Does maths anxiety impact drug calculation errors in paramedicine?

Eihab Khasawneh

DDS Dental Surgery, BSc Nursing, MS Emergency Health Services

A thesis submitted for the degree of Doctor of Philosophy at

Monash University (2020)

Department of Paramedicine

Faculty of Medicine, Nursing and Health Sciences

Abstract

Maths anxiety not only involves feeling tension when dealing with mathematical tasks but is related to poor math performance and indirectly impacts education and future career choice. Maths anxiety is a widespread, worldwide problem affecting all age groups and can occur in all stages of education from primary school to higher education. Maths anxiety antecedents can be divided into environmental, which include aspects such as educational and cultural values, and personal, such as prior knowledge, trait anxiety, or gender. Maths self-efficacy has been defined as the judgment about the abilities to learn successfully in maths or to assess a particular situation or issue which shows the individuals' confidence in their abilities for successful accomplishment or execution of a task, an issue or a mathematical problem.

Numerical and drug calculation skills are essential for patient safety. Health care providers, including pharmacists, physicians, nurses and paramedics, who perform drug calculation in their work, require excellent math skills, especially numerical ability. It is currently unclear what factors may influence the occurrence of drug errors among paramedic care. However, studies in other professions have demonstrated that maths anxiety might impact ones' ability to perform accurate drug calculations. Therefore, the primary aim of this thesis was to explore the impact of maths anxiety on drug calculation performance of paramedic students by addressing the following objectives: to determine the rate and nature of reported medication errors in Victoria, Australia in the past ten years, identify the facilitators and barriers of maths anxiety in university students, study the effects of self-efficacy on maths anxiety, determine the difference in maths anxiety and maths self-efficacy at two universities with different cultural backgrounds, and to ascertain the association between numerical ability and maths anxiety and drug calculation ability of paramedic students.

The findings of this thesis revealed that maths anxiety impacts the drug calculation ability of paramedic students by being negatively correlated with maths self-efficacy and positively correlated with numerical ability. Moreover, the studies in this thesis indicated that gender, year level and cultural background are all factors that are related to increasing levels of maths anxiety.

Future research may benefit from the findings and the methodologies used in this thesis to design studies that investigate the impact of maths anxiety on medication errors in practicing paramedics and to compare the maths anxiety impact on paramedic student's performance at national and international levels. For example, the methods and designs that were used in this thesis can be utilised in other schools of paramedicine in Australia and other countries in the Middle East such as Saudi Arabia and the United Arab Emirates to have a clearer picture about this issue in countries with similar cultural backgrounds.

Published works declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes five manuscripts currently under review in peer-reviewed journals. The core theme of the thesis is the impact of maths anxiety on drug calculation ability among paramedic students. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the Paramedicine Department under the supervision of Professor Brett Williams and Dr Cameron Gosling.

The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.

In the case of *(2,3,4,5 and 6*) my contribution to the work involved the following:

Thesis Chapter	**Publication Title**	**Status** *(published, in press, accepted or returned for revision)*	**Nature and % of student contribution**	**Co-author name(s) Nature and % of Co-author's contribution***	**Co-author(s), Monash student Y/N***
2	A 10-year comparison of hospital medication complication rates in Victoria, Australia. Currently. Hospital Topics.	Published in *Hospital Topics* on 14/10/2020.	Principal author, responsible for overall study, concept, literature search, data collection and synthesis, interpretation of results and development a writing up of the manuscript (70%).	The co-authors contributed in the following: editing and providing critical feedback on the manuscript 1) Cameron Gosling (15%) 2) Brett Williams (15%)	No

3	What impact does maths anxiety have on university students?	Accepted for publication in *BMC Psychology*.	Principal author, responsible for overall study, concept, literature search, data collection and synthesis, interpretation of results and development a writing up of the manuscript (70%).	The co-authors contributed in the following: editing and providing critical feedback on the manuscript 1) Cameron Gosling (15%) 2) Brett Williams (15%)	No
4	The effect of self-efficacy on maths anxiety among paramedic students.	Under review	Principal author, responsible for overall study, concept, literature search, data collection and synthesis, interpretation of results and development a writing up of the manuscript (70%).	The co-authors contributed in the following: editing and providing critical feedback on the manuscript 1) Cameron Gosling (15%) 2) Brett Williams (15%)	No
5	A comparison between the Self-efficacy and Maths Anxiety levels among paramedic undergraduate students in Jordan and Australia: A cross-cultural study	Under review	Principal author, responsible for overall study, concept, literature search, data collection and synthesis, interpretation of results and development a writing up of the manuscript (70%).	The co-authors contributed in the following: editing and providing critical feedback on the manuscript 1) Alaa Oteir (10%) 2) Cameron Gosling (10%) 3) Brett Williams (10%)	No
6	How Mathematics Anxiety Correlates to Numerical and Drug Calculation Ability of Paramedic Students? An explanatory Mixed Method Study."	Accepted for publication in *Advances in Medical Education and Practice.*	Principal author, responsible for overall study, concept, literature search, data collection and synthesis, interpretation of results and	The co-authors contributed in the following: editing and providing critical feedback on the manuscript	No

			development a writing up of the manuscript (70%).	1) Cameron Gosling (15%) 2) Brett Williams (15%)	

I have not renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

Student signature: (   ) **Date:** 20/08/2020

The undersigned hereby certify that the above declaration correctly reflects the nature and extent of the student’s and co-authors’ contributions to this work. In instances where I am not the responsible author, I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor signature: **Date:** 20/08/2020

Acknowledgments

I am thankful to many people who have helped me to overcome the many challenges through this PhD project. I would like to acknowledge and express my gratitude to:

- My supervisors: Professor Brett Williams and Dr Cameron Gosling for their tremendous professional support and guidance they have provided me with, which gave me great development opportunities throughout my candidature. I would like to thank them for their constant support, patience, challenging conversations and constructive feedback. Their efforts in this journey helped me to improve my research skills and develop into an independent researcher.
- My sponsor: Jordan University of Science and Technology for providing me with a scholarship to complete this doctoral degree.
- The undergraduate students of the Paramedicine programs at Jordan University of Science and Technology and Monash University for their participation in my project.
- The staff and postgraduate students in the Paramedicine Department for their supporting, welcoming and professional environment, which added significant value to this research project.
- The Department Research Coordinator, Dr Kelly-Ann Bowles for her continuous support and motivating conversations.
- Elsa Lapiz from Safer Care Victoria for supplying the medication complications data.
- My father, mother, brothers and sisters for their continuous support and prayers.
- My friends: Saad, Khaled, Ameer, and Wazi for their support.

- To my wife Huda, my sons (Baha, Diaa and Alaa) and my daughter Rawah. Thank you for your love, patience, encouragement and prayers.

Contents

Abbreviations

ADE: Adverse Drug Event.

AP: Accidental Poisoning.

CINHAL: Cumulative Index of Nursing and Allied Health Literature.

ERIC: Education Resources Information Centre.

HMA: High Maths Anxious.

ICD: International Classification of Diseases.

LDA: Learning Difficulty Australia.

LMA: Low Maths Anxious.

MBS: Maths Barrier Scale.

MCS: Maths Confidence Scale.

MeSH: Medical Subject Headings**.**

MVS: Maths Value Scale.

UI: Undetermined Intent.

UK: United Kingdom.

US: United States.

R-MARS: Revised Maths Anxiety Rating Scale.

Publications, presentations and awards

Publications

1. **Khasawneh, E**, Gosling, C & Williams, B. A 10-year comparison of hospital medication complication rates in Victoria, Australia**.** Published in *Hospital Topics* on 14/10/2020.
2. **Khasawneh, E**, Gosling, C & Williams, B. The Impact of Maths Anxiety on University students. Accepted for publication in *BMC Psychology*.
3. **Khasawneh, E**, Gosling, C & Williams, B. The effect of self-efficacy on maths anxiety among paramedic students. Currently under review at *Australian Journal of Paramedicine.*
4. **Khasawneh, E**, Otier, A, Gosling, C & Williams, B. A comparison between the Self-efficacy and Maths Anxiety levels among paramedic undergraduate students in Jordan and Australia: A cross-cultural study. Currently under review at *Jordanian Medical Journal.*
5. **Khasawneh, E**, Gosling, C & Williams, B. How Mathematics Anxiety Correlates to Numerical and Drug Calculation Ability of Paramedic Students? An explanatory Mixed Method Study." Accepted for publication in *Advances in Medical Education and Practice*.

Conference Presentations

Presentations Arising from PhD

1. **Khasawneh, E**, Gosling, C & Williams, B. What are the facilitators and barriers of maths anxiety among university students? A scoping review. Poster presentation at Paramedicine Research Symposium: 6th July 2018, Monash University, Melbourne, Australia.

2. **Khasawneh, E**, Gosling, C & Williams, B. The effect of self-efficacy on maths anxiety among paramedic students. Oral presentation at Paramedicine Research Symposium: 26th November 2019, Monash University, Melbourne, Australia.

Other presentations during the PhD

1. AL Obaid, A, Gosling, C, **Khasawneh, E**, McKenna, L, & Williams, B. Challenges faced by female healthcare professionals in the workforce: A scoping review. Oral presentation at Paramedicine Research Symposium: 26th November 2019, Monash University, Melbourne, Australia.

Grants/ awards

1. Monash University travel grant (AUD 1500)
2. PhD Scholarship from Jordan University of Science and Technology (2016-2020).

Chapter One: Introduction.

1.1 Overview

Maths, which is essential for routine paramedic tasks, can impact the performance of the paramedics and the services that are provided to patients. Paramedics should be confident in their maths ability so that they can perform drug dose calculation correctly in any stressful situation. Failure to have competency in maths skills might impact the quality of care that is provided to patients.

1.2 Maths anxiety

The American Psychological Association (2014) defined anxiety as "an emotion characterised by feelings of tension, worried thoughts and physical changes like increased blood pressure." A subtype of generalised anxiety is maths anxiety which is considered an essential topic for the researchers in different disciplines such as education, science, engineering, medicine, nursing and paramedicine. The physiological symptoms of maths anxiety include increased heart rate, clammy hands, upset stomach, and dizziness. (1) A study by Luttenberger, Wimmer (2) reported that students with high levels of maths anxiety had higher increases in cardiovascular reactions when solving mathematical tasks than students with low levels of math anxiety. Maths anxiety not only involves feeling tension when dealing with mathematical tasks but is related to poor math performance and indirectly impacts education and future career choice. (3) Maths anxiety is a widespread, worldwide problem affecting all age groups and can occur in all stages of education from primary schools until the higher education levels. (4) Even though maths anxiety is present in younger school children (5,6), it continues to persist in post-secondary education and adulthood. (7) For example, in the US, 93% of adult Americans indicated that they experience some level of maths anxiety, and it is estimated that approximately 17% of the American population suffers from high levels of maths anxiety. (2)

In the UK, about 18% of the people are affected by high maths anxiety levels. (8) Maths anxiety is spread worldwide, and its causes should continue to be explored.

1.2.1 Antecedents of Maths anxiety

Maths anxiety antecedents can be divided into environmental and personal. Environmental include aspects such as educational and cultural values, while personal includes issues such as prior knowledge, trait anxiety, or gender. (2) These will be individually discussed below.

1.2.1.1 Environmental antecedents (role models)

Teachers, parents, and other important adults serve as role models that influence children through their attitudes toward maths. (9) Teachers may spread the myth that math ability is a talent and depends on giftedness. (2) Moreover, teachers who have low expectations for students tend to impact students' educational growth. (10) Scarpello (11) reported that teachers are a crucial element in reducing maths anxiety and encouraging students to access higher maths levels. Parents have an essential role in either the development or reduction of maths anxiety levels in their children. Parental attitudes about maths when they were students and the importance of maths in society are incredibly influential in their children's performance in maths. (12) Parents' attributions toward maths serve as a frame of reference, meaning that they may transfer their maths anxiety to their children. (9)

1.2.1.2 Personal antecedents

These include prior knowledge, gender and trait anxiety. Inability to understand mathematical concepts actively contribute to maths anxiety. (1) Whilst poor performance may trigger maths anxiety in specific individuals, maths anxiety lowers or causes a further reduction in the mathematics performance in others. (13) According to the Reciprocal Theory, poor performance causes maths anxiety, and further maths anxiety leads to future poor returns in task-related situations, exacerbating the condition. (14) Maths anxiety is related to cognitive processing deficits in the working memory and, consequently, to poor performance and reduced uptake of knowledge in task-related situations.

1.3 Maths self-efficacy

Self-efficacy is also related to maths anxiety. Self-efficacy is defined as people's judgments of the capabilities to organise and execute courses of action required to attain designated types of performances. (15) Self-efficacy theory postulates that people acquire information to evaluate efficacy beliefs from four primary sources. These include enactive mastery experiences (actual performances), observation of others (vicarious experiences), forms of persuasion, and physiological and affective states from which people partly judge their capability, strength, and vulnerability to dysfunction. (16) Self-efficacy depends on a defined area, meaning that humans have self-efficacy particular to specified areas. (17) One of these areas is academic self-efficacy which refers to individuals' judgments about their abilities to organise and execute a set of tasks for reaching the pre-determined kinds of performances. (17)

Academic self-efficacy plays a vital role in predicting academic progress at different levels as well as in specific areas. (18) One of these areas is maths. Maths self-efficacy has been defined as the judgment about the abilities to learn successfully in maths (17) or to assess a particular situation or issue which shows the individuals' confidence in his or her ability to accomplish or execute a task, a question or a mathematical problem. (19) Individuals with a high level of self-efficacy try harder to solve problems; they are more accurate in mathematical calculations and show more consistency in dealing with complex issues. However, those with lower levels of self-efficacy have negative thoughts and consider the challenges not only as competitive issues but also as being negative. (18) Moreover, these feelings negatively influence the self-belief of the individual, resulting in a loss of capabilities in performing the required tasks. (20)

1.4 Numerical ability

Numeracy is the ability to reason and to apply simple numerical concepts such as addition, subtraction, multiplication, and division. (21) Numerical and drug calculation skills are essential for patient safety. (22) Health care providers who perform drug calculations in their work require excellent math skills, especially numerical ability. Most of the available literature that shows studies on the importance of numerical ability in drug calculation performance has been undertaken within the nursing profession. For example, numerical ability was the main predictor of drug calculation ability of a cohort of British nursing students. (23) In another study, Dilles, Vander Stichele (24) found that just before graduation, nursing students' pharmacological knowledge and calculation skills were limited and that nursing students did not perceive themselves as able to deliver safe medication care in practice. The study suggested that nursing schools need to address these shortcomings and be aware of the possible limitations of the newly graduated. (24)

Poor math performance can be the result of many factors, which frequently interfere with math cognition. (22) Bagnasco, Galaverna (25) explored nursing students' understanding of maths principles and found that these students mainly had difficulty with basic maths principles. As a result, they identified appropriate educational interventions to help bridge their mathematical knowledge gaps. (25).

1.5 Drug calculation in paramedicine

One of the tasks that paramedics regularly perform in the management of their patients is drug calculations. Performing drug calculations and medication administration is often completed under unique pressures due to the dynamic and often unpredictable nature of their working environment. (26) Paramedics are also required to treat a wide variety of patient complaints, from social issues to life-threatening conditions. Their working environment can vary from a well-lit location to a very dark confined space. Different pressures, stressors and extraneous variables present in the out-of-hospital setting at any given time are potentially unique to this discipline. These include time, environment, management of distressed individuals, other agencies at incident sites, and the management of critically ill patients. Other factors attributed to poor mathematical performance include skills decay and poor initial mathematical education. (26) Research into paramedics' drug calculation abilities was first reported in 2000 by Hubble, Paschal. (27) These researchers found that the overall performance on the drug calculation examination in a population of US-trained paramedics was poor; with a mean score of 51.4% (SD 27.4). Intravenous flow rate problems and medication bolus problems were calculated correctly in most cases (68.8%). Still, results for non-weight-based medication infusions (33.9%), weight-based medication infusions (32.5%), and percentage-based medication infusions (4.5%) were poor. Examination scores were higher among paramedics with a college-level education, and scores were lower among paramedics with more years of EMS experience. (27)

A study by Bernius, Thibodeau (28) assessed 523 practising paramedics during a mandatory continuing education class in Maryland, USA. Of these 523, 277 paramedics undertook the study performing paediatric calculation mentally or using paper (unaided), and the remaining participants used a paediatric code card (aided) with all the necessary drug calculations. The study found a statistically significant difference between the unaided and aided group in percentage of total question errors [33% vs. 6.6%, respectively ($p < 0.001$)]; severe errors [20.9% vs. 4.9%, respectively ($p < 0.001$)]; correct ETT calculation [23% vs. 98%, respectively (p

<0.001)] and time taken to complete the questionnaire [11.4 minutes and 7.1 minutes, respectively ($p < 0.001$)]. (28) LeBlanc, MacDonald (29) reported that the experienced paramedics performed better on the drug calculation task than did the newly hired paramedics [61.1% vs. 39.8% (95% CI: 50.6%–71.6% and 31.2%–48.4%), $p < 0.01$]. Moreover, they reported that both groups performed better in the low-stress condition than in the high-stress condition [57.9% vs. 43.1% (95% CI: 48.6%–67.1% and 36.9%–49.2%), $p < 0.01$]. They also reported that there was a decrease in mathematical performance when under the pressure of a patient-based scenario rather than a written scenario. (29) These studies indicate that drug calculations are performed more accurately by experienced paramedics, in low-stress situations using calculation aids. However, as indicated earlier, these situations do not always exist in paramedic practice.

1.6 Chain of medication errors.

Increasing the number of new medications and the increase in patient care demand in paramedic practise may increase the possibility of drug administration errors. (30) The chain of patient care and drug administration commences on the scene with paramedics and continues through to hospital physicians and nurses. (31) Medication errors can occur at any stage in this chain, and many factors may impact medication errors made by paramedics. It is currently unclear what factors may influence the occurrence of drug errors among paramedic care. However, studies in other professions have demonstrated that maths anxiety (32) might impact the ability of healthcare professionals to perform accurate drug calculations. (23) Wrong drug dose calculation can lead to medication administration errors and failures. (33)

Medical errors occur both in and out of hospital settings (34) at any part of the health care system (35) and different stages of care, including diagnosis and treatment (36). In a survey of 352 US paramedics, 9.1% of respondents reported they committed at least one medication error in the last 12 months. (37) Of these reported errors, 79.1% were self-reported, the base hospital radio nurse reported 8.3%, 8.3% were found upon chart review, and 4.2% were noted by a paramedic during the call but never reported. The researchers also classified most errors as dose-related (63%). These errors included failure in the triple check protocol of drugs, infrequent use of certain medications, dosage calculation errors and incorrect dose administration. (37) However, these data are based on US paramedics, and currently, there is no published literature covering the scope of errors within an Australian context. Therefore, it is important to determine the incidence of medication errors within paramedic practice and the role maths anxiety plays in contributing to these errors.

1.7 Thesis aim and objectives.

The primary aim of this thesis was to explore the impact of maths anxiety on drug calculation performance of paramedic students.

The objectives of this thesis included the following:

1. To determine the rate and nature of reported medication errors in Victoria, Australia in the past ten years;
2. To identify the facilitators and barriers of maths anxiety in university students;
3. To study the effects of self-efficacy on maths anxiety in paramedic students;
4. To determine the difference in maths anxiety level as measured by Maths Anxiety Rating Scale (MARS) and maths self-efficacy levels as measured by Maths Self-Efficacy Scale (MSES) for paramedic students at two universities with different cultural backgrounds; and

5. To ascertain the association between numerical ability and maths anxiety and drug calculation ability of paramedic students.

1.8 Overview of thesis chapters

This PhD consists of different studies and methodologies to meet the aforementioned primary aim and objectives. Chapter one includes an introduction of the background, the aim and the objectives, an overview of the thesis chapters and the significance of the research.

Chapter two presents study information identifying medication errors utilising a cohort research design using mandatorily collected hospital administrative data. Medication errors in this chapter were retrieved from the Victorian Admitted Episodes Dataset (VAED) for private and public hospitals in Victoria, Australia. The findings of this chapter indicated that all types of medication errors occurred with different rates in the last ten years in Victoria. Moreover, this chapter highlighted that future research should focus on contributing factors to, and the rate of, medication errors and their related concepts such as maths anxiety in other health care context, such as paramedicine. Drug dose calculation competency and the role of drug dose errors in causing accidental poisoning events can be investigated in practicing paramedics and paramedic students.

Chapter Three utilised a scoping review methodology. This scoping review summarises the latest literature regarding maths anxiety, identifies gaps in the literature and concludes with the need for further studies. The scoping review addressed the facilitators and barriers of maths anxiety in university students. The initial aim was to explore the facilitators and barriers of maths anxiety in paramedic discipline; however, the initial search yielded no studies that met the inclusion criteria focused on the paramedic discipline or other health care providing sectors. Therefore, the search was expanded to involve all university students.

Chapter Four, Five and Six are the core prospective studies of this thesis. Chapter Four addresses the relationship between self-efficacy and maths anxiety among paramedic students at a large Australian university. This study utilised a cross-sectional study design to explore the predicting factors of maths anxiety in paramedic students. The findings of this chapter indicated that self-efficacy is a negative predictor of maths anxiety among Australian paramedic students. The study in this chapter was conducted in one cultural context, thereby limiting its external validity. Therefore, to generalise the findings of the study in chapter four, the study in chapter five was conducted.

Chapter Five compared the levels of maths anxiety and self-efficacy between two schools with different cultural backgrounds in Jordan and Australia. Chapter Five utilised a sequential explanatory mixed-method approach indicated that maths anxiety is a persistent issue common between those of different cultural backgrounds.

Chapter Six also utilised a sequential explanatory mixed-method approach and addressed the association between maths anxiety and numerical ability and drug calculation ability of the paramedic students at a large Australian university. Chapter Six concluded that while previous maths education and numerical ability were direct predictors of the students' drug dose calculation abilities, maths anxiety indirectly impacted drug calculation abilities.

Chapter Seven concludes this thesis, provides an overview of the included work and a summary of the objectives, describes the implication of this work and provides recommendations for future research.

1.9 Significance of the research

This PhD thesis is the first to address maths anxiety and its contributing factors and impact on drug calculation errors in the paramedic discipline. Studies arising from this PhD contribute to improved knowledge and understanding through describing and exploring the predicting factors of maths anxiety and the associations between them. Moreover, it serves as a baseline for future research and potential changes to clinical practice and paramedic curricula. The findings of this thesis will guide researchers and instructors to develop training programs that may improve the students' self-efficacy, which will, in turn, overcome high maths anxiety levels. Furthermore, the findings of this thesis may aid the development of drug calculation curriculum in the pharmacology course in Middle Eastern countries, such as Jordan, which at present lack significant curricula in this area.

Chapter Two: Medication errors in Victorian Hospitals

2.1 Introduction

Medication errors occur in both prehospital and in-hospital settings. This chapter involves a retrospective cohort study using administrative data extracted from the Victorian Admitted Episodes Dataset (VAED). The study aimed to explore the rate and types of medication complications in Victoria, Australia. The sample comprised a count of all reported complications from all private and public hospitals in Victoria between July 2009 and May 2019. Data were extracted from the VAED using the external cause ICD-10 classifications for adverse drug event (ADE), accidental poisoning (AP), and underdetermined intent (UI).

The results of this chapter are reported in the following manuscript, which is published in the Hospital Topics Journal on 14/10/2020, "Ten-year comparison of hospital medication complications rates in Victoria, Australia".

2.2 The manuscript: A 10-year comparison of hospital medication complication rates in Victoria, Australia.

Abstract

Background

Medication errors occur because of failure in the treatment process that leads to or has the potential to lead to, harm to the patient. Medication errors can occur at any point in the health care system. This study aimed to determine the rates of medication-related errors over ten years in hospitals in Victoria, Australia.

Methods

A retrospective cohort study using the Victorian Admitted Episodes Dataset (VAED) was used to explore the rate and types of medication complications. The sample comprised a count of all reported complications from all private and public hospitals in Victoria between July 2009 and May 2019. Data were extracted from the VAED using the external cause ICD-10 classifications for Adverse drug event (ADE), accidental poisoning (AP), and underdetermined intent (UI).

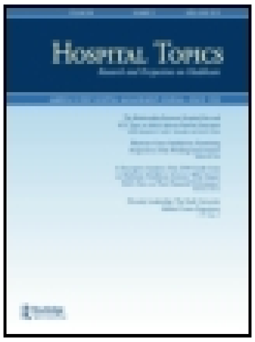
Results

Less than 1% of all hospital separations across the sample had an adverse drug event, while this proportion was even lower for accidental poisonings (0.01%) and undetermined intent (0.002%). From 2009 to 2019, the overall rate for ADE, AP and UI were 86.15, 1.3 and 0.17 per 10,000 hospital separations, respectively.

Conclusion

Medication complications occurred in public and private hospitals in Victoria, Australia, with a different rate. Adverse drug events are low, accounting for less than 1% of all hospital separations. ADE, AP & UI are reported more often in public hospitals in Victoria and events appear to fluctuate according to year. Medication errors and their contributing factors should be investigated in the out-of-hospital environment.

Keywords: Adverse drug event; Health care providers; Medication errors; Public hospitals; Private hospitals.



Hospital Topics

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/vhos20

Ten-Year Comparison of Medication Complications Rates in Public and Private Hospitals in Victoria, Australia

Eihab A. Khasawneh , Cameron M. Gosling & Brett A. Williams

To cite this article: Eihab A. Khasawneh , Cameron M. Gosling & Brett A. Williams (2020): Ten-Year Comparison of Medication Complications Rates in Public and Private Hospitals in Victoria, Australia, Hospital Topics, DOI: 10.1080/00185868.2020.1828011

To link to this article: https://doi.org/10.1080/00185868.2020.1828011

Published online: 14 Oct 2020.

HOSPITAL TOPICS
https://doi.org/10.1080/00185868.2020.1828011

Taylor & Francis
Taylor & Francis Group

ARTICLE

Check for updates

Ten-Year Comparison of Medication Complications Rates in Public and Private Hospitals in Victoria, Australia

Eihab A. Khasawneh[a,b], Cameron M. Gosling[a], and Brett A. Williams[a]

[a]Department of Paramedicine, Monash University, Victoria, Australia; [b]Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan

ABSTRACT

Medication errors occur as a result of failure in the treatment process at any point in the health-care system. This is a retrospective study aimed at determining the rates of medication-related errors over a 10-year period in hospitals in Victoria, Australia. From 2009 to 2019, the overall rate for adverse drug events, accidental poisoning and undetermined intent were 86.15, 1.3 and 0.17 per 10,000 hospital separations, respectively. Medication complications occurred more in public hospitals. Adverse drug events account for less than 1% of all hospital separations. Medication errors contributing factors should be investigated in out of hospital environment.

KEYWORDS

Adverse drug event; healthcare providers; medication errors; private hospitals; public hospitals

Introduction

Medical error is a near miss or preventable adverse event due to planned action failures or the incorrect use of a plan to achieve a treatment aim (Pham et al. 2012). Medical errors contribute to death worldwide; with more than 250,000 people in the United States (US) and as many as 18,000 patients in Australia dying and a further 50,000 Australians suffering permanent injury each year as a result of medical errors (Sipherd 2018).

Medical errors occur both in- and out-of-hospital settings (Havens and Boroughs 2000), at any point or part of the healthcare system (Karthikeyan et al. 2015), and at different stages of care, including diagnosis and/or treatment (Elder and Dovey 2002). A common treatment-related error involves the prescription and administration of medications to patients (Tariq and Scherbak 2019). Medication-related errors include incorrect medication, incorrect dose, delayed drug administration (Shah et al. 2016), or omitted medication administration (Elder and Dovey 2002).

Medication errors, which result from failures in treatment regimens (Roughead, Semple, and Rosenfeld 2016), are the most common medical error types. Medication errors result in harm to 1–2% of patients admitted to the United Kingdom (UK) and US hospitals (Lifshitz et al. 2012). Costs arising from medication errors in the US had been estimated at more than $6 billion (Gorgich et al. 2016). In Australia, there has been an increase in the cost of medication errors related to hospital admissions in Australia over the last two decades. In 2000, the Australian Institute of Health and Welfare (AIHW) reported that costs relating to the inappropriate use of medications were approximately $380 million annually which had ballooned to $1.2 billion by 2012 (Roughead, Semple, and Rosenfeld 2016).

