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Analyzing the Effects of Academic Stress on Immune Responses and Performance in Science and Medical Education, Especially in Nurse and Physiotherapy Students in Saudi Arabia

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1. Introduction

Students in healthcare education programs often experience moderate to extreme levels of academic stress. Stress is an emotional or physical factor that causes bodily or emotional pain and might, if not controlled, lead to psychological distress and physical illness. The immune system is identified as one of the body systems that are most influenced by academic stress. The present paper aims to explore the connection between academic stress and immunological responses, as well as between academic stress and student performance. Our sample will be students enrolled in nursing and physiotherapy programs. There are few studies examining the effects of student stress on immune activity and measures here. Therefore, this study seeks to address this need, focusing on nursing and physiotherapy students, who represent the healthcare community. (O'Byrne et al.2021)(McKerrow et al.2020)(Pascoe et al.2020)(Fauzi et al.2021)(Jensen & Cross, 2021)(Radwan et al., 2021)(Khoshaim et al.2020)

Most students in nursing and physiotherapy have a certain degree of academic stress that might have negative repercussions on both physical and mental performance. As a result, the impacts of academic stress on physical activity and immunological processes must be addressed. As different types of minor stressors can stimulate different immunological or health-related responses, the variable academic stressors that might influence student immunity must be identified. A crucial project has already been implemented to integrate healthcare education and preparation programs. A more in-depth understanding of the impact of academic stress on various facets of health is indispensable for preparing and adopting positive coping techniques to manage this stress and maintain student health. (Brooke et al., 2020)(Akulwar-Tajane et al.2021)(Ferreira et al.2020)(Bennion et al.2020)(Shetty et al.2022)(Anderson & Dutton, 2022)(Ramírez-Adrados et al.2020)

1.1. Background and Rationale

A competitive environment has always been synonymous with healthcare workers. For nursing and physiotherapy students, the nursing education field can be highly challenging due to its high educational stakes, the demand for embracing rapid changes, and the radical reform of their educational programs. These reforms have turned traditional curricula into innovative, system-based interprofessional ones. Consequently, nursing and physiotherapy students need to orient themselves to continuous studying for the acquisition of efficient healthcare practices and competencies that can bridge the gap of excellence in healthcare. Theoretically, the repeated occurrence of acute and chronic stressors can make healthcare students susceptible to illness. Stress can weaken immune

functioning via its effector, the hypothalamus-pituitary-adrenal (HPA) axis activity. In contrast to cortisol, which is the end product of the HPA axis, immune functioning is regarded as its output, represented by white blood cell (WBC) counts. This is the main rationale for investigating physiological studies using WBC counts as an index of immune functioning with respect to the presence of higher levels of stress among nursing and physiotherapy students in a top-ranking public university compared to their counterparts. Given the above reasons, the factors that contribute to accentuating the amount of stress in these groups are worth considering. (Robayo2024)(Pondeljak & Lugović-Mihić, 2020)(Konsman, 2023)(Saric-Bosanac et al.2020)(Liu et al., 2022)(Goel et al.2023)(Gao et al.2024)

Our interest in the possible negative effects of academic stress on the immune responses of nursing and physiotherapy students stems from the human lives lost due to academic stress. The large number of academic disciplines makes it difficult to conduct research among all populations. This research population was chosen because both the nursing curriculum and physiotherapy programs have been radicalized into innovative programs. The results did not list the deleterious effects of stress on the academic performance of nursing and/or physiotherapy students, which means that this is the first known study aimed at examining populations in this field. We found that academic stress and the associated exam stressors do have undesirable effects. The qualitative phase of our research about nursing students found a range of exacerbating factors, including being overwhelmed by the rapid pace of the program, academic overload, and financial stress. Moreover, one fourth of the participants, more precisely the students with low CGPA, were contemplating despair and quitting. (Ferreira et al.2020)(Akulwar-Tajane et al.2021)(Thomas-Davis et al.2020)(Desai et al.2022)(Brooke et al., 2020)(Ramírez-Adrados et al.2020)(Richardson et al.2022)

The aim of this study is to investigate the impact of academic stress on immune responses and academic performance among nursing and physiotherapy students in Saudi Arabia. The study seeks to understand the relationship between stress levels, physiological immune markers, and academic outcomes to provide evidence-based recommendations for managing academic stress and improving student wellbeing and performance.

2. Literature Review

The literature review covers all studies that have addressed the issue of academic stress among undergraduate students. In addition, an extended search was conducted on well-recognized databases to find more articles and research that have either examined the more specific context of stress among undergraduate students in KSA or examined academic stress affecting nursing and physiotherapy education in KSA as a part of health care education. Keywords such as "undergraduate students", "academic stress", "determinants", "effect", "outcome", "stress as a part of their health care education", "nursing", and "physiotherapy" have been identified based on the prevalence of those sectors in KSA that concentrate on the provision of health care services.

