of years one to six undertaking various courses across 6 public universities in Malaysia.

2.1.1. Inclusion Criteria

The following are the inclusion criteria for the participants in the study:

I. Enrolment Status: Participants had to be active full-time undergraduate students enrolled in Malaysian public universities at the time of data collection.

II. Age Range: Only students within the 18–25-year-old range were included to ensure the sample represented traditional undergraduate students.

III. Academic Level: The study included students from year 1 to year 6 across multiple disciplines to capture diverse experiences.

IV. Informed Consent: Only students who voluntarily agreed to participate and provided informed consent were included in the study.

V. Data Completeness: Responses with significant missing data or inconsistencies were excluded to maintain data integrity.

2.1.2. Exclusion Criteria

The following are the exclusion criteria for the participants in the study:

I. Students enrolled in postgraduate programs or part-time study programs were excluded.

II. Participants with prior diagnosed mental health disorders requiring clinical intervention were excluded to focus on general undergraduate experiences rather than clinical cases.

III. Any participant who withdrew consent during the study was excluded from the final analysis.

2.2. Instruments for Data Collection

In the current study, a survey instrument was developed to gather information on the mental health statuses of students, exposure to mental health disorders, factors perceived as responsible for their mental health problems, as well as several coping mechanisms employed by the students. To comprehensively capture the educational and personal factors influencing mental health, a structured and validated instrument was utilized. The instrument incorporated established scales and items from existing psychometric tools related to mental health, academic challenges, financial situations, and personal circumstances. The content validity of the instrument was assessed by experts in the field, ensuring its relevance to the Malaysian higher education context. Participants were asked to self-report their mental health status using standardized scales, providing insights into the prevalence and severity of mental health issues. The instrument, on average, took 20 min for the students to fill up. To assess the test-rest reliability of the questionnaire instrument, 30% of the respondents (418 students) were selected to complete the survey for the second time 14 days after their initial responses were received [12, 13]. The Cronbach's alpha and the intraclass correlation coefficient (ICC) were excellent, with 0.95 and 0.92 values, respectively, demonstrating the test-retest reliability as well as the internal consistency of the instrument.

3. DATA ANALYSIS

3.1. Data Cleaning and Transformation

The dataset was first cleaned to handle missing values. Any incomplete responses were removed to ensure data quality. This step was crucial to avoid biases in the association rule mining results. Categorical variables (*e.g.*, gender, mental health status, financial problems) were encoded into binary or numerical formats suitable for association rule mining. For example, mental health status was categorised into three groups: "No mental health issues," "Yes, I have mental health issues," and "Not sure." Continuous variables, such as age, were discretized into meaningful bins (*e.g.*, 18–20, 21–23, 24–25) to facilitate the mining of association rules. To ensure consistency across variables, normalization was applied to scale the data where necessary. This step was particularly important for variables measured on different scales (*e.g.*, financial stress *vs*. academic stress). Another study analyzed data from 232 users of the FeelingMoodie app, applying ARM to uncover relationships between daily activities and mood, offering insights into enhancing mHealth apps and personalizing user experiences [14].

3.2. Development of the Rule Mining Model

Association rules learning is a data mining technique that identifies relevant associations between different categories of valid data. In the consumer industry, this technique is known as "market basket analysis" and is used to confirm the buying patterns of customers visiting a store. Introduced by Agrawal, Lmielinski, and Swami in 1993, association rule learning has since been applied to various studies [15]. In the current study, an Apriori algorithm, which ranks data and information into three groups: support, confidence, and lift, to check correlation was used. To identify useful patterns, minimum parameters were set for data in support and confidence, with a value of 1 or more selected. The dataset, comprising responses to the survey instrument, was preprocessed to handle missing values and ensure data quality. Association rules were then generated using Apriori to identify relationships between different variables, with a focus on

factors related to mental health status. The algorithm was configured to generate rules with a maximum of 3 items in the antecedent and consequent to maintain interpretability and avoid overly complex rules.

