# IJMS

# INTERNATIONAL JOURNAL *of* MEDICAL STUDENTS

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# INTERNATIONAL JOURNAL *of* MEDICAL STUDENTS

The *International Journal of Medical Students* (IJMS) is an open-access, peer-reviewed scientific journal (ISSN 2076-6327) that publishes original research in all fields of medicine. The Journal was created in 2009 to share the scientific production and experiences of medical students (*i.e.*, MBBS students, MD students, DO students, MD/MSc students, MD/PhD students, etc.) and recently graduated physicians from all over the world. Our objective is to be the primary diffusion platform for early-career scientists, using standards that follow the process of scientific publication.

The *IJMS* receives submissions where there is at least one author enrolled as a medical student in any medical school in the world or a recently graduated physician worldwide. For research articles, early-career scientists must be accompanied by a senior researcher that must be also responsible for the research, guaranteeing the quality of the work. We publish Original Articles, Short Communications, Reviews, Case Reports, Interviews, Experiences, and Letters, which follow an innovative and unique two-step, double-masked peer-review process, in brief:

> The first step of revisions is carried out by two Student Editors (medical students with publications indexed in the US National Library of Medicine (NLM) with the supervision of an Associate Editor. The aim of this step is to improve the quality of articles and identify those that can proceed to external peer-reviews. The second step of revisions is carried out by external peer-reviewers who are researchers with publications indexed in the NLM related to the topic of the submission.

The time between submission and final publication in most cases has been two to four months depending on the diligence of Peer-Reviewers and Authors.

The *International Journal of Medical Students* is published online quarterly (March, June, October, December) by the University of Pittsburgh Library System, a member of the Open Access Scholarly Publishers Association, as part of its Pitt Open Library Publishing imprint.

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The *IJMS* acceptance rate is 18% of the almost 350 annual submissions. Published articles in 2021 came from 32 different countries. The average days to a first decision is 14 days, 143 for acceptance, and 31 to decline a submission. The time between submission and final publication in most cases has been three to four months depending on the diligence of Peer-Reviewers and Authors.

The journal's website got over 75 thousand visits only in 2021. The *IJMS*'s reach includes a growing social media presence (more than 15,000 followers on Twitter, Facebook, Instagram, and LinkedIn). Only in the last 2 years, the Journal has been visited from nearly every place in the world (+190 countries). You can find more of the *IJMS* statistics here.

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Reviewers and editors are obliged to retain the contents as privileged and confidential until publication. The Editor in Chief and the Editorial Board will have final authority over an article's suitability for publication.

The *IJMS* also strive towards the training of a new generation of Editors and Peer-reviewers promoting different training strategies among our Editorial Team that includes the Web of Science Academy courses and the Committee on Publication Ethics (COPE) courses available to its members (*IJMS* is a member of COPE).

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**Editorial Office:**
1400 Locust Street
Suite 3103
Pittsburgh, PA 15219.
United States of America (USA)
Tel.: 413-232-7884
Fax: 412-232-8966

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# Thinking Globally in the Pursuit of Individual Identity: Diversity, Equity, and Inclusion in the International Journal of Medical Students (IJMS)

Muhammad Romail Manan,[1] Kiera Liblik,[2] Francisco J. Barrera,[3] Ciara Egan,[4] Juan C. Puyana,[5] Francisco J. Bonilla-Escobar.[6]

Inequity and inequality are pervasive in healthcare despite recent efforts to advance inclusivity and multiculturalism in research and practice.[1] Diversity refers to *"the recognition of the visible and invisible physical and social characteristics that make an individual or group of individuals different from one another, and by doing so, celebrating that difference as a source of strength for the community at large".*[2] Recent circumstances in global health, including those highlighted by the COVID-19 pandemic, have demonstrated societal insufficiencies concerning equity especially relating to the disease burden and health outcomes of black, indigenous, and people of color (BIPOC).[3,4] This systemic discrimination can hinder the accessibility of health services, compounding inequity. Following a set of predefined diversity, inclusion, and equity policies may aid in combatting these problems. Therefore, we need to reflect on our mandates and their development to foster an inclusive environment free from unfair circumstances and nourished by equitable access to opportunities, collectively embodying equity and equality.

*Diversity promotes balanced perspectives with important insight from marginalized voices.* Accordingly, diverse teams have enhanced problem-solving skills and innovation capacity, resulting in better work output and productivity with enhanced collaboration.[5] Recruiting a diverse pool of individuals also provides inclusion of underrepresented groups. When pursuing competitive career paths in medicine, it is beneficial to have contributed to the scientific literature by serving on a journal's editorial team. Therefore, diversity may be highlighted as impacting individual as well as institutional growth. However, imbalance in the representation of groups of people (e.g., gender) is not an uncommon phenomenon, as journals have been demonstrated to foster increasingly homogenous editorial boards.[6-9] The International Journal of Medical Students (IJMS), however, has a history of highlighting the achievements and research of a diverse pool of medical learners. The IJMS aims to elevate these promising upcoming leaders, promoting their

voices regardless of their institution and sociodemographic background. The IJMS is free to submit to, publish in, and read - fully accessible at no cost. Furthermore, the IJMS strives to include contributors and editorial members from various countries in all global regions. In 2021 alone, the IJMS featured authors from 39 different countries. Additionally, our team represents over 60 different countries with people affiliated with institutions in all seven of the World Bank geographical regions (*Figure 1*) and all four of the World Bank country income groups. The IJMS is unique because it also features a student experiences section for medical learners who have had perspective-changing experiences in their field. In addition, there is a newly introduced option in 2022 to publish articles with a summary section in the author's language of origin to further increase visibility. Furthermore, the IJMS supports the global community of medical learners by taking an active stance on current issues such as the ongoing conflict in Ukraine,[10] and climate change.[11-13]

At IJMS, we strive to represent our community as a whole, and we believe in global and multicultural insight when publishing innovative solutions to problems concerning healthcare and publication biases. We find strength in our differences and acknowledge individuality with respect, equity, and inclusivity. Therefore, to materialize our vision, we have decided to proclaim our dedication to representing researchers regardless of their gender identity, sexual orientation, race/ethnicity, geography, career stage, religious beliefs, socioeconomic level, national origin, language, marital status, and political ideology. IJMS has demonstrated this by publishing on important issues relating to gender,[3,14-16] culture,[17-20], and ethnicity.[21,22] Through our statement on diversity, equity, and inclusion (DEI), we take a positive step towards representing the underrepresented and welcoming researchers, editors, authors, ambassadors, and reviewers from various communities irrespective of the above-mentioned domains of diversity.

1 Medical Student. Services Institute of Medical Sciences, Lahore, Pakistan. Student Editor, IJMS.

2 BSc. MSc. Faculty of Medicine, Queen's University, Kingston, ON, Canada. Associate Editor, IJMS.

3 MD. SM. Department of Epidemiology, Harvard "TH Chan" School of Public Health, Harvard University, Boston, MA, USA. Associate Editor, IJMS.

4 Medical Student. Humanitas University, Humanitas Research Hospital, Milan, Italy. Deputy Editor, IJMS.

5 MD, FRCSC, FACS, FACCP. School of Medicine, Department of Surgery, Professor of Surgery, Critical Care Medicine, and Clinical Translational Science, Director for Global Health-Surgery, University of Pittsburgh, Pittsburgh, PA, United States. Editorial Board Member, IJMS.

6 MD, MSc, PhD(c). Researcher, Department of Ophthalmology; Institute for Clinical Research Education (ICRE), University of Pittsburgh, Pittsburgh, PA, United States. CEO, Fundación Somos Ciencia al Servicio de la Comunidad, Fundación SCISCO/Science to Serve the Community Foundation, SCISCO Foundation, Cali, Colombia. Grupo de investigación en Visión y Salud Ocular, VISOC, Universidad del Valle, Cali, Colombia. Editor in Chief, IJMS.

**Correspondence:** Muhammad Romail Manan
Address: G8QM+JWR, Jail Road, Shadman 1 Shadman, Lahore, Punjab, Pakistan. Email: romailmanan1@gmail.com

**Editorial**

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Thinking Globally in the Pursuit of Individual Identity: Diversity, Equity, and Inclusion in the International Journal of Medical Students (IJMS)

*Figure 1*. International Journal of Medical Students Editorial Team Geographic Distribution by Country.
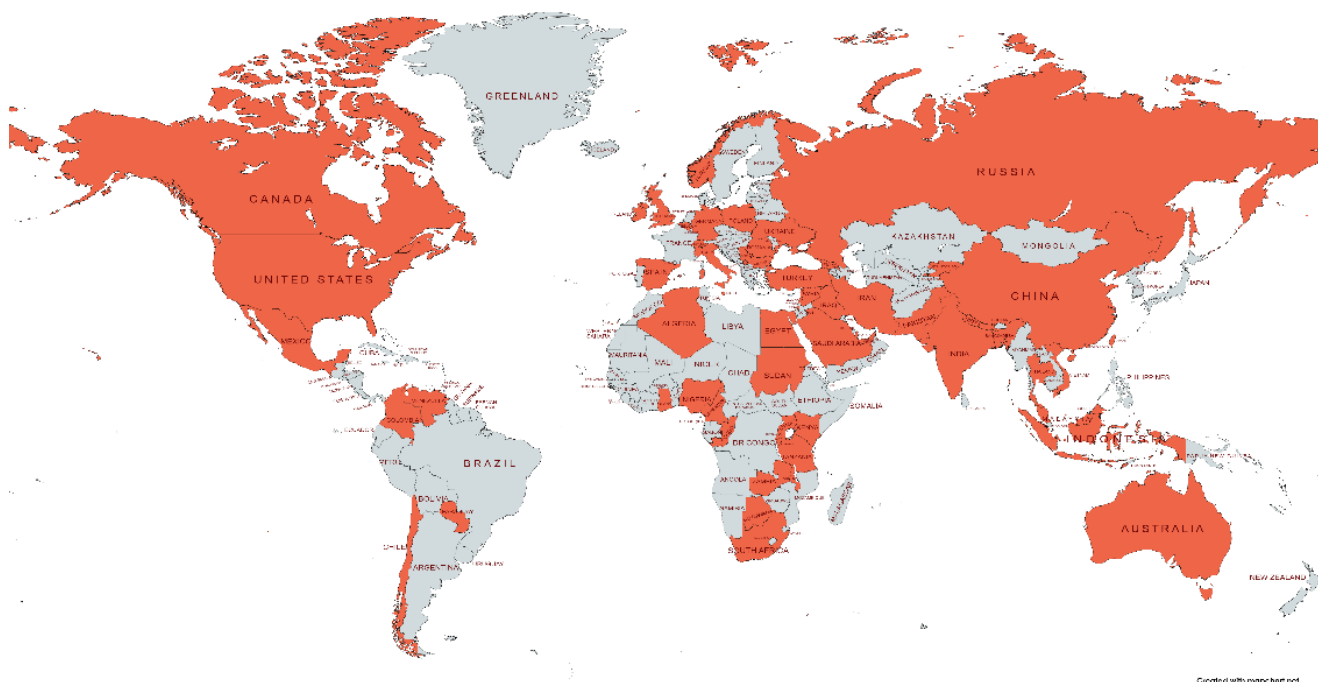


We have further formulated a Committee on Diversity, Equity, and Inclusion which will be tasked to improve the overall DEI status of the Journal by maintaining equity in the representation of researchers as well as in the availability of opportunities. Our priority with this implementation is to be transparent about our posture as a Journal regarding diversity and inclusion practices. We will do our best to maintain practices that reflect our statement and improve it as appropriate. Feedback and constructive discussion about this topic is relevant to us. We are open to this and will use it to initiate discussions and make iterations to our statement to improve our practices further, when and if appropriate. The role of students is particularly important in this aspect. Students can provide insightful feedback on issues pertaining to equity that they could be experiencing in their home countries and institutions. This can allow us to take a more comprehensive approach to our statement and direct us to incorporate views and perspectives that align with our objectives of adopting a worldwide inclusive practice of scientific publication and dissemination.

Principles of equity, diversity, and inclusion will continue to shape the navigation of the IJMS practices and, consequently, the perspective of our Editorial Team. We acknowledge the complexity of developing and implementing comprehensive practices of diversity and inclusion within our community, and hence, we are committed to longitudinally improving our approach as we develop further.[23] We recognize that achieving a comprehensively diverse community requires continuous and dedicated effort. Therefore, we consider it our responsibility to ceaselessly work towards our vision of diversity, equity, and inclusion.

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# The IJMS World Conference of Medical Student Research and an Overview of the IJMS Volume 10 Issue 2

Adnan Mujanovic,[1] Vincent Kipkorir,[2] Cesare Mercalli,[3] Arkadeep Dhali,[4] Purva Shah,[5] Camila Velandia,[6] Ciara Egan,[7] Mihnea-Alexandru Găman,[8] Juan C. Puyana,[9] Francisco J. Bonilla-Escobar.[10]

Medical education depends on the foundation of scientific evidence in order to ensure the provision of the best, most up-to-date, training. Expectedly, physicians with a scientific background continually remain vital to the advancement of medicine.[1] Therefore, the inculturation of research in physicians at their initial formative stages, can significantly bridge the gap between research and clinical practice.[2] A recent survey among medical students found an overall poor scientific grasp but positive attitudes towards research. Some barriers identified in this survey included time-consuming school tasks and a lack of proper support for conducting studies.[3] Consequently, the observed positive attitude towards research holds little significance without an appropriate training system or platform where medical students can engage actively in research.

The International Journal of Medical Students (IJMS) has existed uninterrupted for more than a decade with its primary aim to serve as the main research-driven global facilitator for early-career scientists in medicine. This expands beyond the scope of manuscript publication to the empowerment of medical students in research while also providing a platform for them to display their work.[4]

Keeping alive the spirit of promoting medical student research worldwide, the IJMS has decided to organize the first **IJMS World Conference of Medical Student Research** that will be held online on **November 12th, 2022**. Here, medical students and recent graduates (up to 3 years after graduation) can present their scientific work in front of an international audience.

The conference organizing committee strongly believes in the importance of medical students and recently graduated physicians in medical research. With the Conference, the IJMS aims to provide opportunities to increase the visibility of early-career researchers through peer evaluation of their work.[4]

The primary target audience of the conference is medical students and early-career scientists. To pursue inclusivity, there will not be a specific conference topic. Instead, participants from all research areas are invited to submit their abstracts and showcase their work to a global and diverse audience.[5] A panel of experienced peer-reviewers will review all the abstracts and timely notify applicants of the result of their submission. Authors of accepted abstracts will have the opportunity to present their work in the form of an oral presentation, which will be evaluated by an international panel of judges. All accepted conference abstracts will be featured in the 2022 Supplement of IJMS and different awards will be distributed among the participants (i.e., top 10, most voted presentation, etc.).

As medical students gather together and share their research experiences, the hope is that there will be increased engagement in research among early-career scientists and a new step towards the global empowerment of medical students with research skills and competence. To the best of our knowledge, no medical student international research conferences are organized and run by a student-led international medical journal; the upcoming conference aims to change that narrative.

Important details for authors:
- Conference date: November 12th, 2022
- Abstract submission link: https://ijms.info/IJMS/Conference/abstracts
- Abstract submissions deadline: October 15th, 2022
- Abstract submission fee: $10 USD
- Contact: conference@ijms.info
- Conference Website: https://ijms.info/IJMS/Conference

Funds from the conference will cover the Journal's running costs and help maintain our free open-access policies.

1 MD, PhD student. Department of Diagnostic and Interventional Neuroradiology, University Hospital Bern Inselspital, University of Bern, Bern, Switzerland. Associate Editor, IJMS.

2 BSc(H). University of Nairobi, College of Health Sciences, Department of Human Anatomy and Physiology, Nairobi, Kenya. Associate Editor, IJMS.

3 Fifth year Medical Student. Humanitas Research Hospital, Milan, Italy. Layout Editor & Director of the first IJMS World Conference of Medical Student Research, IJMS.

4 MBBS; Department of GI Surgery, Institute of Postgraduate Medical Education and Research, Kolkata, India. Student Editor, IJMS.

5 MBBS. Research Associate, Medical College, Baroda, India. Student Editor, IJMS.

6 Fifth year Medical Student, Grupo de investigación ACEMED-UPTC. Universidad Pedagógica y Tecnológica de Colombia - UPTC. Tunja, Colombia. Logistics WCMSR, IJMS.

7 Medical Student. Humanitas University, Humanitas Research Hospital, Milan, Italy. Deputy Editor, IJMS.

8 MD, PhD student. Faculty of Medicine, "Carol Davila" University of Medicine and Pharmacy, 050474 Bucharest, Romania & Department of Hematology, Center of Hematology and Bone Marrow Transplantation, Fundeni Clinical Institute, 022328 Bucharest, Romania. Scientific Editor, IJMS.

9 MD, FRCSC, FACS, FACCP. School of Medicine, Department of Surgery, Professor of Surgery, Critical Care Medicine, and Clinical Translational Science, Director for Global Health-Surgery, University of Pittsburgh, Pittsburgh, PA, United States. Editorial Board Member, IJMS.

10 MD, MSc, PhD(c). Researcher, Department of Ophthalmology; Institute for Clinical Research Education (ICRE), University of Pittsburgh, Pittsburgh, PA, United States. CEO, Fundación Somos Ciencia al Servicio de la Comunidad, Fundación SCISCO/Science to Serve the Community Foundation, SCISCO Foundation, Cali, Colombia. Grupo de investigación en Visión y Salud Ocular, VISOC, Universidad del Valle, Cali, Colombia. Editor in Chief, IJMS.

**Correspondence:** Francisco J. Bonilla-Escobar.
Address: 1400 Locust Street, Pittsburgh, PA 15219, UPMC Mercy Hospital - Eye Center, USA. Email: conference@ijms.info

# Editorial

Shifting gears to the current second Issue publication in our historic tenth-year anniversary Volume, we have 14 articles including 7 original research articles, 1 short communication, 3 reviews, and 3 experience reports. The topics range from the COVID-19 aftermath and emerging mental health conditions to medical student perspectives regarding different topics of their medical training.