There have been differing approaches to the classification of medication errors (Ferner and Aronson 2006). Any medication error that has resulted in actual patient harm is categorized as an Adverse Drug Event (ADE) (Dedefo, Mitike, and Angamo 2016). Potential ADEs are errors that have the potential to harm a patient, without actually causing harm (near-miss) and are further categorized as intercepted or non-intercepted (Dedefo, Mitike, and Angamo 2016). For example, an intercepted potential ADE may be a

CONTACT Eihab Khasawneh eihab.khasawneh@monash.edu; eakhasawneh1@just.edu.jo Department of Paramedicine, Monash University, 47 – 49 Moorooduc Highway, Frankston Victoria 3199, Australia.

drug order that is intercepted before it reaches the patient, whereas a non-intercepted potential ADE has reached the patient but does not cause injury because the patient has enough physiological reserves (Dedefo, Mitike, and Angamo 2016). Another category of medication error is Accidental Poisoning (AP) that include accidental overdose of the drug, or wrong drug is given or taken in error, and drug taken inadvertently, accidents in the use of drugs (Pournamdar and Zare 2016). The last category, Undetermined Intent (UI), is where the intent is unspecified, unstated or cannot be determined. That is, injuries are not specified as accidental or self-inflicted. The outcomes from medication errors vary according to the type of medication involved, the dose administered, patient's age, the timing of error discovery, and availability of antidotes and reversal solutions (Khasawneh and Hani 2018).

In Australia, most of the studies addressed the adverse drug reactions or the AP with no study focusing on all medication complications together in private and public hospitals (Hodgkinson, Dirnbauer, and Larmour 2009; Hauck and Zhao 2011; Claydon-Platt, Manias, and Dunning 2012). Therefore, the aim of this study was to determine and compare the rates of the adverse medication-related events between 2009 and 2019 in private and public hospitals in Victoria, Australia.

Methods

Study Design

A retrospective cohort designed study based on counts of data and using administrative data from the Victorian Admitted Episodes Dataset (VAED) were used to explore the rate and types of medication complications.

Sample and Procedure

The sample comprised a count of all reported complications by private and public hospitals in Victoria between July 2009 and May 2019. Data were extracted from the VAED using the ICD-10 external cause code classifications for ADE (Y40 – Y59), AP (X40 – X44), and underdetermined intent (Y10 – Y14).

Ethics

This study was approved by the University Human Research Ethics Committee (Project ID# 21661).

Data Analysis

Count data from each year across all variables were reported against the total hospital separations. The proportion of cases was calculated for each variable. Incident rates for medication complications were calculated and reported as a rate per 10,000 hospital separations. Poisson regression was used to calculate incident rate ratios for comparisons between the year of occurrence, and hospital type. Significance was assigned if $p < .05$.

Results

There were 176,698 ADE, 2662 AP and 354 UI reported over the study period, across all hospital sites. Less than 1% of all hospital separations across the sample had an ADE, while this proportion was even lower for APs (0.01%) and UI (0.002%). From 2009 to 2019, the overall rate for ADE, AP, and UI were 86.15, 1.3 and 0.17 per 10,000 hospital separations, respectively. The comparison data are presented in Table 1.

Event rates and rate ratios for ADEs, AP events and undetermined intent events are presented in Table 1. Event rates varied by hospital type with public hospitals demonstrating significantly higher rates for ADE (IRR = 2.44, 95% CI (2.41, 246), $p < .001$), AP (IRR= 4,17, 95% CI (3.75, 4.65), $p < .001$) and UI (IRR = 2.02, 95% CI (1.60, 2.57), $p < .001$). The rate of the AP events (IRR, 95%CI) across years fluctuated between 1.02 (0.99, 1.04) and 1.18 (1.15, 1.21) times greater than 2009–2010. However, there appears to be no consistent upward or downward trend in the results. Year-by-year fluctuations were also reported for AP, although from 2016 to 2017 there were significant reductions in the rate of AP ($p < .05$) events. Higher rates of UI across each year were reported, but significantly higher rates ranging from 2.07 (1.2, 3.63) to 2.55 (1.49, 4.37) occurred between 2012–2013 and 2015–2016.

Table 1. Comparison of the rates and Incident Rate Ratio (IRR) comparisons of adverse drug events, accidental poisoning events and undetermined events across hospital types and 10 years of collected Victorian Admitted Episodes Data (July 2009 to May 2019).

Variable	Hospital Separations (*n*)	Adverse drug events Events (*n*)	Rate*	IRR (95% CI)	Accidental poisoning events Events (*n*)	Rate*	IRR (95% CI)	Undetermined intent events Events (*n*)	Rate*	IRR (95% CI)
Hospital type										
Private	8,547,345	40,113	46.93	Reference	391	0.46	Reference	93	0.11	Reference
Public	11,962,161	136,585	114.85	2.44 (2.41, 2.46)[b]	2271	1.9	4.18 (3.75, 4.65)[b]	261	0.22	2.03 (1.6, 2.57)[b]
Year:										
2009/2010	1,858,561	14,511	78.08	Reference	247	1.33	Reference	18	0.1	Reference
2010/2011	1,901,645	15,328	80.6	1.02 (0.99, 1.04)	267	1.4	1.04 (0.87, 1.23)	27	0.14	1.45 (0.8, 2.63)
2011/2012	1,968,439	16,055	81.56	1.04 (1.01, 1.06)[b]	292	1.48	1.1 (0.93, 1.31)	27	0.14	1.41 (0.77, 2.55)
2012/2013	1,871,060	16,852	90.07	1.17 (1.15, 1.2)[c]	260	1.39	1.07 (0.9, 1.27)	37	0.2	2.07 (1.2, 3.63)[a]
2013/2014	1,970,691	17,982	91.25	1.18 (1.15, 1.21)[c]	302	1.53	1.17 (0.99, 1.38)	42	0.21	2.22 (1.28, 3.85)[b]
2014/2015	2,070,462	17,929	86.59	1.11 (1.09, 1.14)[c]	265	1.28	0.97 (0.81, 1.15)	51	0.25	2.55 (1.49, 4.37)[b]
2015/2016	2,151,634	18,547	86.2	1.10 (107, 1.12)[c]	263	1.22	0.91 (0.77, 1.09)	47	0.22	2.25 (1.3, 3.87)[b]
2016/2017	2,260,780	19,987	88.41	1.12 (1.09, 1.14)[c]	251	1.11	0.82 (0.69, 0.98)[a]	36	0.16	1.62 (0.92, 2.86)
2017/2018	2,335,139	20,892	89.47	1.12 (1.1, 1.15)[c]	264	1.13	0.83 (0.7, 0.98)[a]	40	0.17	1.74 (0.99, 3.04)
2018/2019	2,121,095	18,615	87.76	1.08 (1.05, 1.1)[c]	251	1.18	0.84 (0.7, 0.99)[a]	29	0.14	1.36 (0.76, 2.45)

*Rates are presented per 10,000 separations.
[a]$p < .05$, [b]$p < .01$, [c]$p < .00$.

Discussion

The aim of this study was to determine and compare the rates of the adverse medication-related events between 2009 and 2019 in private and public hospitals in Victoria, Australia. Reported events were low, accounting for less than 1% of all separations for ADE, AP, and UI events. Data from this study demonstrated that all types of medication-related complications are reported more often in public hospitals than in private hospitals. Year-by-year comparison of events identified fluctuations in rates across all event variables measured. However, it was noted that improvements in the rates of AP have occurred since 2016–2017.

There are more than 200 hundred public and private hospitals in Victoria (Victorian Department of Health and Human Services 2018), with public hospitals accounting for 55% of the total hospital number. In our study, the number of separations in public hospitals was 1.5 times the number of separations in the private hospitals. Having more separations might increase the chance of having more adverse medication-related events and medical complications (Scott, Considine, and Botti 2014).

The proportion of ADEs reported in our study were consistent with previous reports. The ADEs occurred over the study period count for 1% of the medication errors, which is similar to the 1.46% reported previously in a 10-year Portuguese study by Scripcaru and Mateus (Scripcaru, Mateus, and Nunes 2017). In Europe, studies using administrative databases have shown that the rate of adverse drug reactions was 0.9% in England (Salmerón-García et al. 2010) and was 1.83% in Netherlands (van der Hooft et al. 2006). Our study demonstrated that the ADEs in public hospitals are two times greater than in the private hospitals. This can be explained by that case mix can be quite different for public and private hospitals, with a significantly higher proportion of private hospital separations being same day elective procedures. Factors that might contribute to ADEs can be classified into the patient, system and healthcare provider factors (Grandell-Niemi et al. 2003; Greenfield et al. 2007; Mrayyan 2007). Patient factors related to the characteristics or attributes of patients that place them at risk of experiencing a medication error. For example, one study indicated that ADEs occur more frequently in a particular group of patients such as older adults, females and patients with polypharmacy needs (Giardina et al. 2018). While others reported that patient-related factors might involve gender, drug allergy, the use of multiple drugs, use of antibiotics, and having diseases such as cancer, tuberculosis, and AIDS (Pongchaidecha, Chalongsuk, and Prakongsai 2009). These reports lend substance to the notion that the higher the polypharmacy regime a patient may be taking the more an adverse event may occur. System and healthcare providers related factors that contribute to the increased rate of ADEs in public hospitals can be due to the influence of the coding practice between public and private hospitals. It is quite likely that there is more comprehensive coding of diagnoses in public hospitals since it is being used for funding purposes. Using updated coding systems will reduce the coding errors in determining the medication error rates because coding error might impact the treatment provided to the patient, might lead to overcharging the patients and their insurance companies, and might lead to reduction in the overall income of the hospital (Zafirah et al. 2018). Reducing coding errors can be achieved through continuous training of staff on coding skills, using new and updated versions of coding software, and continuous auditing and quality assurance policy.

Another type of adverse medication-related event reported in our study is the AP related to drugs. Our study demonstrated an AP rate over the study period (0.01%), which was better than the 0.06% previously reported (Scripcaru, Mateus, and Nunes 2017). In 2012, AP caused 899 premature deaths in Australia; two-thirds of these premature deaths ($n = 592$) were among males (Australian Institute of Health and Welfare 2016). Although the AP events rate fluctuated through our study period, it was observed to be significantly reduced from the 2016/2017 calendar year.

Little is known about the causes and the contributing factors to AP events (Bari, Khan, and Rathore 2016). Accidental poisoning could be due to system (institutional-related) and personal (individual health practitioner characteristics-related) factors (Cloete 2015). The systematic factors might include staffing levels, shift length, patient acuity, and organizational climate (Khammarnia et al. 2015). The health practitioner characteristics-related factors that can lead to AP include characteristics of individual providers such as training and fatigue levels, nature of the clinical work such as the need for attention to details and time pressures, and design of the physical environment (Henriksen et al. 2008).

Staffing workloads may impact the AP events (Keshk and Abd El-Moneem 2012); as increased workload can lead to fatigue, resulting in feelings of weakness and weariness of mind which, between them, may interfere with one's ability and role-playing activities (Bolandianbafghi et al. 2017). Another personal factor that might contribute to AP is stress which many health sector workers experience. Having responsibility for the welfare of patients makes health workers particularly vulnerable to anxiety, pressure and stress (Widodo 2019). Stress and anxiety can come from working long shift hours, the working environment that includes interacting with patient family members, crowded wards, supervisors, and workmates (Johan, Sarwar, and Majeed 2017). Stress encountered in clinical situations can increase medical errors, including AP, even in highly experienced individuals (LeBlanc et al. 2005). According to Ehsani, Cheraghi (Ehsani et al. 2013) the shortage of nursing staff, inadequate pharmacological knowledge, stress and fatigue resulting from high workload were among the managerial and human factors associated with all type of medication errors.

Death rates from drug overdose and other forms of AP among young adults increased by three times between 1999 and 2014, rising from 3.8 deaths per 100,000 to 12.8 deaths per 100,000 (Rudd et al. 2016). Accidental poisoning contributed to the death of almost 3000 young adults in 2014, accounting for 15% of all young adult deaths. In 2014, 96% of all AP deaths among young adults were due to drug overdoses (Ehsani et al. 2013). This means that the drug dose error which contributes to AP, should be investigated in different healthcare providing discipline highlighting the causes and contributing factors. Moreover, the impact of stress and anxiety should be investigated, ending up with strategies to overcome the negative impact of these two important issues in health practice.

Finally, some strategies might be used and applied by the decision makers and administrators of the hospitals to reduce and prevent the medication errors. These strategies include computerized physician order entry with or without clinical decision support systems, automation, computer-assisted, barcode technology, pharmacist role, training and system designs (Acheampong, Anto, and Koffuor 2014).

Limitations and Future Research

One of the limitations of this study is using an administrative data set which may under-report the medication-related adverse events due to the potential under reporting of cases in which there was no harm or negligible harm done to the patient. A typical problem using ICD-based classifications includes coding errors due to complex coding rules. Another limitation is that there is uncertainty in determining the true cause of the medication-related adverse events; whether was it a system, clinician or patient-related.

Future research should highlight the contributing factors and the rate of medication error and its related concepts in other healthcare context, such as the prehospital environment. Drug dose calculation competency and the role of drug dose errors in causing AP events can be investigated in practicing paramedics and paramedic students.

Conclusion

Adverse drug events in Victorian hospitals are low, accounting for less than 1% of all hospital separations. ADE, AP & UI are reported more often in public hospitals in Victoria and events appear to fluctuate according to year. Medication errors result from a combination of factors that are classified as patient-, system-, and healthcare providers- related factors. Medication errors and their contributing factors should be investigated in out of hospital environment.

Acknowledgments

We would like to acknowledge Elsa Lapiz from Safer Care Victoria and Mark Gill from Victorian Agency for health Information for supplying us with the study data.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Availability of Data and Material

The data that support the findings of this study are available from the Victorian Admitted Episodes Dataset supplied by Safer Care Victoria but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of Safer Care Victoria.

ORCID

Eihab A. Khasawneh http://orcid.org/0000-0002-9106-9008
Cameron M. Gosling http://orcid.org/0000-0003-1771-0458
Brett A. Williams http://orcid.org/0000-0001-6307-1779

References

Acheampong, F., B. P. Anto, and G. A. Koffuor. 2014. Medication safety strategies in hospitals-a systematic review. *Int. J. Risk Saf. Med.* 26 (3):117–31. doi: 10.3233/JRS-140623.

Australian Institute of Health and Welfare. 2016. Admitted patient care 2014–15: Australian hospital statistics. Australian Government, Canbera Health services series no 68, Cat no HSE 172.

Bari, A., R. Khan, and A. Rathore. 2016. Medical errors; causes, consequences, emotional response and resulting behavioral change. *Pak. J. Med. Sci.* 32 (3):523–8. doi: 10.12669/pjms.323.9701.

Bolandianbafghi, S., T. Salimi, M. Rassouli, R. Faraji, and M. Sarebanhassanabadi. 2017. Correlation between medication errors with job satisfaction and fatigue of nurses. *Electr. Phys.* 9 (8):5142–8. doi: 10.19082/5142.

Claydon-Platt, K., E. Manias, and T. Dunning. 2012. Medication-related problems occurring in people with diabetes during an admission to an adult teaching hospital: A retrospective cohort study. *Diabetes Res. Clin. Pract.* 97 (2):223–30. doi: 10.1016/j.diabres.2012.03.003.

Cloete, L. 2015. Reducing medication errors in nursing practice. *Cancer Nurs. Pract.* 14 (1):79–82. doi: 10.2196/mhealth.3942.

Dedefo, M. G., A. H. Mitike, and M. T. Angamo. 2016. Incidence and determinants of medication errors and adverse drug events among hospitalized children in West Ethiopia. *BMC Pediatr.* 16 (1):81. doi: 10.1186/s12887-016-0619-5.

Ehsani, S. R., M. A. Cheraghi, A. Nejati, A. Salari, A. H. Esmaeilpoor, and E. M. Nejad. 2013. Medication errors of nurses in the emergency department. *J. Med. Ethics Hist. Med.* 6:1–7.

Elder, N., and S. Dovey. 2002. Classification of medical errors and preventable adverse events in primary care: A synthesis of the literature. *J. Fam. Pract.* 51 (11):927–32.

Ferner, R. E., and J. K. Aronson. 2006. Clarification of terminology in medication errors: Definitions and classification. *Drug Saf.* 29 (11):1011–22. doi: 10.2165/00002018-200629110-00001.

Giardina, C., P. M. Cutroneo, E. Mocciaro, G. T. Russo, G. Mandraffino, G. Basile, F. Rapisarda, R. Ferrara, E. Spina, and V. Arcoraci. 2018. Adverse drug reactions in hospitalized patients: Results of the FORWARD (facilitation of reporting in hospital ward) study. Front. Pharmacol. 9:350. doi: 10.3389/fphar.2018.00350.

Gorgich, E. A., S. Barfroshan, G. Ghoreishi, and M. Yaghoobi. 2016. Investigating the causes of medication errors and strategies to prevention of them from nurses and nursing student viewpoint. *Global J. Health Sci.* 8 (8):54448. doi: 10.5539/gjhs.v8n8p220.

Grandell-Niemi, H., M. Hupli, H. Leino-Kilpi, and P. Puukka. 2003. Medication calculation skills of nurses in Finland. *J. Clin. Nurs.* 12 (4):519–28. doi: 10.1046/j.1365-2702.2003.00742.x.

Greenfield, S. F., A. J. Brooks, S. M. Gordon, C. A. Green, F. Kropp, R. K. McHugh, M. Lincoln, D. Hien, and G. M. Miele. 2007. Substance abuse treatment entry, retention, and outcome in women: A review of the literature. *Drug Alcohol Depend.* 86 (1):1–21. doi: 10.1016/j.drugalcdep.2006.05.012.

Hauck, K., and X. Zhao. 2011. How dangerous is a day in hospital? A model of adverse events and length of stay for medical inpatients. Med. *Care* 49 (12):1068–75. doi: 10.1097/MLR.0b013e31822efb09.

Havens, D. H., and L. Boroughs. 2000. To err is human": A report from the institute of medicine. *J. Pediatr. Health Care.* 14 (2):77–80.

Henriksen, K., E. Dayton, M. A. Keyes, P. Carayon, and R. Hughes. 2008. Understanding adverse events: A human factors framework. In *Patient safety and quality: An evidence-based handbook for nurses.* 1–27. Agency for Healthcare Research and Quality (US). Rockville (MD).

Hodgkinson, M. R., N. J. Dirnbauer, and I. Larmour. 2009. Identification of adverse drug reactions using the ICD-10 Australian modification clinical coding surveillance. J. *Pharm. Pract. Res.* 39 (1):19–23. doi: 10.1002/j.2055-2335.2009.tb00698.x.

Johan, S., H. Sarwar, and I. Majeed. 2017. To identify the causes of stress among nurses working in intensive care unit of Ittefaq Hospital Lahore. *Int. J. Soc. Sci. Manage.* 4 (2):96–109. doi: 10.3126/ijssm.v4i2.17159.

Karthikeyan, M., T. Balasubramanian, K. Muhamed, S. Muhamed, and P. Rashifa. 2015. A systematic review on medication errors. *Int. J. Drug Dev. Res.* 7 (4):9–11.

Keshk, L. I., and D. S. Abd El-Moneem. 2012. Effect of Nurses' work hours and fatigue on occurrence of medication errors in ICU and medical oncology unit-Cairo University. *Life Sci. J.* 9 (3):347–55.

Khammarnia, M., R. Ravangard, E. Barfar, and F. Setoodehzadeh. 2015. Medical errors and barriers to reporting in ten hospitals in southern Iran. *Malays J. Med. Sci.* 22 (4):57.

Khasawneh, W., and S. B. Hani. 2018. Intravenous lipid emulsion overdose in infancy: A case report and overview of opportunities, challenges and prevention. *Drug Safety - Case Rep.* 5 (1):13. doi: 10.1007/s40800-018-0079-y.

LeBlanc, V. R., R. D. MacDonald, B. McArthur, K. King, and T. Lepine. 2005. Paramedic performance in calculating drug dosages following stressful scenarios in a human patient simulator. Prehosp. Emerg. Care 9 (4):439–44. doi: 10.1080/10903120500255255.

Lifshitz, A. E., L. H. Goldstein, M. Sharist, R. Strugo, E. Asulin, S. B. Haim, Z. Feigenberg, M. Berkovitch, and E. Kozer. 2012. Medication prescribing errors in the prehospital setting and in the ED. *Am. J. Emerg. Med.* 30 (5): 726–31. doi: 10.1016/j.ajem.2011.04.023.

Mrayyan, M. T. 2007. Jordanian nurses' job satisfaction and intent to stay: Comparing teaching and non-teaching hospitals. *J. Prof. Nurs.* 23 (3):125–36. doi: 10.1016/j.profnurs.2006.12.006.

Pham, J. C., M. S. Aswani, M. Rosen, HWon Lee, M. Huddle, K. Weeks, and P. J. Pronovost. 2012. Reducing medical errors and adverse events. *Ann. Rev. Med.* 63: 447–63. doi: 10.1146/annurev-med-061410-121352.

Pongchaidecha, M., R. Chalongsuk, and N. Prakongsai. 2009. *Factors contributing to adverse drug reactions in Prapokklao hospital*. Thailand: Chantaburi Province.

Pournamdar, Z., and S. Zare. 2016. Survey of medication error factors from nurses perspective. *Biol. Med.* 8 (5): 1–4. doi: 10.4172/0974-8369.1000310.

Roughead, E. E., S. J. Semple, and E. Rosenfeld. 2016. The extent of medication errors and adverse drug reactions throughout the patient journey in acute care in Australia. *Int. J. Evidence-Based Healthcare* 14 (3):113–22. doi: 10.1097/XEB.0000000000000075.

Rudd, R. A., N. Aleshire, J. E. Zibbell, and R. Matthew Gladden. 2016. Increases in drug and opioid overdose deaths—United States, 2000–2014. *Am. J. Transpl.* 16 (4): 1323–7. doi: 10.1111/ajt.13776.

Salmerón-García, A., J. Cabeza Barrera, M. J. Vergara Pavón, E. Román Márquez, S. Cortés de Miguel, I. Vallejo-Rodríguez, S. Raya García, and E. Casado Fernández. 2010. Detection of adverse drug reactions through the minimum basic data set. *Pharm World Sci.* 32 (3):322–8. doi: 10.1007/s11096-010-9372-2.

Scott, B. M., J. Considine, and M. Botti. 2014. Medication errors in ED: Do patient characteristics and the environment influence the nature and frequency of medication errors? *Australas. Emerg. Nurs. J.: AENJ* 17 (4):167–75. doi: 10.1016/j.aenj.2014.07.004.

Scripcaru, G., C. Mateus, and C. Nunes. 2017. Adverse drug events-Analysis of a decade. A Portuguese case-study, from 2004 to 2013 using hospital database. *PLoS One.* 12 (6):e0178626. doi: 10.1371/journal.pone.0178626.

Shah, K., C. Lo, M. Babich, N. W. Tsao, and N. J. Bansback. 2016. Bar code medication administration technology: A systematic review of impact on patient safety when used with computerized prescriber order entry and automated dispensing devices. *Can. J. Hosp. Pharm.* 69 (5):394–402. doi: 10.4212/cjhp.v69i5.1594.

Sipherd, R. 2018. The third-leading cause of death in us most doctors don't want you to know about. *CNBC*, February 22.

Tariq, R. A., and Y. Scherbak. 2019. *Medication errors*. StatPearls [Internet]: StatPearls Publishing. Traesure Island (FL).

Widodo, I. U. 2019. Risk factors and stress management among hospital nurses: A systematic review. *KnE Life Sci.* 4 (10):39–46. doi: 10.18502/kls.v4i10.3705.

van der Hooft, C. S., M. C. J. M. Sturkenboom, K. van Grootheest, H. J. Kingma, and B. H. C. Stricker. 2006. Adverse drug reaction-related hospitalisations. *Drug Saf.* 29 (2):161–8. doi: 10.2165/00002018-200629020-00006.

Zafirah, S. A., A. M. Nur, S. E. Puteh, and S. M. Aljunid. 2018, December 1. Potential loss of revenue due to errors in clinical coding during the implementation of the Malaysia diagnosis related group (MY-DRG®) Casemix system in a teaching hospital in Malaysia. *BMC Health Serv. Res.* 18 (1):38. doi: 10.1186/s12913-018-2843-1.

2.3 Chapter Summary

Adverse drug events in Victorian hospitals are low, accounting for less than 1% of all hospital admissions. Adverse drug events (ADE), accidental poisoning (AP), and underdetermined intent (UI) were reported more often in public compared to private hospitals in Victoria and events appear to fluctuate according to year. Even though the medication error rates were low in this study, they are still occurring. Approaching zero medication error rate might be achieved through addressing the contributing factors to the medication errors classified as patient-related, system-related, and health care provider-related (WHO, 2016). Medication errors and their contributing factors need to be investigated in the out-of-hospital environment so that patient safety and the health services that are provided to patients would be maintained at a very high quality.

Potential factors contributing to health care providers medication errors have included lack of staff, workload, stress and anxiety. Health care providers' related factors that contribute to medication errors should be investigated by addressing anxiety to maths, particularly how this anxiety is causing these errors. Moreover, Drug dose calculation competency and the role of drug dose errors in causing accidental poisoning events can be investigated in university students, especially paramedic students. Results of this chapter prompt an investigation into the reasons why these errors persist. One potential cause could be anxiety created by the requirement to perform medication calculations. This prompted a review of the impact of maths anxiety on university students by identifying any potential facilitators and barriers of maths anxiety in university students.

Chapter Three: Maths anxiety in university students

3.1 Introduction

One of the potential factors contributing to errors in Victorian hospitals could be difficultly and anxiety in performing maths calculations. This chapter addresses our understanding of the facilitators and barriers of maths anxiety in university students utilising a scoping literature review approach. A scoping review methodology was used to identify the facilitators and barriers of maths anxiety in university students because our primary search revealed nothing in the literature about this topic in the paramedic discipline. In this study a search of databases including Cumulative Index of Nursing and Allied Health Literature (CINHAL), Embase, Scopus, PsycInfo, Medline, Education Resources Information Centre (ERIC), Google Scholar and grey literature. Articles were included if they addressed the maths anxiety concept, identified barriers and facilitators of maths anxiety, had a study population comprised of university students and were in Arabic or English languages.

The results of this chapter are reported in the following manuscript, which is accepted for publication in BMC Psychology Journal: “What impact does maths anxiety have on university students?”.

3.2 The manuscript: What impact does maths anxiety have on university students?

1. Eihab Khasawneh

Monash University Department of Community Emergency Health and Paramedic Practice, Victoria, Australia.
Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan

2. Dr Cameron Gosling

Monash University Department of Community Emergency Health and Paramedic Practice, Victoria, Australia.

3. Professor Brett Williams

Monash University Department of Community Emergency Health and Paramedic Practice, Victoria, Australia.

Corresponding author:
Eihab Khasawneh
Monash University, Department of Community Emergency Health and Paramedic Practice, Monash University-Peninsula Campus, McMahons Road, Frankston, Victoria, Australia.
eihab.khasawneh@monash.edu
eakhasawneh1@just.edu.jo
+61 03 9904536

ABSTRACT

Introduction

Maths anxiety is defined as a feeling of tension and apprehension that interferes with maths performance ability, the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations. We aimed to identify the facilitators and barriers of maths anxiety in university students.

Method

A scoping review methodology was used in this study. A search of databases including Cumulative Index of Nursing and Allied Health Literature (CINHAL), Embase, Scopus, PsycInfo, Medline, Education Resources Information Centre (ERIC), Google Scholar and grey literature. Articles were included if they addressed the maths anxiety concept, identified barriers and facilitators of maths anxiety, had a study population comprised of university students and were in Arabic or English languages.

Results and Discussion

After duplicate removal and applying the inclusion criteria, ten articles were included in this study. Maths anxiety is an issue that affects many disciplines across multiple countries and sectors. The following themes emerged from the included papers: gender, self-awareness, numerical ability, and learning difficulty. The pattern in which gender impacts maths anxiety differs across countries and disciplines. There was a significant positive relationship between students' maths self-efficacy and maths performance and between maths self-efficacy, drug calculation self-efficacy and drug calculation performance.