3.3. Performance Evaluation Metrics

Support is the proportion of transactions in the dataset that contain the items in the association rule. Higher support values indicate that the itemset is common in the dataset. It represents the popularity or frequency of the items occurring together. Confidence is the conditional probability that a transaction containing item A also contains item B. Higher confidence values indicate a stronger likelihood that item B will be bought when item A is bought. It is a measure of how often the rule has been found to be true. Lift is the ratio of the observed support to that expected if the two items are independent. A lift greater than 1 indicates that the presence of item A has a positive effect on the presence of item B, suggesting a stronger association. A lift less than 1 implies a negative association, and a lift equal to 1 suggests independence. Redundant rules (*e.g.*, rules that are subsets of more general rules) are pruned to ensure that only the most meaningful and non-redundant rules are retained. It is worth noting that the generated rules were validated using a holdout validation approach, where the dataset was split into training (70%) and testing (30%) sets. The rules generated from the training set were evaluated on the testing set to ensure their generalizability.

4. RESULTS

4.1. Determinants of Mental Health among Malaysian Undergraduate Students (RQ1)

Rule 1 shows that the association between "no mental health issues" and female students having moderate support demonstrates relatively high confidence but a lift of less than 1, as depicted in Table **1**. Figs. (**1** and **2**) present the summary of the connected associations across the rules. A lift of less than 1 suggests that "no mental health disorder" and "female students" occur less frequently together than would be expected if they were independent. Similar to rule 1, rule 2 has moderate support and high confidence but a lift of less than 1, indicating a weaker association between personal problems and female students than would be expected by chance.