## Post-COVID-19 pandemic
Even though in most countries, the peak of COVID-19 pandemic is behind us, it had unprecedented consequences on the entire globe, and we are still dealing with its aftermath. Yousef and Khandalavala reported one such instance in their investigation of the impact of COVID-19 pandemic on medical students' diet quality at one medical college in the United States of America.[6] Overall, during the early days of the pandemic, there was an overall reported decrease in diet quality and a higher-than-normal BMI, which could have potential long-term effects.

In addition to its deteriorating effects on physical health, the COVID-19 pandemic also caused psychological instability resulting in higher burnout rates and emotional exhaustion in medical students in Monterrey in Mexico. One study group suggested that medical schools should promote easily accessible mental health programs for their students to curb this problem.[7] Using the Maslach Burnout Inventory-Student Survey, authors reported burnout rates of 15% and emotional exhaustion in more than half (53%) of their study participants, with male students being four-times more likely to develop it when compared to their female colleagues. Authors suggest that medical faculties should promote easily accessible mental health programs for their students.

One review addressed the possible relation between multiple sclerosis (MS) relapse and COVID-19.[8] MS patients are a vulnerable population for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), given the natural history of MS. This review sums findings of seven original studies and highlights the effects of COVID-19 on the blood-brain barrier and how this interaction reflects the exacerbation of MS. Interestingly, there have even been reports on increased rates of MS in previously healthy patients during this period.

## Mental Health
Mental health is often stigmatized when compared to its physical counterpart. Addictive diseases, with their severe impact on mental health, are no exception to this rule. Fusillo from the United States shares his experience as a third-year medical student and showcases how his personal experience and thoughts on mental health changed during his inpatient psychiatric rotation.[10]

Another rising problem in the mental health sphere is the internet gaming disorders (IGD). This can be predominantly ascribed to increased access to technology availability among adolescents, but the circumstances created by the pandemic and lockdowns could have increased its prevalence. A cross-sectional study covering four schools in the Colombo Educational Zone in Sri Lanka assessed gaming habits among 412 students.[11] They found high a prevalence of IGD in their study group and were more frequently associated with low involvement in extracurricular activities and poor family relationships. The wave of IGD after the pandemic should be included in medical education efforts.

When talking about mental health, it is essential to mention empathy in patient contact. During the course of students' academic advancement, there is a recurring trend of emphasizing clinical and practical skills while empathy and social skills tend to be left behind. A multi-center study encompassing 304 students from 12 medical schools in the United Kingdom reported that almost half of the respondents (45.7%) had never heard of the human factor as an important aspect of evaluating fitness to practice.[12] Respondents agreed that learning the value of the human factor should occur early on in their education. Authors suggest that new strategies are needed to ensure that future medical providers are equipped with the necessary social and human skills to help them deliver a safer, patient-oriented, care.

## Medical Students and Education
Health disparities are present among many underrepresented populations. One of them is the Globally, Neurodivergent, Disability, and Chronic Illness (NDCI) populations.[9] A group from the University of California performed a cross-sectional study on medical students' perceptions, knowledge, and competence regarding NDCI. One in ten participants reported that their medical school included the NDCI population in their curriculum, but also that most of their knowledge on this cohort comes from their personal experience and media outlets and not from academical setting. Even though this was a single-institution study, the authors commented on alarmingly low knowledge and awareness rates of NDCI. They suggested that informed efforts should be undertaken to tackle disparities in the knowledge of future physicians regarding NDCI.[9]

The journey into the medical career often starts with the preparations for admission into medical school. As this is an important step, it is also quite stressful, but stress levels vary between future medical students in different countries, as admission criteria are different. Prospective students from different medical schools in Australia and the United States share their joint experiences on this topic and provide a comparative overview.[13] This study reports the biggest differences in admission exam criteria and applicants' profiles (e.g., high school vs. college students).

Medical College Admission Test (MCAT) is one example of an admission test used in the United States and parts of Canada. Liu et al. investigated the stress levels of those from the Underrepresented in Medicine (URM) backgrounds who were taking the MCAT.[14] Through their near-peer coaching program,

this single-institution study has found decreased anxiety levels in URM students after several coaching sessions, concluding that these types of interventions are warranted and well-received among URM students.

Aside from different educational system models, it is also important for medical students to stay up to date with administrative changes in the healthcare system. Value-Based-Health-Care (VBHC) model will soon be implemented in Brazil, and Hirt et al evaluated VBHC model awareness among Brazilian medical students.[15] This cross-sectional study collected 3030 responses across 148 medical schools in Brazil and reported a low number of students who understood the VBHC concept. The authors suggested that medical schools use their resources to prepare future physicians for working in the VBHC model, as it will help their everyday practice and increase patient management.

As medical students move towards the end of their medical school journey, they face many uncertainties, one of them being their final clinical year. Most medical students would prefer to spend their final clinical year in a tertiary-level university hospital, which offers a wider array of residency and fellowship options. But what happens when students have to do their final year in a secondary level or small rural hospital? Delgado Sanchez sheds light on this subject and reflects on his personal experience in this journey.[16]

**Future Perspectives**

Srinivas et al presented a current literature summary on the use of animal models in the endovascular treatment of ascending aortic dissection.[17] An overview of twenty-three published papers revealed that porcine and ovine species are the most suitable animal models for the examination of endovascular stent-graft feasibility. Increasing rates of Vancomycin-Resistant Enterococci (VRE) infections have provided ideal conditions for this opportunistic pathogen to develop antibiotic resistance.[18]

Recently reported additional resistance to linezolid has resulted in urgent appeals from the World Health Organization and Center for Disease Control in antimicrobial therapy management. The current state of evidence reviewed by Beale and Durward-Diioia proposed a multifactorial approach to dealing with VRE, including preventive, diagnostic, and therapeutic measures.

Lastly, with summer around the corner, it is important to be aware of conditions associated with increasing temperatures, such as heat strokes. Alebaji et al. assessed awareness levels of heat stroke among residents of the United Arab Emirates with an original questionnaire.[19] A third of the total sample size of 402 participants did not think that severe heat stroke might lead to fatal outcomes. Males and older participants were also less likely to know what a heat stroke is. Authors proposed that governmental institutions should implement adequate informative measures for the general population, especially in regions/areas where heat strokes occur more often. The 2022 FIFA world cup to be held in Qatar is around the corner. The country is under scrutiny due to recent concern for under-reporting deaths caused by the high temperatures reaching over 50° Celsius (120° Fahrenheit), especially in vulnerable populations such as migrant workers.[20]

Finally, diversity, equity, and inclusion (DEI) are core values of healthcare research and practice. However, inequities remain attached to healthcare provision, research, journal editorial teams, and publication practices. In an effort to tackle this issue, the IJMS has aimed to have an inclusive editorial process and an editorial team that includes a global population of students and researchers. The Journal has taken a step toward an equitable environment by publishing a policy statement on DEI.[5] We recognize the complexity of implementing comprehensive DEI practices, but we are committed to its continuous development based on iterative processes and clear internal and publicly available regulations (https://ijms.info/IJMS/Diversity_statement).[21]

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# The Education of Medical Students in Human Factors – A National Survey

Michael Conroy,[1] ID Joel Chilaka,[2] ID Gianluca Colucci.[3] ID

## Abstract

**Background:** The importance of human factors (HF) has been highlighted recently by the General Medical Council's decision to include it in their processes for evaluating fitness to practice. Medical school is vital for embedding concepts into medical practice, but little is known about the rigor and extent to which HF is taught across United Kingdom (UK) medical schools. **Methods:** Cross-sectional study assessing HF among medical students in the UK. An 8-question survey was designed and disseminated nationally using the Qualtrics platform. Respondents were asked for their existing knowledge and perception of HF, education throughout medical school and relevant demographic factors. **Results:** The survey was completed by 304 medical students from 12 UK medical schools. In total, 45.7% of respondents had never heard of HF as a concept. Furthermore, 96.9% of respondents deemed the concept of HF as very important to medicine and future clinical practice. Moreover, simulated scenarios, one-to-one and small group teaching emerged as the most effective teaching methods, whilst many students agreed this teaching should occur in the early stages of medical education. Lastly, communication and teamwork were perceived to be the most important aspects of HF. **Conclusion:** These findings reveal a lack of awareness regarding HF among UK medical students. New strategies are needed to ensure the doctors of tomorrow are equipped with the necessary tools to implement and deliver safer, more effective patient care.

**Key Words:** Interprofessional Education; Medical Students; Medical Education; Health Communication (Source: MeSH-NLM).

## Introduction

The International Ergonomics Association defines human factors (HF) as "a scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance."[1,2] In medicine, HF or soft skills are generally understood to mean all the non-technical skills doctors' needs to perform efficiently in different clinical scenarios ranging from routine practice to high-stress emergency settings, such as trauma and resuscitation.

The importance of HF and the application of its underlying principles within medicine have been recently emphasized by the General Medical Council's (GMC) decision to incorporate HF into their process for evaluating fitness to practice in the United Kingdom (UK).[3] In the light of events such as the case of Dr Bawa-Garba,[4–6] or the failings at the Mid Staffordshire NHS Trust in 2014, the patient safety agenda has been brought to the forefront of both public and professional interest. Much of this work has centered around the number of "avoidable deaths" within the

National Health Service and how this figure can be reduced. This data feeds into a wider exploration of the impact of medical error – defined as the "failure to execute an action as intended" or "use of an inappropriate plan to achieve a stated outcome."[7] Data from the UK suggests that up to 35,000 deaths each year occur due to medical error.[7] The cost of these errors to the UK has been estimated at around £2 billion,[8] with an intangible emotional cost to patients and families.[9] Data from patients admitted to the hospital also suggests that up to 10% may suffer some form of avoidable harm.[10] From an international perspective, the six International Patient Safety Goals from the Joint Commission International include correct patient identification, effective communication, medication safety and safe surgery.[11] HF can have a key impact on these four goals, and knowledge surrounding HF supports healthcare professionals in meeting these goals. The World Health Organization (WHO) produced a Global Patient Safety Action Plan in 2021, highlighting HF as critical in producing a safe healthcare system. Strategy 2.4 of this action plan includes recommendations for ensuring the availability of training programs in HF and that any patient safety accreditation requires training on HF.[12]

[1] MRCS, MBBS, Urology Registrar, University Hospital Sussex NHS Foundation Trust, United Kingdom.
[2] MBBS, MSc, Foundation Year Doctor, North Cumbria Integrated Care NHS Foundation Trust, United Kingdom.
[3] FRCS, Consultant Colorectal and General Surgeon, Worthing Hospital, University Hospitals Sussex NHS Foundation Trust, United Kingdom.

**About the Author:** *Dr Chilaka is a Foundation Year Doctor in Cumbria, having graduated from the Brighton and Sussex Medical School in 2021. He holds a Master's degree in Public Health from the London School of Hygiene and Tropical Medicine. His Year 4 individual research project, that forms the basis of this article, was awarded the Sussex Healthcare Prize for 'Best Community-based research project'.*

**Correspondence:**
Joel Chilaka.
Address: Newtown Rd, Carlisle, CA2 7HY, United Kingdom
Email: joel.chilaka1@nhs.net

# Original Article

Whilst greater emphasis is placed upon the teaching of HF during post-graduate training, there appear to be wide variations in the rigor and formality of HF teaching in UK medical schools.[13] This research aims to describe the awareness of HF in medical students in the UK and establish their perception of HF teaching and confidence in soft skills.

## Methods

A cross-sectional study based on a survey to identify knowledge and perceptions about HF of UK medical students. Ethical approval was obtained from the Brighton and Sussex Medical School Research and Governance Ethics Committee (RGEC Ethical Approval ER/BSM6909/1).

A draft questionnaire was developed from an initial literature search using PubMed (search terms with and/or used: HF, education, medical, questionnaire, medical student) highlighting existing work and was then tested on a group of medical students (n=10) based at one district general hospital. The use of feedback, including the clarity of the questions, understanding of questions and answer terms used, and perceived relevance of questions from the pilot group, allowed the construction of a final 8-question survey (*Supplementary Material*). The survey was accessible online via the Qualtrics platform.

In 2016/2017, the GMC reported 39,185 medical students in the United Kingdom.[14] We aimed to recruit one percent of this cohort to gain data representative of the population. The inclusion criteria were all students currently studying at a UK medical school, including those in intercalation years. No exclusion criteria in terms of demographic were used.

The survey was available online via a web link distributed by contacting medical student societies ("MedSoc") via email. This contact outlined the aims of the study and provided a shareable web link to access the survey. A second phase followed up on the initial email and contacted a selected range of medical school administrative offices where no response was received in phase one. The survey was available online for five months.

Personal data were gathered as part of the questionnaire, including gender, age, and medical school attended. Participants were required to provide informed consent to participate in the survey prior to commencing questions. Students who completed the survey in its entirety could opt-in for a prize draw. Participation in the study was voluntary, and data were treated in accordance with the Data Protection Act and GDPR (2018).[14,15] This work received £800 from Brighton and Sussex Medical School, which funded the prize draw; the medical school had no input in the study design, data analysis, or manuscript production. The data from participants who did not complete the survey in full were removed prior to analysis.

Data were extracted from the Qualtrics software,[17] which allowed for the separation of groups of participants based on responses

to specific demographic and HF-related questions. Statistical analysis was undertaken on SPSS using Fisher's exact test and chi-squared with a 95% confidence interval.[18] Results were accepted as significant if the p-value was <0.05. Categorical data were collected using a Likert scale with not at all confident, somewhat confident and very confident as options.

## Results

Over the five-month survey period, 304 students from 13 medical schools consented and completed the survey. Respondents were primarily aged between 19 and 24 (92.6%) with a range of 18 to 37 years and a mean of 21 years. The gender of participants was weighted towards females (66.97%), with 32.4% males and 0.61% who prefer not to say. Participants ranged from all years of medical school education. No link was identified between which medical school was attended and awareness of HF (p>0.05). Furthermore, there was no significant difference between gender or age and awareness of HF (p>0.05).

Of the respondents, 45.7% stated that they were not aware of the term HF from their training so far. Within this group (n=148), only 51.3% of students were familiar with related terms, including "soft skills" and "non-technical skills." Of the 176 students aware of HF, 83.9% had gained experience in the first three years of their degree. A statistically significant difference (p<0.001) was found between the year of study and awareness of HF. As participants progressed through medical school training, a higher proportion was aware of HF – only 24.7% of year one students were aware, but 61% of the third year and 80.9% of final-year students had come across the term (*Figure 1*).

*Figure 1.* The Number of Respondents in each Year Group who were either Aware or Unaware of Human Factors (HF) as a Concept.
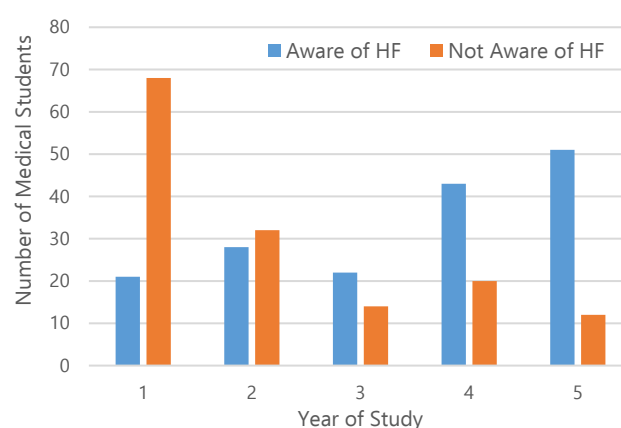


The questionnaire highlighted that a large proportion of students were extremely or somewhat confident in communication and leadership skills, but 50.5% were not at all confident in challenging authority. *Table 1* outlines this information for all ten skills related to HF. Chi-squared analysis was conducted comparing the confidence levels of students from different years in each of the ten skill areas, with statistically significant

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differences found in confidence in leadership (p<0.001), communication (p<0.05), coping with stress (p<0.05), coping with criticism (p<0.001) and situational awareness (P<0.001), with those in later years of study expressing higher confidence levels. In total, 48.1% of respondents stated they were more confident in soft skills/HF than technical skills (such as venipuncture or cannulation), with 30.9% equally confident in both areas.

**Table 1.** Reported Confidence Levels (%) of Participants in Various Human Factor (HF) related Skills.

| Human Factors related Skills | Confidence Levels of Participants (% of responses) | | |
|---|---|---|---|
| | Not at all Confident | Somewhat Confident | Extremely Confident |
| Communication | 1.7 | 47.8 | 50.5 |
| Leadership | 14.2 | 57.1 | 28.7 |
| Teamwork | 1.0 | 31.5 | 67.5 |
| Decision Making | 12.5 | 70.6 | 16.9 |
| Coping with Stress | 10.0 | 70.2 | 19.8 |
| Coping with Criticism | 20.4 | 55.7 | 23.9 |
| Situational Awareness | 14.2 | 55.4 | 30.4 |
| Task Prioritization | 10.4 | 60.5 | 29.1 |
| Reporting Errors | 17.6 | 56.1 | 26.3 |
| Challenging Authority | 50.5 | 40.8 | 8.7 |

A range of teaching methodologies for teaching HF were reported. Most frequently were small group based (n=252), lecture-based (n=219) and simulation (n=182) learnings. The opinion of participants on which teaching methodology was most effective was obtained. Simulated scenarios, small groups and one-to-one teaching were perceived as best methods (*Table 2*).

**Table 2.** Participants' Beliefs Regarding which Teaching Methodologies are most Effective for Human Factor (HF) Education and which Teaching Methodologies are Utilized in HF Skills Teaching.

| Type of Teaching for HF skills | Receiving this Type of Teaching (%) | | Beliefs Regarding Effectiveness (% of responses) | | |
|---|---|---|---|---|---|
| | Yes | No | Not Effective | Somewhat Effective | Extremely Effective |
| One to One Teaching | 43.8 | 56.2 | 4.9 | 36.1 | 59.0 |
| Small Group Teaching | 87.5 | 12.5 | 1.7 | 24.3 | 74.0 |
| Lecture | 76.0 | 24.0 | 40.0 | 56.9 | 3.1 |
| Simulated Scenarios | 63.2 | 36.8 | 0.7 | 22.2 | 77.1 |
| E-learning | 33.3 | 66.7 | 54.5 | 43.4 | 2.1 |

Assessment of which direct skills related to HF were being taught revealed areas where education may be lacking. Participants indicated that coping with criticism (20.8%), challenging authority (32.7%), leadership (34.4%) and task prioritization (33.3%) were the least frequently taught skills. Most participants received education in communication (91.8%) and teamwork (74.4%) skills.