Conclusion

Maths anxiety is an issue that affects many disciplines across multiple countries and sectors. Developing anxiety toward maths might be affected by gender; females are more prone to maths anxiety than males. Maths confidence, maths values and self-efficacy are related to

self-awareness. Improving these concepts could end up with overcoming maths anxiety and improving performance.

Keywords: Anxiety, Mathematics, Anxiety, Barriers, Facilitators, and Gender.

Introduction

Maths anxiety can be defined as a feeling of tension, apprehension and anxiety that interferes with maths performance ability, the manipulation of numbers, and the solving of mathematical problems in a wide variety of ordinary life and academic situations. (1) According to Olango (2) maths anxiety consists of an affective, behavioural and cognitive response to a perceived threat to self-esteem that occurs as a response to situations involving mathematics. Maths anxiety, which is rooted in emotional factors, can be differentiated from dyscalculia, which is characterised by a specific cognitive deficit in mathematics, (3) in two ways. Firstly, maths anxiety can exist in people who have maths capability even though they may dislike maths. Secondly, maths anxiety has an emotional component which is not the case in dyscalculia. (4)

Maths anxiety may occur in all levels of education from primary school to university education. Harari, Vukovic and Bailey (5) reported that adverse reactions and numerical confidence are the most salient dimensions of maths anxiety in a sample of first-grade students. Similar findings were also observed at tertiary levels across multiple disciplines, including health care professions. For example, Roykenes and Larsen (6) studied 116 baccalaureate nursing students and found that there was a negative relationship between previous mathematic likes/dislikes and self-assessment of mathematic ability.

Many factors may contribute to, or facilitate, maths anxiety. These factors or facilitators may include previous experiences with teachers, parents, peers and society. Negative experiences of maths learning in classroom or home can lead to maths anxiety. (7) Firstly, the teacher plays a vital role in making the class more attractive and reducing anxieties. Good maths teachers can create a learning environment in which students have a positive expectation about their learning. (8) Secondly, parents play an essential part in developing or reducing maths anxiety in their children. Parents' behaviours and relations with children are critical in this aspect. (7) By discussing the anxieties and the fears that their children might face, parents can pinpoint learning problems at an early stage. (8) This might prevent the development of learning anxieties that a student might face later in life. Moreover, parents’ maths anxiety can cause their children to learn less maths over the school year and to have more maths anxiety by the school year's end. (9) Thirdly, peers play an important role in facilitating maths anxiety. (7) Peers at any stage of learning may have a negative impact on their colleagues, for example, when students might feel inferior in front of their colleagues when they make mistakes. (7) Finally, society can contribute to the development of maths anxiety due to the misconception about mathematics, or maths myths. (7)

Maths anxiety has negative impacts on individuals; many students who suffer from maths anxiety have little confidence in their ability to do mathematics and tend to take the minimum number of required mathematics courses, which can significantly limit their career. (10) Fortunately, specific strategies can act as barriers or prevent maths anxiety occurring. Uusimaki and Kidman (11) stated that whenever a person becomes self-aware of maths anxiety and its consequences, their ability to overcome it might increase (11). On the other hand, activity-based learning and online/distance learning may reduce the fear of looking stupid in front of peers. (12) Another strategy is the use of untimed/unassessed (low stakes) tests to reduce maths anxiety and increase confidence. (13) Applying mathematics and statistics to real-life examples rather than pure maths can also reduce maths anxiety. (13)

Empirical investigations first began on maths anxiety in the 1950s, and Dreger and Alken (14) introduced the concept of maths anxiety to describe students' attitudinal difficulty with maths. This study aimed to identify the facilitators and barriers of maths anxiety in university students using a scoping review methodology.

Method

A scoping review methodology was used in conducting this study to allow for a greater breadth of literature to be investigated. Scoping reviews identify and map existing literature on a selected subject. This scoping review utilised the Arksey and O'Malley framework which includes six methodological steps: identifying the research question; identifying relevant studies; selecting studies; charting the data; collating, summarising and reporting the results; and consulting experts. (15) The scoping approach systematically maps and reviews existing literature on a selected topic (16) including evidence from both peer-reviewed research and non-peer-reviewed literature.

1. Identify the research question

After several review iterations, the research team agreed on the question that guided this review: What are the barriers and facilitators of maths anxiety in university students? This question was broad, so it could cover a wide scope of literature in different disciplines that allowed for a better summary of the available literature.

2. Identify relevant studies

A list of search terms was compiled from both the available literature and previous research into maths anxiety and students. Suitable Medical Subject Headings (MeSH) terms and free text keywords were identified (Table 1). A search of databases included: Cumulative Index of

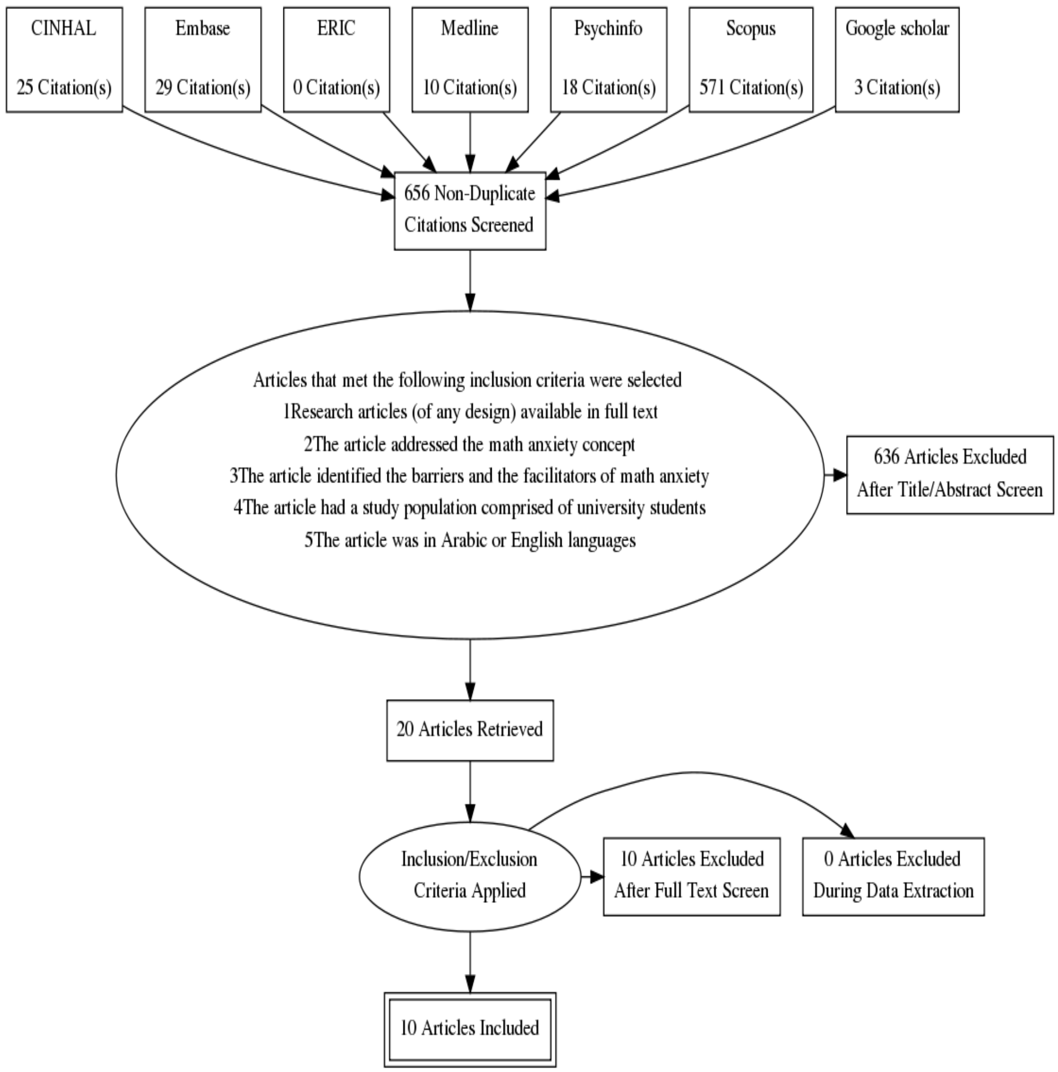
Nursing and Allied Health Literature (CINHAL), Embase, Scopus, PsycInfo, Medline, ERIC, Trove, Google Scholar and Grey literature. The search involved any related studies from July-2018 backward. Studies in Arabic and English languages were filtered from the search yield, and the abstracts scanned. The databases search was conducted by one of the researchers (EK). The search yield resulted in 656 records which were exported to EndNote17 referencing for screening.

Duplicates and irrelevant studies were removed by one of the researchers (EK), and potentially relevant abstracts were complied. The selection process was conducted at two levels: a title and abstract review and full-text review. The title and abstract of the retrieved studies were independently screened (EK and BW) for inclusion based on predetermined criteria. In the second stage, the selected full-text studies were assessed, and inclusion confirmed by two of the authors (EK and BW). After removing the duplicates, (EK and BW) conducted the title and abstract review of 656 articles. After applying the inclusion criteria, 20 articles remained. These 20 articles were reviewed by (EK and BW) for the second time, which ended in 10 articles to be included in the scoping review.

Table 1 Search strategy including the Medical Subject Heading (MeSH) and the keywords

MeSH: University students	**MeSH:** Barriers	**MeSH:** Facilitators	**MeSH:** Maths Anxiety	
Keyword: University Students	**Keyword** Obstacle* inhibitor*, limit*, blockage*, barricade*, impediment*, drawback*	**Keyword** Develop*, promote*, arrange*, aid*, support*, reinforce*, contribute*	**Keyword** Mathematics, mathematical concepts	**Keyword** Apprehend*, concern*, panic*, psychologic stress*, problem*, phobia*, fear*, stress*
* **Truncation**				

4. *Study selection (Fig.1).*



Articles that met the following inclusion criteria were selected.

1. Research articles (of any design) available in full text.
2. The article addressed the maths anxiety concept.
3. The article identified the barriers and the facilitators of maths anxiety.
4. The article had a study population comprised of university students.

5. The article was in Arabic or English languages.

Articles that are systematic and scoping reviews, abstracts, editorials and letters for editors were excluded.

4. Charting the data

This stage allows data extraction from the included studies for more data description. A narrative review method was used to extract the data from each study. Narrative reviews summarise studies from which conclusions can be drawn into more holistic interpretation by the reviewers. (17) The data included: the author and the year of publication, the country the study was conducted in, the study design or type, the sample size, results and themes emerging from the study (Table 2). Four themes emerged following full-text review of the ten included papers; these included: gender, self-awareness, numerical ability and learning difficulties.

5. Collating, summarising and reporting the results

The data extracted from the included studies are reported in Table 2. The table shows a summary of the selected articles in this scoping review study. It presents data on the different scales used to evaluate the maths anxiety across the various disciplines. Key outcome data from each of the included studies is shown and consists of some of the causes or predictors of maths anxiety in university students such as gender and self-efficacy.

Table 2 Included studies reporting author and year of publication, country of origin, undergraduate discipline, study design and participant numbers, primary outcomes and scoping review theme(s)

Author(s) /year	**Country**	**Discipline**	**Design and Participants**	**Outcomes**	**Theme**
Zeidner (1991).	Israel	Social science and education students who had undertaken a statistics unit.	Cross-sectional n= 431	Lack of maths foundation and low maths self-esteem reinforce maths anxiety. Females have higher statistics test anxiety than males (59.33>54.28, t (429) =-3.29, P<0.001). Statistics anxiety is correlated positively with maths anxiety experienced in high school (r (265) =0.410, P<0.05.	Self-awareness
Hopko et al. (2003)	USA	Psychology	Randomised controlled trial n=64	High maths anxious individuals generally exhibited higher error rates on mathematical tasks, especially those requiring working memory resources. MARS-R mean score=59.0. Females reported more maths anxiety than males (t (812) =5.53, P<0.001).	Gender
Maloney, E, Ansari, D. & Fugelsang, J. (2011)	Canada	Not reported	Cross-sectional n=48	High Maths Anxious (HMA) individuals have less precise representations of numerical magnitude than their Low Maths Anxious (LMA) peers. a t-test on the slopes of the distance effects for HMA and LMA by revealing a steeper numerical distance effect for HMA than for LMA group (46)=2.0, p= 0.05	Gender
McMullan, M, Jones, R. & Lea, S.(2011)	UK	Nursing	Cross-sectional n=229	A strong significant relationship between maths anxiety, self-efficacy and ability in nursing students. 93% of the students who failed the numeracy test, and 83% of those who failed the drug calculation test demonstrated signs of maths anxiety (score>25%). Students who failed numeracy test were significantly more anxious (t (216) =7.04, p< 0.001 and less confident (t (214) =-5.77, p<.001) in performing numerical calculations and less confident in performing drug calculation (t (213) =-3.42, p= 0.001).	Numerical ability
Hunt, T, Clark-Carter, D. & Sheffield, D (2014).	UK	Psychology	Cross-sectional n=78	There is a significant positive correlation between maths anxiety and fixations, dwell time and saccades. No significant difference between males and females on self-reported maths anxiety r (67) = 0.13, p= 0.26. The overall sample means for maths anxiety 48.42, SD= 13.97.	Self-awareness
Jordan, J, McGladdery, G. & Dyer, K. (2014)	UK	Psychology, nursing and other	Prospective Cohort Dyslexia group n=28 Control group n=71	Higher maths anxiety was associated with having a dyslexia diagnosis. The predictors of maths anxiety: self-esteem (r=-327, p=0.001), worrying (r=.394;p<.001), denial (r=.238;p= 0.018), seeking instrumental support (r=.206;p= 0.040) and positive reinterpretation (r=-.216;p= 0.032)	Numerical ability
Liew et al. (2014)	USA	Not reported	Cross-sectional n=184	Interventions targeting emotion regulation and stress management skills may help individuals to reduce their maths and test anxieties. Coefficient of gender on avoidance temperament was significant, higher in females (M= 0.17, SD=0.80) than in males (M= -0.41, SD=0.84).	Gender
Hendy, H, Schorschinsky, N. & Wade, B. (2014)	USA	Mathematics	Cross-sectional. n=368	Students with low Maths confidence or high maths anxiety might benefit from the maths self-evaluation and self-regulation intervention that is guided by Ramdass and Zimmerman 2008 suggestions. The scales related to maths belief that are used in this study: Maths Value Scale (MVS), Maths Confidence Scale (MCS) and Maths Barriers Scale (MBS). The most commonly reported maths belief was Maths Confidence (mean rating=3.79, SD=0.90.	Learning difficulty

Alves (2015)	Portugal	Engineering	Cross-Sectional n=140	Gender shows no differences in the perceived importance of maths anxiety. The Mann-Whitney test showed no significant differences in anxiety toward maths between male and female students (U=2270.5, P=0.541) No significant differences in self-efficacy between male and female students (U=2110.5, P= 0.198).	Gender
Paechter et al. (2017).	Austria	Psychology	Prospective cohort n= 225	High maths anxious individuals have less precise representations of numerical magnitude than their low maths anxious peers. Female students report higher levels of maths anxiety β=_0.660 Participants with a higher propensity to experience anxiety in general report higher levels of maths anxiety (β= 0.385)	Gender

6. ***Consultation (optional)***

Two experts were contacted for consultation to ensure no new or existing literature was missed; however, no new articles were added following this consultation.

Discussion

Maths anxiety is an issue that affects many disciplines across multiple countries and sectors. Literature analysed in this scoping review spanned disciplines as diverse as education, engineering, health and science, while covering different geographical locations such as United States (US), Austria, United Kingdom (UK), Israel, Portugal and Canada. The included articles utilised an array of varied study designs, including, cross-sectional, randomised control trial, and prospective cohort studies. The main themes that emerged from this review include gender, self-awareness, numerical ability, and learning difficulty each of these will now be synthesised and discussed.

Gender

Six articles addressed the gender concept; two American studies, three European and one Israeli study with mixed findings for the role gender plays in maths anxiety. Some of these articles found that gender has a role in maths anxiety (Zinder, 1991 (21);

Hopko et al., 2003(18); Liew et al., 2014 (18) and Paechter et al., 2017 (20)), while others found there was no significant difference between males and females (Alves et al., 2015 (22) and Hunt et al., 2015(19)). For example, a study of female psychology students in the US reported more maths anxiety than males (19). In contrast, there was no significant difference between males and females in maths anxiety in psychology students reported in the UK. (20) Psychology female students in the US (19) and Austria, (21) and social science and female education students in Israel showed more maths anxiety than male students. (22) While in another study, there was no significant difference in maths anxiety between males and females in the Portuguese engineering students. (23)

The reasons why females frequently report higher maths anxiety than males are not well understood. (24) One explanation might be the different gender socialisation during childhood that may differentially affect the anxiety experienced by males and females in certain situations which are known as the sex-role socialization hypothesis. (24) The sex-role socialization hypothesis argues that because mathematics has been traditionally viewed as a male domain, females may be socialised to think of themselves as mathematically incompetent and therefore avoid mathematics. When females do participate in mathematical activities, they may experience more anxiety than males. (24)

The pattern of gender effect on maths anxiety is different among disciplines and countries. In a recent study, Paechter et al. (21) administered the Revised Maths Anxiety Rating Scale (R-MARS) to 225 psychology students at the University of Graz, Austria. This study showed that there were three antecedents of maths anxiety.

Firstly, female students reported a higher level of maths anxiety β=-0.660. Secondly, students that had a high proneness to experience anxiety, in general, reported higher levels of maths anxiety β=0.385. Finally, students who had previously gained poor grades in maths were more likely to experience maths anxiety. According to Paechter et al. (21), maths anxiety is inversely related to maths grades β=0.393. Of the above three factors, female gender was the most strongly related to maths anxiety and is supported by the findings of other studies such as Devine et al., 2012. (23). Developing anxiety toward maths might be affected by gender and highlights a specific area for future empirical work.

Self-awareness

Self-awareness helps people to manage themselves and improve performances; while the opposite is true for a lack in self-awareness which leads to making the same mistakes repeatedly. (25) Being self-aware enables us to determine our strengths and areas that can be improved. (25) Four studies addressed the self-awareness concept concerning maths anxiety, one American study, one UK study, one Israeli study and one Portuguese study. Under the self-awareness theme, a few other subthemes emerged including self-efficacy, maths confidence, maths value, maths barriers and performance. McMullan, Jones and Lea (26) developed a Drug Calculations Self-Efficacy Scale that measured critical skills of medication calculations (dose of liquid oral drugs, solid drugs, injections, percentage solutions and infusion and drip rates). McMullan et al. (26) reported that there was a significant positive correlation between students' maths self-efficacy and maths performance and between maths self-efficacy, drug calculation self-efficacy and drug calculation performance. Low level of maths anxiety was demonstrated by 10% of the students, medium level by 70%, and a high level by 20% of the students. McMullan et al. (26) also noted that remedial approaches can improve numerical skills as lectures, study groups, workshops, and computer-assisted instructions. The authors suggested that lectures should be more student-directed and not only didactic. Study groups increase cooperation and encourage students to exchange and clarify information leading to improve the self-efficacy (26).

Maths confidence, maths value and maths barriers are related to maths behaviour and performance. Hendy, Schorschinsky and Wade (27) studied maths behaviours in 368 university maths students. They reported maths behaviours (attending class, doing homework, reading textbooks and asking for help) at week 8 of the 15 week-semester using self-reported questionnaires. Their study aimed to identify the subclasses of maths beliefs and their role in maths behaviours. The most commonly reported maths belief was maths confidence (mean rating=3.79, SD=0.90). This study indicated that students with low maths confidence or high maths anxiety might benefit from the maths self-evaluation and self-regulation interventions. These interventions utilised Hendy, Schorschinsky and Wade (27) suggestions which included: understanding that maths skills are learnable and not innate; assessing current capabilities and believing in their development abilities; teaching students the specific strategies to solve maths problems, and keeping self-regulatory records to track development in overcoming maths anxiety. These interventions may be used in overcoming maths anxiety. This study outlined the approach to develop interventional teaching methods that can be applied to students or the course curriculum to help reduce maths anxiety. Self-awareness might determine a person's areas of strength that might help future career selection. Self-efficacy, maths confidence and values, maths barriers and performance are all factors that related to self-awareness. Assessing these factors can determine the methods of improving self-awareness which may end in overcoming maths anxiety.

Numerical ability

Two articles addressed the numerical ability concept (Maloney et al., 2011(28) and McMullan et al., 2012(25)). In their efforts to understand the origin of maths anxiety, Maloney et al. (28) investigated the processing of symbolic magnitude by high and low maths anxious individuals. They reported that high maths anxious individuals have less precise representations of numerical magnitude than their low maths anxious peers. Two experiments were performed on 48 undergraduate students at the University of Waterloo. A single Arabic digit in 18-font Arial font was used with numbers ranging from 1-4 and 6-9. The participants were told to identify whether the number was above five or below it. This study revealed that high maths anxious individuals had a less precise representation of numerical magnitude than the low maths anxious individuals. The results suggested that maths anxiety is associated with low-level numerical deficits that compromise the development of higher-level mathematical skills.

On the other hand, McMullan et al. (26) reported that numerical ability and maths anxiety is the leading personal factors that might influence drug calculation ability in nursing students. The numerical ability test (NAT), used by McMullan et al. (26), is comprised of 15 questions that covered calculation operations like multiplication, addition, fraction, subtraction, percentage, decimals, and conversion. McMullan et al. (26) reported that both numerical ability and drug calculation abilities of the participants (229 UK nursing students) were poor which might have been from an over-reliance on using calculators or not having adequate maths education in the past. Improving numerical ability and reducing maths anxiety can be achieved through teaching in a supportive environment using multiple teaching strategies that address the needs of all students and not being didactic. (26) Examples of these strategies included: accepting and encouraging students creative thinking, tolerating dissent, encouraging students to trust their judgments, emphasising that everyone is capable of creativity, and serving as a stimulus for creative thinking through brainstorming and modelling. (29)

Learning difficulty

Australian surveys have indicated that 10 to 16 per cent of students are perceived by their teachers to have learning difficulties according to Learning Difficulty Australia (LDA) (2012). Within the population of students with learning difficulties, there is a smaller subset of students who show persistent and long-lasting learning impairments, and these students are identified as having a learning disability. It is estimated that approximately 4 per cent of Australian students have a learning disability (LDA, 2012).

In this scoping review, one UK study addressed this concept, comparing undergraduate psychology students (who represented 71% of the sample) and nursing students (who represented 14% of the sample) who either had dyslexia (n=28) or were assigned to the control group (n=71). In 2014 Jordan, McGladdery and Dyer (30) reported that students with dyslexia had higher levels of maths anxiety relative to those without. (30) This study showed that significant correlations with maths anxiety were found for self-esteem (r=-.327; n=99, *P*.001), worrying (r=393; n=99; *P*<.001), denial (r=.238; n=99; *P*=.018), seeking instrumental support (r=.206; n=99; *P*=.040) and positive reinterpretation (r=-.216; n=99; *P*=.032). Also, this study found that seeking instrumental support served as an indicator of students at high risk of maths anxiety. In explaining variation in maths anxiety. Jordan et al. (30) claimed that 36% of this variation is due to dyslexia, worrying, denial, seeking instrumental support and positive reinterpretation. The limitation of this study is that not the students disclosed all dyslexia cases. If some of the students with dyslexia were not reported, the generalisation of the findings of this study would be limited. This study recommends positive reframing and thought challenging as techniques to overcome difficult emotions and anxiety.

Limitations and future research

While multiple databases were used in this scoping review, some articles may be missed due to using specific terms in the search strategy. The disciplines covered in this scoping review were psychology, engineering, mathematics and some of the health disciplines such as nursing. Future research might focus on numerical ability and maths anxiety in university students who need maths abilities in their future careers as engineers and health care professionals.

For example, the relationship between medication and drug calculation errors and maths anxiety in the health care field can be researched. Moreover, the relationship between self-awareness and numerical ability and maths anxiety and its impact on the performance and ability of university students can be a future research topic. Finally, developing a new teaching package or strategy that reduces maths anxiety can be tested with university students.

Conclusion

Maths anxiety is an issue that affects many disciplines across multiple countries and sectors. This study aimed to identify the facilitators and barriers of maths anxiety in university students using a scoping review methodology. The main themes that emerged from this review included gender, self-awareness, learning difficulty and numerical ability. Developing anxiety toward maths might be affected by gender; females are more prone to maths anxiety than males. Maths confidence, maths values and self-efficacy are related to self-awareness. Improving these concepts could end up with overcoming maths anxiety and improving performance.

References

1. Ashcraft. Math Anxiety: Personal, Educational, and Cognitive Consequences. Curr Dir Psychol Sci. 2002;11(5).
2. Olango M. Mathematics anxiety factors as predictors of mathematics self-efficacy and achievement among freshmen science and engineering students. African Educational Research Journal. 2016;4(3):109-23.
3. Mammarella IC, Hill F, Devine A, Caviola S, Szucs D. Math anxiety and developmental dyscalculia: A study on working memory processes. J Clin Exp Neuropsychol. 2015;37(8):878-87.
4. Helal A, Abo Hamza E, Hagstorm F. Math Anxiety in College Students across Majors: A cross Culture Study. 2011.
5. Harari RR, Vukovic RK, Bailey SP. Mathematics Anxiety in Young Children: An Exploratory Study. 2013:538-55
6. Røykenes K, Larsen T. The relationship between nursing students' mathematics ability and their performance in a drug calculation test. Nurse Educ Today. 2010:697-701.
7. Mutodi P, Ngirande H. Exploring Mathematics Anxiety: Mathematics Students' Experiences. Mediterr J Soc Sci. 2014;5(1):283-94.
8. McNaught M, Grouws D. Learning goals and effective mathematics teaching: What can we learn from research? Taiwan Journal of Mathematics Teachers. 2007.
9. Maloney EA, Ramirez G, Gunderson EA, Levine SC, Beilock SL. Intergenerational Effects of Parents' Math Anxiety on Children's Math Achievement and Anxiety. Psychol Sci. 2015;26(9):1480-8.

10. Eispino M, Pereda J, Recon J, Perculeza E, Umali C. Mathematics Anxiety and Its Impact on the Course And Career Choice of Grade 11 Students. International Journal of Education, Psychology and Counselling. 2017;2(5):99-119.

11. Uusimaki L, Kidman G. KID04997 Reducing maths-anxiety: Results from an online anxiety survey. . 2004.

12. Taylor JA, Mohr J. Mathematics for Math Anxious Students Studying at a Distance. J Dev Educ. 2001:30-8.

13. Marshall E, Mann V, Wilson D. Teaching strategies for helping students overcome maths anxiety. 2016.

14. Dreger R, Alken L. The identification of number anxiety in a college population. J Educ Psychol. 1957:344-51.

15. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. . Int J Soc Res Methodo. 2005:19-32.

16. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci. 2010;5(59).

17. Kirkevold M. lntegrative nursing research-an important strategy to further the development of nursing science and Practice. J Adv Nurs. 1997.

18. Liew J, Lench HC, Kao G, Yeh YC, Kwok OM. Avoidance temperament and social-evaluative threat in college students' math performance: a mediation model of math and test anxiety. Anxiety, stress, and coping. 2014;27(6):650-61.

19. Hopko DR, McNeil DW, Lejuez CW, Ashcraft MH, Eifert GH, Riel J. The effects of anxious responding on mental arithmetic and lexical decision task performance. J Anxiety Disord. 2003;17(6):647-65.

20. Hunt TE, Clark-Carter D, Sheffield D. Exploring the Relationship Between Mathematics Anxiety and Performance: An Eye-Tracking Approach. Appl Cogn Psychol. 2015;29(2):226-31.

21. Paechter M, Macher D, Martskvishvili K, Wimmer S, Papousek I. Mathematics Anxiety and Statistics Anxiety. Shared but Also Unshared Components and Antagonistic Contributions to Performance in Statistics. Front Psychol. 2017;8:1196.

22. Zeidner M. Statistics and mathematics anxiety in social science students:some intersting parallels. Br J Educ Psychol. 1991;61:319-28.

23. Alves M, Rodrigues CS, Rocha AMAC, Coutinho C. Self-efficacy, mathematics' anxiety and perceived importance: an empirical study with Portuguese engineering students. 2015;41(1):105-21.

24. Devine A, Fawcett K, Szucs D, Dowker A. Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. Behav Brain Func. 2012;8:33.