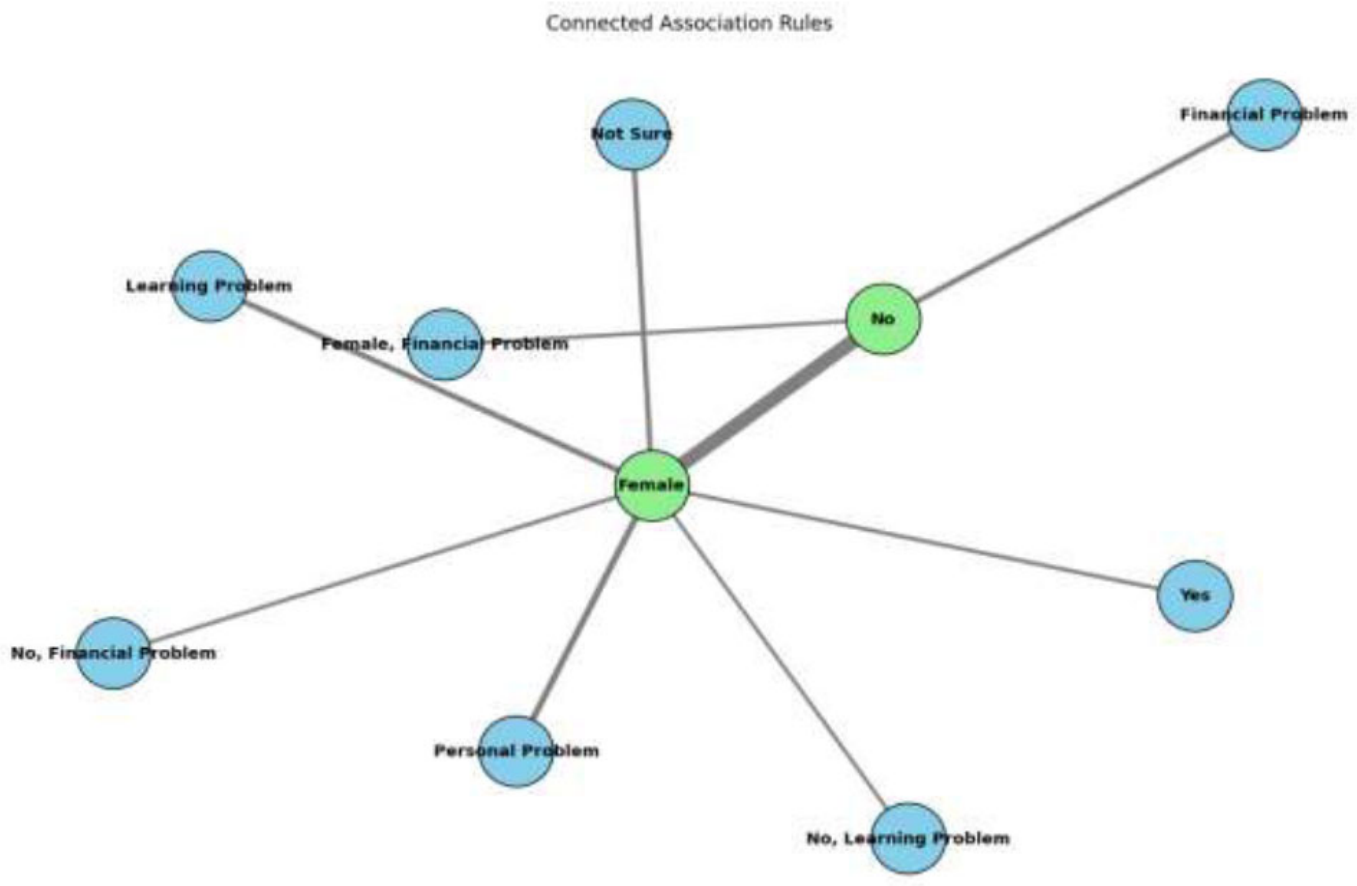

Fig. (1). Connected, associated rules for the study variables.

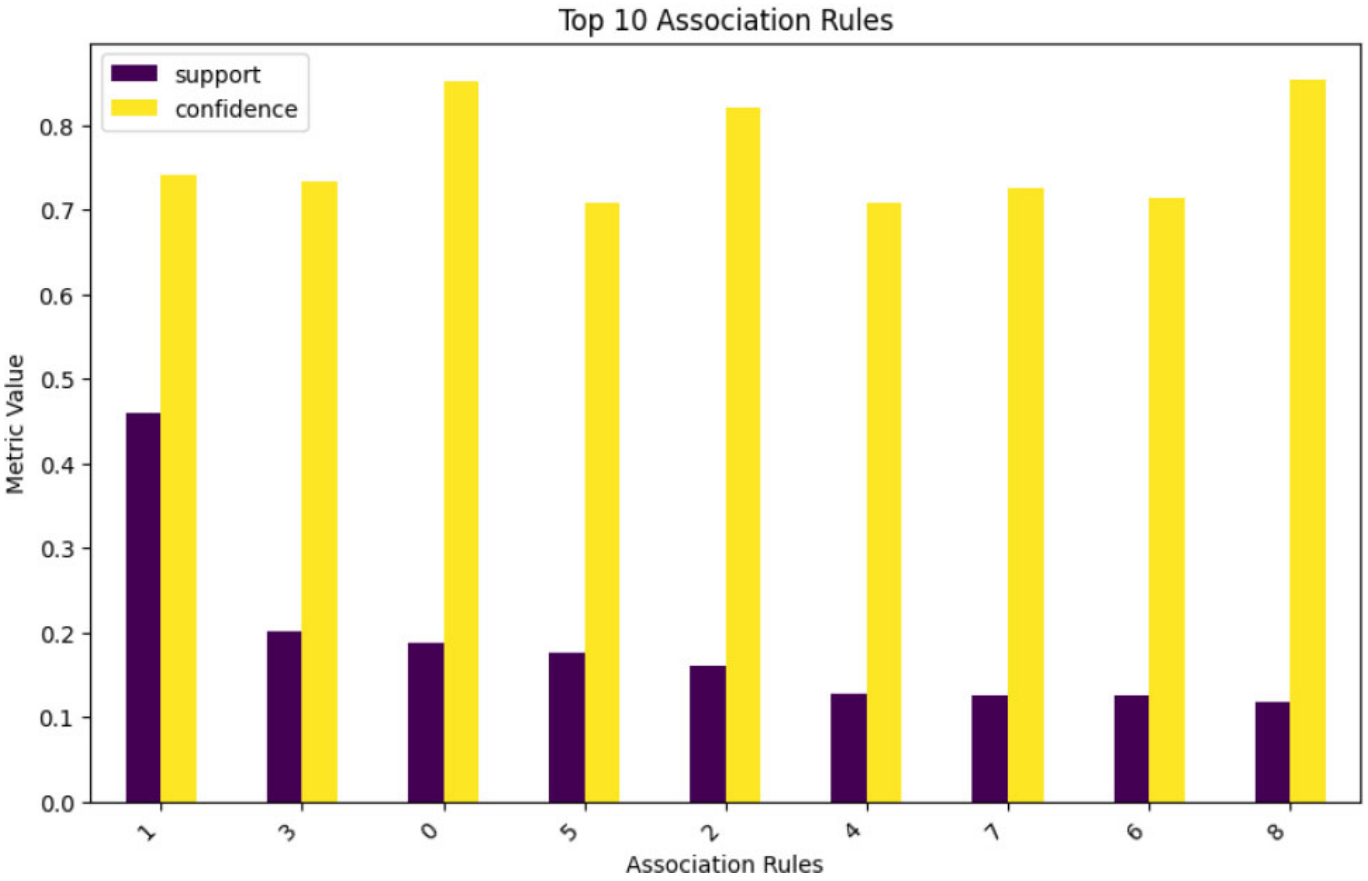

Fig. (2). Evaluation metrics for the generated associated rules.