Almost all (96.9%) medical students considered HF teaching in medical schools to be very (24.8%) or extremely (72.1%) important. Moreover, 55.4% believed that "pre-clinical" years (one to three) would be the most appropriate stage of medical school for HF teaching to occur. Nine students selected 'other' and commented that teaching should occur throughout the curriculum. The perceived importance of specific HF skills over others was explored. Students were asked to rank ten HF skills from one (most important) to ten (least important) compared to each other. This question established that communication (90%) and teamwork (47%) were ranked highly as important skills (% who rated this skill rank one or two). The lowest-ranked aspects (% who rated this skill rank nine or ten) were challenging authority (69%), reporting an error (37%) and coping with criticism (36%).

## Discussion

Our results show that HF is forming part of the medical curriculum, with over 80% of final-year students aware of this concept, but it could potentially be featured to a greater extent within undergraduate studies.[19] In recent years, the House of Commons Health Committee produced a patient safety report (2009) highlighting a need to integrate non-technical skills and HF training into the training of undergraduates.[10] Similarly, a multi-professional patient safety curriculum guide from the WHO details the importance of HF in patient safety.[20] Both advocates increased HF training for medical professionals and appear to show progress has been made. However, a significant percentage who were unaware shows that further work is still required both in improving awareness of HF as a term and in providing training earlier in undergraduate training. This is supported by 55.4% of participants responding that the pre-clinical years would be the best time to provide HF education. Studies have shown favorable feedback to curriculum reform with the aim of providing more HF training. In this regard, students report more confidence in communication, overall patient interactions, and breaking bad news.[21] A survey targeted at NHS and military doctors in the UK identified that junior clinicians were much more likely to have had training in HF, with 60% of senior doctors reporting no HF training.[22] Further providing evidence of a movement towards HF educational provision.

Students showed high confidence levels in leadership (96.2%) and communication skills (92.6%). This data is supported by participants specifically stating they received education in these areas of HF skills from their respective institutions. A systematic review of 22 studies providing non-technical skills education found that key featured themes were leadership, communication and teamwork.[23] A 2014 study explored medical students'

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attitudes regarding leadership and management training, and again, similar areas were highlighted as necessary.[24] The GMC's guidance regarding expected outcomes for graduates gives a range of HF-related skills as requirements for newly graduated doctors, including awareness of patient safety, communication skills, leadership and team working, and multi-disciplinary work.[25] Considering the significant non-technical requirements for new graduates, limited assessment is undertaken regarding these skills nationally.[26] In light of the requirement to provide this training, it is positive that almost all undergraduate students receive education in these specific areas and have high confidence levels with these skills. Exploring further, we found that 48.1% of students had more confidence in HF-related skills over technical skills, and 30.9% stated equal confidence in both areas. We hypothesize this could be due to a perceived lesser technical skill ability rather than specific confidence in HF-related skills. There may also be an element of more junior students feeling their technical skills are more limited than HF.

Only 48.5% of students stated an element of confidence in challenging authority; this is unsurprising when just 32.7% received any education on this topic, although 69% of students ranked challenging authoring as one of the most important HF skills. The well-known case of Elaine Bromiley, who died of cerebral damage after a prolonged hypoxic episode pre-operatively, highlighted multiple failures in HF within the team, including poor communication and a failure to challenge authority, and valuable lessons were learned from this.[27] Challenging authority in the healthcare setting can be a difficult part of HF. A review of 31 studies discussed that significant barriers were in place to speak out. These included poor inter-professional skills, fear of repercussions and perceived hierarchal gradients amongst professionals.[28] Methods exist to improve communication when challenging authority, including the use of incremental challenges or provocative words (such as expressing concern, discomfort or that an action is unsafe).[29] We suggest the further introduction of education in this area of HF to the medical school curriculum would allow individuals to feel more able to challenge authority if the need arose. Even relatively small interventions can be of significant effect, with four one-hour simulation sessions with subsequent guided debriefs found to improve self-reported confidence in the correction of another healthcare provider.[30]

The methodologies utilized most frequently for HF teaching were small groups, lectures and simulation. The most effective of these were highlighted to be a small group of simulation-based teaching. This is supported by research into the effects of simulation-based training as a tool to develop non-technical skills. 93% of medical students found a mass casualty simulation useful in developing non-technical skills.[31] Hagemann et al. (2017)[32] compared medical students undertaking simulation before and after exposure to either a clinical or HF skills-based seminar. After the seminar, the HF group significantly improved teamwork and situational awareness, decreased stress and improved error handling. There was no difference in clinical outcome in either group.

Further work shows a correlation between higher non-technical skills scores and clinical performance in simulated scenarios in medical students.[33] This supports simulation with facilitated debrief as a highly effective method for delivering HF training, evidenced by the increasing use of simulation in medical training at all stages.[34]

An understanding of HF can be seen as a threshold concept within medical education.[35] Establishing this understanding allows for a shift in perspective in how individuals view and act in professional interactions. A transformation is required from a clinical-based viewpoint to a non-clinical to facilitate higher quality educational experiences for the student and allow for growth both as a professional individual and as part of a multi-disciplinary team. For HF to be fully utilized in practice, students must undertake higher levels of cognitive processing (evaluation and analysis), as detailed in Bloom's Taxonomy.[36] Higher-level thinking can allow for reflective practice to occur upon learning events and for future practice to be influenced by experiential learning.

We do acknowledge a number of limitations of our study. Respondents were from 12 of the 33 UK medical schools; we feel this number of high enough to be representative overall as curricula are designed to meet the GMCs outcomes for graduates.[25] The methods of content and delivery of teaching may have variations between schools. This is evidenced by Meats et al. (2009),[37] who showed variation in methods and content of medical school curricula but noted that most schools had the same core topics. The limited number of participants from a few medical schools may provide a non-representative sample of the HF teaching at those establishments. However, the overall opinion of these students regarding feelings and beliefs around HF is still valid. The recruitment methodology may lead to participation bias with initial reliance upon medical school societies to share the survey and limited response from administrators of establishments. We feel the data obtained is broad enough in scope to allow for the assessment of medical students' opinions regarding HF and to guide future educational planning.

Further research from this survey could explore the various teaching methodologies in more depth to identify the most effective and guide best educational practice. The survey can be expanded to explore the beliefs of post-graduate medical professionals about HF. The introduction of novel training curricula for postgraduate surgical training focusing on generic professional capabilities highlights a clear need for training in and acknowledgment of HF-related skills in professional practice. [35,36] The increased focus on HF could improve patient safety, patient care, and interdisciplinary work.[40,41]

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The research findings highlight several areas where specific development of teaching in aspects of HF can be undertaken. Whilst individual curricular changes would be under the remit of the medical school itself, and we would advocate for improved awareness of HF as a concept at an earlier stage of medical education to allow for the development of higher levels of thinking on the subject. We also note students' significant lack of confidence in challenging authority – which is, when appropriate, the safest course of action in clinical care. Further work on the nature of education and teaching in this specific topic is required and we would advise this to be an area of focus for educators. Students highlighted which teaching methods they perceived to be most effective (simulation, small group and one-on-one teaching), and this should be taken into account when planning educational delivery, although resource and time allocation has to be balanced against meeting course aims and objectives.

Minimal literature exists regarding student perceptions of HF teaching in UK medical schools. This research establishes that there is some awareness of the term HF, but most students believe it to be of significant importance as a part of their training. We have identified a number of areas within HF where teaching is almost universally performed, but some specific aspects of HF were identified as lacking. These areas could be focused on further improving undergraduate education. The most effective methodologies were perceived to be simulation and smaller group-based learning. These results can assist in the further development of undergraduate curricula and impact medical education methodology as a whole. Increasing awareness of HF will allow students to graduate with the skills to improve patient safety and healthcare delivery.

## Summary – Accelerating Translation

The International Ergonomics Association defines Human Factors (HF) as "a scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance". In the field of medicine, human factors or soft skills are generally understood to mean all the non-technical skills needed by doctors to perform efficiently in different clinical scenarios ranging from routine practice to high-stress emergency settings, such as trauma and resuscitation.

This research aims to describe the awareness of HF in medical students in the UK and establish their perception of HF teaching and confidence in soft skills.

A draft questionnaire was developed, and after refinement, the finalized survey was available online via a web link which was distributed through contacting medical student societies ("MedSoc") via e-mail. This contact outlined the aims of the study and provided a shareable web link to access the survey. A second phase followed up on the initial e-mail contact and contacted a selected range of medical school administrative offices where no

response was received in phase 1. The survey was available online for 5 months. Over the 5-month survey period, 304 students from 13 medical schools consented and completed the survey in full.

Headline results included the fact that 45.7% of participants stated that they were not aware of the term human factors from their training so-far. The questionnaire highlighted that a large proportion of students were extremely or somewhat confident in communication and leadership skills, but 50.5% were not at all confident in challenging authority. A range of teaching methodologies for teaching human factors were reported. Most frequently were small group based (n=252), lecture-based (n=219) and simulation (n=182). The opinion of participants on which teaching methodology was most effective was obtained. Simulated scenarios, small groups and one-to-one teaching were perceived as the best methods.

Students were asked to rank 10 human factors skills from one (most important) to ten (least important) compared to each other. This question established that communication (90%) and teamwork (47%) were ranked highly as important skills (% who rated this skill rank 1 or 2). The lowest-ranked aspects (% who rated this skill rank 9 or 10) were challenging authority (69%), reporting an error (37%) and coping with criticism (36%).

Understanding human factors can be seen as a threshold concept within medical education. Establishing this understanding allows for a shift in perspective in how individuals view and act in professional interactions. A transformation is required from a clinical-based viewpoint to a non-clinical to facilitate higher quality educational experiences for the student and to allow for growth both as a professional individual and as part of a multi-disciplinary team. For human factors to be fully utilized in practice, students are required to undertake higher levels of cognitive processing (evaluation and analysis), as detailed in Bloom's Taxonomy. Higher-level thinking can allow for reflective practice to take place upon learning events and for future practice to be influenced by experiential learning.

This research establishes that there is some awareness of the term human factors, but most students believe it to be of significant importance as a part of their training. We have identified a number of areas within HF where teaching is almost universally performed, but some specific aspects of human factors were identified as lacking. These areas could be focused on further improving undergraduate education. The most effective methodologies were perceived to be simulation and smaller group-based learning. The significance of these results in assisting the development of undergraduate curricula would impact medical education methodology as a whole. Increasing awareness of human factors will allow students to graduate with the skills to improve patient safety and healthcare delivery.

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# Original Article

## Supplementary Material

**The Education of Medical Students in Human Factors – Student Survey**

This short survey contains eight questions and seeks to establish what medical students are being taught about human factors, and how competent they consider themselves to be in some of the relevant areas.

To thank you for taking part in this survey, we are offering [1x£100 and 7x£50 amazon vouchers] as prizes. The winners of this draw will be chosen by the 7th May 2020. If you would like to be included in the draw to win one of our prizes, please enter your e-mail address on the last page of the survey.

Patient safety is an important aspect of medical education, constituting one of the four domains of a doctor's duties in the General Medical Council's publication Tomorrow's Doctors. The importance of technical skills in maintaining patient safety is well established; alongside this, there is an increasing appreciation of the importance of human factors. The term "human factors" describes an understanding of how human performance is affected by the behaviors of individuals, their relationship with each other, and their interaction with their environment. Within medicine, this includes a focus on the skills of communication, teamwork and leadership, improving systems to mitigate human error, and effective learning from such errors when they do occur. Human factors has been incorporated into training and development across many different industries, and is recognized as a key component of patient safety by bodies such as the World Health Organization and the Royal College of Nursing. The National Quality Board has committed to improving understanding of human factors and including it in its core training for health professionals. Thank you for participating – your input is very valuable to our research.

| | |
|---|---|
| 1. Do you consent to taking part in this survey? This gives us permission to include your anonymized responses as part of this research. | ☐I give my consent<br>☐I do not give my consent |
| **Basic Demographic Questions.** Before you start the survey, we would appreciate it if you could answer some brief demographic questions. * Indicates questions that must be answered to progress to the next page of the survey. | |
| 2. What is your gender? | ☐Male<br>☐Female<br>☐I prefer not to say |
| 3. What is your age? | |
| 4. Which medical school do you attend? | ☐Aberdeen<br>☐Anglia Ruskin<br>☐Aston<br>☐Barts and The London<br>☐Birmingham<br>☐Brighton and Sussex Medical School<br>☐Bristol<br>☐Buckingham<br>☐Edge Hill<br>☐Cambridge<br>☐Cardiff<br>☐Dundee<br>☐Edinburgh<br>☐Exeter<br>☐Glasgow<br>☐Hull York<br>☐Imperial College<br>☐Keele<br>☐Kent and Medway<br>☐King's College London<br>☐Lancaster<br>☐Leeds<br>☐Leicester<br>☐Liverpool<br>☐Manchester<br>☐Newcastle<br>☐Norwich (UEA)<br>☐Nottingham<br>☐Oxford<br>☐Plymouth University (Peninsula)<br>☐Queen's University Belfast<br>☐Sheffield<br>☐Southampton<br>☐St Andrews<br>☐St George's<br>☐Sunderland<br>☐Swansea<br>☐UCLAN<br>☐University College London<br>☐Warwick |

| | |
|---|---|
| 5. Which stage of the medical school course are you currently in? * | ☐First Year<br>☐Second Year<br>☐Third Year<br>☐Fourth Year<br>☐Fifth Year<br>☐Intercalating |
| **Awareness of Human Factors.** | |
| 6. During your medical education thus far, have you ever come across the term "human factors"? | ☐Yes<br>☐No |
| If yes, at which stage of your medical education did you first come across the term "human factors?" | ☐First Year<br>☐Second Year<br>☐Third Year<br>☐Fourth Year<br>☐Fifth Year<br>☐Intercalating |
| If no, have you ever come across either or both of the terms "soft skills" or "non-technical skills" during your medical education thus far? | ☐Yes<br>☐No |
| **Self-assessment of ability in non-technical skills.** | |
| 7. "Human factors" is broadly understood to include the following set of non-technical skills. How confident do you think you would be at applying these skills in real-life scenarios? | |
| Communication | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Leadership | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Teamwork | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Decision making | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Coping with stress | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Coping with criticism | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Situational awareness | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Task prioritization | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Reporting errors | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| Challenging authority | ☐Not confident at all<br>☐Somewhat confident<br>☐Extremely confident |
| 8. How would you rate your ability in these areas (teamwork, leadership, communication, etc.) compared to your ability in technical skills (e.g. venipuncture, cannulation, examining a patient, etc.)? | ☐I am more confident in technical skills<br>☐I am equally confident in both areas<br>☐I am more confident in "soft" skills or human factors |
| **Teaching of human factors** | |
| 9. "Human factors" is broadly understood to include the following set of non-technical skills. Have you ever received dedicated teaching in any of the following skills whilst at medical school? * | |
| Communication | ☐Yes ☐No |
| Leadership | ☐Yes ☐No |
| Teamwork | ☐Yes ☐No |
| Decision making | ☐Yes ☐No |

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| | |
|---|---|
| Coping with stress | ☐Yes ☐No |
| Coping with criticism | ☐Yes ☐No |
| Situational awareness | ☐Yes ☐No |
| Task prioritization | ☐Yes ☐No |
| Reporting errors | ☐Yes ☐No |
| Challenging authority | ☐Yes ☐No |
| 10. If you have answered yes at least once in question 9, which of the following methods of teaching have been used to teach you in those disciplines? * | ☐One-to-one teaching (e.g. shadowing a doctor in a clinical placement) <br> ☐Small group teaching <br> ☐Lectures <br> ☐Simulated scenarios <br> ☐E-learning <br> ☐None of the above |
| 11. How effective do you think each of the following teaching methods would be for teaching "human factors"? | |
| One-to-one teaching | ☐Not effective at all <br> ☐Somewhat effective <br> ☐Extremely effective |
| Small group teaching | ☐Not effective at all <br> ☐Somewhat effective <br> ☐Extremely effective |
| Lecture | ☐Not effective at all <br> ☐Somewhat effective <br> ☐Extremely effective |
| Simulated scenarios | ☐Not effective at all <br> ☐Somewhat effective <br> ☐Extremely effective |
| E-learning | ☐Not effective at all <br> ☐Somewhat effective <br> ☐Extremely effective |
| 12. Which do you think would be the most appropriate stage of medical education for learning about human factors? * | ☐Medical School – preclinical (Year 1-3) <br> ☐Medical School – clinical (Year 4-6) <br> ☐ Postgraduate training – foundation program <br> ☐Postgraduate training – core/specialty training <br> ☐Other – please specify |
| **Importance of human factors** | |
| 13. How important do you think it is that medical students are taught about human factors? | ☐1 – not important at all <br> ☐2 <br> ☐3 <br> ☐4 <br> ☐5 – extremely important |
| 14. Which do you think are the most important human factors? Please rank the following skills. A rating of 1 indicates the skill that you think is most important, whilst 10 indicates the skill that you think is least important. | __ Communication <br> __ Leadership <br> __ Teamwork <br> __ Decision making <br> __ Coping with stress <br> __ Coping with criticism <br> __ Situational awareness <br> __ Task prioritization <br> __ Reporting errors <br> __ Challenging authority |
| **End of survey** | |

# Medical Students' Awareness About Value-Based Health Care in Brazil: A Cross-Sectional Study

Gustavo Hirt,[1] Fernanda Gushken,[2] Guilherme Borges Gomes da Silva,[3] Daniel Lacerda Heringer,[4] Luciano Castro Gomes de Mello,[5] Daniel Tavares Malheiro,[6] Marcia Makdisse.[7]

## Abstract

**Background:** Rising healthcare costs demand a transition from the current fee-for-service to a Value-Based Health Care (VBHC) Model. This requires that all future doctors to understand the VBHC Model. We aimed to evaluate the VBHC awareness among Brazilian medical students and to identify it's associated intrinsic/extrinsic factors through a survey-based, cross-sectional study. **Methods:** An online survey was sent to students from Brazilian medical schools. A descriptive analysis based on participants' level of awareness about VBHC was performed. The categorical variables included were absolute and relative frequencies using chi-square tests. A multivariate binary logistic regression analysis was performed by calculating the odds ratio (OR) and 95% confidence intervals (95%CI) to compare each response according to VBHC awareness. **Results:** We collected 3030 responses from 148 Medical Schools across all Brazilian states. Medical students were compared into 2 groups; 1 was familiar with VBHC (14%; 426); 2 were not (86%; 2575). The univariate analysis showed that group 1 was more willing to share clinical outcomes/costs data related to their practice (57.04%) compared to 2 (48.12%), p<0.01. The multivariate analysis showed that internship experience was the most relevant factor associated with VBHC exposure (OR 4.32 [CI 95% 1.82 - 10.24]). **Conclusion:** We found that few medical students understand VBHC concepts, and that exposure was due to self-education efforts. Our results suggest that medical schools have the potential to reinforce both intrinsic and extrinsic factors related to students with regards to VBHC knowledge in order to prepare future doctors to practice in a value-driven context.