25. Rasheed S. Self-Awareness as a Therapeutic Tool for Nurse/Client Relationship. Int J Caring Sci. 2015;8(1).

26. McMullan M, Jones R, Lea S. Math anxiety, self-efficacy, and ability in British undergraduate nursing students. Res Nurs Health. 2012;35(2):178-86.

27. Hendy HM, Schorschinsky N, Wade B. Measurement of math beliefs and their associations with math behaviors in college students. Psychol Assess. 2014;26(4):1225-34.

28. Maloney EA, Ansari D, Fugelsang JA. The effect of mathematics anxiety on the processing of numerical magnitude. Q J Exp Psychol. 2011;64(1):10-6.

29. Cole DG, Sugioka HL, Yamagata-Lynch LC. Supportive Classroom Enviroments for Creativity in Higher Education. J Creat Behav. 2011.

30. Jordan JA, McGladdery G, Dyer K. Dyslexia in higher education: implications for maths anxiety, statistics anxiety and psychological well-being. Dyslexia. 2014;20(3):225-40.

3.3 Chapter Summary

Maths anxiety is an issue that affects many disciplines across multiple countries and sectors. Developing anxiety toward maths might be affected by gender, as females appear to be more prone to maths anxiety than males. Maths confidence, maths values and self-efficacy are all related to self-awareness, and improvement in any one of these could end up with individuals' overcoming their maths anxiety and improving task performance. The critical items identified in this scoping review that impact on maths ability was primarily numerical ability and self-efficacy. The interaction of these factors in both Australian and international contexts will be the focus of the remaining studies in this thesis (Chapters Four to Six).

Chapter Four: Maths Self-Efficacy in Paramedicine

4.1 Introduction

The scoping review (Chapter Three) concluded that self-efficacy is one of the critical factors that affect maths anxiety in university students. The study presented in Chapter Four explored the relationship between self-efficacy and maths anxiety among paramedic students. This chapter involves the first primary study in the thesis. This study is the first in Australia to investigate the interaction between self-efficacy and maths anxiety among paramedic students. It will add to the background knowledge derived from the literature and may provide a reference point for future research to enable practice change and improve the services that are provided to patients. The findings and results of this study are reported in the following manuscript that is currently under review in the Australian Journal of Paramedicine, "The effect of self-efficacy on maths anxiety among paramedic students".

4.2 The manuscript: The effect of self-efficacy on maths anxiety among paramedic students.

1.Eihab Khasawneh

Monash University Department of Community Emergency Health and Paramedic Practice, Victoria, Australia.

Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan.

2.Dr Cameron Gosling

Monash University Department of Community Emergency Health and Paramedic Practice, Victoria, Australia.

3.Professor Brett Williams

Monash University Department of Community Emergency Health and Paramedic Practice, Victoria, Australia.

Corresponding author:

Eihab Khasawneh

Department of Community Emergency Health and Paramedic Practice, Monash University-Peninsula Campus, McMahons Road, Frankston, Victoria, Australia.

Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan.

eihab.khasawneh@monash.edu

eakhasawneh1@just.edu.jo

+61 03 9904536

Abstract

Introduction

Maths anxiety is defined as feelings of tension that interfere with dealing with numbers and mathematical problems. Self-efficacy, which is related to maths anxiety, can be defined as perceptions of one's abilities to math problems, tasks, and math-related course work. This study aims to investigate the effect of sex, age and year level on maths anxiety and self-efficacy and to study the relationship between self-efficacy and maths anxiety among paramedic students.

Methods

A cross-sectional study of paramedic students at Monash University was conducted. Participants completed a 15-minute paper-based questionnaire which is composed of Maths Anxiety Rating Scale (MARS), the Maths Self-Efficacy Scale (MSES) and demographic information.

Results

The questionnaires were completed and returned by 344 students. (81.3% return rate). The mean score for the MARS was 25.71 (SD = 8.80) and for the MSES was 125.59 (SD=29.55). Females had higher maths anxiety levels (M=26.83, SD=9.00) than males (M=23.67, SD=8.26) and lower self-efficacy (M=119.59, SD=29.30) than males (M=135.73, SD=27.39). There was a significant negative relationship between MARS and MSES levels. Multiple linear regression indicated that maths self-efficacy (beta = -0.626, $p < .001$) made the strongest contribution to maths anxiety levels.

Conclusion

There was a significant negative relationship between maths anxiety and self-efficacy levels reported by the paramedic student cohort. Sex plays an integral part in determining maths anxiety and self-efficacy level. To improve maths performance and reduce anxiety during calculation tasks, such as dose determinations, targeted education should be developed to improve maths self-efficacy.

Keywords: allied health personnel; paramedics; anxiety; maths anxiety; self-efficacy.

Introduction

Even though the 'paramedic' term started to emerge in the 1960s, non-medically qualified personnel who are providing emergency medical care have been established since ancient times (1). while historically associated with life support and other advanced skills for dealing with emergencies, the role of the current paramedic has evolved rapidly since 2000. For example, paramedics in the UK now provide far more than just emergency care and are expected to manage a broad range of conditions in the out-of-hospital environment (1, 2). This shift has been driven by growing health care system pressures such as hospital crowding and lack of hospital staff, and evolving views on how health care is conceptualised and delivered (2). For example, paramedicine has become recognised as a health profession whose growing clinical acumen and unique point of contact with the public/patients can be leveraged to serve their health care needs better and meet policy goals; not only for those who contact paramedic services in a time of acute or emergent crisis (as is traditionally the case) but also for broader patient groups and needs (2, 3). The nature of the paramedics' work and responsibilities force them to work in situations where they must make critical decisions under stressful conditions that might increase their anxiety toward accomplishing their tasks properly (4).

Anxiety is characterised by feelings of tension, worried thoughts and can manifest with physical changes such as increased blood pressure, increased heart rate, and sweating (5). Richardson and Suinn (6) in 1972 first described a subtype of anxiety related to maths. Maths anxiety is defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (7). Others have described maths anxiety as a negative emotional state created when engaging in activities requiring mathematical skills (8,9).

There are several listed causes of maths anxiety, including experiences in maths classes or with maths teachers, low self-efficacy or previous bad experiences with maths, and low intelligence or poor maths ability (10). Unsurprisingly, students with high levels of maths anxiety tend to perform poorly on maths tasks (11-13). One of the critical risk factors associated with maths anxiety is one's self-efficacy level.

Self-efficacy is "the belief in one's ability to organise and execute the courses of action needed to manage and to perform a required task (14). Low self-efficacy expectations regarding behaviour or task, leads to avoidance. As self-efficacy increases, a corresponding rise in the frequency of behaviour or task performance should be observed (15). Self-efficacy is related to maths, are the perceptions of one's performance abilities related to math problems, tasks, and math-related course work .

Mathematics self-efficacy and anxiety influence maths achievement (16, 17). Ahmed et al. (16) in 2012 reported findings that among 522 seventh grade students in the Netherlands, there was a reciprocal relationship between math self-concept and anxiety. Although self-concept and anxiety are linked, students who have low self-concept are likely to be anxious. Still, students who have higher anxiety levels do not necessarily have a low self-concept of their math ability (16). examined the math self-efficacy, math anxiety, and math attitudes of 372 university students in Turkey. Akin and Kurbanoğlu found that maths anxiety was negatively related to positive attitudes and self-efficacy and that maths self-efficacy was positively associated with positive attitudes. They also found that self-efficacy as the proximal determinant of maths attitudes and maths anxiety in Turkish university students.

The type of anxiety that was addressed in the paramedic discipline was test anxiety (18). In their study, distance and campus-based students from all three years of the Bachelor of Health Science (Paramedic) program at Whitireia, New Zealand participated in this study by utilising a mixed-method data collection. Participants completed an online survey including the Westside Test Anxiety Scale (WTAS), program-specific questions and free-response section to gather qualitative data. They found that high levels of anxiety were identified across the student body. There were significant differences in anxiety based on previous educational achievement and between full-time and part-time students. In this study, this demonstrates that different course delivery methods and student backgrounds may impact on paramedic student anxiety (18). Moreover, the thematic analysis of the qualitative questions in the survey has revealed three broad themes that are related to maths anxiety: stressors, obstacles to learning and negative experiences (18).

Most of the studies in the literature focused on the relationship between maths anxiety and self-efficacy in the secondary school stage and some disciplines at the university level other than the paramedic discipline; other studies focused solely on test anxiety among paramedic students. Therefore, this study aimed to study the effect of sex, age and year level on maths anxiety and self-efficacy and the relationship between self-efficacy and maths anxiety among paramedic students.

Methodology

Design and participants

A cross-sectional study with a convenience sampling of the first, second- and third-year Bachelor of Paramedicine students (N=423) studying at Monash University, Australia were recruited during the first week of semester one, 2019. The participants completed an anonymous paper-based questionnaire during the last 15 minutes of one of their classes. Participation in the study was voluntary, and submission of the completed questionnaire implied consent. The Monash University Human Research Ethics Committee approved this study (project number: 17969).

Instrumentation

The questionnaire was composed of three parts: i) non-identifiable demographic information including age group, sex and year level, ii) the modified Maths Anxiety Rating Scale (MARS) (19), iii) the Maths Self-Efficacy Scale (MESS) (19,20).

Maths Anxiety Rating Scale

The original MARS is a 98-item questionnaire developed and used by Richardson and Suinn (6). One disadvantage of this scale is its length, which may lead to tool filling fatigue and bias due to time constraints. Due to these issues, alternative shorter maths anxiety scales with fewer items were developed (21-23). Betz (1978) revised the MARS and created a 10-item tool, which was used in our study, to measure maths anxiety. The tool has good concurrent validity with .70 correlation with the original MARS (24) and reliability with a Cronbach alpha of .94 (McMullan et al., 2012). It is scored on a 5-point Likert scale for each item(1= strongly disagree, 5= strongly agree). Scores are reported as a total score and as a percentage to determine anxiety severity.

Maths Self-Efficacy Scale

To determine how confident students felt in completing everyday mathematics-related tasks, the 18-question math task subscale of the MSES was used (19). For each item on the math task subscale, individuals were asked to indicate their confidence in their ability to successfully perform the maths tasks on a 10-point scale ranging from "no confidence at all" (1) to "complete confidence" (10). The final score for the MSES task subscale can range from 18 to 180. The overall scale has good reliability with a Cronbach alpha of .92 for the task subscale was reported by Betz and Hackett (1993) and Nielsen and Moore (25) in 2003 study.

Data analysis

Data were compiled for analysis using SPSS software version 26. Data were presented using descriptive statistics, including mean ± standard deviations, median or frequencies where appropriate. Revised-MARS scores converted to a percentage to give a severity rating of low (0-24%), medium (25-74%), and high (75-100%) (20). Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. To identify factors that were predictive of maths anxiety, multiple linear regression was used. Before carrying out multiple linear regression analysis, the linearity between dependent and independent variables, normality, homoscedasticity, and multicollinearity was checked. Independent variables (Self-efficacy level, sex, and age group) were analysed using a univariate regression with the dependant variable (maths anxiety level). Variables that were significant at $p < 0.20$ were then entered a multivariate model. The level of significance was assigned at $p < 0.05$, and the effect size was also calculated.

Results

The surveys were completed and returned by 344 (81.3%) of sampled students. The demographic profiles of the consenting participants are reported in Table 1. Most of the participants were from the first-year cohort (46.2%), female (63.1%) and aged from 20 to 24 years (50.6%).

Table 1. Demographic data (sex and age groups) for 1st, 2nd and 3rd-year paramedicine students.

	Year	***1st Year***	***2nd Year***	***3rd Year***	***Total (%)***
	N (%)	*159(46.2%)*	*86(25%)*	*99(28.8%)*	*344(100%)*
Sex: n (%)	*Male*	*52(30%)*	*39(47%)*	*34(34%)*	*125(36.6%)*
	Female	*105(69.9%)*	*48(53%)*	*65(66%)*	*218(63.1%)*
	Prefer not to say	*1(.001%)*	*0*	*0*	*1(0.3%)*
Age group: n (%)	*≤19*	*94(59.5%)*	*29(33.3%)*	*2(2%)*	*125(36.3%)*
	20-24	*47(29.7%)*	*50(57.5%)*	*77(77.8%)*	*174(50.6%)*
	25-29	*7(4.4%)*	*2(2.4%)*	*15(15.1%)*	*24(7%)*
	30-34	*5(3.2%)*	*3(3.4%)*	*5(5.1%)*	*13(3.8%)*
	=>35	*5(3.2%)*	*3(3.4%)*	*0*	*8(2.3%)*

Measure reliability:

Cronbach's alpha reliability of the revised MARS in this study was .93, while the Cronbach's alpha reliability of the maths task MSES in this study was .92.

Maths Anxiety:

The revised-MARS scores are reported in table 2. The MARS anxiety scores in this study were normally distributed (skewness: 0.238; kurtosis: -0.552). Most respondents (n = 292, 85%) were classified with a medium anxiety score, and the mean (SD) was 25.7 (8.9). The remaining respondents were evenly spread between the high (8%) and low anxiety (7%) classifications. There was a significant difference (t (341) = -3.562, p<0.001 and Cohen's d =0.37) between males (mean (SD): 23.46(7.956)) and females (mean (SD): 26.94(9.096)). Comparison of MARS scores identified a significant difference between year level groups (*F* (2) = 3.185, *p* = 0.043, partial eta squared = 0.023), but not between age groups (*F* (4) = 0.517, *p* = 0.723, partial eta squared = 0.006).

Table 2: MARS Scores

		Number	***MARS: mean (SD)***	***Coefficient (95% CI)***
Year level	*Year 1*	*159*	*24.74(8.04)*	*Reference**
	Year 2	*86*	*27.98(9.04)*	*3.23 (0.92, 5.54)*
	Year 3	*99*	*25.27(9.65)*	*0.532 (-1.68, 2.74)*
Age group (Years)	*=<19*	*125*	*26.52(8.38)*	*Reference***
	20-24	*174*	*25.33(8.89)*	*-1.18 (-3.23, 0.86)*
	25-29	*24*	*24.71(10.41)*	*-1.81 (-5.70, 2.08)*
	30-34	*13*	*26.08(10.16)*	*-0.44 (-5.53, 4.65)*
	=>35	*8*	*23.75(9.58)*	*-2.77 (-9.14, 3.60)*
Sex	*Male*	*126*	*23.46(7.95)*	*Reference****
	Female	*217*	*26.94(9.09)*	*3.47(1.55, 5.39)*

**** p =0.043, ** p = 0.723, *** p<0.001***

Self-efficacy:

The MSES scores are reported in table 3. The MSES (self-efficacy) scores in this study were normally distributed (skewness: -0.302; kurtosis: -0.364). The

MSES scores in this study ranged from 24 indicating low self-efficacy level to 180 indicating the highest self-efficacy level. There was a significant difference in MSES scores (t (341) = 5.471, p<0.001, Cohen's d = 0.62) between males (mean (SD): 136.66 (25.48)) and females (mean (SD): 119.37(29.60)). Comparison of MSES scores between groups identified a significant difference between year level groups (F (2) = 6.809, p = 0.001, partial eta squared=0.038), and age-groups (F (4) = 5.213, p<0.001, partial eta squared = 0.058).

Table 3: MSES Scores

		Number	***MSES: mean (SD)***	***Coefficient (95% CI)***
Year level	*Year 1*	*158*	*130.22(26.30)*	*Reference**
	Year 2	*87*	*116.13(32.74)*	*-14.08(-21.65 - -*
	Year 3	*99*	*126.77(28.97)*	*-3.447(-10.71-*
Age group (Years)	*=<19*	*125*	*120.70(24.84)*	*Reference***
	20-24	*174*	*124.94(31.63)*	*4.240(-2.35-10.83)*
	25-29	*24*	*146.62(21.15)*	*25.92(13.38-*
	30-34	*13*	*133.31(29.10)*	*12.61(-3.78-29.01)*
	=>35	*8*	*143.63(32.20)*	*22.93(115.66-*
Sex	*Male*	*125*	*136.66(25.47)*	*Reference ****
	Female	*218*	*119.37(29.60)*	*-17.29(-23.51- -*

**** p =0.043, ** p = 0.723, *** p<0.001***

Predicting Maths anxiety levels

Backward method of entry was used and results of the multiple regression, which included as independent variables year level, sex, age, and maths self-efficacy level indicated a good fit (R^2 = 37.63%) and the overall relationship was significant (F [2,341] = 104.49, p < 0.001). Maths self-efficacy level (beta

= -0.626, $p < 0.001$) made the strongest unique contribution, when controlling for the other variables.

Discussion

To our knowledge, this study is the first in Australia to describe the relationship between self-efficacy and maths anxiety among paramedic students. It will add to the background knowledge derived from the literature and may provide a reference point for future research to enable practice change and improve the services that are provided to the patients.

This study found that sex and year level are the factors that affect maths anxiety. In contrast, sex, year level and age are the factors that affect maths self-efficacy levels among paramedic students at a large Australian university. Moreover, this study found that there is a significant inverse relationship between maths self-efficacy and maths anxiety levels.

The severity of maths anxiety among the participants was similar with McMullan's findings on the British nursing students in 2012 where 10% reported low levels of anxiety toward maths, 70% reported moderate level and 20% reported high levels of anxiety toward maths. The results of our study showed that there was a significant mean difference between males and females regarding their maths self-efficacy and maths anxiety scores, favouring males which is consistent with previous studies (26-29). Our findings disagreed with Alves et al. (30), who found that sex showed no differences in the perceived importance of maths anxiety. Why some people develop that maths anxiety can explain maths anxiety is experienced by some people because of their learned attitude from childhood, previous negative experiences, and their perception of an intense situation (31). According to the Australian Mathematical Sciences Institute (2018) girls are more maths anxious and less confident in their mathematical ability than boys. However, there is no evidence of why there is a sex difference in mathematical knowledge and ability.

An interesting finding of our study is that the age group did not play a significant role in the maths anxiety score. At the same time, it is important in determining the maths self-efficacy scores. The effect of age on maths anxiety was studied by many researchers ending with inconsistent findings. For example, Hembree (32) in 1990 and Zeidner (33) in 1991 found that there is no significant effect of age group on maths anxiety level while Dew et al. (34) in 1984 reported that older students have more maths anxiety than younger students.

Another surprising finding of our study is that students who are at year two of their degree have more anxiety toward maths and lower self-efficacy levels than the students in year one and year three. This might be explained by being in the midway of their study, where they start to have more in-class clinical scenarios and placements that require drug calculations under stressful conditions and might trigger their anxiety. On the other hand, students at year 3, have reached the last year in their study and are more prepared to the actual work in the field, have been exposed to more stressors in their field placements that might increase their confidence and reduce anxiety levels.

The inverse relationship between maths anxiety level as measured by MARS and the self-efficacy level as measured by MSES agreed with Akin and Kurbanoğlu (17) in 2011 findings in that maths anxiety-related negatively to self-efficacy. Our finding supports Bandura's (1986) social cognitive theory in which he argued that there was an inverse relationship between maths anxiety and self-efficacy. Self-efficacy develops after personal experiences or by learning from the experiences of others (vicarious learning), what a person is taught or convinced of, and how the experiences affected the person emotionally (14). Warwick (35) in 2008 reported that a feedback loop for self-efficacy leads to engagement in learning that leads to outcomes; the positive effects will lead to reengagement in the learning process(14). The feedback loop, however, can be positive or negative. Therefore, a negative self-efficacy may lead to less engagement and poorer outcomes and might determine some mental health issues as anxiety (35). The finding of our study supported with McMullan et al. (20) in 2012 study on 229 British nursing students who found that a statistically significant relationship between anxiety, self-efficacy, and ability. Anxiety was associated with self-efficacy and ability in a negative direction, whereas self-efficacy and ability had a positive association.

Improving the self-efficacy of the students may increase their beliefs in their capabilities that will decrease their anxiety toward maths. Motivation is one of the techniques that can enhance self-efficacy because people like to succeed and avoid failing (36). Motivation in learning reflects a means for activating students' ability for academic achievement. Motivation may include role modelling sessions in which the participants observe the actions of others which help them in having an objective understanding of the performance.

Moreover, enhancing motivation requires that the development of competencies be linked with rewards (14). Rewards, in turn, inform students that they are developing competence and raise self-efficacy (14).

Limitations

One of the limitations of this study is that being carried in one Australian paramedic program, which means the generalisation of the findings is limited. Another limitation of this study is using self-reported data and the numbers of the participants in all the groups are not equal. This study utilises the maths task subscale of the MSES because it has 18 items and to avoid the participants survey fatigue. Using the other subscales of the MSES might give different results.

Future Research

This study was conducted at one paramedic school at Victoria, Australia, and for the generalisation of the findings, more paramedic schools should be researched nationally and internationally. For example, a cross-cultural study to compare the results of this study can be carried out. Future research should also focus on measuring MARS and MSES levels among practising paramedics in the field. Further research on the association between maths anxiety and a maths-related paramedic skill such as drug dose calculation could be conducted since there was a significant inverse relationship between maths anxiety level and self-efficacy level among paramedic students. This could include an interventional teaching package, including motivational techniques, and role modelling techniques can be tested in improving the self-efficacy that will consequently reduce the maths anxiety of the students.

Conclusion

This study which was conducted in Australia addressed the relationship between self-efficacy and maths anxiety among paramedic students. Paramedic students reported medium to high maths anxiety levels and maths self-efficacy is negatively related to maths anxiety among paramedic students. Maths self-efficacy and maths anxiety levels differ between sex, age groups and the study year level.

Acknowledgment

We would like to acknowledge the paramedic students for their participation in this study.

References

1. Eaton, G., Mahtani, K., and Catterall, M. The evolving role of paramedics – a nice problem to have? *J. Health. Serv. Res. Policy* 2018;23(3)**,** 193-195. DOI: 10.1177/1355819618768357.

2. Tavares, W., Bowles, R., and Donelon, B. Informing a Canadian paramedic profile: framing concepts, roles and crosscutting themes *BMC Health. Serv. Res.* 2016;16. DOI: 10.1186/s12913-016-1739-1.

3. Caffey, M., and Crane, J. Paramedic student anxiety levels toward concepts in pharmacology at a regional university in Australia. *Aust. J. Paramed* 2016;13(4).

4. LeBlanc, V.R., MacDonald, R.D., McArthur, B., King, K., and Lepine, T. Paramedic performance in calculating drug dosages following stressful scenarios in a human patient simulator. *Prehosp Emerg Care* 2005;9(4)**,** 439-444.

5. Hodges, W.F. The psychophysiology of anxiety. *Emotions and anxiety (PLE: emotion): New concepts, methods, and applications* 2015;12**,** 175.

6. Richardson, F.C., and Suinn, R.M. The mathematics rating scale; Psychometric data. *J. Couns. Psycholy,* 1972;19(6)**,** 551-554. DOI:10.1037/h0033456.

7. Passolunghi, M.C., Caviola, S., De Agostini, R., Perin, C., and Mammarella, I.C. (2016). Mathematics anxiety, working memory, and

mathematics performance in secondary school children. *Front. Psychol* 2016;7**,** 42. DOI:10.3389/fpsyg.2016.00042.

8. Lou, X., Wang, F., and Lou, Z. Investigation and analysis of mathematics anxiety in middle school students. *J. Math. Educ 2009;*12(2)**,** 12-19.
9. Sparks, S. Brain imaging provides clues on math anxiety. *Education Week* 2011;31(9).
10. Rubinsten, O., and Tannock, R. Mathematics anxiety in children with developmental dyscalculia. *Behav. Brain. Funct.* 2010;6(1). DOI: 10.1186/1744-9081-6-46.
11. Finlayson, M. Addressing math anxiety in the classroom. *Improv. Schol*, 2014;17(1)**,** 99-115. DOI: doi.org/10.1177/1365480214521457.
12. Lyons, I., and Beilock, S. Numerical ordering ability mediates the relation between number-sense and arithmetic competence. *Cognition* 2011;121(2)**,** 256-261. DOI: org/10.1016/j.cognition.2011.07.009.
13. Núñez-Peña, M.I., Guilera, G., and Suárez-Pellicioni, M. The single-item math anxiety scale: an alternative way of measuring mathematical anxiety. J. Psychoeduc. Assess 2014;32(4), 306-317. DOI: org/10.1177/0734282913508528.
14. Bandura, A. Social foundations of thought and action: A social cognitive theory. 1986; Englewood Cliffs, NJ: Prentice-Hall.

15. Han, S., Liou-Mark, J., Yu, K., and Zeng, S. self-efficacy and attitudes towards mathematics of undergraduates: A US and Taiwan comparison*. J. Math. Teach. Educ.* 2015;8(1)**,** 1-15.

16. Ahmed, W., Minnaert, A., Kuyper, H., and Van der Werf, G. Reciprocal relationships between math self-concept and math anxiety.s. *Learn. Individ. Differ* 2012;22(3), 385-389. DOI: 10.1016/j.lindif.2011.12.004.

17. Akin, A., and Kurbanoğlu, İ. The relationships between math anxiety, math attitudes, and self-efficacy: A structural equation model. *Stud. Psychol* (Bratisl) 2011;53(3)**,** 263-273.

18. Wills, H., and Asbury, E. The incidence of anxiety among paramedic students. *Aust. J. Paramed* 2019;16. doi: http://dx.doi.org/10.33151/ajp.16.649.

19. Betz, N., and Hackett, G. Mathematics self-efficacy scale. (Redwood City, CA: Mind Garden);1993.

20. McMullan, M., Jones, R., and Lea, S. Math anxiety, self-efficacy, and ability in British undergraduate nursing students. *Res. Nurs. Health* 2012;35(2)**,** 178-186. doi: 10.1002/nur.21460.

21. Alexander, L., and Martray, C.R. The development of an abbreviated version of the mathematics anxiety rating scale. *Meas. Eval. Couns. Devel*, 1989;22(3)**,** 143-150.

22. Hopko, D.R., McNeil, D.W., Lejuez, C.W., Ashcraft, M.H., Eifert, G.H., and Riel, J. The effects of anxious responding on mental arithmetic and

lexical decision task performance. *J. Anxiety. Disord*. 2003;17(6), 647-665. doi: 10.1016/s0887-6185(02)00240-2.

23. Suinn, R.M., and Winston, E.H. The mathematics anxiety rating scale, a brief version: Psychometric data. 92(1), 167–173. *Psychol. Repor,* 2003;9(21), 167-173. doi: org/10.2466/pr0.2003.92.1.167.

24. Cooper, S., and Robinson, D. The relationship of mathematics self-efficacy beliefs to mathematics anxiety and performance *Meas. Eval. Couns. Develp*, 1991;24, 4-11.

25. Nielsen, I., and Moore, K. Psychometric data on the mathematics self-efficacy scale. *Educ. Psychol. Meas,* 2003;63(1), 128-138.

26. Busch, T. Gender differences in self-efficacy and academic performance among students of business administration. *Scand. J. Educ. Res* 1995;39(4), 311-318. doi: 10.1080/0031383950390403.

27. Ferla, J., Martin, V., and Yonghong, V. Academic self-efficacy and academic self-concept: Reconsidering structural relationships. *Learn. Individ. Differ*2009;19(4), 499-505. doi: 10.1016/j.lindif.2009.05.004.

28. Louis, R.A., and Mistele, J.M. The differences in scores and self-efficacy by student gender in mathematics and science. *Int. J. Sci. Math. Educ* 2012;10. doi: org/10.1007/s10763-011-9325-9.

29. Paechter, M., Macher, D., Martskvishvili, K., Wimmer, S., and Papousek, I. Mathematics anxiety and statistics anxiety. Shared but also unshared components and antagonistic contributions to

performance in statistics. *Front. Psychol* 2017;8, 1196. doi: 10.3389/fpsyg.2017.01196.

30. Alves, Manuela, Cristina S. Rodrigues, Ana Maria A. C. Rocha, & Clara Coutinho. Self-efficacy, mathematics' anxiety and perceived importance: an empirical study with Portuguese engineering students. European Journal of Engineering Education 2015;41(1):105-121. doi: 10.1080/03043797.2015.1095159.

31. Ho, H., Senturk, D., Lam, A., Zimmer, J., Hong, S., Okamoto, T., et al. The affective and cognitive dimensions of math anxiety: A cross-national study. *J. Res. Math. Educ* 2000;31(3), 362-379.

32. Hembree, R. The nature, effects, and relief of mathematics anxiety. *J. Res. Math. Educ* 1990;21(1), 33-46. doi: doi:10.2307/749455.