Table 1. Association rules for determinants of mental health among undergraduate students.

Rules	Antecedents	Consequents	Support	Confidence	Lift
1	No	Female	0.459	0.741	0.985
2	Personal problem	Female	0.201	0.734	0.976
3	Learning Problem	Female	0.188	0.852	1.134
4	Financial Problem	No, I don't have a mental health Problem	0.175	0.707	1.142
5	Not sure	Female	0.160	0.821	1.091
6	Yes	Female	0.128	0.708	0.942
7	Female, Financial Problem	No, I don't have a mental health Problem	0.125	0.725	1.171
8	No	Female	0.125	0.714	0.950
9	No, Learning Problem	Female	0.118	0.855	1.137

Note: No = No, I don't have a mental health problem.
Yes = Yes, I have a mental health problem.
Not Sure = Not sure of my mental health problem.

The association between learning problems and female students has moderate support, high confidence, and a lift greater than 1, suggesting a positive association between the variables. This further indicates that female students are often confronted with learning challenges. Similarly, rule 4 demonstrates the association between financial problems and being free from mental health problems, with moderate support, high confidence, and a lift greater than 1. This finding revealed that financial problems may not necessarily be a predictor of mental health disorders.

Furthermore, the rule-driven from rule 5 reveals the association between not being sure of mental health disorders and female students. Moderate support, high confidence, and a lift greater than 1 are observed, indicating a

positive association between the variables. Hence, it could be postulated from the findings that female students are most frequently unsure of their mental health statuses. Rule 6 shows relatively lower support, moderate confidence, and a lift less than 1, hence suggesting a weaker association between mental health problems and female students than expected.

4.2. Stressors and Risk Factors Affecting Mental Health (RQ2)

Rule 7 projects low support, moderate confidence, and a lift greater than 1, indicating a positive association between female students, financial problems, and being free from mental health-related problems. This suggests that female students do have financial problems, which is further associated with being free from mental health issues. Moreover, rule 8 indicates low support, moderate confidence, and a lift less than 1, suggesting a weaker association between a lack of mental health disorders and female students. On the other hand, analysis of rule 9 depicts low support, high confidence, and lift greater than 1, indicating a positive association between being free from mental health disorders, learning problems, and female students.

5. DISCUSSION

The findings of this study hold substantial implications for the development of targeted interventions to address the mental health challenges faced by Malaysian undergraduate students. The nuanced associations revealed through association rule mining shed light on specific determinants that necessitate focused attention from university administrators, mental health professionals, and policymakers.

The observed association between female students and learning challenges, as depicted in Table **1** as well as Figs. (**1** and **2**) (Rule 3), aligns with existing research highlighting gender-specific academic stressors [16, 17]. The studies reflect that female students may experience higher academic pressure due to societal expectations and self-imposed performance standards. As a result, it emphasizes the need for tailored support systems and resources to help female students navigate these challenges, fostering a more inclusive learning environment.

The lack of a straightforward predictive association between financial problems and mental health disorders (Rule 4) challenges conventional assumptions and underscores the importance of considering multifaceted factors in mental health research [18]. Furthermore, the lack of a strong association between financial problems and mental health issues contradicts conventional assumptions. While financial stress is a well-documented challenge for students, its weaker predictive power in this study suggests that mental health outcomes are influenced by a combination of multiple stressors rather than financial strain alone, necessitating a holistic approach that considers the interplay of various stressors.

The positive association between female students and being unsure of their mental health status, as shown in Fig. (**2**) (Rule 5), emphasizes the need for targeted mental health awareness campaigns and support services. This aligns with studies suggesting that female students may be more prone to self-doubt and uncertainty regarding their mental well-being [19]. Moreover, the uncertainty about female student's mental health status highlights gaps in mental health awareness and self-assessment skills. This suggests a need for targeted awareness campaigns, self-screening tools, and mental health literacy programs that help students recognize early signs of psychological distress.