**Key Words:** Delivery of Health Care, Health Care Costs, Medical Students, Brazil (Source: MeSH-NLM).

## Introduction

Health care costs increase yearly, representing more than 10% of the world's Gross Domestic Product (GDP).[1] In the United States, 17.07% of the GDP is spent on health, while in Brazil, this rate is 11.77%.[1] However, spending more does not necessarily mean better quality of health. This dissonance between costs and quality results from the current payment model, fee-for-service, which promotes volume of services over outcomes achieved.[2] In 2006, Porter and Teisberg coined the term "Value-Based Health Care" to refer to a strategy aimed at restructuring health care systems and maximizing value for patients. In this proposal, value is the relationship between the outcomes that matter to patients and the costs required to achieve these outcomes.[3]

In Latin America, only a few initiatives have implemented Value-Based Health Care Models (VBHCs).[5-7] These initiatives are necessary to foster the transition from the current flawed model towards one focused on health promotion and outcomes, as well as require the timely inclusion of this topic in medical training programs.[7,8] In order to advance VBHC implementation, it is key to educate all healthcare stakeholders. An analysis of 255

citations of 12 VBHC trend-starting articles pointed out that although the VBHC discussion is spreading through medical journals, a significant proportion of the publications miss the exact understanding of the aspect they are discussing or referring to, and the authors conclude that diffusion of shallow knowledge is underway.[9] In Brazil, a survey conducted in a private nonprofit organization by Makdisse M et al demonstrated that the level of awareness of VBHC is still low among physicians, with only 27% percent of them being familiar with the VBHC concepts.[10] Of note, the percentage was 80% among physicians in executive roles[10]

An effective way to increase the awareness among healthcare professionals would be to include VBHC in medical and other health undergraduate programs curriculum. The first step is to understand the current context and degree of familiarity of medical students with VBHC core concepts. Currently, there are no published studies that assess this degree of awareness in future doctors. Therefore, this study aimed to evaluate the degree of awareness among Brazilian medical students about VBHC and to correlate the intrinsic and extrinsic factors with VBHC exposure. We hypothesize that this awareness is still low, especially due to

1 MD. Universidade de Passo Fundo, Passo Fundo, Brazil.
2 Fourth-year Medical Student. Faculdade Israelita de Ciências da Saúde Albert Einstein Brazil.
3 MD. Pontifícia Universidade Católica de São Paulo, Sorocaba, Brazil.
4 Sixth-year Medical Student. Faculdade de Medicina de Ribeirão Preto - Universidade de São Paulo, Ribeirão Preto, Brazil.

5 MD. Universidade de Passo Fundo, Passo Fundo, Brazil.
6 MSC. Hospital Israelita Albert Einstein, São Paulo, Brazil.
7 MD, PhD, MBA. Academia VBHC, São Paulo, Brazil.

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the recent advent of the topic and its absence in a formal medical school curriculum. In this way, beyond spreading the value concepts, we may establish a baseline level of VBHC awareness and compare it with post-intervention assessments.

## Methods

This cross-sectional study was based on an electronic survey applied to medical students from 148 Brazilian medical schools located in the five Brazilian regions, including both public and private schools.

The eligibility criteria consisted of medical students enrolled in Brazilian medical schools between January 2019 to December 2020 and who signed an electronic consent form. The selection method was online-based, with the survey sent through social media, email, and WhatsApp® with no paid advertisements. The survey was open from November 2019 to June 2020. In order to prevent selection bias, the survey was advertised beyond the direct connections of the authors. The authors contacted student organizations from universities in all states of Brazil to assist with adverting. Due to the exploratory nature of this study, the sample size was not calculated. This study was approved by the ethical committee from Universidade Passo Fundo (Brazil) with the reference number 3.681.791 and received no funding.

The survey questions (*Supplementary Material*) were developed based on a similar study adapted to the Brazilian context.[11] The primary endpoint was to determine the self-reported level of awareness of Value-Based Health Care among medical students. Secondary endpoints were to assess intrinsic and extrinsic factors related to this level of awareness. Intrinsic factors included age, gender, previous college degree obtained, medical area of interest, interest in pursuing academic programs other than medical school, participation in extracurricular activities, and interests beyond the medical field. Extrinsic factors included the medical school year, the university name, its location, whether management and health systems classes were included in the curriculum, teaching methodology, and the existence of a health management/health consulting club at their institution.

To compare students regarding their level of awareness of VBHC, answers to Question 6 (How do you rate your degree of familiarity with the topic "Value-Based Healthcare"?) on the online survey were transformed into binary variables, where "yes" (high level of awareness on VBHC) was considered if options "a, b or c" had been selected, and no (low level of awareness on VBHC) for all of the others, in order to make groups homogeneous and to reduce the degrees of freedom of the variables.

A descriptive analysis based on participants' level of awareness about VBHC was performed. The continuous variables were mean standard deviation, median, and interquartile range. The normality assumptions were tested a priori. When normality assumptions were met, t-tests were performed, if not, non-parametric tests (Mann-Whitney U or Kruskal-Wallis) were used.

The categorical variables included were absolute and relative frequencies using chi-square tests. A multivariate binary logistic regression analysis was performed by calculating the odds ratio (OR) and 95% confidence intervals (95% CI) to compare each response according to VBHC awareness. The software used for statistical analysis was R version 3.6.0. Statistical significance considered was 5%.

## Results

### Descriptive Analysis

A total of 3,030 medical students completed the survey, corresponding to 148 institutions across 24 states of Brazil and the Federal District. Thirty-three responses were excluded due to lack of signed consent or incomplete information (*Figure 1*). Among included participants, 63.6% were female, and the mean age was 22.6 years old, with a standard deviation of 3.1 years. Male respondents had a mean age of 22.7 years and a standard deviation of 3.6 years. Regarding the medical students' profile, 34% were in 1st and 2nd year, 38% in 3rd and 4th year, and 28% in 5th and 6th year. The last two medical school years in Brazil are equivalent to the clinical rotation years in the United States.

*Figure 1.* Flowchart of Participant Responses.
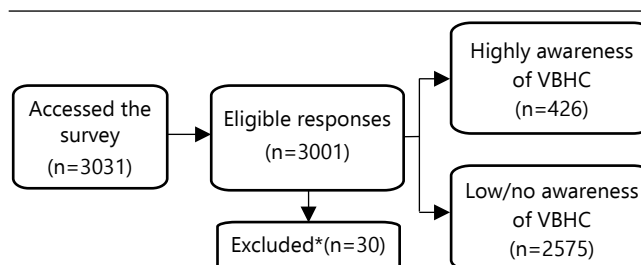


**Legend:** *Excluded responses were due to no consent form signature or absent response on the degree of VBHC awareness.

In *Table 1*, we divided participants into two groups: group 1 consisted of students who declared to be familiar with VBHC (14.19%; 426) and group 2 with those who were not (85.81%; 2575). Among all participants, 53.91% correctly identified Porter's concept of Value, with no statistical significance between the two groups. However, group 1 was more likely to know Porter's Value equation (9.39% vs 0.43%; p<0.01) and to indicate both components of the formula correctly in order, outcomes (14.08% vs 4.97%; p<0.01) and costs (17.37% vs 5.75%; p<0.01). Altogether, only 4.19% of participants got Porter's formula correct. Regarding their future as healthcare professionals, group 1 noted that knowing the costs of care would impact their practice (82.63% vs 78.64%; p=0.02) and considered that health outcomes should play a key role in reimbursement for care delivery (49.53% vs 41.51%; p<0.01). Likewise, they were more open to being evaluated and compared to other doctors by patients (32.86% vs 25.36%; p <0.01).

*Table 1.* Students Characteristics and Career Interests According to Value-Based Health Care (VBHC) Awareness.

| Variable | High level of awareness on VBHC (n=426) | Low level of awareness on VBHC (n=2575) | p-value |
|---|---|---|---|
| Gender, n (%) | | | |
| Female | 242 (56.81) | 1670 (64.85) | p <0.01 |
| Male | 184 (43.19) | 905 (35.5) | |
| Progression in Medical School, n (%) | | | |
| 1st year | 49 (11.15) | 354 (13.75) | |
| 2nd year | 81 (19.01) | 538 (20.89) | |
| 3rd year | 107 (25.12) | 642 (24.93) | p=0.29 |
| 4th year | 67 (15.73) | 323 (12.54) | |
| 5th year | 65 (15.26) | 402 (15.61) | |
| 6th year | 57 (13.38) | 316 (12.27) | |
| Does your university have a mandatory healthcare management class? n (%) | | | |
| Yes | 170 (39.91) | 742 (28.82) | |
| No | 100 (23.47) | 627 (24.35) | p<0.01 |
| No, but there is an optional | 23 (5.4) | 120 (5.47) | |
| I don´t know | 133 (31.22) | 1086 (42.17) | |
| Do you have any previous college degree? n (%) | | | |
| Yes | 30 (7.04) | 120 (4.66) | p=0.02 |
| No | 396 (92.96) | 2455 (95.34) | |
| What is your medical area of interest? n (%) | | | |
| Internal Medicine | 233 (54.69) | 1514 (58.8) | p=0.09 |
| Surgery | 192 (45.07) | 1138 (44.19) | p=0.71 |
| Management | 50 (11.74) | 156 (6.06) | p<0.01 |
| Research | 73 (17.14) | 349 (13.55) | p=0.03 |
| Do you have interest in pursuing academic programs other than medical school? n (%) | | | |
| Residency Program | 416 (97.65) | 2539 (98.6) | p=0.1 |
| Masters /PhD | 241 (56.57) | 1400 (54.37) | p=0.36 |
| MBA | 85 (19.95) | 218 (8.47) | p<0.01 |
| What extracurricular activities have you engaged in? n (%) | | | |
| Students/Sports Associations | 148 (34.74) | 698 (27.11) | p<0.01 |
| Junior Enterprises | 23 (5.4) | 32 (1.24) | p<0.01 |
| Startups | 18 (4.23) | 22 (0.85) | p<0.01 |
| NGOs | 59 (13.85) | 207 (8.04) | p<0.01 |
| Do you have any interest beyond healthcare? n (%) | | | |
| Research | 225 (52.82) | 1207 (46.87) | p<0.01 |
| Innovation | 186 (43.66) | 919 (35.69) | p<0.01 |
| Patient Safety | 156 (36.62) | 697 (27.07) | p<0.01 |
| Healthcare Economics | 292 (68.54) | 2079 (80.74) | p<0.01 |
| Artificial Intelligence | 132 (30.99) | 500 (19.42) | p<0.01 |
| Healthcare Policies | 155 (36.38) | 671 (26.06) | p<0.01 |

With respect to intrinsic factors, group 1 was more familiar with payment models (global budget [55.87% vs 42.6%], fee-for-service [57.04% vs 49.28%], bundles [23.24% vs 12.58%] and pay-for-performance [19.01% vs 9.55%], all p<0.01). The same students were more likely to have completed another undergraduate course before medical school (7.04% vs 4.66%; p=0.02) and to participate in student organizations (34.74% vs 27.11%; p < 0.01), NGOs (13.85% vs 8.04; p<0.01), or Junior Enterprises (5.4% vs 1.24%; p<0.01). Moreover, they intended to follow careers in management (11.74% vs 6.06%; p<0.01) and pursue a Master's in Business Administration (MBA) in the future (19.95% vs 8.47%; p<0.01). Finally, they showed more interests in fields others than medical practice, such as innovation (43.66% vs 35.69%; p<0.01), research (52.82% vs 46.87%; p=0.01), patient safety (36.62% vs 27.07%; p<0.01), health economics (31.46% vs 19.26%; p<0.01), and health policy (36.38% vs 26.06%; p<0.01).

With regards to teaching methodology, students familiar with VBHC were more often taught through active learning methodologies (Problem-Based Learning [11.5% vs 10.83%;] and Team-Based Learning [10.33% vs 5.67%]; p<0.01). Similarly, those aware of VBHC were more often required to attend a mandatory healthcare management course (39.91% vs 28.82%; p<0.01) where payment models were debated (15.02% vs 8.04%; p<0.01) and were also more likely to attend optional management lectures (47.89% vs 23.82%; p<0.01) and participate in Junior Enterprises (10.56% vs 5.01%; p<0.01).

**Multivariate Analysis**

The multivariate analysis presented in *Table 2* showed that the most frequent way of contact with VBHC concepts cited by respondents was through internships (OR 4.32, 95%CI 1.82 - 10.24). We hypothesize that students seeking job opportunities during medical school are more inclined to actively learn by themselves and to stay updated on market trends. Similarly, group 1 was more likely to know Porter's Value Formula (OR 6.95, 95%CI 1.74 - 27.9) and to recognize the importance of discussing clinical outcomes during medical school (OR 20.83, 95%CI 1.59 - 272.11). We recognize that future studies are necessary to investigate whether extrinsic factors could increase VBHC awareness. In this study, we found that medical school classes were not a source of VBHC exposure (OR 1.44, 95%CI 0.83 - 2.5). Likewise, the discussion of payment systems in medical school curricula was not significantly correlated to VBHC knowledge (OR 1, 95%CI 0.29-3.42).

**Table 2.** Results of a Multivariate Analysis Used to Determine Which Factors are Associated with High Value-Based Health Care (VBHC) Awareness Compared to Low VBHC Awareness.

| Variable | OR (95%CI) | Respondents (Yes) |
|---|---|---|
| Previous exposure to VBHC | 12.53 (7.53 - 20.85) | 599 |
| Exposure to VBHC through internships | 4.32 (1.82 - 10.24) | 73 |
| Exposure to VBHC through conferences and lectures | 1.71 (0.99 - 2.94) | 194 |
| Exposure to VBHC through extracurricular activities | 1.62 (0.87 - 3.0) | 126 |
| Exposure to VBHC through articles | 1.57 (0.67 - 3.71) | 66 |
| Exposure to VBHC through medical school classes | 1.44 (0.83 - 2.5) | 191 |
| Do you know the "Value" formula presented by Porter and Teisberg (2006)? | 6.95 (1.74 - 27.9) | 51 |
| Do you consider it important to discuss "outcomes" during medical school? | 20.83 (1.59-272.11) | 2949 |
| Do you consider it important to discuss "costs" during medical school? | 0.38 (0.1-1.5) | 2907 |
| Do you consider it important to discuss "payment systems" during medical school? | 1 (0.29 - 3.42) | 2882 |
| Are you aware of any payment system? | 0.5 (0.27-0.93) | 1908 |
| Do you think that knowing the costs of your medical practice influences how you practice medicine? | 1.02 (0.62 - 1.67) | 2377 |
| Do you think that knowing the outcomes of your medical practice influences how you practice medicine? | 1.22 (0.52 - 2.85) | 2795 |
| Would you be willing to have the outcomes and costs of your medical practice monitored and compared to other physicians' performance? | 1.1 (0.47 - 2.6) | 2901 |
| Would you be willing to share data of the outcomes and costs of your medical practice in order to contribute to reduce costs and improve healthcare quality? | 1.45 (0.94 - 2.23) | 2737 |

*Legend:* CI=Confidence intervals, OR=odds ratio. In bold, we presented the results with significant p values (p <0.05)

## Discussion

In this study, only 14.19% (426) of the assessed population was found to be familiar with VBHC concepts, a rather small percentage of students considering the implications of this sample representing part of the future healthcare workforce in Brazil. We have not found any previous studies that analyzed the familiarity of medical students with VBHC. Compared to doctors in a top-tier, non-profit hospital in Brazil, this percent is also low (14.19% vs 27%).[10] This result suggests that most doctors do not know VBHC concepts and, when they are familiar with them, the exposure happens mostly after they graduate from medical school. Although it is recognized that VBHC is essential to prepare doctors for 21st-century medical practice, several barriers delay this part of education.[12] Therefore, we stand by the hypothesis that VBHC concepts are unknown to most of the future and present medical workforce in Brazil.

The medical students who declared to be familiar with VBHC share specific intrinsic and extrinsic traits. Some characteristics depended primarily on the medical school, such as a mandatory Health Management course, which increases the likelihood of a student being familiar with VBHC concepts (39.91% vs 28.82%). Less than half of the students who declared they had a mandatory management discipline were familiar with VBHC, which points out that this concept is still not a strong facet of the curriculum in medical schools. The existence of a Healthcare Systems discipline, present in more than 90% of the Brazilian medical schools reported, did not increase the likelihood of familiarity with VBHC.