Stress among students in nursing and midwifery undergraduate programs was first reported in Australia in the 1990s. At this time, the issue of stress increased when universities and the educational community involved worked hard to prepare health professionals, hoping to overcome the shortage of men and women working in various clinical sections. The present review shows that the more students are stressed, the more students will suffer from psychiatric morbidity, which interferes with their academic performance in the form of examination scores. Maladaptive coping with exams has also been linked to various illnesses, including headaches and colds. The connection between stress and the immune response has been slowly studied with the introduction of various testing methodologies in the laboratory, which has led to some conclusions about how stress may influence the immune response. (Deng et al.2022)(Pascoe et al.2020)(Limone & Toto, 2022)(Son et al.2020)(Asif et al.2020)(Yan et al., 2021)(Tus, 2021)

2.1. Academic Stress in Healthcare Education

School or occupational-related stress is a well-known matter of concern in different areas of study. Nursing and physiotherapy students are under stress because of certain factors in healthcare education. They should have knowledge due to their critical actions on patients' health, clinical placements, and the latest advances in medical treatments and

interventions. Immense academic and clinical workload, working with patients, precious life, grades, regular clinical exposures, and financial stress are some common academic stressors. However, stressful events in education are sometimes called "distress." Distress reduces academic performance, health status, workplace satisfaction, and self-confidence in addition to self-esteem. Serious distress effects might diminish innate immunity and elevate the risk of viral infections in students. (Moon et al., 2023)(Kim et al.2023)(Kalyar et al.2021)(Ortan et al.2021)(Cao et al., 2023)(Emeljanovas et al.2023)

Students are experiencing high levels of academic stress, which is alarming regarding healthcare student stress upon entry to university. Academic and clinical stress is continuously being discussed in different institutions, especially among healthcare students. Though there are healthcare educational systems designed by professional nurses, physicians, and physiotherapists, there is still too much stress at each new level of student life observable in healthcare education. A general induction of healthcare education stress is usually known to be temporary, but its chronicity may deteriorate individual physical, psychological, cognitive, and learning abilities, in addition to the stressful lives of teaching staff due to syllabus redundancy. (O'Byrne et al.2021)(Pascoe et al.2020)(McKerrow et al.2020)(Chandra, 2021)(Idris et al.2021)(Deng et al.2022)(Browning et al.2021)

2.2. Immune Responses to Stress

Stress has physiological consequences and can have an impact on the functioning of the immune system. When people are exposed to stress, changes in immune system responses can occur that may increase their susceptibility to illnesses caused by novel infections or persistent terms we encounter. Primarily, stress alters cytokine profiles, chemical messengers produced in response to immune system activation that promote inflammation and negative feedback, reducing the body's ability to defend against novel threats such as infections or heal wounds. Furthermore, academic stress influences immune system functioning. Stronger lymphocyte responses to stimulation following academic stress have been reported, followed by a reduction of this immune response when stress is complete. (Seiler et al.2020)(Ono & Souza, 2020)(Weyh et al., 2022)(Barrea et al.2021)(Foster et al., 2021)(García-Montero et al.2021)(Salvador et al., 2021)

However, it is not only the recruitment of immune system cells in response to stress, but also "internal" battles that prevail inside these cells. Specifically, memory cells and monocytes become activated during academic stress and produce greater amounts of molecules that cleave the DNA inside infected or damaged cells in readiness to self-destruct. This is in contrast to what we understand about infectious disease stress responses. The mounting of a robust immune response under these conditions is thought to improve health as long as recovery from the stress occurs. Resistance to apoptosis in healthcare students also increases during examinations. Apoptosis is necessary to dispose of diseased, infected, or damaged cells such as malignant and virus-infected cells. Resistance to apoptosis, accompanied by an increase in the production of apoptotic counter-regulatory molecules, may help to explain persistent inflammation and impair immune defenses evoked by chronic academic stress. Finally, psychological factors of depression and anxiety can attract various other cells of the immune system to the site of this inflammation during academic stress, thus increasing it further. (Morawin et al.2021)(Dai et al., 2022)(DeForest et al.2024)(Lopez et al.2022)(Li et al.2024)(Feng et al.2022)

2.3. Impact of Stress on Academic Performance

It is documented that mental illness negatively affects academic performance. Likewise, 'academic stress', a form of psychosocial stress, significantly impacts the academic performance of Nepalese B.Sc. nursing and M.Pth physiotherapy students. Numerous studies have found an association between high levels of stress and a reduction in academic efficiency quantified by lower academic results achieved. Related outcomes include lower grades in objective structured clinical exams, psychometric test scores, and in-course examination results. Studies have reported that high psychological stress hinders the acquisition of theoretical knowledge and physical training in a practical hospital setting, and one study reports a lower ability to learn and a lower retention of knowledge as a result of the experience of stress. Difficulty in concentrating and noisy classroom environments were the most frequently reported

stressors associated with academic learning by undergraduate students. Additionally, stress may result in hormones worsening the depressive mood response of individuals to failure, which can in turn reduce performance in exams. (Ferreira et al.2020)(Thomas-Davis et al.2020)(Akulwar-Tajane et al.2021)(Mazalová et al., 2022)(Brooke et al., 2020)(Chisholm-Burns et al.2021)(Richardson et al.2022)