A previous study reported that female students may experience higher academic pressures and expectations, leading to heightened stress levels [20]. Furthermore, the observed gender gap in mental health statuses among undergraduate students carries implications for the design and implementation of targeted interventions. Tailoring mental health support services to address the specific needs and stressors faced by female students becomes paramount. The study by preceding researchers exemplifies the efficacy of gender-specific interventions, demonstrating that targeted programs for female college students led to a significant reduction in reported stress levels [21]. It is essential to recognize that gender differences in mental health are not merely biological but are intricately linked to sociocultural factors. The study by Comacchio, Carla *et al*. [22] highlights the influence of cultural expectations and societal norms on the mental health of female students. Addressing these sociocultural determinants becomes crucial in developing comprehensive strategies to promote mental well-being.

The findings of this study also offer important pedagogical implications for educators and university administrators. First, the identification of learning challenges as a significant stressor, particularly among female students, highlights the need for inclusive teaching practices that accommodate diverse learning needs. Educators should consider incorporating flexible assessment methods and active learning strategies to reduce academic pressure and enhance student engagement. Second, the prevalence of uncertainty about mental health statuses among students suggests the importance of integrating mental health literacy into the curriculum. Workshops or modules on stress management, self-care, and mental health awareness could help students better understand and address their mental well-being. Finally, universities should prioritize faculty training to equip educators with the skills to recognize and support students experiencing mental health challenges, fostering a more empathetic and supportive academic environment.

CONCLUSION

The purpose of the current study was to investigate complex associations between various factors and mental health outcomes of Malaysian undergraduate students. The findings demonstrated that female students were more likely to experience learning difficulties and uncertainty about their mental health status, underscoring the need for targeted academic and psychological support mechanisms. Additionally, the study found that financial problems were not a strong predictor of mental health

issues, suggesting that other stressors, such as academic workload and personal challenges, may play a more significant role. These results further emphasize the importance of holistic and evidence-based mental health interventions to foster a supportive learning environment. The prevalence of uncertainty regarding mental health statuses among female students highlights the necessity for targeted mental health awareness campaigns and support services. This suggests that creating an environment where students feel comfortable seeking help and accessing mental health resources is crucial.

RECOMMENDATION, FUTURE DIRECTION, AND LIMITATION OF THE STUDY

The prevalence of uncertainty regarding mental health statuses among female students highlights the necessity for targeted mental health awareness campaigns and support services. This finding suggests that creating an environment where students feel comfortable seeking help and accessing mental health resources is crucial. Personalized learning interventions should be developed for female students struggling with academic pressure, such as flexible coursework structures, time management workshops, and mentorship programs. Academic resilience training should be introduced to equip students with coping strategies for handling academic stress. Universities should incorporate exercise-based mental health programs, such as group sports activities, yoga, or mindfulness workshops, particularly for students who may be reluctant to seek traditional counselling. Moreover, the universities could offer stress-management retreats, outdoor learning activities, and structured social engagement programs to build resilience and reduce isolation.

Despite its contributions, this study is subject to certain limitations. First, the cross-sectional design restricts the ability to establish causality between the identified factors and mental health outcomes. Longitudinal studies would be beneficial in capturing the evolution of mental health challenges over time. Second, the study primarily relied on self-reported data, which may be subject to social desirability bias or inaccurate self-assessment. Incorporating objective mental health assessments or qualitative interviews could provide a more in-depth understanding of students' experiences. Lastly, while the study included a diverse sample from multiple universities, findings may not be fully generalizable to students from private universities or different cultural contexts. Future research should aim to include broader student populations to enhance the external validity of the findings.

AUTHOR'S CONTRIBUTIONS

A.M. and R.M.M.: Contributed to the methodology, investigation, formal analysis, and conceptualization; K.S.L.C.: Curated the software, gathered the resources, took part in project administration, and proposed methodology; B.W.F.: Involved in writing, reviewing, editing, writing the original draft, formal analysis, data curation, and conceptualization.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the departmental ethics committee of Universiti Malaysia Terengganu (UMT/PPAL/500-32 JILID).

HUMAN AND ANIMAL RIGHTS

All human research procedures followed were 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

All students provided consent to participate in the study.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

The data and supportive information are available within the article.

FUNDING

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CONFLICT OF INTEREST

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

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