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In the United States, despite the effort to include VBHC in medical education through Health Systems Sciences, the VBHC curricula remain non-uniform, varying from multi-year activities during medical school to brief didactic sessions during clerkships.[13] In a recent survey in the US, clerkship directors cited a lack of generalizable curricular materials and local faculty expertise as the main barriers to implementing VBHC education.[14] In order to address these challenges, Dell Medical School at the University of Texas in Austin has incorporated VBHC into the undergraduate curriculum. Throughout the four years of training, students are introduced to the core concepts of VBHC, and they experiment with VBHC-in-practice during their clinical rotations in UT Health Austin's affiliated clinics that have implemented Integrated Practice Units for different medical conditions. Through a partnership with the Value Institute for Health and Care, third-year medical students are also offered the opportunity to participate in a dual degree program, including the Master of Science in Health Care Transformation, which equips health care professionals to lead change, catalyze transformation, and create high-value services in their field. Students can also access the open-online interactive modules called 'Discovering VBHC,' aimed at teaching the foundations of VBHC to different types of health professionals and also can be accessed and incorporated independently across diverse educational settings.[14]

The other two examples of VBHC curriculum implementation are The Mayo Clinic Alix School of Medicine (MCASOM) and Harvard Medical School (HMS). MCASOM developed a program that aims "to ensure that graduating medical students enter residency prepared to train and eventually practice within person-centered, community- and population-oriented, science-driven, collaborative care teams delivering high-value care."[15] This objective is pursued through a four-week course distributed throughout four years of medical school. The course is organized around six domains, one being the High-Value Domain, which focuses on three main desired outcomes: applying scientific literature in patient care, improving the system, and balancing quality and cost in patient care.[16] In HMS, students take two four-week courses. The first one, applied during the first year of medical school, covers foundational topics in clinical epidemiology and population health, health policy, social medicine and medical ethics. The second (after a minimum of 12 months of clinical rotations) includes advanced topics in these disciplines, and is taken in collaboration with Harvard Business School (HBS), using the case method, with which they provide detailed information about a single organization to focus in-class discussions around key elements of VBHC.[16]

Furthermore, a significant proportion of the students familiar with VBHC concepts share intrinsic traits, partially dependent on medical schools. Interest in following a career in management and a desire to pursue an MBA almost doubles the likelihood of a student being familiar with VBHC, 11.74% vs 6.06% and 19.95% vs 8.47%, respectively. Moreover, engagement in extracurricular activities exposes students to VBHC concepts and increases

students' awareness of VBHC concepts (16.16% vs 11.74%), demonstrating that this knowledge is still mostly reserved for the students open to seeking knowledge outside the medical school education. Therefore, medical schools interested in promoting VBHC knowledge among their students are more likely to achieve this objective not only through required VBHC curricula but also by promoting extracurricular activities. According to the multivariate analysis presented in *Table 2*, the most frequent way respondents contact VBHC concepts was through internships. Although this result may seem to minimize the effect of intrinsic factors on VBHC knowledge, we believe that successful strategies need to mix both intrinsic and extrinsic factors.

We believe that familiarity with VBHC concepts is correlated to future professional decisions. Based on the survey, there is a correlation between being familiar with VBHC and accepting to have outcomes and costs monitored and compared to peers' data. Also, students familiar with value-based health care are more prone to accept a salary amount according to outcomes and rankings by patients. Therefore, exposing medical students to the concepts of VBHC early in their careers might facilitate future attempts to implement the value agenda.

The limitations of this study include the inherent factors of a cross-sectional study with voluntary participants, the uneven distribution of responses in the country, and the absence of a validated questionnaire. Although we had a representative sample including participants from all states of Brazil, most (86%) of the responses were from southern and southeastern universities, which correspond to the regions where most Brazilian medical schools are located (58%). Furthermore, since all medical schools adhere to a national curriculum under the Brazilian Ministry of Education, we believe that the responses acquired from this study have a relatively high external validity. Another limitation to this study is the absence of a validated questionnaire, including objective measures to evaluate VBHC familiarity, with the exclusive use of the subjective perception of self-awareness about the subject, which can vary widely among survey responders. Furthermore, an active search to analyze curricula of the Brazilian medical schools was not conducted but analyzed indirectly through student reports.

One of the purposes of this study is to spread the word on the VBHC strategy among future healthcare professionals in Brazil, which justifies the selection specifically of the Brazilian population of medical students. Future perspectives include the implementation of interventions to promote the learning of VBHC in undergraduate medical education and the international analysis of VBHC familiarity among medical students from several countries.

## Summary - Accelerating Translation

**Título:** Avaliação da Familiaridade dos Estudantes de Medicina no Brasil sobre Cuidado à Saúde Baseado em Valor: um estudo transversal.
**Problema:** O aumento constante dos custos com saúde exige uma transformação do modelo atual caracterizado por fragmentação do cuidado e pagamento por serviço (fee-for-service) para um modelo de Cuidado à Saúde Baseado em Valor (VBHC). Para que isso seja feito, é fundamental que os futuros

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médicos entendam a teoria por trás do VBHC. **Objetivo:** O objetivo desse estudo foi identificar o nível de familiaridade sobre VBHC entre estudantes de medicina no Brasil e identificar fatores intrínsecos e extrínsecos associados com essa familiaridade. **Métodos**: O trabalho é um estudo transversal, ou seja, uma foto da situação, baseado em um questionário online aplicado a estudantes de medicina de Escolas de Medicina brasileiras. Realizamos uma análise descritiva baseada no nível de familiaridade dos estudantes e uma análise de regressão logística para calcular as probabilidades e intervalos de confiança de cada uma das respostas conforme o grau de familiaridade em VBHC. **Resultados:** Coletamos respostas de 3030 respondentes, representando 148 Escolas de Medicina de todos os Estados Brasileiros. Os estudantes de medicina foram comparados em 2 grupos; o grupo 1 representa aqueles familiarizados com VBHC (14%; 426); já o grupo 2, aqueles não familiarizados (86%; 2575).

Observando cada uma das variáveis, o grupo 1 era mais propenso a compartilhar dados clínicos e de custo relacionados a sua prática assistencial (57.04%) em comparação ao grupo 2 (48.12%), p<0.01. Já observando múltiplas variáveis, experiências prévias com estágios foi o fator mais relevante relacionado à exposição à VBHC (OR 4.32 [IC 95% 1.82 - 10.24]). **Conclusão:** Descobrimos que poucos estudantes de medicina entendem os conceitos de Cuidado à Saúde Baseado em Valor e que sua exposição ao assunto, quando presente, estava relacionada a esforços individuais, sem relação com as Escolas onde estudam. Nossos resultados sugerem que as Escolas Médicas possuem potencial de reforçar tanto fatores intrínsecos, quanto extrínsecos relacionados aos conhecimentos de VBHC para preparar os futuros médicos para atuarem em um contexto de saúde orientado a Valor.

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## Supplementary Material

*Research Instrument.* Online questionnaire sent to medical students.

**1. Email Address**

**2. Informed Consent Form attached**
I agree
I do not agree (survey ends if this button is clicked)

**3. I am a medical student with active enrollment in the current semester**
Yes
No (survey ends if this button is clicked)

**Awareness of VBHC**

**4. Have you ever had contact with the subject of Value-Based Healthcare?**
Yes
No

**5. If you answered "YES" in the previous question, how did you get in touch? (Open question)**
University Lectures
Extracurricular activities
Internships, professional experiences
Scientific Articles
Congresses and seminar lectures
Electronics (YouTube, TED, Coursera, edX or other platforms)
Courses
Other:

**6. How do you rate your degree of familiarity with the topic "Value-Based Healthcare"?**
I am enthusiastic about the topic, and I try to keep myself updated on initiatives involving VBHC.
I am familiar with the topic and have already read some articles or attended lectures on the topic.
I am familiar with the topic but have never read articles or attended lectures on the topic.
I had little contact with the topic, and I don't feel comfortable discussing it.
I never had contact with the topic.

**7. How do you define "Value" in Health?**
It is the patient's perception of the benefits obtained from the treatment in relation to the amount paid for it, regardless of the clinical result.
It is the amount of money paid for treatment.
Achieve a high degree of patient satisfaction even if clinical results and costs are outside expected values.
Clinical results (outcomes that matter to the patient) obtained in relation to the costs to achieve these outcomes.

**8. In your opinion, how important should each of the following factors be in defining the remuneration for the medical service?**

|  | 1. Irrelevant | 2. Not very important | 3. Important | 4. Very Important | 5. Fundamental |
|---|---|---|---|---|---|
| Quantity of services provided |  |  |  |  |  |
| Time spent in the service |  |  |  |  |  |
| Complexity of the service |  |  |  |  |  |
| Outcomes delivered at the end of the service |  |  |  |  |  |

**9. When you graduate, you intend to:**
Work as a self-employed physician.
Work as an employee in a fixed institution or practice.
Act as an employee physician in a fixed institution or practice and maintain some degree of self-employment.
I do not know.

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**10. Do you think that knowing the outcomes of your clinical practice influences how you carry out your clinical practice?**
Yes, knowing the costs influences the way I do my clinical practice.
No, knowing the costs doesn't change the way I do my clinical practice.
I do not know.

**11. Do you think that knowing the costs related to your clinical practice influences the way you carry out your clinical practice?**
Yes, knowing the costs influences the way I do my clinical practice.
No, knowing the costs doesn't change the way I do my clinical practice.
I do not know.

**12. Would you be willing to have the outcomes and costs of your clinical practice continuously monitored and compared to the performance of other physicians?**
Not willing
Willing if there was clarity of individual benefit
Willing if there was clarity of collective benefit
Willing if data were anonymous

**13. Would you be willing to share data related to the outcomes (outcomes) and costs of your clinical practice for the benefit of cost reduction and improvement in the quality of healthcare?**
Not willing
Willing if there was clarity of individual benefit
Willing if there was clarity of collective benefit
Willing if data were anonymous

**14. Would you be willing to be evaluated and ranked against other physicians by patients?**
Not willing
Willing
Willing if data were not released to the public
Willing if there was a way to assess extreme opinions before releasing it to the public

**15. Do you know the formula that defines "Value" developed by Porter and Teisberg (2006)?**
Yes             No

**16.Check the components of Porter's "Value" formula, which defines the Value-Based Healthcare components:**

|                    | Numerator (check one) | Denominator (check one) |
|--------------------|------------------------|--------------------------|
| Cost               |                        |                          |
| Price              |                        |                          |
| Outcomes           |                        |                          |
| Satisfaction       |                        |                          |
| Expectation        |                        |                          |
| Benefits           |                        |                          |
| I do not know      |                        |                          |

**17. How important do you think it is to discuss Outcomes, Costs, Compensation Systems and Value-Based Health Care (VBHC) during graduation?**

|                 | 1. Irrelevant | 2. Not very important | 3. Important | 4. Very Important | 5. Fundamental |
|-----------------|---------------|------------------------|--------------|--------------------|-----------------|
| Outcomes        |               |                        |              |                    |                 |
| Costs           |               |                        |              |                    |                 |
| Payment systems |               |                        |              |                    |                 |
| VBHC            |               |                        |              |                    |                 |

**18. Are you familiar with the functioning of the different compensation models for health services practiced in Brazil? Check all that you think are familiar.**

**-Payment by global budget:** The hospital receives a fixed annual fee, generally based on the history of the volume of care and the complexity of the services offered. This model predominates in public hospitals. The model may include penalties (deductions) based on pre-agreed indicators.

**-Payment by global adjusted budget**: Similar to the item above, but includes the possibility of period adjustments, generally every 3 or 4 months, based on volume, complexity and pre-agreed indicators that define a penalty or bonus.,

**-Payment for service - "open account" (Fee-for-service):** The provider (hospital, laboratory or doctor) receives for each service provided, regardless of the result obtained with the treatment.

**-Payment for care - "procedure packages" or "managed procedures" (Fee-for-service):** The provider (hospital, laboratory or doctor) receives per a package that includes services directly linked to the care provided and excludes other care that may be provided due to complications or complications. These extra items are charged "Out of the package."

**-Payment for care - "inpatient global per diem" (Fee-for-service):** The hospital receives a single fee for a set of services negotiated between the parties, which includes daily rates, most nursing procedures, gas therapy, use of equipment, etc.,

**-Episode Bundles:** The provider receives a single fee per episode of care, including diagnostic evaluation, hospitalization for the performance of procedures and the post-discharge period, including guaranteeing coverage of complications related to the procedure for a predetermined period and performance guarantee that may generate bonuses or penalties based on pre-defined indicators.,

**-Payment by Related Diagnostic Groups (DRG or similar):** The provider receives based on the classification of each case by diagnostic grouping. The DRG gives a different weight according to a set of clinical conditions and procedures performed. Ex: A patient hospitalized with myocardial infarction and has diabetes and kidney failure has a lower weight than a patient without the last 2 conditions; therefore, the remuneration of the first will be higher.

**-Payment per Capitation**: O provider receives a defined value for each registered person assigned to it for a while, regardless of the services that each person will use

**-Payment for Performance, P4P:** The provider receives remuneration according to the performance presented in the pre-defined indicators. Ex: P4P for Diabetes: A basal remuneration is defined, and a bonus will be assigned according to the number of patients with glycated hemoglobin < 7.

**-I am not familiar with any of the compensation models.**

**Student and University Profile**
**19. What is your full name?**
**20. How old are you in years?**
**21. What is your gender?**
Male            Female            Others

**22. Where do you study medicine (University and Local)? Ex: USP - Ribeirão Preto/SP**
**23. What year of college are you in? Write in years, between 1-6**
**24. What is your registration number?**
**25. Does your college have any mandatory subjects in Health Management?**
Yes
No
No, but it has an optional class
I do not know

**26. If you answered "YES" in the previous question: Throughout this mandatory subject of Health Management, is the theme of Health Compensation Systems discussed?**
Yes
No
I do not know

**27. Does your college usually offer lectures, symposia or other complementary training on Health Management topics?**
Yes
No
I do not know

**28. During graduation at your university, does any chair discuss Health Systems? (SUS, NHS…)**
Yes
No
I do not know

**29. Does your university have an Academic Club of Health Management?**
Yes
No
I do not know

**30. Does your university have a Junior Medical Enterprise?**
Yes
No
I do not know

**31. What is your university's teaching methodology?**
Traditional
Problem-Based Learning
Team-Based Learning

**32. Did you complete another undergraduate degree before medicine? If the answer is "YES", which one(s)?**
Open question

**33. What areas do you intend to pursue in medicine?**
Clinical                          Management                          Radiology
Surgery                           Research                            I do not know

**34. What training do you intend to do in addition to a medical degree?**
Residency
Master's/Doctorate
MBA
I do not intend to carry out any of these

**35. Do you participate or have participated in any extracurricular activities? Which ones?**
Academic Clubs
Academic, Athletic Center/Directory
AEMED, DENEM, IFMSA, COUNCILS, UNIONS
Junior enterprises
Startup
NGOs
I do not participate in any extracurricular activities.

**36. Do you have any interests other than medical care?**
Research
Innovation
Patient safety
Quality
Health Economics
Artificial intelligence
Health policies
No interest beyond medical care

# A Pilot Study of Reducing Test Anxiety in a Cohort of Underrepresented in Medicine MCAT Students Using Near-Peer Coaching

Benjamin Liu,[1] Allen Hodge,[2] Crystal Jushka,[3] William J Hueston.[4]

## Abstract

**Background:** The Medical College Admission Test (MCAT) is a standardized exam taken by prospective medical students. The MCAT is critical for success in most of the US and parts of Canada, and such pressures may enhance test anxiety. Students from Underrepresented in Medicine (URM) backgrounds are often compounded by being the first in their families to take the MCAT. **Methods:** We conducted a literature review for interventions on test-related anxiety. Based on our findings, we elected to establish a pilot near-peer coaching (NPC) program for URM students enrolled on the Medical College of Wisconsin MCAT program. We quantified baseline and specific time point test-anxieties using the validated Westside test anxiety scale. We asked about MCAT concerns and program impressions via a free-response section and analyzed the results with inductive analysis. **Results:** Our review could find no other studies examining MCAT-related test anxiety in the prospective medical student population. NPC was chosen because of its accessibility. At baseline, approximately 50% of students had at least moderately high-test anxiety, meeting the threshold for intervention. Most students perceived themselves as unconfident in their ability to do well on the MCAT. We observed a decrease in test anxiety after coaching sessions. Students received the program well; however, they wanted to be able to choose the content and number of meetings. **Conclusion:** This observational pilot study suggests that URM pre-medical students have MCAT-related test anxieties high enough to warrant intervention and that NPC is well-received and correlates to reduce test anxiety levels.

**Key Words:** Students; Anxiety; Stress; College admission test; Test Anxiety scale (Source: MeSH-NLM).

*ClinicalTrial.gov identifier*: NCT05224427

## Introduction

The Medical College Admission Test (MCAT) is a standardized exam taken by prospective medical students in the United States. It includes 4 sections deemed important skills for future physicians: Chemistry and Physics, Critical Analysis and Reading Section, Biology and Biochemistry, and the Psychology and Sociology sections. The test is roughly 7.5 hours long, with each section containing multiple passages with questions related to the excerpts. Many prospective medical students spend months, even years, preparing for this test. These students understand that the MCAT is a critical component of every medical school application and that not scoring well often means rejection and/or having to re-take the exam multiple times. Naturally, prospective medical students are anxious about this exam. While helpful in certain amounts, test anxiety can be extremely detrimental to one's performance. Studies have shown that heightened test anxiety leads to worse outcomes on the United States Medical Licensing Step 1 exam, undergraduate students' GPA, nursing licensure tests, and even the ability to engage in new instructional content.[1-3]

In the United States, as per the American Association of Medical Colleges, "Underrepresented in Medicine (URM) students are students from racial and ethnic backgrounds relative to their numbers in the general population".[4] This includes students from various backgrounds, including Black, Mexican American, Native American, and mainland Puerto Rican backgrounds. For example, when adjusting for the total population of Hispanic individuals in the United States, Hispanic medical school applicants and matriculants are underrepresented by nearly 70%.[5] Some pre-medical students have the advantage of support from a family member or close friends who have gone through the process and can help mitigate MCAT-related test anxiety. Unfortunately, URM students often are the first in their families to take the MCAT and often have socioeconomic backgrounds that prevent them from accessing expensive MCAT preparatory courses. Factors such as stereotype threat and inadequate access to mentors have also been cited as additional obstacles URM students must overcome.[6,7] While not officially studied, all of this may lead to an increased level of MCAT-related test anxiety. Finally, based on the author's personal experience, most existing MCAT preparatory courses focus on training the students on exam content and strategy needed instead of recognizing the role test anxiety may play.