33. Zeidner, M. Statistics and mathematics anxiety in social science students: some interesting parallels. *Br. J. Educ. Psychol* 1991;61, 319-328.

34. Dew, K.H., Galassi, J.P., and Galassi, M.D. Math anxiety: Relation with situational test anxiety, performance, physiological arousal, and math avoidance behavior. *J. Couns. Psychol* 1984;31(4), 580-583. doi: org/10.1037/0022-0167.31.4.580.

35. Warwick, J. Mathematical self-efficacy and student engagement in the mathematics classroom. *MSOR Connections* 2008;8(3), 31-37.

36. Nurwendah, W., and Suyanto, S. Relationship among Self-Motivation, Self-Efficacy and Achievement of High School Student in Biology. *In J.*

Physic:2009; Conference Series (Vol. 1233, No. 1, p. 012009). IOP Publishing.

4.3 Chapter Summary

This study, conducted at a major Australian University, addressed the relationship between self-efficacy and maths anxiety among paramedic students. This study concluded that maths self-efficacy is negatively related to high maths anxiety levels in paramedic students. Furthermore, it was identified that maths self-efficacy and maths anxiety levels differ between gender, age, and year level. However, before confirmation of these factors has occurred, it is crucial to study these outcomes across other national and international paramedic schools.

Chapter Five: Maths anxiety cross-culturally.

5.1 Introduction

Chapter Four established that paramedic students from an Australian University experienced moderate to severe maths anxiety levels which are primarily impacted by self-efficacy level. The primary focus of this chapter is to compare differences in maths anxiety level and maths self-efficacy levels for paramedic students at two universities with different cultural backgrounds.

The study in this chapter utilises a sequential explanatory mixed-method where data were collected using anonymous self-report questionnaires from students who were studying Bachelor of Paramedicine at Monash University, Australia, and Jordan University of Science and Technology, Jordan. The quantitative data were then supplemented using by face-to-face interviews addressing the participants' views and concerns about the effect of maths self-efficacy on their maths anxiety levels. The results of this study are reported in the following manuscript which has been submitted and is currently under review at Jordanian Medical Journal, "A comparison between the Self-efficacy and Maths Anxiety levels among paramedic undergraduate students in Jordan and Australia: A cross-cultural study".

5.2 The manuscript: A comparison between the Self-efficacy and Maths Anxiety levels among paramedic undergraduate students in Jordan and Australia: A cross-cultural study.

1. Eihab Khasawneh
Department of Paramedicine, Monash University, Victoria, Australia.

Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan.

2. Dr Alaa Otier
Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan.

3. Dr Cameron McR Gosling
Department of Paramedicine, Monash University, Victoria, Australia.

4. Professor Brett Williams
Department of Paramedicine, Monash University, Victoria, Australia.

Corresponding author:
Eihab Khasawneh

47 – 49 Moorooduc Highway
Frankston VIC 3199

eihab.khasawneh@monash.edu
eakhasawneh1@just.edu.jo
+61 03 9904536

Abstract

Background

Health care providers' and students' performances are impacted by maths anxiety and self-efficacy levels. Many factors may contribute to maths anxiety and self-efficacy. This study aimed to determine the difference in maths anxiety level and maths self-efficacy levels for paramedic students at two universities with different cultural backgrounds.

Methods

A sequential explanatory mixed-method where data were collected using anonymous self-report questionnaires from students who are studying Bachelor of Paramedicine at Monash University, Australia (n=423) and Jordan University of Science and Technology, Jordan (n = 215) followed by face-to-face interviews.

Results

Jordanian students had a higher level of maths anxiety and lower level of self-efficacy than the Australian students. Maths self-efficacy level (beta = -0.53, $p < .001$) made the strongest unique contribution to maths anxiety followed by the school location (b=.08, $p < .001$). Interviews revealed that motivation, self-confidence and practising could improve self-efficacy.

Conclusion

This study which was conducted in Australia and Jordan paramedic schools, addressed the relationship between self-efficacy and maths anxiety among paramedic students. Maths self-efficacy and maths anxiety levels differ between the two schools according to gender, age groups and the study year level. Future research should focus on studying the effect of self-efficacy on maths anxiety at practising paramedics at national and international levels.

Keywords: self-efficacy, anxiety, allied health personnel, paramedicine

Introduction

Maths anxiety is consisting of affective, behavioural and cognitive responses to a perceived threat to self-esteem, happened as a response to situations involving mathematics (Olango, 2016). Maths anxiety is not only concerning a dislike toward maths; but many people become nervous when engaging in maths-related tasks (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015), avoid mathematics and maths-related professions, severely limiting their future career and earning opportunities (Olango, 2016). Feelings of maths anxiety are widespread; an estimated 25% of 4-year college students and up to 80% of community college students suffer from a moderate to a high degree of maths anxiety in the US (Beilock & Maloney, 2015). Maths anxiety is usually linked to prior negative maths experience (Helal, Abo Hamza, & Hagstorm, 2011); this could include being punished by teachers for failing to solve or understand mathematical concepts, not scoring good grade in maths at school, a lack of support from parents or teachers, and not having role models. Maths anxiety has been associated with academic failure and emotional tension (Gurefe & Bakalim, 2018). This state of anxiety sometimes leads to obliviousness and causes the individual to lose positive self-confidence, and the learning efficiency drops to its lowest level (Arslanoglu & Ercan, 2017).

Part of this self-confidence is self-efficacy, which is defined as “one's judgment of one's capabilities to organise and execute courses of action required to attain designated types of performances” (Bandura, 1986). Maths self-efficacy is one's confidence in one's ability to solve a mathematical problem (Hackett & Betz, 1989). Maths self-efficacy can positively impact academic achievement by allowing one to use cognitive strategies, enhancing the belief in the successful completion of tasks, and encouraging one to come up with alternative solutions for the problem in hand (Gurefe & Bakalim, 2018). Studies showed that students with high-perceived self-efficacy make more effort to accomplish a task and are more persistent in the face of difficulties (Arslanoglu & Ercan, 2017);(Schwarzer & Warner, 2013); (Artino, 2012). Hackett and Betz (1989) report that students with higher maths self-efficacy have lower maths anxiety and place more value on mathematics.

Health care providers' and students' performances are also impacted by maths anxiety and self-efficacy levels. For example, within nursing, one study has highlighted that learning and comprehending science-based material such as pharmacology causes significant anxiety that may even result in medication errors conducted in practice (Caffey & Crane, 2016). Another study showed that also though performing equally to their male peers, female medical students reported decreased self-confidence, efficacy and increased anxiety, particularly over issues related to their maths competence (Blanch, Hall, Roter, & Frankel, 2008). In the paramedic discipline a study aimed to evaluate the effect of stressors on the paramedic performance in calculating drug dosages found that paramedics scored lower accuracy scores when they are in a high-stress condition in comparison to being in a low-stress state (43% (95% confidence interval (CI: 36.9–49.2) vs. 58% (95% CI: 48.6–67.1), $p < 0.01$) (LeBlanc, MacDonald, McArthur, King, & Lepine, 2005).

All the previously mentioned studies were conducted within one cultural context; this may be a limitation in the literature because results may not be generalised in a cross-cultural context. Investigation of maths anxiety and its contributing factors in a single context gives only a partial picture and might not permit direct comparisons in different regions of the world, thus limited the understanding of this concept and its cultural differences (Fan, Hambleton, & Zhang, 2019). Therefore, we conducted this cross-cultural study, which sought to analyse the differences in maths anxiety and self-efficacy profiles between paramedicine students in Australia versus those in Jordan.

Methodology

Design and participants

This is a sequential explanatory mixed-method study. Data were collected using anonymous self-report questionnaires from students studying a Bachelor of Paramedicine at Monash University, Australia (n=423) and Jordan University of Science and Technology (JUST), Jordan (n = 215). The students of both schools were recruited during the first week of semester one, 2019. The participants completed the anonymous paper-based questionnaire during the last 15 minutes of one of their classes. Participation in the study was voluntary, and submission of the completed questionnaire implied consent. In the second part, the students were invited to participate in a face-to-face structured interview after completing the questionnaire.

Instrumentation

The questionnaire

The questionnaire was composed of three parts: non-identifiable demographic information included questions asking responders their school location, course year level, age group, and gender, the modified Maths Anxiety Rating Scale (MARS) (Betz

& Hackett, 1993), and the Maths Self-Efficacy Scale (MESS) (Betz & Hackett, 1993) and (McMullan, Jones, & Lea, 2012).

Maths Anxiety Rating Scale (MARS)

The original 98-item maths anxiety rating scale is very long (Richardson & Suinn, 1972), so a shorter 10-item scale was used in this study (Hopko et al., 2003); (Suinn & Winston, 2003). The used scale in this study has good reliability with a Cronbach alpha of .94 (McMullan et al., 2012), and is scored on a 5-point Likert scale for each item (1= strongly disagree, 5= strongly agree). The first five items were reversely coded so that a high score indicates high maths anxiety level. Scores are reported as a total score out of 50 points.

Maths Self-Efficacy Scale (MSES)

In this study, the 18-question math task subscale of the MSES was used (Betz & Hackett, 1993) and (McMullan et al., 2012). For each item, participants were asked to indicate their confidence in their ability to successfully perform the maths tasks on a 10-point scale ranging from "no confidence at all" (1) to "complete confidence" (10). The final score for the MSES task subscale can range from 18 to 180 points. The overall scale has good reliability with a Cronbach alpha of .92 for the task subscale as reported by Betz and Hackett (1993).

The interviews

The interviews were conducted using a structured interview guide that explored participants' perceptions of the effect of self-efficacy on maths anxiety among paramedic students. The interviewer was unknown to the participants and had not been directly involved in the delivery of the educational program. The interviews were audio-recorded and transcribed verbatim.

Ethics

The project was approved by the Monash University Human Research Ethics Committee (MUHREC) (project number: 17969) and JUST Institutional Review Board (IRB) (Ref#. 33/127/2019).

Data analysis

Phase 1: The questionnaires

Data were analysed using SPSS software version 26 (IBM). Data are presented using descriptive statistics, including mean ± standard deviations (SD), (IQR) or frequency and proportions where appropriate. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. Independent samples student's t-test, one-way ANOVA and Post-hoc tests were used to compare mean differences between groups where appropriate. To identify the factors that were associated with maths anxiety, linear regression was used. Each predictive independent variable was analysed using a univariate regression with the dependant variable. Variables that were significant at $p < 0.20$ were then entered into a multivariate model. The level of significance was assigned at $p < 0.05$, and the effect size was calculated.

Phase 2: The interviews

Interviews were conducted by one of the researchers (EK). As a first step in the interview process, each participant was reminded of the study objectives, benefits, and confidentiality. To develop a good rapport with respondents and to demonstrate familiarity with the topic (Creswell, 1994), the researcher identified himself as a PhD student. Written informed consent was obtained before the start of the interview. All the interviews were audio-recorded, and there was no time limit for ending the interview. A research assistant took notes during the interviews which enabled the researcher to track critical points to return to later in the interview and for use during data analysis, all recordings were then transcribed verbatim and translated to English. Each interviewee was labelled by the letter J followed by a number for JUST students, for example, interviewee number 1 is labelled as (J1). Each interviewee was marked by the letter M followed by a number for Monash University students, for example, interviewee number 1 is labelled as (M1). The interviews for JUST students were conducted in the Arabic language by the primary author (EK) who speaks Arabic and English languages, and they were sent to a translation agency to be translated into English. The JUST participants recorded interviews were immediately transcribed because they were spoken in Arabic. The translation was performed by a professional translator where the Arabic interviews were translated into English. Using the method of back translation translators back-translated some of the interview transcripts from English to Arabic to ensure transcripts accuracy (Choi, Kushner, Mill, & Lai, 2012).

The first author then checked all data by listening to the audio recordings and comparing them to the transcripts (Choi et al., 2012). The interviews for MU students were conducted in the English language by the primary author.

EK coded all transcripts with a subset additionally coded by BW. The interviews were analysed using qualitative content analysis performed in several steps. First, all transcripts were read through several times to gain a sense of the whole document. The text was then reread and divided into meaning units, each representing a single unit of content (Driscoll, Appiah-Yeboah, Salib, & Rupert, 2007).

Results

Phase 1: the questionnaires

The total number of the participants in this study was 505; 344 students (68%) from Australia and 205 students (32%) from Jordan. This distribution represents an 81% and 75% response rate from Monash University and JUST, respectively. The demographic profiles of the consenting participants are reported in Table 1. Most of the participants from Monash University were from the first-year cohort (45.9%), female (63.4%) and aged from 20 to 24 years (50.6%). On the other hand, most of the participants from JUST were from the third-year cohort (32.9%), female (65.2%) and aged 20 to 24 years (54.7%).

Table 1. Demographic data for Monash University and JUST paramedicine students.

	MU Number (%) N= (100%)	**JUST** Number (%) N= (100%)
Gender		
Male	125 (36.3)	56 (34.8)
Female	218 (63.4)	105 (65.2)
Prefer not to say	1 (.3)	---
Age group		
≤19	125 (36.3)	58 (36.0)
20-24	174 (50.6)	88 (54.7)
≥25	45(13.1)	15 (9.3)
Year level		
1st Year	158 (45.9)	40 (24.8)
2nd Year	87 (25.3)	46 (28.6)
3rd Year	99 (28.8)	53 (32.9)
4th Year	---	22 (13.7)

Maths Anxiety Rating Scale

The MARS scores are shown in Table 2. MARS scores for JUST students ranged from 10 to 42 points while for Monash University students from 10 to 50. The mean (SD) scores for Monash students (25.7 (±8.9)) were lower than for JUST students (29.3 (±4.9)). The independent-samples t-test showed that there was a significant difference in MARS mean scores between Monash students and JUST students; $t(503) = -4.8$, 95% CI (-5.1, -2.1) $p < .001$, $d = .50$.

In addition, there was a significant difference in the MARS mean scores for the male students (t(179)=-4.9, 95% CI(-8.1,-3.4), p<.001, d=.84) and the female students (t(321)=-2.5, 95% CI(-4.2,-.5), p=.001, d= 1.0) between Monash University and JUST students. While the independent-samples t-test showed that there was a significant difference in MARS, mean scores between males and females; t (341) = -3.6, p <.001 for Monash University students, it showed that there was no significant difference in MARS scores between males and females among JUST students; t (159) = -.122, p = .9.

In comparing the different year levels MARS mean scores, the one-way ANOVA showed that there was a significant difference between the two schools in the mean scores for the first-year students (F (1,196) = 7.1, p=.008 and the third-year students (F(1,150)= 10.3, p=.002). There was a statistically significant difference in MARS mean scores between Monash University students' year level; F (2, 341) = 3.8, p = .02. However, there was no statistically significant difference in MARS mean scores between JUST students' year level; F (3, 157) = 2.4, p = .07.). Post-hoc comparisons using Gabriel test indicated that the MARS mean score for Monash University students who are at year one level was significantly different from those who are at year two-level, p=.019. Year three students MARS mean score did not differ considerably from year one and year two students mean MARS score.

There was a significant difference in the MARS mean score between the two schools for the students who are aged between 20-24 years; F (1,260) =22.3, p<.001. In contrast to Monash University students MARS mean scores which were not significantly different between age groups (F (2, 341) = .85, p = .43), the JUST students MARS mean scores were significantly different between age groups (F (2, 158) = 3.2, p = .045). Post-hoc comparisons using Gabriel test indicated that the MARS mean score for JUST students differed significantly between those who are ≤19 years and those who are between 20-24-year-old, p=.038.

Maths Self-Efficacy Scale

The MSES scores are shown in table 2. MSES scores for JUST students ranged from 33 to 167 while for Monash University students from 46 to 180. The mean (SD) MSES scores for Monash University students were 125.7 (29.3) while for JUST students were 110.6 (27.3). The independent-samples t-test showed that there was a significant difference in MSES mean scores between Monash students and JUST students; t (503) = 15.8,95% CI(9.7,20.5) p <.001, d= .53.There was a significant difference in the MSES mean scores for the male students (t(179)=6.7, 95% CI(19.9,36.5), p<.001, d= .33 and the female students (t(321)=2.2, 95% CI(.9,14.4), p=.001, d= .27) between Monash University and JUST students. While the independent-samples t-test showed that there was a significant difference in MSES, mean scores between males and females; t (341) = 5.5, p <.001 for Monash university students, it showed that there was no significant difference in MSES scores between males and females in JUST students; t (159) = -.72, p = .90.

In comparing the different year levels effect on the MSES mean scores, there was a significant difference between the two schools in the mean scores for the first-year students (F(1, 196) = 11.1, p=.001 and the third-year students (F(1, 150)= 15.6, p<.001). There was a statistically significant difference in MSES mean scores between

Monash University students' year level; F (2, 341) = 6.8, p = .001. Post-hoc comparisons using Gabriel test indicated that the MSES mean score for students who are at year two level was significantly different from those who are at year one level, p=.001 and year three-level, p=.001. Year three students MSES mean score did not differ significantly from year one scores. There was no statistically significant difference in MSES mean scores between JUST students' year level; F (3, 157) = .71, p = .06. There was a significant difference in the MSES mean score between the two schools for the students who are aged between 20-24 years; F(1, 260)=18.6, p<.001 and those who are aged older than 25 years; F(1, 58)= 25, p<.001.In contrast to Monash University students MSES mean score which is significantly different between age groups (F (2, 341) = 9.5, p < .001), the JUST students MSES mean scores was not significantly different between age groups (F (2, 158) = 2.3, p = .109).

Table 2: A comparison of MARS and MSES Scores between MU students and JUST

	MARS Score		**MSES Score**	
	MU	**JUST**	**MU**	**JUST**
	M (SD)	M (SD)	M (SD)	M (SD)
Gender				
Male	23.44 (7.95)*	29.21 (5.7)*	136.71 (25.7)*	108.50 (27.5)*
Female	26.92 (9.10)*	29.31 (4.5)*	119.40 (29.6)*	111.75 (27.3)*
Year level				
Year 1	24.74 (8.1)*	28.25 (4.1)*	130.21 (26.3)*	114.75 (25.7)*
Year 2	27.93 (9.1)	28.45 (4.7)	116.14 32.8)	112.28 (25.8)
Year 3	25.25 (9.7)*	29.88 (5.6)*	112.86 (29.0)*	107.32 (29.1)*
Year 4	---	31.22 (1.6)	---	107.59 (29.2)
Age group				

=<19	26.50 (8.4)	28.06 (4.8)	120.65 (27.9)	116.60 (24.6)
20-24	25.31 (8.9)*	30.12 (4.9)*	125.03 (31.7)*	107.57 (29.4)*
>=25	24.93 (10)	29.00 (4.5)	142.24 (21.2)*	105.29 (21.3)*
* level of significance was assigned at p < .05. MU: Monash University; JUST: Jordan University of Science and Technology; M: Mean; SD: Standard Deviation				

Scales reliability

Cronbach's alpha reliability for MARS in this study was .88 and of the (MSES) was .92. This indicated that both scales had good reliability.

Predicting Maths anxiety levels.

Before carrying out multiple linear regression analysis, the linearity between dependent and independent variables, normality, homoscedasticity, and multicollinearity was assessed. Enter method of entry was used to enter the independent variables that included school, year level, gender, age, and maths self-efficacy level. The results of the multivariate regression (Table 3) indicated a good fit (Adjusted R^2 = 30.8%) and the overall relationship was significant (F [3, 500] = 76.06, p < .001). School location (1.48, p =0.024) made the strongest unique contribution to maths anxiety which followed by maths self-efficacy level - 0.14, p < .001) and gender (0.89, p = 0.158). Age and year level were non-significant and not included in the model(Table 3).

Table 3 Regression model summary.

Factor	Coefficient	95% CI	p-value
MSES	- 0.14	(- 0.16, - 0.12)	<.001
School location			
Monash University	(Reference)		
JUST	1.48	(0.2, 2.77)	0.024
Gender*			
Male	(Reference)		
Female	0.89	(- 0.34, 2.12)	0.158

* Data from the single responder preferring not to identify gender was removed from the regression analysis.**CI**: Confidence Interval; **MSES**: Maths Self-Efficacy Scale

Phase 2: Interviews evaluation

The results of the qualitative phase were based on 16 interviews. Ten of the interviews were conducted through face-to-face method (Six students from JUST and four from MU) and four interviews via telephone (two from JUST and four from MU= 4). Females comprised 75% of the participants. Most interview questions were exactly asked as they were written. However, the researcher often followed up the semi-structured questions with open-ended questions such as, "Why?" and "Could you please explain ?". This was the researcher's way to get a richer understanding of the participant's experiences. The themes that emerged from the interviews that were related to maths anxiety and self-efficacy included: mathematical concepts and operations, motivation, self-confidence and practice.

Mathematical concepts and operations

Participants have different views regarding the difficulty of specific mathematical methods. For example, some participants argued that division is more difficult mathematical operation than multiplication because it is a time-consuming procedure; (J4) stated that "I feel dividing needs more time, unlike multiplication which can be done quickly. The idea is that division needs more time". Another student (J8) stated that "I guess division is the hardest calculation". On the other hand, other participants reported that addition and multiplications are the most complicated mathematical methods; (J5) stated that "I guess addition is the most difficult mathematical operation" and (M4) reported that "Yeah, probably multiplication and stuff. Just stuff without a calculator basically".

One participant argued that failure to have good mathematical competency due to anxiety might lead some errors in the paramedic practise in the field; (J5) stated that "Sure, because there is something called medication calculation. Meaning, there are certain doses that a paramedic needs to pay attention to. If the dose increases, many complications can occur to the patient".

Motivation

Motivation can improve person self-efficacy. Factors that might contribute to increasing the motivation levels involve role modelling and the impact of peers and the family. (J1) stated that:

> It plays a big role. In terms of personality enhancement, you through encouragement can enhance your personality. From an environmental

> perspective, the people around you influence you, so you find people trying to frustrate you, and you must overcome these things, in addition to the difficulties of life. Meaning that you try as much as you cannot be affected by these things and enhance yourself.

Another student claimed that the community around you could motivate the person to practise more efficiently by enhancing the self-efficacy of the person. (J5) stated that “I think motivation has a lot to do with especially the one comes from the family and the society. This motivation creates an incentive for the individual to do more”.

Role modelling plays an important role in increasing person motivation toward achieving goals. (J5) stated that

> This effect is dependent on the role model. If your role model is a person who is successful and has wide knowledge and understanding at work. Then you start feeling that he is perfect, and this encourages you to be like him and feel that you are longing to learn.

Another participant argued that family has most of the effect on motivation; (J5) stated that “In my opinion, the family accounts for 80% of motivation”.

Self-confidence

Self-confidence is essential in health care practice. Participants reported that self-confidence is related to self-efficacy and can positively impact the maths anxiety level; (J2) stated that:

> They're almost inseparable. While you try to trust yourself, you fear failure. Here, you must control and convince yourself that there are

> people who fail only because the stress has taken over. Here, I think you should train to control yourself and not allow anything to provoke you or frustrate you, while weighing your self-confidence.

(J7) Stated that:

> Belief in abilities means believing that you can do something even if it is wrong. In an emergency, if you make a mistake, you will not remain in your place also if you make a mistake one or two times. Frankly, I suffer from this. Belief in abilities means that you do not give up if you make a mistake once because you must try again with training and practices until you reach a level of 100% mastery and get rid of this problem.

Participant (M5) argued that stress could be reduced when you have a higher confidence level. (J1) stated that:

> They're almost inseparable. While you try to trust yourself, you fear failure. Here, you must control and convince yourself that there are people who fail only because the stress has taken over. Here, I think you should train to control yourself and not allow anything to provoke you or frustrate you while weighing your self-confidence.

Participant (M3) reported that:

> I get nervous simply because it’s not something I practice all the time, so it’s not my most comfortable strength. So again, because I do get anxious (because it’s not my most confident skill) nerves impact any sort of performance.

Practising

Practise is critical to achieving competency in any math-related skill. Participants argued that solving more mathematical problems can improve the ability of the person to do these skills in all situations. (J3) stated that “mathematics needs intelligence as well as a continuation of solving mathematical calculations”. (J6) stated that:

> I was able to overcome this problem by practice. Gradually, I began to practice and understand, especially with the solution of many mathematical problems. Here, I discovered that mathematics relied primarily on solving many problems.

Another participant (J8) stated that "Negligence on the part of the student himself, refraining from practising such types of calculations, and refraining from following up well may create the problem for him".

One participant argued that self-efficacy and maths anxiety is related to the amount of experience and practice that the person can do. (J1) stated that:

> They almost complement each other. If you have experiences, your faith in your abilities will improve. This has already happened to me. If you have the necessary experiences, you can act in the situations you are exposed to. They are complementary to one another and cannot be separated.

Another participant (M8) stated that:

> I would do a lot of practice with a friend who has got a good maths brain and he always just knew it and got it and I just could not. So yeah, I was sort of a bit discouraged that he was so good at it and could just see it and was getting good marks.

The merging of the results from both the qualitative and quantitative analyses indicated that mathematical concepts and operations, motivation, self-confidence and practising are the main themes that were related to maths anxiety and self-efficacy. The participants reported that self-efficacy and maths anxiety are essential concepts in paramedic practice.

Discussion

This study was the first cross-cultural comparative study in the paramedicine discipline to determine the difference in maths anxiety level and maths self-efficacy levels for paramedic students at two universities with different cultural backgrounds. Our study reported that Jordanian paramedic students have higher maths anxiety levels and lower self-efficacy levels compared to Australian students. Maths self-efficacy level and the school location (cultural background) were the contributing factors to maths anxiety.

Maths self-efficacy among Jordanian students was lower than that among the Australian students. Our finding is unlike Mueller and Goić (2003) study who found no significant differences in self-efficacy between undergraduate business students the

United States and Croatia. Moreover, our findings were in contrast with Basol and Karatuna (2017) study which found that there were no significant differences for the level of self-efficacy between the students of economics and administrative sciences in Poland and Turkey.

We found that as students progressed through their paramedic education in both schools, the mean self-efficacy level decreased. Our finding is unlike Marra and Bogue (2006) study on engineering students in the US who found that progression in the year level of education would improve the self-efficacy. From the interviews in our study, we found that one factor that might affect self-efficacy level was the positive self-confidence. Self-confidence, which is often used interchangeably with self-efficacy, refers only to the strength of certainty of one's beliefs, but does not require a positive outcome, for example, a person may be confident in failure (Bandura, Freeman, & Lightsey, 1999). The participants felt that having a positive self-confidence can increase self-efficacy because self-confidence has a considerable effect on the outcome and improving the performance (Barrows, Dunn, & Lloyd, 2013).

One interesting finding in our study was that in contrast to the Australian female students, the Jordanian female students had a higher self-efficacy level than their male counterparts. Our results are inconsistent with a Turkish study that was conducted on 1679 students studying at Anadolu University (Satici & Can, 2016). They reported that self-efficacy scores of males are higher than females $t(1677) = 5.47$, $p < .01$, which indicated that gender impacted the self-efficacy level. Another study in, Albania, found that males and females in universities differ in self-efficacy. The mean of self-efficacy was for male M = 3.06 (SD= .74) and female M=2.67 (SD=.89) (Shkullaku, 2013). In the Albanian culture, sex role stereotypes have a substantial effect, and therefore females' capacities are undermined by male capacities (Shkullaku, 2013). In Jordan, the traditional gender stereotyping and the male dominancy start to decrease in the last decades. This makes the percentage of students in tertiary education who are female (%) in Jordan to be reported at 52.92 % in 2017 (Dandan & Marques, 2017).

Our study found that the maths anxiety levels were higher in the Jordanian students, which indicates that cultural background might impact maths anxiety levels. This finding is similar with Helal et al. (2011) study which studied the maths anxiety difference between the American and Egyptian students and reported a significant main effect for countries, $F(1, 187) = 11.41$, $p < .001$, on maths anxiety levels. Helal et al. (2011) argued that the Egyptian educational system might contribute to the difference in maths anxiety level. Each culture has its values and own policies where it organises its educational system in a different way (Brown, Ortiz-Padilla, & Soto-Varela, 2020). Another study reported that there were differences in maths anxiety between German students and Mexican engineering students that they attribute to differential beliefs and attitudes between the two cultures(Brown et al., 2020). In Jordan, the paramedic program is a four-year program where the students in the first year are enrolled in basic science classes. Maths is not part of these basic sciences. This means that students' first use of mathematics related to their paramedic study would be in the third year in the pharmacology class. A study conducted by Kalaycioglu (2015) found that the different educational systems may explain maths anxiety levels in Turkey, Greece, and Hong Kong, which are more centralized and more challenging for students. These countries education systems currently use high stake testing as a means of allocating students into academic schools, and students are ranked depending on their test scores. In Hong Kong, Turkey, and Greece, students are allowed access to specific schools based on their exam score starting in middle school (Kalaycioglu, 2015).