Depression is also related to lower academic performance, as well as burnout, a syndrome of emotional exhaustion that reduces professional efficacy and critical engagement. Moreover, academic stress triggers positive feedback within the RAS-HPA axis, leading to further activation of the immune system inflammasome. Finally, academic stress has a direct effect on the learning system by diverting cognitive resources away from learning. This changes learning performance significantly and has a negative impact on health. In summary, the physical and mental illness of healthcare practitioners is a cause of concern. Thus, it is necessary to establish a preventive strategy and program designed to enhance the positive balance in this relevant area of healthcare education, through which better learning and a better learning experience can be achieved. This highlighted area is important because of its positive implications for healthcare education, with a focus on mental health as an educational outcome, and the prevention of academic stress and related health conditions. The study states academic stress is negative and may result in physical and mental illness. For example, some studies have found a negative correlation between stress and nursing students' academic performance, as a reduced ability to learn is a direct result of the experience of stress in educational practice. Moreover, the effect of stress on academic performance is well documented in the depression literature. Lower academic performance is associated with depressive illness. Therefore, service agencies need to better understand how to enhance educational resilience and how to prevent mental health illness related to academic stress in the health professional education program. (Deng et al.2022)(Pascoe et al.2020)(Idris et al.2021)(Barbayannis et al.2022)(Yang et al., 2021)(Robinson et al.2023)(Adegboye et al.2021)

Methodology

To ensure a comprehensive review of the literature, a systematic approach was adopted to identify and evaluate studies that examine the relationship between academic stress, immune responses, and academic performance among nursing and physiotherapy students. The methodology consisted of the following steps:

1. Search Strategy

A systematic search of peer-reviewed literature was conducted using electronic databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search focused on articles published between January 2010 and December 2024. The following keywords and their combinations were used:

- "Academic stress"
- "Immune response"
- "Nursing students"
- "Physiotherapy students"
- "Healthcare education stress"
- "Cognitive performance"
- "Psychological stress and immunity"

Boolean operators (AND, OR) were applied to refine the search results and include relevant combinations of terms.

2. Inclusion and Exclusion Criteria

The inclusion criteria for selecting studies were:

- Peer-reviewed articles in English.
- Studies examining academic stress in healthcare students, particularly nursing and physiotherapy students.
- Research addressing physiological markers of stress (e.g., white blood cell counts, cytokines) and/or academic outcomes (e.g., GPA, exam performance).
- Quantitative, qualitative, or mixed-method studies.

The exclusion criteria were:

- Studies not related to academic stress or healthcare students.

- Articles focused exclusively on non-academic stressors.
- Review articles that did not provide new or relevant findings.
- Non-peer-reviewed literature (e.g., opinion pieces, blogs).

3. Data Extraction

Key information was extracted from each included study using a standardized data collection form. Extracted data included:

- Study objectives and research design.
- Sample characteristics (e.g., population, age, education level).
- Measures of academic stress (e.g., perceived stress scales, cortisol levels).
- Immune response markers (e.g., cytokine profiles, WBC counts).
- Academic performance metrics (e.g., GPA, exam scores).
- Main findings and conclusions.

4. Quality Assessment

The quality of the selected studies was assessed using the Mixed Methods Appraisal Tool (MMAT) to evaluate the validity and reliability of their methodologies. Each study was rated based on:

- Clarity of objectives and research questions.
- Appropriateness of methodology and data analysis.
- Relevance and applicability of findings to nursing and physiotherapy education.

5. Synthesis of Findings

The findings were synthesized thematically to highlight:

1. The prevalence and sources of academic stress among nursing and physiotherapy students.
2. The physiological impacts of stress on immune responses.
3. The relationship between stress and academic performance.
4. Proposed interventions to mitigate stress and improve outcomes.

4. Findings and Discussion

The review identified a consistent relationship between academic stress, immune suppression, and diminished academic performance. Nursing and physiotherapy students in Saudi Arabia face unique stressors, compounded by cultural and institutional factors. Key findings include:

- **Physiological Effects:** Chronic stress impairs immune function, as evidenced by reduced WBC counts and altered cytokine profiles.
- **Academic Outcomes:** Stress leads to poorer academic performance, particularly during high-stakes assessments.
- **Regional Challenges:** Limited research in Saudi Arabia highlights the need for localized studies and culturally sensitive interventions.

5. Implications and Recommendations

1. **For Institutions:**
    - Incorporate stress management programs into the curriculum.
    - Provide accessible mental health services.
    - Reduce academic overload through flexible scheduling and support systems.
2. **For Researchers:**
    - Conduct longitudinal studies to explore long-term effects of academic stress.
    - Investigate the impact of specific cultural factors on stress and immunity.
3. **For Students:**
    - Engage in regular physical activity and mindfulness practices.
    - Utilize available institutional resources for stress management.

6. Conclusion

This review underscores the profound impact of academic stress on immune responses and academic performance among nursing and physiotherapy students. Addressing these issues is essential for fostering a resilient healthcare workforce. By implementing targeted interventions and conducting further research, educational institutions can promote student well-being and ensure the success of future healthcare professionals.

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