To address this gap, we conducted a literature review to explore effective test anxiety coaching interventions. We then discuss a program we created for a cohort of URM students enrolled in an existing MCAT training program, which focuses on near-peer

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coaching provided by current medical students at the Medical College of Wisconsin (MCW). Near-peer coaching model was chosen due to the ability of medical students to share stories from their recent "lived experiences" as pre-medical applicants. In addition, we elected to follow the students in a longitudinal, observational study, due to ethical reasons. From this cohort, we report the quantitative test anxiety levels in this cohort at specific intervals: at baseline and after each coaching session. Finally, we report the qualitative responses from students in terms of their MCAT-related concerns and perceptions of the near-peer coaching program.

## Methods

### Study-Design
The study began with phase 1 of a literature review for other interventions on test-related anxiety. Based on these results, near-peer coaching was chosen as the intervention for Phase 2 of the study. The proposed study designs were approved by the Medical College of Wisconsin's Institutional Review Board (PRO00035403), with clinical trial identifier NCT05224427. Phase 3.1 and phase 3.2 analyzed the quantitative and qualitative results gathered from the coaching.

### Part 1: Literature Review
To determine what other interventions for test-related anxiety were reported, two independent, masked reviewers conducted a literature review with no time limit with the last search on May 11th, 2021, on OVID Medline and APA psychINFO. Studies included were primary literature investigating the effect of an intervention on student test anxiety. Due to the limited literature available, students of any level were deemed acceptable for analysis purposes. Exclusion criteria were any studies that did not report the effect of the intervention on student test anxiety or studies that did not examine test anxiety specifically. The medical subject headings (MeSH) included: "Students", "Anxiety", "Stress", "College admission test", and "Test Anxiety scale". Key terms included "Anxiety", "anxiousness", "Exam", and "test anxiety". The Boolean operator AND and OR were used to link the above-mentioned terms. Any duplicate results were removed. Studies included were English language only. Appropriate variations were also used to account for plurals and other alternatives. A manual search of study reference lists was conducted to include any potentially missed publications. Any disagreements were resolved via consensus. A review of the results prompted the authors to propose near-peer coaching as the optimal test anxiety intervention for the context.

### Part 2: Near-Peer Coaching
The proposed study occurred in person at the Medical College of Wisconsin or online via video conferencing. A previous Medical College of Wisconsin (MCW) MCAT training program for URM students was started in 2017, and we enrolled all twenty-two students from this program within the first year and all twelve students in the second year. All participants enrolled in the MCAT program were from Wisconsin and they attended undergraduate or finished undergraduate studies within the past 5 years and intended to apply to medical school.

Volunteer near-peer mentors were recruited from existing MD or MD-PhD candidates at MCW. Coaches were oriented at the beginning of each program year and periodically sent reminders and instructions on what to cover. Initial MCAT coaching meetings were instructed to cover study schedules, effective studying, and exam strategy, while later coaching meetings recommended coaches share their stories of how they dealt with test anxiety, strategies to deal with test anxiety (i.e. visit the test center a week before, positive mentality about wrong answers during practice, and increasingly practicing under test-day conditions), and for open discussion with the student about how they were feeling. Coaches were provided cheat sheets leading up to these sessions that recommended how to approach these conversations. In response to student concerns about feeling limited by these topics, we no longer instructed, but recommended these topics to be covered in the program's 2nd year.

Students were consented and oriented in a group, or individual setting, and surveys were distributed via Qualtrics^XM for baseline, after a mock MCAT exam four months before most exam dates, and after each MCAT Coaching meeting. Surveys were anonymous and tracked using a pin. A sample of the survey is available in the *Supplementary material*. In the program's first year, between 2019-2020, we scheduled three official MCAT coaching sessions: one every three months starting in August. In response to student concerns, the program's second year continued with the three official MCAT coaching sessions, while explicitly stating that students can meet as many times as they wish above this number. Due to COVID-19, an in-person mock MCAT time point was not possible in the second iteration.

### Part 3.1: Quantitative Analysis
Surveys measured quantitative test anxiety scores using the validated Westside test anxiety scale.[8] The mean and the standard deviation were calculated in excel. Significance was calculated first using an F-test to determine the variances between the populations, followed by two-tailed student's t-test in Excel®. Statistical significance was $p < 0.05$.

### Part 3.2: Qualitative analysis
Qualitative data regarding student concerns regarding the MCAT as well as comments on the program were elicited via a free response in the same survey. Inductive analysis was performed on the free-response answers. They were categorized with various themes using line-by-line coding. Sentences within the answers could overlap into different themes or not be related to any theme.

## Results

### Literature Review
A total of 275 articles were retrieved. Hand scanning reference lists provided 16 other potentially includable articles. After carefully reading titles, abstracts, and full text, we excluded 251 articles based on our criteria. 40 articles met inclusion criteria *Figure 1*. The results and characteristics of the studies included in the literature review are shown in *Table 1.* Zero studies examined test anxiety in the setting of the MCAT, and two studies examined peer coaching as a potential intervention.[9,10]

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*Table 1.* Literature Review Results Showing Population and Anxiety Intervention Tests Investigated.

| Author | Population | Intervention |
|---|---|---|
| Kwon et al., 2020.[11] | Elementary and high-school students | Virtual reality desensitization |
| Harris et al., 2019.[6] | Undergraduate STEM students | Expressive writing, reappraisal |
| Fergus et al., 2019.[12] | Adolescent students | Group format attention training |
| Prinz et al., 2019.[13] | University students | Imagery |
| Shen et al., 2018.[14] | Senior high-school students | Expressive writing |
| Reiss et al., 2017.[15] | University students | Cognitive behavioral therapy and imagery rescripting |
| Cho et al., 2016.[16] | University students | Mindful breathing |
| Hahm et al., 2016.[17] | Veterinary students | Seminars |
| Bellinger et al., 2015.[18] | Calculus students | Mindfulness techniques |
| Brown et al., 2011.[19] | University students | Cognitive behavioral therapy and acceptance-based therapy |
| Bradley et al., 2010.[20] | High school students | Emotional self-regulation |
| Handelzalts et al., 2010.[21] | University students | Advanced muscle relaxation and change in internal dialogue |
| Benor et al., 2009.[22] | University students | Emotional freedom techniques and cognitive behavioral therapy |
| Baker et al., 2003.[23] | University students | Argentum nitricum administration |
| McGlynn et al., 1978.[24] | University students | Cue controlled relaxation therapy |
| Smith et al., 1973.[25] | University students | Systemic desensitization and implosive therapy |
| McManus et al., 1971.[26] | University students | Group desensitization |
| Allen et al., 1971.[27] | University students | Study counseling and desensitization |
| Contreras et al., 2021.[28] | 10th grade students | Deep breathing exercises |
| Kumar et al., 2019.[29] | Pre-engineering and pre-medical students in India | Cognitive drill therapy |
| Donato, 2010.[30] | 4th grade students | Emotional refocusing and restructuring, breathing, music, water, test-wiseness strategies and educational kinesiology exercises. |
| Kacprowicz, 2009.[31] | 8th grade students | relaxation training |
| Johnson, 2008.[32] | Students with learning difficulties | progressive muscle relaxation and systematic desensitization |
| Egbochuku et al., 2005.[33] | High school students | systematic desensitization therapy |
| Earnest et al., 1991.[34] | Adult students | Test-taking skills training and cognitive restructuring |
| Mann et al., 1970.[35] | 7th grade students | Serial retesting |
| Snider et al., 1966.[36] | University students | Autogenic training |
| Anton, W. D., 1976.[37] | University students | Systematic desensitization |
| Beggs et al., 2011.[38] | Nursing students | Guided reflection |
| Decker et al., 1981.[39] | University students | Cue controlled relaxation therapy and cognitive restructuring |
| Dunne et al., 2018.[40] | Veterinary students | Coaching workshop |
| Griffin et al., 1998.[41] | University students | Reciprocal peer tutoring |
| Himle et al., 1984.[42] | University students | Relaxation skill training, cognitive restructuring |
| Holahan et al., 1979.[43] | University students | Anxiety management training and cognitive modification |
| Hudesman et al., 1978.[44] | University students | Desensitization |
| Hudesman et al., 1984.[45] | University students | Desensitization |
| Ihli et al., 1969.[46] | University students | Group and individual desensitization |
| Neuderth et al., 2009.[10] | University students | Lectures and peer coaching |
| Powell et al., 2004.[47] | Medical students | Behavioral rehearsal |
| Suinn, 1968.[48] | University students | Deep muscle relaxation and desensitization |

## Quantitative results

All 22 students within the existing MCAT program participated in the first iteration of the coaching program, and all 12 students participated in the second year of the program *Figure 2*. Demographic characteristics and test anxiety scores are shown in *Table 2* and *Table 3* respectively**.**

In the first cohort, 19 out of 22 students responded to the baseline, and all 12 responded to the second iteration baseline survey *Figure 2*. Higher test anxiety scores meant higher test anxiety on a scale between 1 to 5. The baseline score for all students in the first iteration was 2.84 (SD 0.66, range 1.6 – 4.1) and 2.71 (SD 0.72, range 1.5 – 4.1) in the second iteration. In the

first iteration, 9 of 19 respondents had an average test anxiety score of 3 or higher, indicating moderately high to extremely high anxiety levels. In the second iteration, 6 of 12 were 3 or higher. Student test anxiety means were observed to trend downwards from baseline (2.84 to 2.26 and 2.69 to 2.3) after coaching sessions and increase after a mock MCAT exam (2.76 to 2.88), although none of these changes was statistically significant from each other or baseline *Table 3*.

## Qualitative results

MCAT-related concerns had 7 themes, as shown in *Table 4*. At baseline, 95% of first iteration respondents stated that they lacked self-confidence in their abilities to do well on the MCAT.

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*Figure 1.* PRISMA Study Flowchart.



*Table 2.* Near-Peer Coaching Students' Demographic Characteristics.

| Total responses | Frequency (%) |
|---|---|
| Year | |
| Year 1 | 19 (86%) |
| Year 2 | 12 (100%) |
| Male | |
| Year 1 | 10 (45%) |
| Year 2 | 8 (67%) |
| Female | |
| Year 1 | 12 (55%) |
| Year 2 | 4 (33%) |

*Figure 2.* CONSORT Recruitment Diagram.
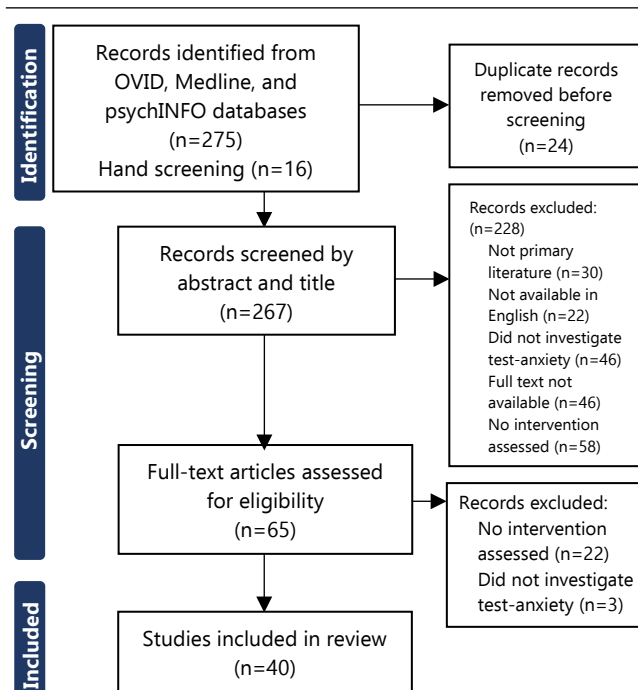


We noted that multiple students stated they suffered from imposter syndrome to some degree, while others were concerned about their past test performances. After MCAT coaching sessions, we observed a drop in the percentage of responses concerned about this theme; however, a notable spike occurred after the mock MCAT. The COVID-19 pandemic dramatically reduced the number of respondents, and 60% of respondents, after the 3rd MCAT coaching session, voiced their concerns regarding the pandemic and the MCAT. The number of respondents concerned about study strategy decreased from baseline with coaching sessions in both years, as well as concerns about accountability. Student concerns about the knowledge needed for the MCAT and exam strategies remained stable.

Students generally felt that the MCAT coaching sessions were helpful and felt supported or felt an increase in their self-confidence. Students in the first iteration shared concerns that they felt only 3 MCAT coaching sessions limited them. After modifying the program to allow an unlimited number explicitly, only 1 response brought up this concern in the following year. Students also felt that the program could benefit by personalizing the content more instead of requiring all coaches and students to cover certain topics. The percentage of respondents concerned about this appeared to decrease the following year after modification.

## Discussion

Test anxiety is a well-recognized phenomenon that affects students of all ages. Test-anxious thoughts, especially over an 8-hour test, can impair performance by exhausting a student's ability to focus on the tasks at hand.[9] Unfortunately, the pre-medical student population has largely been ignored in terms of

research regarding how this may affect their ability to do well on the MCAT. Our literature review showed no other studies examining test anxiety in this population. As a result, this is the first study - to our knowledge – to investigate the level of test anxiety present in URM prospective medical students taking the MCAT.

Our literature review found many studies that utilize licensed therapists to perform cognitive behavioral therapy or other training-intensive interventions (*Table 1*). These interventions are costly, time-intensive on both student and provider and can be out of reach of free MCAT preparation programs. Near-peer coaching addresses this issue by providing an easily accessible intervention for most medical school-based MCAT preparation programs. In addition, near-peer coaching has the advantage of medical students being able to provide tips and tricks specific to their experience with MCAT testing and future medical school admission process.

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**Table 3.** Near-Peer Coaching Students' Test Anxiety Scores at Baseline and at Each Time Point.

| Assessment | Test anxiety Score | Range | Number of responses (%) |
|---|---|---|---|
| **Baseline** | | | |
| Year 1 | 2.84 ± 0.66* | 1.6 - 4.1 | 19 (86%) |
| Year 2 | 2.69 ± 0.72** | 1.5–4.1 | 12 (100%) |
| **Post-MCAT Coaching 1** | | | |
| Year 1 | 2.44 ± 0.63* | 1.3 - 3.8 | 16 (73%) |
| Year 2 | 2.46 ± 0.21** | 2.0 - 2.8 | 11 (92%) |
| **Post-MCAT Coaching 2** | | | |
| Year 1 | 2.76 ± 0.58* | 1.8 - 4.2 | 14 (64%) |
| Year 2 | 2.24 ± 0.2** | 2.0 - 2.5 | 8 (67%) |
| **Post-MCAT Mock Exam** | | | |
| Year 1 | 2.88 ± 0.64* | 1.7 - 4.1 | 16 (73%) |
| Year 2 | - | - | - |
| **Post-MCAT Coaching 3** | | | |
| Year 1 | 2.26 ± 0.29* | 1.7 - 2.6 | 5 (23%) |
| Year 2 | 2.3 ± 0.2** | 2.0 - 2.5 | 6 (50%) |

**Legend:** *These values were not statistically different from each other per student's t-test $p < 0.05$. **These values were not statistically different from each other per student's t-test $p < 0.05$.

**Table 4.** Themes of MCAT Related Concerns with Examples and Percentage of All Responses Containing the Respective Theme.

| Category of response | Examples (General Concern) | Year 1 | | | | | Year 2 | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Baseline n=19 (%) | Post-MCAT Coaching 1 n=16 (%) | Post-MCAT Coaching 2 n=14 (%) | Post-MCAT Exam n=16 (%) | Post-MCAT Coaching 3 n=5 (%) | Baseline n=12 (%) | Post-MCAT Coaching 1 n=11 (%) | Post-MCAT Coaching 2 n=8 (%) | Post-MCAT Coaching 3 n=6 (%) |
| Study Strategy | "I am afraid that I am not studying properly on my own and that I do not know how to properly study." | 11 (58) | 6 (38) | 4 (29) | 4 (25) | 2 (40) | 11 (92) | 5 (45) | 4 (50) | 2 (33) |
| Knowledge | "Retaining all necessary knowledge to do well on the test" | 11 (58) | 10 (63) | 9 (69) | 15 (93) | 3 (60) | 12 (100) | 10 (91) | 7 (87.5) | 3 (50) |
| Exam Strategy | "I always found it difficult to fully understand what a question is asking, it feels like each one is a trick and designed to confuse you." | 8 (42) | 12 (75) | 6 (43) | 15 (93) | 2 (40) | 6 (50) | 6 (55) | 4 (50) | 4 (66) |
| Self-Confidence | "I believe that I am not worthy. Imposter syndrome. I constantly am comparing myself to my peers. I think they know a lot more than I do because I struggle to retain information." | 18 (95) | 8 (50) | 7 (50) | 11 (69) | 1 (20) | 8 (75) | 4 (36) | 1 (13) | 1 (17) |
| Accounta-bility | "Being accountable to study schedules and having passion to study." | 8 (42) | 7 (37) | 4 (29) | 5 (31) | 0 (0) | 8 (57) | 3 (27) | 3 (38) | 1 (17) |
| Balancing School and Study | "That I might not have enough time to study with being in school." | 9 (50) | 7 (44) | 7 (50) | 5 (31) | 2 (40) | 11 (92) | 4 (36) | 4 (50) | 5 (83) |
| COVID-19 related | "I feel mad and hopeless… I don't know when my MCAT date is going to be!!!!" | - | - | - | - | 3 (60) | 2 (17) | 1 (9) | 1 (13) | 0 (0) |

Our pilot study suggests that near-peer coaching is not only accessible but also well-received by students. The fact that students felt limited by three coaching sessions simply demonstrates that they wanted more sessions because they felt they were helpful. This is supported by Neuderth et al., 2009, who also showed that peer coaching is well received by students.[10] Our data also shows that our cohort of URM pre-medical students had baseline concerns about their confidence in their ability to do well

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on the MCAT. Sherman (1980) showed that confidence while taking a test is positively correlated with test performance in high school students.[49] This is corroborated by Smith (2002), suggesting that self-perception of one's test-taking skills is predictive of one's confidence during the test.[50] Concerns about one's MCAT self-confidence dropped after MCAT coaching, as did concerns about study strategies and accountability. Since our coaching sessions aimed to address these issues directly, this suggests that near-peer MCAT coaching may have had some role in alleviating these concerns. However, we acknowledge that this may also be due to various other factors, including the increased time students had to study, opportunities to talk with their peers outside of the program, and other resources the students may have utilized. At baseline, slightly less than half of all students in the first iteration and half in the second had test anxiety above 3, suggesting moderately to extremely high anxiety.