While our study showed that gender impacted maths anxiety level for the Australian students, it did not affect the maths anxiety levels for the Jordanian students. This finding was consistent with the study conducted by Helal et al. (2011) who reported that gender was not found to have an impact on math anxiety in either Egyptian or American sample of their study and inconsistent with the conclusions of Fuson (2007) study who reported that females, especially adult women, experience more math anxiety than men.

Our study found that self-efficacy and the school location (cultural background) were predicting factors for maths anxiety in this sample of paramedic students. This means that improving self-efficacy can reduce maths anxiety. To decrease maths anxiety level, a positive and supportive learning environment is needed (McMullan et al., 2012). Teaching should be more student-directed, not merely didactic (Squires & Farrell, 2006). Murray, Ma, and Mazur (2009) argued that because students have different learning styles, instruction must be flexible to meet the needs of all the students and be able to address the frustration that can cause to maths anxiety. Participants in the interviews claimed that maths anxiety could be reduced by increasing the mathematical competency. Other students in our study qualitative part claimed that continuous practising and enriching the person experience would improve the self-efficacy, which will, in turn, decrease the maths anxiety level among the students.

Moreover, the participants argued that motivation through family positive reinforcement and positive role modelling could increase the self-efficacy level. This was consistent with McMullan et al. (2012) study on British nursing students. They reported that a meaningful way to improve a person's self-efficacy is by providing positive encouragement and constructive feedback. There is consistent evidence demonstrating that evaluative and positive ability or effort feedback during maths practice can increase maths self-efficacy and achievement (McMullan et al., 2012).

Limitation and future research

One limitation of this study is the use of convenient sampling technique which may negatively affect the generalisation of the results. Another limitation is the self-reporting nature of the questionnaires; one assumes that students are honest and respond to the items based on their true feelings. Furthermore, using a thematic analysis approach in the qualitative analysis might mean a more narrowed insight into study concepts.

Future research should also focus on practising paramedic in the field to address the impact of maths anxiety and its contributing factors on the paramedics' practise. Further research on the association between maths anxiety and a maths-related paramedic skill such as drug dose calculation can be conducted since there was a significant inverse relationship between maths anxiety level and self-efficacy level among paramedic students. For example, the association between maths anxiety, self-efficacy, numerical ability, and drug dose calculation among paramedic students can be investigated.

Conclusion

This study, which was conducted in Australia and Jordan paramedic schools, addressed the relationship between self-efficacy and maths anxiety among paramedic students. School location and maths self-efficacy are the predicting factors of maths anxiety. Maths self-efficacy and maths anxiety levels differ between the two schools according to gender, age groups and the study year level. Future research should focus on studying the effect of self-efficacy on maths anxiety at practising paramedics at national and international levels. Moreover, developing training packages to reduce the maths anxiety level among paramedic students should be tested in future studies by addressing the role of motivation, self-confidence, and practising.

References

Arslanoglu, A., & Ercan, Z. (2017). The effect of montessori sensorial education on children's developmental areas. *Educational Research and Practise.*, 28.

Artino, A. R. (2012). Academic self-efficacy: from educational theory to instructional practice. *Perspectives on Medical education, 1*(2), 76-85.

Bandura. (1986). *Social Foundation of Thought and Action* (Vol. null).

Bandura, Freeman, W., & Lightsey, R. (1999). Self-efficacy: The exercise of control. In: Springer.

Barrows, J., Dunn, S., & Lloyd, C. A. (2013). Anxiety, self-efficacy, and college exam grades. *Universal Journal of Educational Research, 1*(3), 204-208.

Basol, O., & Karatuna, I. (2017). Entrepreneurial self-efficacy of university students: A cross-cultural study. *Management (18544223), 12*(1).

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences, 2*(1), 4-12.

Betz, N., & Hackett, G. (1993). Mathematics self-efficacy scale. *The fourteenth mental measurements yearbook. Lincoln, NE: Buros Institute of Mental Measurements*.

Blanch, D. C., Hall, J. A., Roter, D. L., & Frankel, R. M. (2008). Medical student gender and issues of confidence. *Patient Education and Counseling, 72*(3), 374-381.

Brown, J. L., Ortiz-Padilla, M., & Soto-Varela, R. (2020). Does mathematical anxiety differ cross-culturally? *Journal of New Approaches in Educational Research, 9*(1), 126-136.

Caffey, M. R., & Crane, J. W. (2016). Paramedic student anxiety levels toward concepts in pharmacology at a regional university in Auastalia. *Australian Journal of Paramedicine, 13*(4).

Choi, J., Kushner, K. E., Mill, J., & Lai, D. W. (2012). Understanding the language, the culture, and the experience: translation in cross-cultural research. *International Journal of Qualitative Methods, 11*(5), 652-665.

Dandan, M. M., & Marques, A. P. (2017). Higher education leadership and gender gap in Jordan. *Asian Development Policy Review, 5*(3), 131.139.

Driscoll, D. L., Appiah-Yeboah, A., Salib, P., & Rupert, D. J. (2007). Merging qualitative and quantitative data in mixed methods research: How to and why not.

Fan, X., Hambleton, R. K., & Zhang, M. (2019). Profiles of mathematics anxiety among 15-year-old students: a cross-cultural study using multi-group latent profile analysis. *Frontiers in Psychology, 10*, 1217.

Fuson, J. Y. (2007). A study of the relationship between math anxiety and select demographics. Capella University,

Gurefe, N., & Bakalim, O. (2018). Mathematics anxiety, perceived mathematics self-efficacy and learned helplessness in mathematics in faculty of education students. *International Online Journal of Educational Sciences, 10*(3).

Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education*, 261-273.

Helal, A., Abo Hamza, E., & Hagstorm, F. (2011). Math anxiety in college students across majors: a cross culture study.

Hopko, D. R., McNeil, D. W., Lejuez, C. W., Ashcraft, M. H., Eifert, G. H., & Riel, J. (2003). The effects of anxious responding on mental arithmetic and lexical decision task performance. *Journal of Anxiety Disorders, 17*(6), 647-665. doi:10.1016/s0887-6185(02)00240-2

Kalaycioglu, D. B. (2015). The influence of socioeconomic status, self-efficacy, and anxiety on mathematics achievement in England, Greece, Hong Kong, the Netherlands, Turkey, and the USA. *Educational Sciences: Theory and Practice, 15*(5), 1391-1401.

LeBlanc, V. R., MacDonald, R. D., McArthur, B., King, K., & Lepine, T. (2005). Paramedic performance in calculating drug dosages following stressful scenarios in a human patient simulator. *Prehospital Emergency Care, 9*(4), 439-444.

Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2015). Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychological Science, 26*(9), 1480-1488. doi:10.1177/0956797615592630

Marra, R. M., & Bogue, B. (2006). Women engineering students' self efficacy--a longitudinal multi-institution study. *Women in Engineering ProActive Network.*

McMullan, M., Jones, R., & Lea, S. (2012). Math anxiety, self-efficacy, and ability in British undergraduate nursing students. *Research in Nursing and Health, 35*(2), 178-186. doi:10.1002/nur.21460

Mueller, S. L., & Goić, S. (2003). East-West differences in entrepreneurial self-efficacy: Implications for entrepreneurship education in transition economies. *International Journal for Entrepreneurship Education, 1*(4), 613-632.

Murray, S., Ma, X., & Mazur, J. (2009). Effects of peer coaching on teachers' collaborative interactions and students' mathematics achievement. *The journal of educational research, 102*(3), 203-212.

Olango, M. (2016). Mathematics anxiety factors as predictors of mathematics self-efficacy and achievement among freshmen science and engineering students. *African Educational Research Journal, 4*(3), 109-123.

Richardson, F. C., & Suinn, R. M. (1972). The mathematics rating scale; Psychometric data. *Journal of Counseling Psychology,, 19*(6), 551-554. doi:doi:10.1037/h0033456

Satici, S. A., & Can, G. (2016). Investigating academic self-efficacy of university students in terms of socio-demographic variables. *Universal Journal of Educational Research, 4*(8), 1874-1880.

Schwarzer, R., & Warner, L. M. (2013). Perceived self-efficacy and its relationship to resilience. In *Resilience in children, adolescents, and adults* (pp. 139-150): Springer.

Shkullaku, R. (2013). The relationship between self-efficacy and academic performance in the context of gender among Albanian students. *European Academic Research, 1*(4), 467-478.

Squires, G., & Farrell, P. (2006). Educational psychology in England and Wales. *The handbook of international school psychology*, 81-90.

Suinn, R. M., & Winston, E. H. (2003). The mathematics anxiety rating scale, a brief version: Psychometric data. 92(1), 167–173. *Psychological Reports,, 9*(21), 167-173. doi: doi.org/10.2466/pr0.2003.92.1.167

5.3 Chapter Summary

This study was the first cross-cultural comparative study in the paramedicine discipline to determine differences in maths anxiety and maths self-efficacy levels for paramedic students with different cultural backgrounds. Our research found that Jordanian paramedic students have higher maths anxiety levels and lower self-efficacy levels compared to Australian students. Maths self-efficacy level and the paramedicine study location (cultural background) were the contributing factors to maths anxiety. This study highlighted the importance of conducting further research on the association between maths anxiety, self-efficacy, numerical ability, and drug dose calculation among paramedic students.

Chapter Six: Numerical ability, maths anxiety and drug calculation.

6.1 Introduction

This chapter involves the final core study of the thesis. The study presented in this chapter was guided by chapters Three, Four and Five and the aims of it were to explore the relationship between numerical ability, math anxiety, and drug calculation performance, and to explore the factors that contribute to drug calculation ability among paramedic students.

The study in this chapter utilised a sequential explanatory mixed-method approach that included a paper-based questionnaire assessing the MARS and MSES of the students followed by face-to-face interviews that were used to confirm the findings of applying the questionnaire. The results of this study are reported in the following manuscript which is submitted and pending minor changes in Advances in Medical Education and Practice, "Is numerical ability associated with mathematics anxiety and drug calculation ability among paramedic students? A mixed-method study".

6.2 The manuscript: Title: How Mathematics Anxiety Correlates to Numerical and Drug Calculation Ability of Paramedic Students? An Explanatory Mixed Method Study"

1. Eihab Khasawneh

Department of Paramedicine, Monash University, Victoria, Australia.

Faculty of Applied Medical Sciences, Jordan University of Science and Technology, Irbid, Jordan.

2. Dr Cameron McR Gosling

Department of Paramedicine, Monash University, Victoria, Australia.

3. Professor Brett Williams

Department of Paramedicine, Monash University, Victoria, Australia.

Corresponding author:

Eihab Khasawneh

47 – 49 Moorooduc Highway

Frankston VIC 3199

eihab.khasawneh@monash.edu

eakhasawneh1@just.edu.jo

+61 03 9904536

Abstract

Introduction

Numeracy is the ability to reason and to apply simple numerical concepts. Numerical and drug calculation skills are essential for patient safety. Health care providers who perform drug calculation in their work required good math skills, especially numerical ability. The aims of this study were to explore the relationship between numerical ability, math anxiety and drug calculation performance and to explore the factors that contribute to drug calculation ability among paramedic students

Methods

A sequential explanatory mixed-method approach that included a paper-based questionnaire followed by face-to-face interviews was used in this study. The participants completed a 30- minutes survey that is composed of demographics, the 10-item Mathematics Anxiety Rating Scale (MARS), a 12-question Numerical Ability Test (NAT) and a 9-question Drug Calculation Ability Test (DCAT) and then were invited for a structured interview.

Results

The mean MARS scores were higher for the second-year students than the third students. The NAT and DCAT scores for the third-year students were higher than the second-year students. There was a significant difference in the mean drug calculation ability test scores (DCAT) ($t (106) = 2.13$, $p = .035$ and Cohen's $d = .43$ between males (5.05 (2.32)) and females (4.03 (2.43)). Math education prior joining the university (beta = .862, $p = .030$) made the strongest unique contribution when controlling for the other variables followed by numerical ability (beta =0.25, $p <.001$). The themes that emerged from the interviews included the impact of technology, classmates' impact, mathematics competence and the mental block.

Conclusion

Drug calculation is fundamental in paramedic practice. It is affected by the numerical ability of the students and is negatively and indirectly impacted by mathematics anxiety. Modifications of a paramedic program curriculum can improve student's ability to think critically and to overcome medication dosage problems.

Keywords: Drug dosage calculation, Allied health personnel, Paramedics, Anxiety, Gender.

Introduction

Numeracy is the ability to reason and to apply simple numerical concepts,[1] such as addition, subtraction, multiplication, and division. As the new technology means such as computers, calculators and, mobile applications increasingly took over computational skills, the focus of numeracy education shifted. [2] In Victoria, Australia and according to the Department of Education (2009), Numeracy is not the same as mathematics, nor is it an alternative to mathematics. Instead, it is an equal and supporting partner in helping students learn to cope with the quantitative demands of modern society. Whereas mathematics is a well-established discipline, Numeracy is necessarily interdisciplinary .[3]

Numeracy-related tasks are common in healthcare and include understanding nutrition information, interpreting blood sugar readings and other clinical data, adjusting medications and dose calculations, and understanding probability in risk communication .[4] Numeracy may affect or impact career decisions and risk perception towards health decisions.[5]

Numerical and drug calculation skills are important for patient safety.[6] Health care providers, including pharmacists, physicians, nurses and paramedics, who perform drug calculation in their work, required excellent math skills, especially numerical ability.[7] The nursing profession has undertaken most of the available literature that has studied the importance of numerical ability in drug calculation performance. For example, according to McMullan et al[7] the numerical ability was the main predictor of drug calculation ability of a cohort of British nursing students. Dilles et al[8] found that nursing students' pharmacological knowledge and calculation skills were limited. In another study, which was conducted at two nursing schools in two different Turkish cities, numerical and drug calculation tests were given to senior-year nursing students. The researchers found that nursing students had poor mathematical and drug dose calculation skills.[6] Poor math performance can be due to many factors, such as mathematics anxiety, which frequently interferes with mathematical cognition abilities. [7]

Mathematics anxiety is defined as "negative affective responses to mathematics that are generally feelings of tension or fear that interfere with mathematics performance".[9] Mathematics anxiety interferes with student cognition; when students with mathematics anxiety perform calculations; the risk of error is much higher than in students without mathematics anxiety. Additionally, students with mathematics anxiety tend to intentionally avoid mathematics courses and anything related to mathematics. [2,3] Causes of mathematics anxiety are usually can be classified as environmental, personal or cognitive.[10] Environmental causes are related to mathematics classes or mathematics teachers. Personal reasons include low self-esteem, lack of confidence and the influence of previous negative experiences. Cognitive causes involve innate characteristics, being either low intelligence or simply poor cognitive abilities in mathematics. [10]

Drug administration and calculation are vital in paramedic practice. Paramedics perform these skills in a very stressful uncontrolled environment. [11] Drug calculation requires good mathematical skills and numerical ability skills which may be affected by the anxiety that is resulted from treating patients in the out-of-hospital setting. Despite the importance, few studies have addressed paramedic drug dose calculation abilities with no research examining the association between numerical ability, mathematics anxiety and drug calculation ability.[12-14] Therefore, the aim of this study was to explore the relationship between numerical ability, mathematics anxiety and drug calculation performance of paramedic students and to explore the factors that contribute to paramedic students drug calculation ability.

Methodology

Design

This study utilized a sequential explanatory mixed-method approach that included a paper-based questionnaire followed by face-to-face interviews.

Participants

Second and third-year Bachelor of Paramedicine students studying at an Australian University were recruited during the tenth week of semester one, 2019. The participants completed an anonymous paper-based questionnaire during the last 30 minutes of one of their classes. Participation in the study was voluntary, and the submission of the completed questionnaire implied consent for the quantitative part of this study. Ethics approval was obtained from the Monash University Human Research Ethics Committee (MUHREC) project# 17970. Students were not informed of the study prior recruitment to avoid any studying or preparation for the study. All participants were told about the purpose of the study and were invited to participate in a 30-minute face-to-face interview.

Phase 1: Questionnaires

Instrumentation

The questionnaire comprised of four parts: participant demographics, Mathematics Anxiety Rating Scale (MARS),[15] Drug Calculation Ability Test (DCAT) [14] and Numerical Ability Test (NAT) which was developed by the authors.

Demographics

Participant demographics collected information from individuals about their course year level, age, gender, the highest level of mathematics education and time between finishing their last mathematics education and enrolling in the paramedic program.

Mathematics Anxiety Rating Scale

There are many tools to assess mathematics anxiety, and a well-recognized one is the 98-item Mathematics Anxiety Rating Scale (MARS) developed by Richardson and Suinn.[17] Due to its length, many researchers have found it too onerous to use which has led to the development of many shorter scales.[18-20] Betz (1978) revised and created a tool to measure mathematics anxiety from the Mathematics Anxiety Rating Scale. The Betz questionnaire comprises ten items and has been found to have good internal reliability, with Betz reporting split-half reliability of 0.92, and other studies reporting Cronbach's alphas of 0.72 and 0.90.7

Numerical ability test

The numerical ability test (NAT) was developed by the authors and was composed of 12 questions. These questions addressed the concepts of addition, multiplication, division, unit conversion and decimal and percentage conversion. The final answer of each item was considered for marking: each correct answer was rewarded one point, and unanswered questions or incorrect responses were given zero points.

Drug calculation test

This test was adapted from Eastwood et al14 drug calculation study. It was composed of 9 questions covering the principal areas of medication dose calculations. Calculators were not allowed to be used during the test. The final answer of each item was considered for marking: each correct answer was rewarded one point, and unanswered questions were considered incorrect with zero points.

The questionnaire was sent for face and content validity checking by four instructors within our university paramedic program who went through the MARS item by item to check their suitability for the Australian context. Moreover, they answered completely the questions of the numerical ability test and drug calculation test to indicate the suitability of the two tests to the program students and whether the timeline for the test was enough or no. After the feedback, one question was added to the demographics, and some formatting issues were rectified.

Data analysis

Data were compiled for analysis using SPSS software version 26 IBM. Data were presented using descriptive statistics, including mean (standard deviations), median or frequency data where appropriate. The independent samples t-test and ANOVA were used to determine differences between groups where applicable. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity, and homoscedasticity. Parametric and non-parametric statistical tests were used where appropriate. The first five items of the MARS were recoded so that high MARS score indicates high mathematics anxiety. To identify factors that were predictive of drug calculation ability, a linear regression was used. Each predictive independent variable was analyzed using a univariate regression with the dependent variable. Variables that were significant at $p < 0.20$ were then entered a multivariate model. Significance was assigned at $p< 0.05$, and effect sizes were calculated.

Phase 2: Qualitative evaluation

The face-to-face interview guide was developed, piloted and revised to ensure clarity and limit biases before beginning data collection. Open-ended questions were used.

The primary researcher had a responsibility to ensure that the sample size was enough to achieve data saturation. EK conducted interviews after an explanatory statement being sent to the participants indicating the purpose of the study, the duration of the interview, and the anonymous study nature. The explanatory statement also indicated that this study was highly confidential, and no personal data will be disclosed at any time; before, during or after the study. An e-mail was sent to the participants with the

Informed Consent Form that included a description of the research study, research procedures, risks and benefits of participation in the study, participant rights, and protection of confidentiality. Each participant signed and dated the consent form and sent it back via email to the researcher.. Some of the interviews were conducted over the telephone, and all the interviews were audio-recorded and allowed to end naturally. A research assistant took notes during the interviews. All recordings were then transcribed verbatim and reviewed for accuracy by a third party before analyses.

EK coded all transcripts with a subset additionally coded by BW. Open coding was conducted throughout to allow for the identification of areas requiring additional data and/or new lines of inquiry. This initial coding was intended to remain open to many possibilities that could be discerned in the data and to avoid any conceptual leaps as we moved through the analytical work. The interviews were analyzed using a thematic analysis approach. First, all transcripts were read through several times to gain a sense of the whole. The text was then reread and divided into meaning units, each representing a single unit of content. [21]

Results

Phase 1: Questionnaires

The surveys were completed and returned by 108 (44%) of sampled students. The demographic profiles of the consenting participants are reported in Table 1.

Mathematics anxiety rating scale, numerical ability test and drug calculation ability test scores different year levels, gender, age group and mathematics education level are shown in Table 2. The mean MARS scores are higher for second-year students(M=29.4(9.6)) than the third-year students(M=26.8(9.9)). The NAT and DCAT scores for the third-year students are higher than the second-year students.

Mathematics Anxiety Rating Scale (MARS)

The mean score was 28.1 (SD=9.8), indicating a moderate level of mathematics anxiety. There were no significant differences in the mean MARS scores between genders $t(106) = -1.19$, $p = .237$, year level $t(106) = 1.31$, $p = .191$ age-group $F(105,2) = .321$, $p = .726$, mathematics education level and students who joined the paramedic program immediately after finishing high school or those who did not.

Drug Calculation Ability Test

The DCAT scores are shown in Figure 1. The lowest score was zero which was scored by 5.5 % of the participants. The mean score was 4.4 (SD= 2.4) which is very low. There was a significant difference in the mean drug calculation ability test scores (DCAT) (t (106) = 2.13, p = .035 and Cohen's d = .43 between males (5.05 (2.32)) and females (4.03 (2.43)). There were no significant differences in the year level DCAT scores (t (106) = -.813, p = .418). Comparison of DCAT data between age groups showed a non- significant difference (F (2) = 1.63., p = .20. There was no significant difference in DCAT scores between the student's mathematics education levels of the paramedic students (F (3) = 1.905, p = .133). There was no significant difference in DCAT scores between students who joined the paramedic program immediately or those who did not.

Numerical Ability Test

The numerical ability test scores are shown in Figure 2. Twenty-one present of the participants scored zero while only seven present scored twelve out of twelve. The mean score was 6.3(SD = 4.2), which is very low. There was no significant difference in the mean numerical ability (NAT) (t (105) = -1.139, p = .257 between males and females. The year level showed no significant difference in the NAT scores (t (105) = .640, p = .524. Comparison of NAT data between age groups showed a non-significant difference (F (2) = .187, p = .083. There was no significant difference in NAT scores between the student's mathematics education levels of the paramedic students. There was no significant difference in NAT scores between students who joined the paramedic program immediately after finishing high school or those who did not.

Predicting drug calculation ability

The linearity and correlation between dependent and independent variables were checked before performing the regression Table 3. Backward method of entry was used and results of the multiple regression, which included as independent variables year level, gender, age, mathematics education, time to enter the paramedic program, numerical ability score and mathematics anxiety level indicated a good fit (R2 = 24.50 %) and the overall relationship was significant (F [5,101] = 7.865, p < .001). Mathematics education prior joining the university (beta = .862, p = .030) made the strongest contribution, when controlling for the other variables, followed by numerical ability (beta =0.25, $p < .001$). Gender, age group, mathematics anxiety and time to enter the paramedic program were not-significant.

Phase 2: Qualitative evaluation

The results of the qualitative phase were based on interviews of eleven students from the second year (N=6) and the third year (N=5). Females comprised 80% of the participants. Seven students were interviewed on campus through face-to-face approach, and four students were interviewed through phone interviews. Most interview questions were asked precisely as they were written. However, the researcher often followed up with questions such as, "Why?" and "Can you tell me more?" to get a deeper meaning and richer understanding of the participant's experiences. The themes emerged from the interviews that were related to mathematics anxiety, numerical ability, and drug calculation ability of the paramedic students included the impact of technology, classmates' impact, mathematical competence and mental block.

Technology impact

In the last few years technology start to affect all the disciplines and sectors. Health care providers are using applications and calculators during their works to facilitate the services that they are providing. Paramedics are one of the health care providers who are using the new technology in drug dose calculation. Students depend a lot in technology in solving the mathematics problems; student I (4) stated: "Yeah, I think we rely too much. Well I rely too much on my phone for adding stuff up". Another student argued that technology had a very positive effect in practice; I (3) stated

I think it's positively. I think technology is definitely a very useful tool, and I actually love this development of the CPG app, because when you have a critical patient, obviously I'm not on-road yet, but on placements and things like that, you have a critical patient, you don't have the time to sit there with your piece of paper and work out the whole run-through of 'what dose do I need to give this patient, what's their weight?' …. It's so much more beneficial now to just go 'can you please quickly look up what dose I need to give this patient?' So, 100% it's such a positive impact on this profession, but at the same time we need to be able to look at it and know if it seems right or seems off.

On the other hand, some students argued that technology impacts their ability to do the calculation in a negative way; I (6) stated "I feel just that we've lost the ability to do calculations and stuff like that, because we have a phone. We've kind of gotten lazy, I guess".

Using technology in a proper way is important in paramedic practice, especially in dose calculations, I (3) stated:

At the end of the day, I understand that yes, we have an app now which does it for us, but at the same time we also need to be able to (in our heads) know 'yep, I agree, this is the right dose'. You could put an age in wrong, by accident, in the app and then that's just mucked up the whole calculation. So if you can, in your head, go 'okay, so you know this patient's a newborn, they should be 3.5kg, that should only be 350' and then you look at it and go 'wait, this is trying to tell me 500, that doesn't sound right'. You shouldn't just be, obviously, relying 100% on technology.

Classmates impact

Dose calculation is one of the skills that paramedic students and practicing paramedics use in their practice widely. Paramedic students do some scenarios that involve dose calculation. These scenarios in most of the time are performed in groups where the students should do some calculations in front of their classmates. Some students do not like to do calculations mistakes in front of their classmates; I (8) stated:

I would do a lot of practice with a friend who has got a good mathematics brain and he always just knew it and got it and I just could not. So yeah, I was sort of a bit discouraged that he was so good at it and could just see it and was getting good marks.

Other students argued that doing the calculation in a group is a better way of overcoming the anxiety of dealing with numbers and doses calculations; I (5) stated "I like to do it in a group particularly. Yeah, a group is good. And that's what real life is like". I (1) stated "I think in front of my friends and my peers, I'd be okay. I think more in like an exam where somebody's asking me upfront to do it, but I can go into classrooms or in front of friends I'd be okay".

Mathematical competence

Mathematical competence is very essential in paramedic practice. It can improve the ability to solve a range of mathematical problems in everyday situations. Students suggested certain methods to get mathematical competence; I (10) stated:

So, I'm always underlining things, circling things, trying to ignore the irrelevant information and just focus on the bits that are necessary… I think just not applying yourself in the beginning. So, if you don't start simple, if you don't start with the easy ones and understand them, you're just going to throw yourself off as it gets harder. So, sometimes it's just a case of going back to the beginning and making sure that you're really comfortable with the first step and then you can start looking at the second step, because if you just try and wing it then you're already going to panic.

Consistency and practice can enrich mathematical competence acquiring and maintaining; I (4) stated "When we were doing it every week it was okay, but then now because it's been quite a while since I've had to, I might be a bit slower than what I normally am". I (9) stated that

Well I know a lot of people find mathematics not fun and they don't want to do it and they worry about it being hard, and I know that a lot of people did worry about that for the pharmacology subject that we did, but like I said, the mathematics that we're doing in this unit is very simple, I could say. So yeah, I think people worry, especially if they haven't done it in a long time, so I feel like mathematics is something that you need to do all the time, even if it's just a simple unit each year. So yeah, I think probably it would help if people constantly did mathematics and then they wouldn't feel so nervous.

Joining university directly after finishing high school made the mathematical competence maintenance easier; I (11) stated

I think it has to do with how frequently you're doing, if you look at mature age students that haven't done mathematics at high school for a long time and have little numerical ability, they really struggle with the drug calculations test. Then you look at the students that have just come out of year 12 and straight into uni, they have less anxiety because they've done a lot of these things prior to the course.

Mental block

Mental block prevents the person from performing mentally related actions. I (11) stated

I think it's a mental block. I think when your mind says you can't do something and if I'm under pressure, I think that's when I really struggle…Things that I've done in those subjects really help if I'm familiar with something. I find that I am more confident with it. If I've seen it before, I really do well. But when there's something that takes me aback or I haven't seen before I think that really is a bit of mental block for me as well.