This is typically the threshold the Westside test anxiety scale suggests to warrant anxiety intervention.[51] This is similar to the cross-sectional studies showing 52.3% of Ethiopian medical students and 40% of Pakistani medical students who experience a Westside test anxiety level of 3 or more without intervention.[52,53] As a result, this suggests that pre-medical URM students have similar baseline test anxiety levels to medical students. Medical students may have experienced this test anxiety before starting medical school.

Based on the author's personal experience, medical students in the United States and Canada, compared to pre-medical medical students, often benefit from strong school support, such as academic enhancement programs, wellness groups and easy access to peers who have been through the process. Pre-medical students, especially if URM, lack access to these resources, for which the alternative is often extremely expensive MCAT preparation programs. Besides the author's personal experience, several studies examine the detrimental effects of test anxiety in the medical student population, and how it may affect their United States Medical Licensing Exam (USMLE) scores and discuss interventions, while there have been no such reports (per literature review) in pre-medical students taking the MCAT.[1,54] Finally, while there was no statistical significance between the time points, there was a trend downwards with each coaching session, suggesting that there may be an effect of near-peer coaching on this population if the sample size increases in future studies.

Lately, there has been a bigger push for physicians to be more representative of the populations they are serving. The results discussed here suggest that test anxiety is an under recognized, underreported barrier that can be addressed through an easy-to-access, relatively simple-to-implement program for most medical schools via near-peer coaching.

*Table 5*. Themes of Student Thought's on the Near-Peer Coaching Program with Examples and Percentage of All Responses Containing the Respective Theme.

| Category of response | Examples (General Concern) | Year 1 | | | Year 2 | | |
|---|---|---|---|---|---|---|---|
| | | Post-MCAT Coaching 1 n=16 (%) | Post-MCAT Coaching 2 n=14 (%) | Post MCAT Coaching 3 n=5 (%) | Post- MCAT Coaching 1 n=11 (%) | Post-MCAT Coaching 2 n=8 (%) | Post MCAT Coaching 3 n=6 (%) |
| Helpful | "What I got most out of this is the wisdom and experience of a medical student. I know what to do and what to avoid because they have been through it and understand how the MCAT should be approached." | 15 (93%) | 14 (100%) | 4 (80%) | 11 (100%) | 7 (88%) | 5 (83%) |
| Needs more meeting opportunities | "I think one or two more meetings as a kind of check-in would help. After the meeting I feel like I know what to do, but I haven't had a chance to apply it yet, so the kinks haven't shown themselves yet. It'd be nice to be able to meet maybe a month or so after these sessions to talk about what I'm doing." | 12 (75%) | 9 (64%) | 1 (20%) | 1 (9%) | 0 (0%) | 0 (0%) |
| Needs different content | "could you go beyond strategies and focus on taking up practice questions?" | 4 (25%) | 6 (43%) | 2 (40%) | 4 (36%) | 2 (25%) | 0 (0%) |
| Felt supported/increased self-confidence | "My first meeting with my mentor went super well!!! It was extremely helpful and I feel much better about myself." | 10 (63%) | 8 (57%) | 3 (60%) | 8 (73%) | 3 (38%) | 3 (50%) |
| Too many topics covered | "yes, just learning study techniques would be better" | 4 (25%) | 3 (21%) | 0 (0%) | 1 (9%) | 0 (0%) | 0 (0%) |
| Other | "better method of communication please!" | 2 (13%) | 1 (7%) | 1 (20%) | 4 (36%) | 4 (50%) | 1 (17%) |

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There are several limitations that our study faced. The biggest is the observational nature of our study. We decided to pursue this instead of a trial with a control group because of the small sample size and the ethical implications of denying half of the pre-medical students - all of who wanted access to a medical student coach - when the overwhelming amount of literature suggesting that coaching is effective for many other purposes and likely would be in the context of the MCAT. This results in an inability to determine the controlled effects of the near-peer coaching intervention and also likely resulted in the Westside test anxiety scores not being statistically different between each time point. Future studies could examine this by comparing to well-recognized interventions such as cognitive-behavioral therapy. However nevertheless, we feel that it is important to report these quantitative findings to serve as a platform for further studies in the area. Furthermore, this issue is somewhat mitigated due to the qualitative aspect of our study. It is important to recognize the students' subjective reports of coaching being effective at increasing one's self-confidence and the students feeling it was helpful enough to warrant more meetings.

An additional issue was that our survey response rate dramatically decreased after the COVID-19 pandemic began. We acknowledge that this contradicts previous data of students wanting more sessions; however, given the relatively consistent number of answers before the pandemic and sharp drop after, we believe these were factors unrelated to the program itself. COVID-19 obviously hampered many of our efforts to meet in person for reminders to fill out the survey and for in-person mentoring sessions, resulting in our students meeting online with their mentors and sending survey reminders by email. This limitation likely biased the answers to extremes with answers from students that either found the coaching session to be the most helpful or students that felt like their coaching experiences were not helping their test anxieties. Nevertheless, key answer trends mostly remained consistent despite the drop-offs. Finally, future studies should ideally gather baseline anxiety that is not just limited to test anxiety. While this may not eliminate the possible participant bias of students with different test anxiety levels enrolling in this program, it would be good to be able to control for baseline anxieties to assess the impact of near-peer coaching on different baseline anxiety levels.

In conclusion, our study is the first of its kind to suggest that URM pre-medical students have MCAT-related test anxieties high enough to warrant intervention and that near-peer coaching is a well-received, easily accessible program that may improve test anxiety.

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## Supplementary Material

Q2 What is your gender?
 O Male  (1) O Female  (2)

Q3 What time point are you completing this survey at?
 O BEFORE your DIAGNOSTIC MCAT (August)  (1)
 O AFTER your first MCAT Coaching session (September-November 1st)  (2)
 O AFTER your second MCAT Coaching session (Dec 20th - February 21st  (5)
 O In Class BEFORE your PRACTICE MCAT (Feburary 22nd)  (3)
 O In Class Survey after your PRACTICE MCAT (February 22nd)  (4)
 O AFTER your third MCAT Coaching session ( February 23rd - b4 your exam date)  (6)

Q4 Rate how true each of the following is of you, from extremely or always true, to not at all or never true. Answers are anonymous

| | Not at all/Never true (1) | Slightly or seldom true (2) | Moderately or sometimes true (3) | highly or usually true (4) | extremely or always true (5) |
|---|---|---|---|---|---|
| The closer I am to an exam, the harder it is for me to concentrate on the material. (1) | O | O | O | O | O |
| When I study, I worry that I will not remember the material on the exam. (2) | O | O | O | O | O |
| During important exams, I think that I am doing awful or that I may fail. (3) | O | O | O | O | O |
| I lose focus on important exams, and I cannot remember material that I knew before the exam. (4) | O | O | O | O | O |
| I finally remember the answer to exam questions after the exam is already over. (5) | O | O | O | O | O |
| I worry so much before a major exam that I am too worn out to do my best on the exam. (6) | O | O | O | O | O |
| I feel out of sorts or not really myself when I take important exams. (7) | O | O | O | O | O |
| I find that my mind sometimes wanders when I am taking important exams. (8) | O | O | O | O | O |
| After an exam, I worry about whether I did well enough. (9) | O | O | O | O | O |
| I struggle with writing assignments, or avoid them as long as I can. I feel that whatever I do will not be good enough. (10) | O | O | O | O | O |

We would also like to hear your open-ended responses. Please fill them in after each question. There is no word limit. Answers are anonymous
Q5 What, if any, are your biggest concerns regarding the MCAT.
_____

Q6  Describe how you feel when you take the MCAT practice exams. If not applicable, write "N/A"
_____

Q7  How, if it all, has working with a mentor helped you with studying for the MCAT? If not applicable, write "N/A"
_____

Q8  Is there anything you would like to improve with the MCAT coaching program? If not applicable, write "N/A"
_____

Q9 Is there anything else you feel we should know?
_____

# Medical Students' Perceptions, Knowledge, and Competence in Treating Neurodivergent, Disability, and Chronic Illness (NDCI) Populations: Results from a Cross-Sectional Study

Emily Hotez,[1] Maya Ayoub,[2] Julianna Rava,[3] Zina Jawadi,[4] Kashia A. Rosenau,[5] Lauren Taiclet,[6] Leane Nasrallah,[7] Charlotte Poplawski,[8] Alice A. Kuo.[9]

## Abstract

**Background:** Globally, Neurodivergent, Disability, and Chronic Illness (NDCI) populations face significant health disparities. Lack of physician knowledge about NDCI is a key mechanism underlying these disparities. The current study aimed to describe medical students' perceptions, knowledge, and competence regarding NDCI. **Methods:** A cross-sectional study was carried out using an online survey of medical students at a large public university with no NDCI-specific curriculum (n = 97; response rate = 18%). The survey asked about students' perceptions, knowledge, and competence pertaining to NDCI populations. **Results:** Most (n = 93, 96%) indicated it is important for physicians to understand the influence of NDCI on patient health and clinical encounters. Yet only seven (7%) and 15 (15%) reported that the NDCI curriculum in their medical school was sufficient, and they felt comfortable taking care of patients with NDCI respectively. Most (n = 87, 90%) wanted their medical school to provide additional NDCI training. Few reported high knowledge about ableism (n = 12, 12%), self-determination (n = 7, 7%), coordinating care (n = 4, 4%) and accommodations (n = 10, 10%). Few indicated high competence in cognitive, physical, social-emotional, and other NDCI types (n = 7 – 32, 7-33%). Existing knowledge often came from personal experiences or the news and media. **Conclusion:** Findings demonstrated the gaps in medical education, as exemplified by medical students surveyed in one U.S. public university. Results can inform efforts to ameliorate global health disparities associated with a lack of physician knowledge about NDCI.

**Key Words:** Medical school; Medical students; Education; Medical education; Disabled persons (Source: MeSH-NLM).

## Introduction

650 million individuals worldwide have a disability, including chronic conditions requiring accommodations, temporary or permanent physical or sensory disabilities, and/or cognitive, educational, and social differences.[1] In recognition of the broad spectrum of disability – in alignment with the social model of disability – the current paper refers to these populations as Neurodivergent, Disability, and Chronic Illness (NDCI) populations.[2]

Despite representing the largest minority group (10% worldwide; 26% nationally), NDCI populations face significant health and healthcare disparities.[1,3] They have higher prevalence rates for chronic diseases and lower rates of preventive care utilization relative to non-NDCI populations.[4] According to the Centers for Disease Control and Prevention (CDC), one in three NDCI adults does not have a typical healthcare provider and experiences unmet healthcare needs.[3] Lower rates of healthcare access begin in childhood and continue throughout their lifetime.[5,8] The COVID-19 pandemic highlighted that having an NDCI condition was among the strongest independent risk factors for a COVID-19 diagnosis and COVID-19 mortality.[9]

Physicians' lack of NDCI knowledge is one mechanism underlying health disparities. Overall, physicians report stress, lack of confidence, fear, and anxiety in providing care for NDCI

[1] Ph.D. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[2] MD, Ed.M. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[3] MPH. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[4] MS. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[5] Ph.D. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[6] MS. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[7] BS. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[8] BS. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.
[9] MD, Ph.D., MBA. University of California, Los Angeles (UCLA), David Geffen School of Medicine, United States.

**About the Author:** *Zina Jawadi completed her bachelor's and master's degrees at Stanford University, is a second-year medical student at UCLA's David Geffen School of Medicine, and serves on the Board of Directors of the Hearing Loss Association of America.*

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patients.[10] Less than half report high confidence that they can provide quality care to NDCI patients, and many hold biased perceptions of this population.[11] Physicians also struggle with navigating key aspects of NDCI patient care, including ableism, self-determination, coordinating care, and accommodations, resulting in a compromise in healthcare quality.[12]

A lack of knowledge originates from shortcomings in medical education training worldwide.[13] For example, only half of U.S. medical school deans report having education curricula about biopsychosocial aspects of caring for patients with NDCI in their schools.[14] Indeed, there is a long history of excluding NDCI populations more broadly from conversations about diversity in medical education and society.[15] For example, medical education competencies do not specifically identify NDCI conditions,[16] and in the instances where an NDCI-focused curriculum is available, content typically focuses on those with physical NDCI conditions.[14] Furthermore, competencies do not necessarily translate into changes in curricula. As a result, medical students often graduate without the capacities needed to treat NDCI patients.

Improving physician knowledge and competence by exploring opportunities to provide education to medical students may address health disparities for this population. This study aims to describe current medical students' perceptions, self-reported knowledge, and competence related to treating NDCI patients. Findings have the potential to inform changes to medical school curricula that can ameliorate health disparities for NDCI populations.

## Methods

### Overview
The current study was cross-sectional and featured the administration of a Qualtrics survey targeting all medical students at a diverse public university in Los Angeles, California ($n$ = 531). The survey was disseminated via email listservs as well as social media and was available for two weeks (05/14/21 – 05/31/21). Recruitment was concurrent with the survey administration during that period. Inclusion criteria included any student currently enrolled in the host institution as a medical student who was at least 18 years old. This information was confirmed in two screening questions on the survey. Any student who did not meet these criteria was redirected to the end of the survey. A priori power analysis (80% 1- β, alpha = 0.05) indicated a recommended sample of approximately 100 participants. This research was approved by the host institution's Institutional Review Board (IRB#21-000798).

### Survey Development
Survey development was an iterative and collaborative process among a team of students and faculty affiliated with the host institution. This team included an NDCI-focused medical student organization, internal medicine residents, and physicians with expertise in NDCI. Psychology and public health researchers

provided the content and methodological expertise. Several survey developers self-identified as having an NDCI or a close friend or family member with an NDCI. All collaboration took place utilizing virtual tools such as Zoom and Google Docs. The survey domains – self-reported perceptions, knowledge, and competence – were derived from a series of team discussions identifying the key priorities pertaining to working with patients with NDCI. The team cross-checked surveys that assessed similar constructs and adapted items necessary to align the work with ongoing efforts.[18] The challenges due to the COVID-19 pandemic required data collection with minimal burden on potential participants. As a result, the team prioritized a survey administration of fewer than 10 minutes.

### NDCI Survey
The final survey (*Supplementary Material*) included ten Likert Scale questions reflecting self-reported perceptions (Cronbach's alpha = 0.48), knowledge (Cronbach's alpha = 0.85), and competence (Cronbach's alpha = 0.97), as well as background and demographic questions.

### Statistical Analyses
Frequency and descriptive statistics were obtained for each survey item utilizing IBM SPSS Statistics, version 28. Perceptions were categorized based on the frequency of responses that indicated strongly or somewhat disagree; neither agree nor disagree; or strongly or somewhat agree. Knowledge was categorized based on responses that indicated the respondent was not or slightly knowledgeable, moderately knowledgeable, or very or extremely knowledgeable. Competence was categorized based on whether respondents indicated they were extremely or somewhat incompetent; neither competent nor incompetent; or extremely or somewhat component. Respondents were asked to select all knowledge sources that applied. Percentages were rounded to the nearest whole number.

## Results

### Study Participants
The sample featured 97 medical students, yielding a response rate of 18%. As displayed in *Table 1*, the sample was diverse with respect to race and ethnicity (White: n = 41, 42%; Black: n = 6, 6%; Native American/Alaska Native: n = 1, 1%; Middle Eastern or North African: n = 3, 3%; Two or more races: n = 5, 5%; Hispanic/Latinx: n = 15, 16%) and year in medical school (one: n = 36, 37%; two-three: n = 29, 30%; four+: n = 17, 18%). The majority reported a close friend or family member with an NDCI condition (54%). Self-reported perceptions, knowledge, knowledge sources, and competence related to working with patients with NDCI are presented in *Table 2* and *Figure 1*.

### Perceptions
Few indicated they strongly or somewhat agreed that the NDCI-focused curriculum in their medical school is sufficient (n = 7, 7%) and that they feel comfortable taking care of patients with NDCI (n = 15, 15%). Most strongly or somewhat agreed that they would

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*Table 1.* Sample Characteristics.

| Variable | n | % |
|---|---|---|
| Race | | |
| White American | 41 | 42 |
| Asian American, Native Hawaiian, or Pacific Islander | 26 | 27 |
| Black or African American | 6 | 6 |
| Two or more races | 5 | 5 |
| Native American or Alaska Native | 1 | 1 |
| Middle Eastern or North African | 3 | 3 |
| I do not wish to answer. | 7 | 7 |
| No response | 8 | 8 |
| Ethnicity | | |
| Not Hispanic/Latinx | 66 | 68 |
| Hispanic / Latinx | 15 | 16 |
| No response | 16 | 17 |
| Close friend or family member with an NDCI | | |
| Yes | 52 | 54 |
| No | 28 | 29 |
| No response | 17 | 18 |
| Year in medical school | | |
| 1 | 36 | 37 |
| 2-3 | 29 | 30 |
| 4+ | 17 | 18 |
| No response | 15 | 16 |

like their medical school to provide additional training about NDCI (n=87, 90%) and that physicians need to understand the influence of NDCI on patient health and clinical encounters (n = 93, 96%).

## Self-Reported Knowledge

Few indicated that they were knowledgeable about ableism and using anti-ableist language (n = 12, 12%), self-determination for patients with NDCI (n = 7, 7%), coordinating care (n = 4, 4%), and accommodations or benefits (n = 10, 10%) for individuals with NDCI.