I (10) stated that

I think because if you expect it to be hard, you overthink it and you can over complicate it and so it's important to make it simple for, like to try and simplify it because the harder it looks, the harder it's – not the harder it's going to be, but your brain is going to panic and when you get flustered it's going to get harder. So yeah, it's about keeping it as simply as you can.

Merging the qualitative and the qualitative results of this study indicated that the MARS, NAT and DCAT scores for the students are low. The participants indicated that improper use of the technology in the drug calculation tasks, the negative impact of the classmates', the lack of mathematical competency and the mental block that is caused by mathematics anxiety were the main contributing factors to these low scores. Moreover, participants indicated that mathematics anxiety, which was reported to be high in this study, is an issue that negatively impacted their drug calculation performances and numerical abilities.

Discussion

To our knowledge, this study was the first study in the paramedicine discipline to explore the relationship between numerical ability, mathematics anxiety and drug calculation abilities of paramedic students and to explore the factors that contribute to paramedic students drug calculation ability at paramedicine program in one Australian university. The findings of this study will improve knowledge and understanding through the description of the factors associated with drug calculation performance for paramedic students. This will lead to better pre-hospital care with improved outcomes and reduction in medication errors, especially the drug dose calculation related errors. Our study found that the mathematics anxiety level, numerical ability and drug calculation ability levels are not significantly different between year level, age group, mathematics education type and the time before joining the paramedicine program. We also found that students' previous mathematics education and numerical ability were the predicting factors of the students' drug calculation ability.

Our study also found that the mean drug calculation ability test general score was low (4.4 out of 9), which agreed with Jukes and Gilchrist study in (2006)[24] where they investigated the ability of British second-year nursing students to perform a 10-question math drug calculations test. They reported that the mean score was 5.5 out of 10. While three students in our study achieved the perfect drug calculation ability score, none of the students achieved a perfect score, and only three were able to earn 9 out of 10 points in Jukes and Gilchrist study. While gender did not affect the mathematics anxiety level and numerical ability level in our study, females' drug calculation ability scores were significantly lower than the males' scores. This finding disagreed with Guneş, Baran [21] who found that the dose calculation skills in Turkish nursing students did not differ according to gender ($t=0.25$, $df=126$, $p=0.79$).[21]

Our study found that numerical ability was one of the factors that contributed to the low drug calculation ability scores. We found that the mean numerical ability test scores were low (6.3/12), which agreed with Brown [22] and McMullan et al[7] in the nursing discipline. Many factors may contribute to this numerical ability low score; one of these factors that we found in our study was the use of technology in the paramedic practice. For example, using the calculators and other technology applications that are available in the mobiles made the students rely on them without using the mind and the manual calculations. Our finding was supported by Özyazıcıoğlu et al[23], who reported that the use of calculators by students and practicing nurses is known to significantly reduce calculation errors. [23] However, the use of calculators can increase conceptual errors due to providing a false security sense.[7]

Our findings demonstrated a significant positive relationship between participants' numerical and drug calculation ability levels (r= .44, p<.001) that agreed with McMullan et al[7] finding in Nursing students in 2012 (r= .58). This result, together with the regression analysis result indicated that numerical ability and previous mathematics education to be the main direct predictors of the students' drug calculation ability. Our findings demonstrated that both the numerical and drug calculation abilities of the participants were low. The reasons for this could include dependence on calculators and different previous mathematical education. Our finding was supported by McMullan et al[7] study in (2010), who reported that calculators and inadequate mathematical education were reasons for the poor numerical and drug calculation abilities. Moreover, the lack of consistency and practice contributed to the numerical ability and drug calculation abilities of the paramedic students. Mathematical tasks practice can improve mathematics competencies by stimulating some areas in the brain that controls the numerical ability and drug calculation ability. [22]

Another factor that we found to affect students' numerical ability was mathematics anxiety. We found that there is a significant medium negative correlation between mathematics anxiety and numerical ability (r=-.305, p<.001) which agreed with McMullan et al[7] who found that mathematics anxiety and numerical ability are negatively correlated (r= -.39, p< .001. This means that mathematics anxiety indirectly impacting the drug calculation ability test. In our study, the participants were not allowed to use the calculators and drug dose calculation formulae. Doing so increased the students' mental block that prevented the person from performing mentally related tasks such as drug calculation tests. [25] Causes of mathematics anxiety vary, but educators agreed that mathematics anxiety primarily stems from student fears of failing and feelings of inadequacy. [26]

Our study indicated that paramedic students have poor mathematical and drug dose calculation skills, which suggests a need to change the educational strategies used in paramedic medication-related curricula. The main aim should focus on improving the mathematical competence of paramedic students. One suggestion from the study interviews was to get refreshing calculation short review at the beginning of the first semester of the third year of the paramedic study. Medication errors are one of the leading medical cause of patient mortality. Consequently, accurate medication dosage calculation and administration should be a primary focus of paramedic education curricula.

Limitation and future research

Our study has certain limitations. Firstly, the response rate was low. Not allowing the students to use calculators might cause this low response rate. Secondly, the study was conducted at only one paramedic school. Therefore, the conclusions can only be applied to the students at this school only. Thirdly, the data were self-reported which has many disadvantages such as: subjects may be less truthful, the participants may not be able to assess themselves accurately, and the wording of the questions may be confusing or have different meanings to different subjects.

Future research should be conducted on other paramedic schools inside Australia and internationally and on practicing paramedics focusing on learning and practicing numerical skills in many paramedic schools. Moreover, teaching packages should be utilized to improve drug calculation abilities of paramedic students. Drug calculation abilities should be addressed in drug and pharmacology course in paramedic schools.

Conclusion

Drug calculation is very important in paramedic practice and is impacted by numerical ability and mathematics education. Mathematics anxiety indirectly impacted students' drug calculation abilities by being negatively correlated to numerical ability of the students. Consequently, accurate drug dose calculation and administration should be a primary focus of paramedic education curricula. modifications of a paramedic program curriculum can improve student's ability to solve medication dosage problems. Paramedic students must be taught mathematical calculation skills for medication administration more often in the curriculum to maintain mathematical competencies that are essential for reducing mathematics anxiety and improving numerical ability that ultimately leads to improving drug calculation ability of the students.

References

1. Brooks MP. Are individual differences in Numeracy unique from general mental ability? A closer look at a common measure of Numeracy. Individ Differ Res. 2010;4(8): 257–265.

2. Kus M. Numeracy. Brock Education J Educ ResPract. 2018;27(2).

3. Smith LM. Numeracy Across the Middle School Curriculum. Culminating Experience Action Research Projects, Volume 15, Part 2, Fall 2009. 2015:48.

4. Rothman RL, Montori VM, Cherrington A, Pignone MP. Perspective: the role of Numeracy in health care. J Health Commun. 2008;13(6):583-595.

5. Reyna VF, Nelson WL, Han PK, Dieckmann NF. How numeracy influences risk comprehension and medical decision making". Psychol Bull. 2009;135(6):943-973.

6. Yılmaz D, Baran L, Guneş U. Mathematical and Drug Calculation Skills of Nursing Students. Int. J. Caring Sci 2016;9(1).

7. McMullan M, Jones R, Lea S. Math anxiety, self-efficacy, and ability in British undergraduate nursing students. Res Nurs Health. 2012;35(2):178-186.

8. Dilles T, Vander Stichele R, Van Bortel L, Elseviers M. Nursing students' pharmacological knowledge and calculation skills. Nurse Educ Today. 2011;31:499-505.

9. Ashcraft MH. Math Anxiety: Personal, Educational, and Cognitive Consequences. Curr Dir Psychol Sci. 2002;11(5).

10. Aarnos E, Perkkilä P. Early signs of mathematics anxiety? Procedia Soc Behav Sci 2012;46:1495 – 1499.

11. Eastwood, Boyle M, Williams B. Paramedics' Ability to Perform Drug Calculations. West J Emerg Med. 2009;10(4).

12. LeBlanc VR, MacDonald RD, McArthur B, King K, Lepine T. Paramedic performance in calculating drug dosages following stressful scenarios in a human patient simulator. Prehos Emerg Car. 2005 1;9(4):439-44.

13. Bernius M, Thibodeau B, Jones A, Clothier B, Witting M. Prevention of pediatric drug calculation errors by pre-hospital care providers. Prehos Emerg Car. 2008 1;12(4):486-94.

14. Eastwood, Boyle MJ, Williams B. Undergraduate paramedic students cannot do drug calculations. World J Emerg Med. 2012;3(3).

15. Betz NE, Hackett G. J Vocat Behav. 1983;23(null):329.

16. Richardson FC, Suinn RM. The mathematics rating scale; Psychometric data. J Couns Psychol. 1972;19(6):551-554.

17. Alexander L, Martray CR. The development of an abbreviated version of the Mathematics Anxiety Rating Scale. Meas Eval Couns Dev. 1989;22(3):143-150.

18. Hopko DR, McNeil DW, Lejuez CW, Ashcraft MH, Eifert GH, Riel J. The effects of anxious responding on mental arithmetic and lexical decision task performance. J Anxiety Disord. 2003;17(6):647-665.

19. Suinn RM, Winston EH. The Mathematics Anxiety Rating Scale, a Brief Version: Psychometric Data. 92(1), 167–173. Psychol Rep,. 2003;9(21):167-173.

20. Driscoll DL, Appiah-Yeboah A, Salib P, Rupert DJ. Merging qualitative and quantitative data in mixed methods research: How to and why not. 2007.

21. Guneş UY, Baran L. Mathematical and drug calculation skills of nursing students in Turkey. Int. J. Caring Sci. 2016;9(1):220.

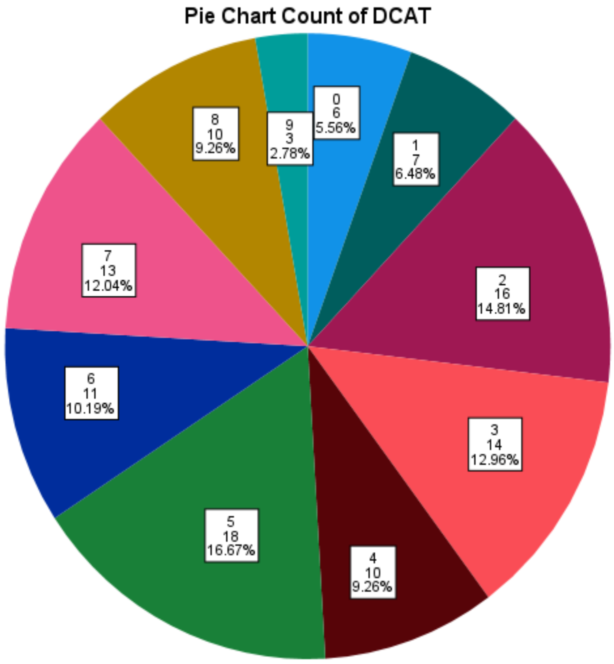
22. Brown DL. Does 1+ 1 still equal 2?: a study of the mathematic competencies of associate degree nursing students. Nurse Educ. 2002;27(3):132-135.

23. Özyazıcıoğlu N, Aydın Aİ, Sürenler S, et al. Evaluation of students' knowledge about paediatric dosage calculations. Nurse Educ Pract. 2018;28:34-39.

24. Jukes L, Gilchrist M. Concerns about numeracy skills of nursing students. Nurse Educ Pract. 2006 1;6(4):192-8.

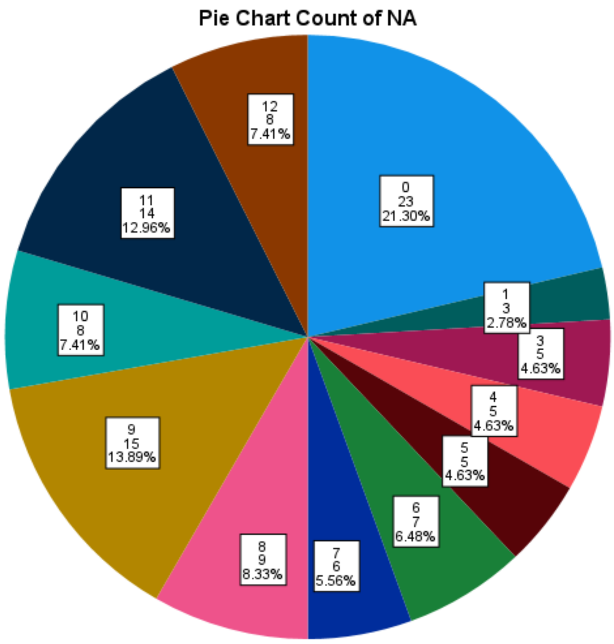
25. Hartwright CE, Looi CY, Sella F, et al. The Neurocognitive Architecture of Individual Differences in Math Anxiety in Typical Children. Sci Rep. 2018;8(1):8500.

26. Perry AB. Decreasing Math Anxiety in College Students. J Coll Stud. 2004;38(2):4-321.



[redacted]

Figure 1 Drug Calculation Ability Test Scores, Counts and Percentages



[redacted]

Figure 2 Numerical Ability Scores, Counts and Percentages

Table 1 Second year and Third-year students' demographics

	Year Level	2nd Year	3rd Year	Total (%)
	N (%)	56 (51.9%)	52 (48.1%)	108 (100%)
Gender: n (%)	Male	25 (44.6%)	14 (26.9%)	39 (36.1%)
	Female	31 (55.4%)	38 (73.1%)	69 (63.9%)
Age group: n (%)	≤19	21 (37.5%)	0	21 (19.4%)
	20-24	31(55.3%)	48 (92.3%)	78 (72.2%)
	≥25	4 (7.1%)	4 (7.7%)	8 (8.4%)

Table 2 MARS, NAT and DCAT Scores

		MARS: mean (SD)	NAT: mean (SD)	DCAT: mean (SD)
Year level	2nd Year	29.4 (9.6)	5.8 (4.2)	4.2 (6.3)
	3rd Year	26.8 (9.9)	6.6 (4.3)	4.6 (2.4)
Age group	≤19	28.7 (9.6)	6.7(3.9)	4.4(2.7)
	20-24	28.1 (9.6)	6.1(3.3)	4.3(2.4)
	≥25	25.5 (12.1)	6.6 (4.2)	5.9 (1.6)
Gender	Male	26.6(9.5)	6.5(4.4)	5.1(2.3)
	Female	28.9(9.9)	6.1(4.1)	4.0(2.4)
Mathematics education level	Tertiary level mathematics	31.5(24.7)	5.5(7.8)	4.0(2.8)
	VCE	27.9(9.6)	6.1(4.2)	4.2(2.4)
	HSC	30.1(8.3)	6.9(3.6)	6.1(2.1)

Table 3 The correlation between Mathematics anxiety, DCAT and NA scores

		Mathematics anxiety	DCAT	NA
Mathematics anxiety	Pearson Correlation	1	-0.291**	-0.305**
	Sig. (2-tailed)		0.002	0.001
	N	108	108	107
DCAT	Pearson Correlation	-0.291**	1	0.439**
	Sig. (2-tailed)	0.002		0.000
	N	108	108	107
NA	Pearson Correlation	-0.305**	0.439**	1
	Sig. (2-tailed)	0.001	0.000	
	N	107	107	107
**. Correlation is significant at the 0.01 level (2-tailed).				

6.3 Chapter Summary

This chapter reported that the ability to perform accurate drug calculations is particularly important in paramedic practice. The results of the study presented here indicate that maths anxiety levels, numerical ability, and drug calculation ability, were not significantly different between year level, age group, mathematics education type, and the time before joining the paramedicine program. We also found that students' previous mathematics education and numerical ability were the predicting factors of the students' drug calculation ability.

Student drug calculation ability is affected by their numerical ability and is indirectly negatively impacted by maths anxiety. This chapter highlighted future steps and research should adapt evidence-based modifications to the paramedic program curriculum to improve student's ability to think critically and to conceptualise medication dosage problems. This chapter suggested that paramedic students must be taught mathematical calculation skills for medication administration more often in the curriculum to maintain mathematical competencies. These competencies are essential for reducing maths anxiety and improving numerical ability that ultimately leads to improving drug calculation ability of the students.

Chapter Seven: Conclusion

7.1 Introduction

To the best of our knowledge, this thesis is the first to address maths anxiety and its contributing factors and impact on drug calculation errors in the paramedic discipline. The primary aim of this thesis was explored sequentially through five objectives and five linked publications that are all under review. The publications provide crucial evidence answering the primary research aim. The studies of this thesis indicated that maths anxiety, which is negatively affected by maths self-efficacy, impacted the drug calculation performance of the paramedic students.

7.2 Key findings in relation to the thesis objectives

7.2.1 **Determine the type, rate and nature of reported medication errors in a health care setting in Victoria, Australia, in the past ten years.**

This objective is addressed in Chapter Two of this thesis utilising a retrospective cohort study using the Victorian Admitted Episodes Dataset (VAED) to evaluate adverse drug events, accidental poisoning and undetermined intent types of medication error that occurred in private and public hospitals in Victoria, Australia. Chapter Two indicated that medication errors in the last ten years occurred in approximately 1% of all hospital separations. One type of accidental poisoning, drug dose errors, has previously been reported as accounting for more than 31% of all medication error types. (38) Most of the studies in the literature focus on reporting medication error rates, health system-related causes and patient-related causes of the medication errors in hospital settings. A Kuwait study examining medication errors in hospitals found that a total of 44.6% of respondents confirmed that they had encountered potential medication errors.

(38) According to this Kuwait study, the main common types of medication errors include making wrong dispensations, prescriptions, dosage, explanation/descriptions, diagnosis, and drug formulation. Also, limited tools to assist clinicians in checking drug-drug interactions, especially in polypharmacy prescriptions, resulted in high medication errors. (38) Another study found that the most common types of reported errors were wrong dosage and infusion rates, and the most common causes were using abbreviations instead of full names of drugs and similar names of drugs. (39) They also found that the most important cause of medication errors was the lack of pharmacological knowledge. Chapter Two also indicated that factors that might contribute to adverse drug events could be classified into the patient, system and health care provider factors. Chapter Two also suggested that health care providers contributing factors can be investigated and controlled in comparison to the patient-related and system-related factors.

7.2.2 Identify the facilitators and barriers of maths anxiety in university students.

This objective was addressed in Chapter Three of the thesis by searching the literature utilising scoping review approach. The findings indicated that maths anxiety is a universal issue across varied disciplines such as education, engineering, nursing, and psychology. The literature reported in the Chapter Three review identified that gender, self-efficacy and awareness, and numerical ability is all related to maths anxiety in university students which is consistent with the previous study by Jameson and Fusco. (7) Chapter Three indicated that the effect of gender on maths anxiety was controversial. For example, Haynes, Mullins (40) reported no significant differences in maths anxiety levels between male and female college students, and maths anxiety in females was most strongly affected by perceived maths ability, perceptions of college maths teachers' teaching ability, as well as general test anxiety. On the other hand, other studies reported that female college students experience significantly more maths anxiety than their male counterparts. (41,42)

7.2.3 **Study the effects of self-efficacy on maths anxiety on paramedic students.**

This objective was addressed in Chapter Four, through a cross-sectional study of a cohort of Paramedicine students at an Australian University. The outcomes from the application of the MARS and MSES questionnaires indicated that self-efficacy is negatively correlated with maths anxiety in paramedic students which is consistent with the findings of studies by Maloney, Ramirez (43) and Olango. (44) Maths self-efficacy appears to be associated with gender, age group, and year level. Chapter Four of this thesis also reported that females, who account for more than 65% of the enrolled students in the paramedic program at Monash University, have higher maths anxiety levels than their male counterparts. Maths self-efficacy was the significant predictor of maths anxiety in paramedic students in Australia which means that improving maths self-efficacy can reduce maths anxiety levels, leading to improvements in paramedic performance.

7.2.4 **Determine the difference in maths anxiety level as measured by Maths Anxiety Rating Scale (MARS) and maths self-efficacy levels as measured by Maths Self-Efficacy Scale (MSES) for paramedic students at two universities with different cultural backgrounds.**

This objective was addressed in Chapter Five by utilising a sequential explanatory research method in the cross-cultural study. Studying any issue cross-culturally involves the systematic comparisons of different cultures that aim to understand variations of human behaviour as it is influenced by cultural context. (45) This research approach is primarily concerned with examining how our knowledge about people and their behaviours from one culture may or may not hold for people from another culture. (45) The outcomes from applying the MARS and MSES questionnaire and the thematic analysis after interviewing students indicated that Jordanian students reported higher maths anxiety and lower self-efficacy levels than Australian students. Educational system differences and cultural background play integral parts in these differences. These findings agreed with a study by Eccius-Wellmann, Lara-Barragán (46) who compared the profiles of mathematical anxiety levels among Mexican students and German students. The researchers found that German students presented a higher level of mathematical anxiety than Mexican students; however, they did not find differences in gender. The differences in the values of maths anxiety can be understood in terms of cultural differences. (46)

7.2.5 Study the association between numerical ability and maths anxiety and drug calculation ability of paramedic students.

This objective was addressed in Chapter Six by utilising a sequential explanatory mixed-method design. The outcomes from applying the MARS, DCAT and NAT indicated that the numerical ability test scores and drug calculation ability test scores of the paramedic students were low. The results of the study presented in Chapter Six are consistent with those reported by McMullan, Jones. (47) In the McMullan study, the numeracy test was failed by 55% of nursing students and 45% of Registered Nurses, while 92% of students and 89% of nurses failed the drug calculation test. Moreover, Chapter Six results are similar to the study by Hubble, Paschal (48) who reported that medication calculation skills were found to be lacking among a group of practicing paramedics. Also, the paramedics reported infrequent opportunities to perform this skill in the clinical setting and that medication calculations were not a routine part of EMS continuing education programs. (48) Chapter Six also concludes that maths anxiety is indirectly impacting numerical ability which in turn leads to low drug calculation ability of paramedic students. It is recommended that paramedic students should continue to practise and refresh different types of drug calculations as often as possible, with regular self-testing of their ability. Additional time should be set aside in curricula for paramedic students to learn how to perform basic numerical and drug calculations. The new generation of university paramedic students reported having concerns with calculations in clinical practice; however, the evidence is that when students are transitioned into an internship phase to link theory with practice, their clinical practice can improve. (49) The strength of university-educated paramedics lies in the flexibility of new graduates who are considered to have appropriate clinical skills, excellent theoretical knowledge, and employability competencies. (49) This learning should be reinforced through regular practice and assessment.

7.3 Thesis Strengths and limitations

The strengths and limitations of each study were discussed in their respective chapters. This section aims to describe some overarching strengths and limitations of the context and methodology of this body of work in the whole thesis.

A key strength of this series of studies was obtaining the data from different data sources; VAED, Monash University and Jordan University of Science and Technology. Collecting data from various sources allows researchers to utilise different research methodologies such as epidemiologic design, cross-sectional quantitative design, sequential explanatory mixed-method (quantitative-qualitative) design and cross-cultural study types.

Another strength of this thesis is that the work included in this thesis provides data for the first time about the impact of maths anxiety and its contributing factors on the ability of paramedic students to calculate drug doses correctly. Furthermore, the study in Chapter Five of this thesis was the first cross-cultural study to address maths anxiety in two countries with different cultural backgrounds. This suggests that maths anxiety is a common issue for the paramedic discipline internationally. Another strength of this thesis is the use of different standardised and psychometrically robust tools to assess maths anxiety, self-efficacy, drug calculation ability, and numerical ability levels.

One limitation is that the studies recruited paramedic students only, with no involvement from practicing paramedics. This was in part due to the nature of the thesis topic, which is considered sensitive by the service agency in the state of Victoria. Practicing paramedics faced more actual stressors in their work and are exposed more to anxiety during drug administration and dealing with patients. Also, the results are limited with potential responder bias, since some students who were not confident performing calculations or anxious about maths may not have wished to participate in the research.

Another limitation is the data obtained for the medication error study were from hospital data. Even though the hospital data can give an overall picture of the rate and nature of medication errors, obtaining data from a paramedic agency would provide a clearer picture.

7.4 Implications

- Pharmacology Curriculum modification could be adjusted to focus more learning opportunities on numerical ability and drug calculation tasks.
- Maths pre-entry or preparatory classes that are tailored to paramedic students can be developed and applied after changing the maths level requirements to join the paramedic program.
- Because self-efficacy negatively impacts maths anxiety, a training program or package can be developed to increase students' self-efficacy to reduce maths anxiety levels. This will help in improving numerical ability which will enhance drug calculation ability, leading to reduced calculation errors.
- For the maintenance of mathematical competences in drug dose calculation, scaffolding through the paramedic program should be applied and tested.

7.5 Recommendations for future research

Future research may benefit from the findings and the methodologies used in this thesis to design studies that investigate the impact of maths anxiety on medication errors in practicing paramedics and to compare the maths anxiety impact on paramedic student's performance at national and international levels. For example, the methods and designs that were used in this thesis can be utilised in other schools of paramedicine in Australia and other countries in the Middle East such as Saudi Arabia and the United Arab Emirates to have a clearer picture about this issue in countries with similar cultural backgrounds.

This body of work identifies the need for extensive prospective studies that examine how to improve students' self-efficacy and reduce maths anxiety levels. An interventional study that addresses the effect of reducing maths anxiety and improving maths self-efficacy on the drug calculation ability of paramedic students can be utilised. This can be achieved by using simulation scenarios by exposing participants to different levels of stressors that increase their anxiety and testing strategies to improve maths self-efficacy to help in developing interventions to overcome maths anxiety. Moreover, the rate and types of medication errors in paramedic agency can be explored and investigated.

7.6 Conclusion

The findings of this thesis revealed that maths anxiety, which is an issue that affects paramedic students, can impact the drug calculation ability of the paramedic students by being negatively correlated with maths self-efficacy and positively correlated with numerical ability. Moreover, the studies in this thesis indicated that gender, year level, and cultural background are all factors that are related to increasing levels of maths anxiety. The data presented in this thesis suggest that maths anxiety may be overcome by improving an individuals' self-efficacy level related to maths task performance. To control and reduce potential risk factors of medication errors in a paramedicine context, the following are recommended: having a systematic approach to recognising the effective causes of medication errors and trying to solve them; increasing of the knowledge of paramedic students about medication errors (both qualitative and quantitative) that result in improving student performance and the reduction of medication errors and holding periodic retraining and professional development for paramedics and students focusing on pharmacological knowledge and application.

Finally, workshops targeting a reduction in maths anxiety should be held in paramedic schools and agencies so that anxiety toward maths and its related factors can be addressed early.

References

1. Blazer C. Strategies for reducing math anxiety. Information Capsule. Volume 1102. Research Services, Miami-Dade County Public Schools. 2011.

2. Luttenberger S, Wimmer S, Paechter M. Spotlight on math anxiety. *Psychol. Res. Behav. Manag.* 2018;11:311-22.

3. Skagerlund K, Östergren R, Västfjäll D, Träff U. How does mathematics anxiety impair mathematical abilities? Investigating the link between math anxiety, working memory, and number processing. *PLoS One*. 2019;14(1).

4. Boh Podgornik B, Dolničar D, Šorgo A, Bartol T. Development, testing, and validation of an information literacy test (ILT) for higher education. *J. Assoc. Inf. Sci. Technol*. 2016;67(10):2420-36.

5. Aarnos E, Perkkilä P. Early signs of mathematics anxiety? *Procedia. Soc. Behav. Sci.* 2012;46:1495-9.

6. Ramirez G, Gunderson EA, Levine SC, Beilock SL. Math anxiety, working memory, and math achievement in early elementary school. *J. Cogn. Dev*. 2013;14(2):187-202.

7. Jameson MM, Fusco BR. Math anxiety, math self-concept, and math self-efficacy in adult learners compared to traditional undergraduate students. Adult education quarterly: *J. Resear.Theor.* 2014;64(4):306-22.

8. Johnston-Wilder S, Brindley J, Dent P. A survey of mathematics anxiety and mathematical resilience among existing apprentices. London: The Gatsby Foundation. 2014.

9. Casad BJ, Hale P, Wachs FL. Parent-child math anxiety and math-gender stereotypes predict adolescents' math education outcomes. *Front. Psychol*. 2015;6:1597.

10. Demanet J, Van Houtte M. Teachers' attitudes and students' opposition. School misconduct as a reaction to teachers' diminished effort and affect. *Teach.Teach.Educ*. 2012;28(6):860-9.

11. Scarpello G. Helping students get past math anxiety. Techniques: Connecting Education and Careers (J1). 2007;82(6):34-5.

12. Tella A. The impact of motivation on student's academic achievement and learning outcomes in mathematics among secondary school students in Nigeria. *Eurasia J. Math. Sci. Technol. Educ*. 2007;3(2):149-56.

13. Sherman BF, Wither DP. Mathematics anxiety and mathematics achievement. *Math. Educ. Res. J*. 2003;15(2):138-50.

14. Carey E, Hill F, Devine A, Szücs D. The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. *Front. Psychol*. 2016;6:1987.

15. Bandura A. The explanatory and predictive scope of self-efficacy theory. *J. Soc. Clin Psychol*. 1986 Sep;4(3):359-73.

16. Bandura, Freeman W, Lightsey R. Self-efficacy: The exercise of control. Springer; 1999.

17. Azar FS, Mahmoudi L. Relationship between Mathematics, self-efficacy and students' performance in statistics: the meditational role of attitude toward Mathematics and Mathematics anxiety. *J. Educ. Scienc. Psychol*. 2014;4(1).

18. Yousef. Science teachers' attitudes towards using ICT and mobile learning technologies in Malaysian schools. *Europ. J. Interdisciplin. Stud*. 2015;1(3):187-96.

19. Hackett G, Betz NE. An exploration of the mathematics self-efficacy/mathematics performance correspondence. *J. Res. Math. Educ*. 1989:261-73.

20. Agüero Calvo E, Meza Cascante LG, Suárez Valdés-Ayala Z, Schmidt Quesada S. Mathematical anxiety in secondary education in CostaRica. *Rev. Electron. Investig. Educ.*2017;19(1):35-45.

21. Brooks ME, Pui SY. Are individual differences in numeracy unique from general mental ability? A closer look at a common measure of numeracy. *Individ. Differ. Res*. 2010.

22. Guneş UY, Baran L. Mathematical and drug calculation skills of nursing students in Turkey. *Int. J. Caring Sci*. 2016;9(1):220.

23. McMullan M, Jones R, Lea S. Math anxiety, self-efficacy, and ability in British undergraduate nursing students. *Res. Nurs. Health*. 2012;35(2):178-86.

24. Dilles T, Vander Stichele RR, Van Bortel L, Elseviers MM. Nursing students' pharmacological knowledge and calculation skills: ready for practice? *Nurse. Educ. Today*. 2011;31(5):499-505.

25. Bagnasco A, Galaverna L, Aleo G, Grugnetti AM, Rosa F, Sasso L. Mathematical calculation skills required for drug administration in undergraduate nursing students to ensure patient safety: A descriptive study: Drug calculation skills in nursing students. *Nurse. Educ. Pract*. 2016;16(1):33-9.

26. Eastwood, Boyle MJ, Williams B. Undergraduate paramedic students cannot do drug calculations. *World J. Emerg. Med*. 2012;3(3).

27. Hubble MW, Paschal KR, Sanders TA. Medication calculation skills of practicing paramedics. *Prehosp. Emerg. Care*. 2000;4(3):253-60.

28. Bernius M, Thibodeau B, Jones A, Clothier B, Witting M. Prevention of pediatric drug calculation errors by prehospital care providers. *Prehosp. Emerg. Care*. 2008;12(4):486-94.

29. LeBlanc VR, MacDonald RD, McArthur B, King K, Lepine T. Paramedic performance in calculating drug dosages following stressful scenarios in a human patient simulator. *Prehosp. Emerg. Care*. 2005;9(4):439-44.

30. Kaufmann J, Laschat M, Wappler F. Medication errors in pediatric emergencies: a systematic analysis. Deutsches Ärzteblatt International. 2012;109(38):609.

31. Carter H, Thompson J. Defining the paramedic process. *Aust. J. Prim. Health* 2015;21(1):22-6.

32. Paechter M, Macher D, Martskvishvili K, Wimmer S, Papousek I. Mathematics anxiety and Statistics anxiety. Shared but also unshared components and antagonistic contributions to performance in Statistics. *Front. Psychol*. 2017;8:1196.

33. Cheng C-H, Chou C-J, Wang P-C, Lin H-Y, Kao C-L, Su C-T. Applying HFMEA to prevent chemotherapy errors. *J. Med. Syst*. 2012;36(3):1543-51.

34. Havens DH, Boroughs L. "To err is human": a report from the institute of medicine. *J. Pediatr. Health. Care*. 2000;14(2):77-80.

35. Karthikeyan M, Balasubramanian T, Muhamed K, Muhamed S, Rashifa P. A systematic review on medication errors. *Int. J. Drug. Dev. Res*. 2015;7(4).

36. Elder N, Dovey S. Classification of medical errors and preventable adverse events in primary care: A synthesis of the literature. *J.Famil.Pract*. 2002;51(11):927-32.

37. Vilke GM, Tornabene SV, Stepanski B, Shipp HE, Ray LU, Metz MA, et al. Paramedic self-reported medication errors. *Prehosp. Emerg. Care*. 2007;11(1):80-4.

38. Ahmed Z, Saada M, Jones AM, Al-Hamid AM. Medical errors: Healthcare professionals' perspective at a tertiary hospital in Kuwait. PLoS One. 2019;14(5).

39. Cheragi MA, Manoocheri H, Mohammadnejad E, Ehsani SR. Types and causes of medication errors from nurse's viewpoint. *Iran. J. Nurs. Midwifery. Res*. 2013;18(3):228.

40. Haynes AF, Mullins AG, Stein BS. Differential models for math anxiety in male and female college students. *Sociol. Spectr*. 2004;24(3):295-318.

41. Khatoon T, Mahmood S. Mathematics anxiety among secondary school students in India and its relationship to achievement in mathematics. *Eur. J. Soc. Sci*. 2010;16(1):75-86.

42. Malinsky M, Ross A, Pannells T, McJunkin M. Math anxiety in pre-service elementary school teachers. *J.Educ*. 2006 Dec 22;127(2):274-80.

43. Maloney EA, Ramirez G, Gunderson EA, Levine SC, Beilock SL. Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychol. Sci*. 2015;26(9):1480-8.

44. Olango M. Mathematics anxiety factors as predictors of mathematics self-efficacy and achievement among freshmen science and engineering students. *Afr. Educ. Res. J.* 2016;4(3):10923.

45. Papayiannis S, Anastassiou-Hadjicharalambous X. Cross-Cultural Studies. In: Goldstein S, Naglieri JA, editors. Encyclopedia of Child Behavior and Development. Boston, MA: Springer US; 2011. 438-40.

46. Eccius-Wellmann C, Lara-Barragán A, Martschink B, Freitag S. Comparison of mathematical anxiety profiles between Mexican students and German students. *Iberoam. J. High.Edu.* 2017;8(23):69-83.

47. McMullan M, Jones R, Lea S. Patient safety: Numerical skills and drug calculation abilities of nursing students and registered nurses. J. *Adv. Nurs*. 2010;66(4):891-9.

48. Hubble, Paschal, Sanders. Medication calculation skills of practicing paramedics. *Prehosp Emerg. Care*. 2000;4:253-60.

49. AlShammari T, Jennings PA, Williams B. Emergency medical services core competencies: a scoping review. *Health. Prof. Educ*. 2018;4(4):245-58.

Appendices

List of appendices.

1. Ethical committee approvals
2. Consent form
3. Explanatory statement (self-efficacy)
4. Explanatory statement (numerical ability)
5. Drug calculation and numerical ability test
6. Interview questions

Monash University Human Research Ethics Committee

Approval Certificate

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project ID:	21661
Project Title:	Does maths anxiety impact medication errors
Chief Investigator:	Professor Brett Williams
Approval Date:	16/09/2019
Expiry Date:	16/09/2024

Terms of approval - failure to comply with the terms below is in breach of your approval and the *Australian Code for the Responsible Conduct of Research*.

1. The Chief Investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.
2. Approval is only valid whilst you hold a position at Monash University.
3. It is responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash letterhead and the Monash University complaints clause must include your project number.
6. Amendments to approved projects including changes to personnel must not commence without written approval from MUHREC.
7. Annual Report - continued approval of this project is dependent on the submission of an Annual Report.
8. Final Report - should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected completion date.
9. Monitoring - project may be subject to an audit or any other form of monitoring by MUHREC at any time.
10. Retention and storage of data - The Chief Investigator is responsible for the storage and retention of the original data pertaining to the project for a minimum period of five years.

Kind Regards,

Professor Nip Thomson

Chair, MUHREC

CC: Mr Eihab Khasawneh, Dr Cameron Gosling

List of approved documents:

Monash University Human Research Ethics Committee

Approval Certificate

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project ID:	17970
Project Title:	Is numerical ability associated with maths anxiety and drug calculation success?
Chief Investigator:	Professor Brett Williams
Approval Date:	17/01/2019
Expiry Date:	17/01/2024

Terms of approval - failure to comply with the terms below is in breach of your approval and the *Australian Code for the Responsible Conduct of Research*.

1. The Chief Investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.
2. Approval is only valid whilst you hold a position at Monash University.
3. It is responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash letterhead and the Monash University complaints clause must include your project number.
6. Amendments to approved projects including changes to personnel must not commence without written approval from MUHREC.
7. Annual Report - continued approval of this project is dependent on the submission of an Annual Report.
8. Final Report - should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected completion date.
9. Monitoring - project may be subject to an audit or any other form of monitoring by MUHREC at any time.
10. Retention and storage of data - The Chief Investigator is responsible for the storage and retention of the original data pertaining to the project for a minimum period of five years.

Kind Regards,

Professor Nip Thomson

Chair, MUHREC

CC: Dr Cameron Gosling, Mr Eihab Khasawneh

List of approved documents:

Document Type	File Name	Date	Version
Supporting Documentation	interview questions	07/01/2019	1
Questionnaires / Surveys	Numerical abilty and Drug calculation ability questionaire	08/01/2019	1
Supporting Documentation	Website Advert Numerical Ability (V2)	17/01/2019	2 revised
Explanatory Statement	EXPLANATORY STATEMENT numerical ability (V2)	17/01/2019	2 revised
Consent Form	PROJECT CONSENT FORM V2	17/01/2019	2 revised

Monash University Human Research Ethics Committee

Exemption Letter

Project Number:	12100
Project Title:	Does maths anxiety impact on drug calculation errors?
Chief Investigator:	Professor Brett Williams
Start Date:	28/02/2018
Expiry Date:	28/02/2023

The above application has been reviewed by the Chairs of the Monash University Human Research Ethics Committee (MUHREC) who determined that the proposal satisfies section 5.1.22 of the *National Statement on Ethical Conduct in Human Research*.

Therefore, the Committee has granted an exemption from ethical review for the research as described in your proposal.

Thank you for your assistance.

Professor Nip Thomson

Chair, MUHREC

CC: Dr Cameron Gosling, Mr Eihab Khasawneh

Monash University Human Research Ethics Committee

Approval Certificate

This is to certify that the project below was considered by the Monash University Human Research Ethics Committee. The Committee was satisfied that the proposal meets the requirements of the *National Statement on Ethical Conduct in Human Research* and has granted approval.

Project ID:	17969
Project Title:	Can self-efficacy reduce students' maths anxiety?
Chief Investigator:	Professor Brett Williams
Approval Date:	14/01/2019
Expiry Date:	14/01/2024

Terms of approval - failure to comply with the terms below is in breach of your approval and the *Australian Code for the Responsible Conduct of Research*.

1. The Chief Investigator is responsible for ensuring that permission letters are obtained, if relevant, before any data collection can occur at the specified organisation.
2. Approval is only valid whilst you hold a position at Monash University.
3. It is responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval and to ensure the project is conducted as approved by MUHREC.
4. You should notify MUHREC immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.
5. The Explanatory Statement must be on Monash letterhead and the Monash University complaints clause must include your project number.
6. Amendments to approved projects including changes to personnel must not commence without written approval from MUHREC.
7. Annual Report - continued approval of this project is dependent on the submission of an Annual Report.
8. Final Report - should be provided at the conclusion of the project. MUHREC should be notified if the project is discontinued before the expected completion date.
9. Monitoring - project may be subject to an audit or any other form of monitoring by MUHREC at any time.
10. Retention and storage of data - The Chief Investigator is responsible for the storage and retention of the original data pertaining to the project for a minimum period of five years.

Kind Regards,

Professor Nip Thomson

Chair, MUHREC

CC: Dr Cameron Gosling, Mr Eihab Khasawneh

List of approved documents:

Document Type	File Name	Date	Version
Supporting Documentation	Website Advert self efficacy (1)	07/01/2019	1
Explanatory Statement	EXPLANATORY STATEMENT self efficacy (1)	07/01/2019	1
Questionnaires / Surveys	Questionaire 1	07/01/2019	1

جامعة العلوم والتكنولوجيا الأردنية
Jordan University of Science and Technology

مستشفى الملك المؤسس عبدالله الجامعي
King Abdullah University Hospital

لجنة أخلاقيات البحث على الإنسان
Institutional Review Board

Ref.: ....
Date: ....

الرقم: ٢٠١٩/١٢٧/٣٣ تاريخ ٢٠١٩/١٠/١٠م
التاريخ: .... هـ
الموافق: ...١٠.../...١٠.../...٢٠١٩.......... م

الأستاذ الدكتور عميد كلية العلوم الطبية التطبيقية المحترم
جامعة العلوم والتكنولوجيا الأردنية

تحية طيبة وبعد،،،

إشارةً الى البحث العلمي المُرسل إلكترونياً رقم (٢٠١٩/٥٨٩)، والمقدّم من الدكتور علاء عمر عطير، والسيد إيهاب خصاونة، بعنوان

A comparison between the Self-efficacy and Maths Anxiety levels among paramedic undergraduate students in Jordan and Australia: A cross-cultural study

يرجى العلم بموافقة لجنة أخلاقيات البحث على الإنسان على إجراء البحث العلمي المُشار إليه أعلاه، على أن يتم التقيّد بالشروط التالية:

١. الإلتزام بسياسة البحث العلمي في المستشفى (رقم السياسة GM7601).
٢. الحفاظ على سرية المعلومات وأن لا تستخدم الا لغايات البحث العلمي.
٣. يحتاج البحث الى استمارة إقرار بالموافقة على المشاركة في البحث.
٤. تُعتبر الموافقة ملغاة تلقائياً بعد مرور ثمانية أشهر من الحصول على موافقة لجنة البحث على الإنسان (IRB)، أوفي حال عدم تزويد اللجنة بنتائج البحث.

وتفضلوا بقبول فائق الاحترام،،،

رئيس لجنة البحث على الانسان

الأستاذ الدكتور يوسف القاعود

م.ر/ منسق لجنة البحث على الإنسان

Ref.: 33/127/2019, date 10.10.2019

Date: 10. 10. 2019

Dean of Faculty of Applied Medical Sciences

Jordan University of Science and Technology

In reference to the scientific research which is presented by Dr. Alaa Oteir, and Mr. Eihab Khasawneh, entitled:

A comparison between the Self-efficacy and Maths Anxiety levels among paramedic undergraduate students in Jordan and Australia: A cross-cultural study

We would like to inform you that the IRB Committee has granted the researcher the approval to conduct this proposal in the Jordanian Community for the purpose mentioned above, under the following conditions:

1. Committment to the Scientific Research Policy at Jordan University of Science and Technology and King Abdullah University Hospital.
2. Maintaining data confidentiality and using it only for scientific purposes.
3. Consent form is required.
4. This approval will be cancelled if the principal investigator doesn't provide IRB with the final report about the results of the research after eight months.

Regards,

Prof. Yousef Al-Gaud

Chairman of the Institutional Review

M.R/ Committee Coordinator

MONASH University

CONSENT FORM

(Paramedic student)

Project ID: 17970
Project title: Is numerical ability associated with maths anxiety and drug calculation success?

Investigator: Eihab Khasawneh

I have been asked to take part in the Monash University research project specified above. I have read and understood the Explanatory Statement and I hereby consent to participate in this project.

I consent to the following:	Yes	No
To be interviewed for 60 minutes after reading the explanatory statement	☐	☐
To audio recording during the interview	☐	☐
The data to be used in future research of the researchers	☐	☐

Name of Participant ______________________________

Participant Signature ______________________________ Date ______________

MONASH University

EXPLANATORY STATEMENT

Project ID: 17969

Project title: The effect of self-efficacy on paramedic students' maths anxiety.

Investigators

Professor Brett Williams

Phone: 99044283
email: brett.williams@monash.edu

Dr Cameron Gosling

Phone: 99044460
email: cameron.gosling@monash.edu

Mr Eihab Khasawneh

Phone: 99044536
email: eihab.khasawneh@monash.edu
Department of Community Emergency Health
and Paramedic Practice

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researcher via the phone numbers or email address listed above.

What does the research involve?

The aim of this study is to explore how well self-efficacy and math anxiety predict paramedic students 'performance in drug calculation. Willing participants will be asked to complete a 15-minute questionnaire.

Why were you chosen for this research?

You were chosen for this study as you are currently a paramedic student studying the Bachelor of Paramedicine at Monash University.

Consenting to participate in the project and withdrawing from the research

Being in this study is voluntary and you are under no obligation to participate. Once you complete the questionnaire it implies that you agreed to participate in the study and it is not possible to withdraw from the study because the responses are anonymous.

Possible benefits and risks to participants

This is an exciting opportunity for you to participate in a research project that will help us better understand the predictors of improving drug calculation skills which are essential in paramedic practice. There are no foreseeable risks to any participant being involved in this research, and there will be no implications if you choose to withdraw from the research.

Confidentiality

All the information about you will be non-identified. Questionnaires are anonymous and not identifiable We intend publishing results in peer-reviewed publications and/or conferences.

Storage of data

Data collected will be stored in accordance with Monash University regulations, kept on University premises, in a locked filing cabinet for five years. Electronic data will be stored on a secure password protected network only accessible by the chief investigator. All data will be destroyed/deleted after five years.

Results

If you would like to be informed of the aggregate research findings, please contact Professor Brett Williams 9904 4283 or brett.williams@monash.edu , Dr Cameron Gosling 99044460 or Cameron.gosling@monash.edu or Eihab Khasawneh 99044536 or eihab.khasawneh@monash.edu .

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the Executive Officer, Monash University Human Research Ethics Committee (MUHREC):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
Room 111, Chancellery Building D,
26 Sports Walk, Clayton Campus
Research Office
Monash University VIC 3800

Tel: +61 3 9905 2052 Email: muhrec@monash.edu Fax: +61 3 9905 3831

Thank you,

The research team

MONASH University

EXPLANATORY STATEMENT

Project ID: 17970

Project title: Is numerical ability associated with maths anxiety and drug calculation success?

Investigators

Professor Brett Williams

Phone: 99044283
email: brett.williams@monash.edu

Dr Cameron Gosling

Phone: 99044460
email: cameron.gosling@monash.edu

Mr Eihab Khasawneh

Phone: 99044536
email: eihab.khasawneh@monash.edu
Department of Community Emergency Health
and Paramedic Practice

You are invited to take part in this study. Please read this Explanatory Statement in full before deciding whether or not to participate in this research. If you would like further information regarding any aspect of this project, you are encouraged to contact the researcher via the phone numbers or email address listed above.

What does the research involve?

The aim of this study is to explore the relationship between numerical ability and math anxiety and drug calculation performance of paramedic students. Willing participants will be asked to complete a 25-minute questionnaire on numerical ability and maths anxiety. Participants who complete the questionnaire will be invited to participate in a 60-minute interview.

Why were you chosen for this research?

You were chosen for this study as you are currently a paramedic student studying the Bachelor of Paramedicine at Monash University.

Consenting to participate in the project and withdrawing from the research

Being in this study is voluntary and you are under no obligation to participate. Once you complete the questionnaire it implies that you agreed to participate in the study and it is not possible to withdraw from the study because the responses are anonymous. As part of this study you will need to complete (sign and return) a consent form to participate in the in the 60-minute interview. All participants have the right to withdraw from further participation at any stage, and no participant (or their data) will be identified in any way.

Possible benefits and risks to participants

This is an exciting opportunity for you to participate in a research project that will help us better understand the association between numerical ability and math anxiety and drug calculation performance. This will help in improving the drug calculation skills of the students. There are no foreseeable risks to any participant being involved in this research, and there will be no implications if you choose to withdraw from the research.

Confidentiality

All the information about you will be non-identified. Questionnaires are anonymous and not identifiable. Focus groups will be audio recorded group data will be transcribed verbatim by a third party transcribing organisation; no personal information will be identifiable by the transcribing organisation. All data will be published in aggregate form using pseudonyms/codes. We intend publishing results in peer-reviewed publications and/or conferences.

Storage of data

Data collected will be stored in accordance with Monash University regulations, kept on University premises, in a locked filing cabinet for five years. Electronic data will be stored on a secure password protected network only accessible by the chief investigator. All data will be destroyed/deleted after five years.

Results

If you would like to be informed of the aggregate research findings, please contact Professor Brett Williams 9904 4283 or brett.williams@monash.edu , Dr Cameron Gosling 99044460 or Cameron.gosling@monash.edu or Eihab Khasawneh 99044536 or eihab.khasawneh@monash.edu .

Complaints

Should you have any concerns or complaints about the conduct of the project, you are welcome to contact the Executive Officer, Monash University Human Research Ethics Committee (MUHREC):

Executive Officer
Monash University Human Research Ethics Committee (MUHREC)
Room 111, Chancellery Building D,
26 Sports Walk, Clayton Campus
Research Office
Monash University VIC 3800

Tel: +61 3 9905 2052 Email: muhrec@monash.edu Fax: +61 3 9905 3831

Thank you,

Professor Brett Williams

Dr Cameron Gosling

Mr Eihab Khasawneh

MONASH University

<u>Project title: Is numerical ability associated with maths anxiety and drug calculation success in paramedic students?</u>

1. **Year of Course? (please tick one box)**

   Year 2 ☐

   Year 3 ☐

2. **What is your age group? (please tick one box)**

   <= 19 years ☐

   20 - 24 years ☐

   25 - 29 years ☐

   30 - 34 years ☐

   => 35 years ☐

3. **What is your gender? (please tick one box)**

   Female ☐

   Male ☐

   Prefer not to say ☐

4. **What was the highest level of Maths education you had completed? (Please tick those applies; you can tick more than one option):**

   Tertiary level maths ☐

   Victoria certificate of education (VCE) ☐

   Higher School Certificate (HSC) Mathematics ☐

   High school Maths (<year 12) ☐

   Other, specify please……………..

5. **Did you enter into the Bachelor of Paramedics directly from high school?**

   Yes ☐

   No ☐

6. **If your answer for Q 5 is No, please specify how many years after finishing the high school before you joined the paramedic programme at Monash University?**

***Maths anxiety part**

Please indicate your level of agreement/disagreement with each statement about maths anxiety below, by circling one option related to using the following scale:

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

It wouldn't bother me at all to take more math courses.	1	2	3	4	5
I have usually been at ease during math tests.	1	2	3	4	5
I have usually been at ease in math courses	1	2	3	4	5
I usually don't worry about my ability to solve math problems	1	2	3	4	5
I almost never get stressed while taking math tests.	1	2	3	4	5
I get really stressed during math tests.	1	2	3	4	5
I get a sinking feeling when I think of trying hard math problems.	1	2	3	4	5
My mind goes blank and I am unable to think clearly when working on mathematics.	1	2	3	4	5
Mathematics makes me feel uncomfortable and nervous.	1	2	3	4	5
Mathematics makes me feel uneasy and confused.	1	2	3	4	5

- **Drug calculation part. No calculators or phones are allowed. Please show all your working out and formulae used for this part.**

7. Could you please answer the following questions related to drug calculation?
   1. You want to administer midazolam for a fitting patient. The presentation of midazolam is 15mg/3ml ampoule. You need to give 0.1 mg/kg and you estimate the patient's weight to be 90kg.
   a. What is the dose in milligrams (mg)?

   ____
   ____
   ____

   b. How many millilitres (ml) you will give the patient?

   ____

   2. You are called to transport patient from rural area to a city hospital. The hospital tells you that the patient should receive all the fluid remaining in a 1000 ml 0.9% saline bag over the next 4 hours. There is currently 750 ml of saline remaining.

   a. If the drip factor of the giving set is 20 drops per ml, what is the required drip rate?

   ____
   ____
   ____

   b. How many (ml) you will give per hour?

   ____
   ____

3. You are asked to draw up 19 mmol of potassium chloride. The ampoule contains 25 mmol in 10 ml. How many (ml) of the drug you will draw up?

____

____

____

4. A patient is to receive 150 mls of 5% dextrose over 90 minutes via a drip set with a factor of 60 drops per ml. What is the required drip rate?

____

____

____

5. If the adrenaline ampoule comes in 1mg/ml and you are asked to dilute it in 10ml of saline. If you are asked to give 300 mcg to the patient, how many mls of the diluted drug you will administer?

____

____

6. A 60 year old woman with angina is prescribed 135mg Verapamil, stock strength available is 90mg. How many tablets will she need to take for each dose (express in decimal)?

____

____

____

7. John weighs 13.5kg. He is prescribed ibuprofen 10mg/kg. Stock is 100mg in 5mL. How many ml do you give?

____

____

8. A 75kg adult requires Enoxaparin 1.5mg / kg for treatment of a Deep Venous Thrombosis (DVT). What dose is required?

____

____

____

9. Adrenaline is available as 10 in 100,000 (10g in 100,000mL), what is the concentration in mg/mL.?

____

____

<u>*Numerical ability part: No calculators or phones are allowed. Please show all your working out and formulae used for this part.</u>

Calculate the following

a. (350⁄100)÷(50⁄250)

____

b. 1⁄4 ÷ 1⁄2

____

c. Convert 4⁄5 into a decimal _______________________________

d. Convert 5⁄2 into a decimal _______________________________

e. 4/5 as a percentage _______________________________

f. 0.4 as a percentage ____
g. Simplify the ratio:
   24:8____
h. Solve the following:
   1/3 x 1/2 ____
i. Convert the following:
   1.15 a.m. to 24-hour time____

j. In Year 3 and 4 at a large primary school there are 6 classes of 31 children and 2 classes of 32 children. How many children is this altogether?
   ____
k. 1gram (g) = 1,000 milligrams (mg). Convert 325 mg to grams.
   ____
l. Two thirds of a group of 72 children have brown hair. How many children have brown hair?
   ____

**** IF YOU ARE INTERSTED IN BEING INTERVIEWED FOR A 60 MINUTES AS PART IOF THIS STUDY PLEASE WRITE YOUR CONTACTS ON THE PROVIDED SHEET AT THE FRONT DESK AND I WILL CONTACT YOU SOON TO ARRANGE FOR THE INTERVIEW.**

MONASH University

Project ID: 17970

Project title: Is numerical ability associated with maths anxiety and drug calculation success?

1. What year of study are you in?
2. Are you comfortable completing maths problems or do you have some difficulties?
3. What types of maths problems do you have the most difficulty with?
4. Why is it a problem? Do you have a strategy to overcome difficult maths problems? Tell me about how you solve difficult problems.
5. What factors do you think reduce your ability to perform mathematical skills?
6. How would you define numerical ability?
7. How would you define maths anxiety?
8. Can you recall examples of positive and negative mathematical experiences you have had prior to joining the university?
9. Can you recall any examples of personal discouragement you have had while undertaking mathematics subjects before applying to university?
10. How do you think mathematical abilities affect paramedic performance while undertaking normal duties? How does it affect you while performing scenarios in class?
11. How do you feel when you are asked to perform a drug calculation?
12. Tell me about your concerns when you are doing drug calculations as part of your course?
13. Do you think that technology has an impact on drug calculation ability? How? (Explore the positive or negative response)
14. What is the importance of having the dose calculation formula ready for you when you are doing dose calculation? Or is this core knowledge that a paramedic must know by heart?
15. Do you think that there is any association between numerical ability and maths anxiety? If yes, why? If no, why?
16. Do you think your ability to perform drug calculations is affected by numerical ability and/or maths anxiety?
17. Do you think you need to improve your numerical ability? If yes, how will you achieve this? If no, how do you maintain your numerical ability?
18. Do you think you need to reduce your anxiety level as it relates to maths performance? If yes, how will you achieve this?
19. Is there anything you wish to add or anything you think I may have missed?