Students indicated that the news/media and personal experiences were their primary sources for knowledge on ableism and using anti-ableist language (news/media: n = 53, 55%; personal experience: n = 53, 55%). They were also the primary sources for self-determination (news/media: n = 23, 24%; personal experience: n = 34, 35%) and accommodations and benefits (news/media: n = 30, 30%; personal experience: n = 53, 55%). Most received their knowledge about coordinating care for patients with NDCI from personal experience (n = 40, 41%), followed by medical school education (n = 20, 21%).

## Self-Reported Competence

Few reported that they were extremely or somewhat competent in caring for individuals with Attention Deficit Hyperactivity Disorder (ADHD, n =32, 33%), other social/ emotional/ mental illness or disability (n = 28, 29%), hearing loss (n = 27, 28%), NDCI related to using a wheelchair (n = 27, 28%), autism spectrum disorder (n = 20, 21%), other physical disability (n = 20, 21%), obsessive compulsive disorder (n = 19, 20%), schizophrenia (n=18, 19%), other cognitive disability (n = 15, 15%), and cerebral palsy (n = 7, 7%).

*Figure 1.* Medical Students' Neurodivergent, Disability, and Chronic Illness (NDCI)-Related Perceptions, Knowledge, Knowledge Sources, and Competence.



**[A] Medical Student NDCI Perceptions**

Legend: Strongly / somewhat agree %; Neither agree nor disagree %; Strongly / somewhat disagree %

**[B] Medical Student NDCI Knowledge**

Legend: No response; Very / extremely knowledgeable; Moderately knowledgeable; Not /slightly knowledgeable

**[C] Medical Student NDCI Knowledge Sources**

Legend: News/media; Personal experience; Medical school education; Pre-medical school education/classes

**[D] Medical Student NDCI Competence**

Legend: Extremely /somewhat incompetent %; Neither competent nor incompetent %; Extremely / somewhat competent %; No response %

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*Table 2.* Perceptions, Knowledge, and Competence Related to Working with Patients with NDCI.

| Variable | Strongly / somewhat disagree | | Neither agree nor disagree | | Strongly / somewhat agree | | No response | |
|---|---|---|---|---|---|---|---|---|
| Perceptions | n | % | n | % | n | % | n | % |
| The disability-focused curriculum in my medical school is sufficient. | 74 | 76 | 16 | 17 | 7 | 7 | 0 | 0 |
| I feel comfortable taking care of patients with disabilities. | 74 | 76 | 8 | 8 | 15 | 15 | 0 | 0 |
| I would like my medical school to provide additional training about disabilities. | 4 | 4 | 6 | 6 | 87 | 90 | 0 | 0 |
| It is important for physicians to understand the influence of disability on patient health and clinical encounters. | 1 | 1 | 1 | 1 | 93 | 96 | 0 | 0 |

| | Not / slightly knowledgeable | | Moderately knowledgeable | | Very / extremely knowledgeable | | No response | |
|---|---|---|---|---|---|---|---|---|
| Knowledge | n | % | n | % | n | % | n | % |
| Ableism and using anti-ableist language[1] | 44 | 45 | 34 | 35 | 12 | 12 | 7 | 7 |
| Self-determination for patients with disabilities [2] | 58 | 60 | 26 | 27 | 7 | 7 | 6 | 6 |
| Coordinating care for patients with disabilities [3] | 71 | 73 | 16 | 17 | 4 | 4 | 6 | 6 |
| Accommodations and benefits for individuals with disabilities [4] | 53 | 55 | 28 | 29 | 10 | 10 | 6 | 6 |

| | Extremely / somewhat incompetent | | Neither competent nor incompetent | | Extremely / somewhat competent | | No response | |
|---|---|---|---|---|---|---|---|---|
| Competence | n | % | n | % | n | % | n | % |
| Autism spectrum disorder | 46 | 47 | 16 | 17 | 20 | 21 | 15 | 16 |
| ADHD | 29 | 30 | 21 | 22 | 32 | 33 | 15 | 16 |
| Other cognitive disability | 42 | 43 | 25 | 26 | 15 | 15 | 15 | 16 |
| Cerebral palsy | 59 | 61 | 16 | 17 | 7 | 7 | 15 | 16 |
| NDCI requiring the use of a wheelchair | 36 | 37 | 19 | 20 | 27 | 28 | 15 | 16 |
| Other physical disability | 38 | 39 | 24 | 25 | 20 | 21 | 15 | 16 |
| Obsessive compulsive disorder | 43 | 44 | 20 | 21 | 19 | 20 | 15 | 16 |
| Schizophrenia | 41 | 42 | 23 | 24 | 18 | 19 | 15 | 16 |
| Other social, emotional, or mental illness/disability | 27 | 28 | 27 | 28 | 28 | 29 | 15 | 16 |
| Hearing loss | 36 | 37 | 19 | 20 | 27 | 28 | 15 | 16 |

*Legend:* Sources are not mutually exclusive

[1]Source: Pre-medical school education/classes (n = 27, 28%); Medical school education (n = 11, 11%); Personal experience (n = 53, 55%); News/media (n = 53, 55%); Other (n = 16, 17%).

[2] Source: Pre-medical school education/classes (n = 22, 23%); Medical school education (n = 11, 11%); Personal experience (n = 34, 35%); News/media (n = 23, 24%); Other (n = 17, 18%).

[3] Source: Pre-medical school education/classes (n = 17, 18%); Medical school education (n = 20, 21%); Personal experience (n = 40, 41%); News/media (n = 15, 16%); Other (n = 16, 17%).

[4] Source: Pre-medical school education/classes (n = 26, 27%); Medical school education (n = 22, 23%); Personal experience (n = 53, 55%); News/media (n = 30, 30%); Other (n = 21, 2).

## Discussion

This paper describes medical students' self-reported perceptions, knowledge, and competence of working with NDCI populations. The study aligns with previous research that reports a lack of NDCI-specific training during medical school in the U.S. and worldwide.[13,19,20] Findings can inform efforts to promote NDCI knowledge and competence among health care workers.

Medical students endorsed the importance of physicians' understanding of NDCI on patient health and clinical encounters. At the same time, most felt that NDCI is insufficiently covered in the curriculum, and they do not feel comfortable caring for patients with NDCI. Most would like their medical school to provide additional training about NDCI. Results support previous findings that medical students require more NDCI training as well as provide new insight into their motivation to receive more substantial training.

In particular, students reported low knowledge about ableism, self-determination, coordinating care, accommodations, and benefits for individuals with NDCI. Existing knowledge on these topics predominantly came from personal experiences or the news and media rather than education or training, reinforcing previously identified gaps in medical training.[13,19,20] Few reported

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high competencies for any of the NDCI conditions asked about on the survey, indicating the need for medical education to provide training on individuals with all NDCI conditions, regardless of support needs or prevalence of the condition.

Gaps in education may be partially due to an under-representation of individuals with NDCI employed in healthcare professions. Three to five percent of medical students disclose an NDCI, which is significantly lower than in the United States (U.S.) NDCI prevalence of 26%.[3] It is unclear if this is due to barriers causing underrepresentation in the field or barriers in disclosure and requesting accommodations. Nonetheless, this underrepresentation limits the eventual number of physicians with lived experience managing long-term health conditions, navigating the healthcare system, and requesting accommodations. This, in turn, makes it less likely that NDCI conditions are prioritized in efforts to train the next generation of physicians.

We propose several next steps to address disparities for individuals with NDCI attributable to a lack of physician knowledge. First, we propose that medical schools develop NDCI-focused curricula to foster knowledge and understanding of NDCI and ensure that future doctors can effectively support this population. Following universal design principles, curricula should be multi-modal and integrate discussion-based sessions, didactic materials, and case studies.[21] Faculty, administrators, and students should identify practical strategies for implementing this curriculum among the numerous other topics that must be covered in medical school.

Second, there is a need to address barriers to medical school for students with NDCI conditions. Medical student recruitment efforts should prioritize outreach to this population. Concerted efforts should be made within medical schools to ensure all curricula are accessible and provide flexible options for clinical requirements. It should be standard practice that faculty receive NDCI-specific training and collaborate to create a medical school culture that proactively accommodates all students. Third, there is a need to prioritize NDCI-specific education before and after medical school. Efforts before medical school should begin early in development when stigma about NDCI originates, be tailored to children's developmental capacities and be integrated into general educational curricula.[22] Efforts after medical school should be integrated into training as Continuing Medical Education. Across all curriculum development efforts, there is a need to collaborate with individuals with NDCI themselves. This is critical to ensure learning objectives, course content, and target outcomes align with their needs, experiences, and priorities.

There were several limitations of this research. Our survey yielded a low response rate relative to the recommended 30% for online surveys.[23] Survey administration coincided with the many challenges associated with the ongoing COVID-19 pandemic. Most students reported having a close family member or friend

with an NDCI, so responses may have favored those with personal investments in the topic. Response bias may have also favored less comfortable or more dissatisfied with the available NDCI training.[24] In addition, the pandemic highlighted and reinforced disparities for NDCI populations, and students may have experienced renewed awareness of these issues.

Further, this research may not be representative of all medical students worldwide. This research was conducted with a small sample of students at a single U.S. institution. Future research should capture a larger and more representative sample and glean cultural and geographic differences. Moreover, there are several emerging medical school initiatives to bolster education on NDCI populations, and results may not apply to institutions that already offer NDCI training.[25] In addition, the current study was descriptive and did not rule out the possibility that medical students, in general, may feel less competent in any area of medicine or patient group. NDCI may be one of many inadequately addressed topics in medical education. Future research should investigate whether students' capacities differ significantly for NDCI conditions relative to other conditions.

It should also be noted that this survey was meant to be exploratory and spur additional research; given the constraints presented by the pandemic, we prioritized expedient research methods and design. Future efforts should build on this study by creating a validated tool with robust psychometric properties. Finally, a strength of the survey was that it was developed via a collaborative process among interdisciplinary faculty and students; this survey, however, might not represent the priorities of all faculty and students. Future efforts should involve more extensive collaborations.

## Conclusion

This research demonstrates the gaps in medical education pertaining to NDCI populations, as reported by medical students surveyed in one U.S. public university. Results can inform changes to medical school curricula and efforts to ameliorate health disparities associated with a lack of physician knowledge about NDCI.

## Summary – Accelerating Translation

**Title:** Medical Students' Perceptions, Knowledge, and Competence in Treating Neurodivergent, Disability, and Chronic Illness (NDCI) Populations: Results from a Cross-Sectional Study.

**Main Problem to Solve:** 650 million individuals worldwide have a disability, including chronic conditions requiring accommodations, temporary or permanent physical or sensory disabilities, and/or cognitive, educational, and social differences. In recognition of the broad spectrum of disability – and in alignment with the social model of disability – the current paper refers to these populations as Neurodivergent, Disability, and Chronic Illness (NDCI) populations. NDCI populations face significant health and healthcare disparities. Indeed, having an NDCI condition was among the strongest independent risk factors for a COVID-19 diagnosis and COVID-19

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mortality. Physicians lack of knowledge about NDCI – originating from shortcomings in medical training worldwide – is an important mechanism underlying health disparities.

**Aim of Study:** This study aims to describe current medical students' perceptions, self-reported knowledge, and competence related to treating NDCI patients. Findings have the potential to inform changes to medical school curricula that can ameliorate health disparities for NDCI populations.

**Methodology:** The current study was cross-sectional and featured the administration of an online survey targeting all medical students at a diverse public university in Los Angeles, California. Survey development was an iterative and collaborative process among a team of students and faculty affiliated with the host institution. The final survey included 10 Likert Scale questions reflecting self-reported perceptions, knowledge, and competence, as well as background and demographic questions. The sample featured a diverse sample of 97 medical students.

**Results:** Few medical students surveyed indicated that the NDCI-focused curriculum in their medical school was sufficient and reported feeling comfortable taking care of patients with NDCI. Most wanted additional training about NDCI. Few indicated that they were knowledgeable about ableism and using anti-ableist language, self-determination for patients with NDCI, coordinating care, and accommodations or benefits for individuals with NDCI. Existing knowledge about these topics primarily came from the news, media, and personal experiences. When asked about specific NDCI conditions, few students reported that they were extremely or somewhat competent in caring for individuals with each condition.

**Conclusion:** Findings from this research demonstrate the gaps in medical education, as exemplified by medical students surveyed in one U.S. public university. Results can inform efforts to develop NDCI curricula and ameliorate global health disparities associated with a lack of physician knowledge about NDCI conditions.

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**Author Contributions**

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## Supplementary Material

### Neurodivergent, Disability, and Chronic Illness (NDCI)Survey

| | |
|---|---|
| 1. Are you a current [medical school] student? | ☐Yes ☐No |
| 2. Are you at least 18 years or older? | ☐Yes ☐No |
| 3. Please indicate the extent to which you agree/disagree with the following statements. | |
| The disability-focused curriculum in my medical school is sufficient. | ☐Strongly disagree<br>☐Somewhat disagree<br>☐Neither agree nor disagree<br>☐Somewhat agree<br>☐Strongly agree |
| I feel comfortable taking care of patients with disabilities. | ☐Strongly disagree<br>☐Somewhat disagree<br>☐Neither agree nor disagree<br>☐Somewhat agree<br>☐Strongly agree |
| I feel comfortable conducting all portions of the physical exam and history for a patient with a disability. | ☐Strongly disagree<br>☐Somewhat disagree<br>☐Neither agree nor disagree<br>☐Somewhat agree<br>☐Strongly agree |
| I would like my medical school to provide additional training about disabilities. | ☐Strongly disagree<br>☐Somewhat disagree<br>☐Neither agree nor disagree<br>☐Somewhat agree<br>☐Strongly agree |
| I believe it is important for physicians to understand the influence of disability on patient health and clinical encounters. | ☐Strongly disagree<br>☐Somewhat disagree<br>☐Neither agree nor disagree<br>☐Somewhat agree<br>☐Strongly agree |
| My medical school is supportive of medical students with disabilities. | ☐Strongly disagree<br>☐Somewhat disagree<br>☐Neither agree nor disagree<br>☐Somewhat agree<br>☐Strongly agree |
| 4. Rate your knowledge on the following topics. | |
| Ableism, and using anti-ableist language. | ☐Not knowledgeable at all<br>☐Slightly knowledgeable<br>☐Moderately knowledgeable<br>☐Very knowledgeable<br>☐Extremely knowledgeable |
| Self-determination for patients with disabilities. | ☐Not knowledgeable at all<br>☐Slightly knowledgeable<br>☐Moderately knowledgeable<br>☐Very knowledgeable<br>☐Extremely knowledgeable |
| Coordinating care for patients with disabilities. | ☐Not knowledgeable at all<br>☐Slightly knowledgeable<br>☐Moderately knowledgeable<br>☐Very knowledgeable<br>☐Extremely knowledgeable |
| Health disparities for individuals with disabilities. | ☐Not knowledgeable at all<br>☐Slightly knowledgeable<br>☐Moderately knowledgeable<br>☐Very knowledgeable<br>☐Extremely knowledgeable |
| Accommodations and benefits for individuals with disabilities. | ☐Not knowledgeable at all<br>☐Slightly knowledgeable<br>☐Moderately knowledgeable<br>☐Very knowledgeable<br>☐Extremely knowledgeable |

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| 5. Indicate the source of your knowledge on the following topics (select all that apply). | |
|---|---|
| Ableism, and using anti-ableist language. | ☐Pre-medical school education/classes<br>☐Medical school education<br>☐Personal experience<br>☐News/media<br>☐Other |
| Self-determination for patients with disabilities. | ☐Pre-medical school education/classes<br>☐Medical school education<br>☐Personal experience<br>☐News/media<br>☐Other |
| Coordinating care for patients with disabilities. | ☐Pre-medical school education/classes<br>☐Medical school education<br>☐Personal experience<br>☐News/media<br>☐Other |
| Health disparities for individuals with disabilities. | ☐Pre-medical school education/classes<br>☐Medical school education<br>☐Personal experience<br>☐News/media<br>☐Other |
| Accommodations and benefits for individuals with disabilities. | ☐Pre-medical school education/classes<br>☐Medical school education<br>☐Personal experience<br>☐News/media<br>☐Other |
| **6. Rate how competent/comfortable you feel treating/providing care for an individual with the following disabilities within your intended specialty.** | |
| Autism spectrum disorder | ☐Extremely incompetent<br>☐Somewhat incompetent<br>☐Neither competent nor incompetent<br>☐Somewhat competent<br>☐Extremely competent |
| ADD/ADHD | ☐Extremely incompetent<br>☐Somewhat incompetent<br>☐Neither competent nor incompetent<br>☐Somewhat competent<br>☐Extremely competent |
| Other cognitive disability | ☐Extremely incompetent<br>☐Somewhat incompetent<br>☐Neither competent nor incompetent<br>☐Somewhat competent<br>☐Extremely competent |
| Cerebral palsy | ☐Extremely incompetent<br>☐Somewhat incompetent<br>☐Neither competent nor incompetent<br>☐Somewhat competent<br>☐Extremely competent |
| Impairment requiring the use of a wheelchair | ☐Extremely incompetent<br>☐Somewhat incompetent<br>☐Neither competent nor incompetent<br>☐Somewhat competent<br>☐Extremely competent |
| Other physical disability | ☐Extremely incompetent<br>☐Somewhat incompetent<br>☐Neither competent nor incompetent<br>☐Somewhat competent<br>☐Extremely competent |
| Obsessive compulsive disorder | ☐Extremely incompetent<br>☐Somewhat incompetent<br>☐Neither competent nor incompetent<br>☐Somewhat competent<br>☐Extremely competent |

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                                                            Disability, and Chronic Illness (NDCI) Populations: Results from a Cross-Sectional Study

| | |
|---|---|
| Schizophrenia | ☐Extremely incompetent |
| | ☐Somewhat incompetent |
| | ☐Neither competent nor incompetent |
| | ☐Somewhat competent |
| | ☐Extremely competent |
| Other social, emotional, or mental illness/disability | ☐Extremely incompetent |
| | ☐Somewhat incompetent |
| | ☐Neither competent nor incompetent |
| | ☐Somewhat competent |
| | ☐Extremely competent |
| Hearing loss | ☐Extremely incompetent |
| | ☐Somewhat incompetent |
| | ☐Neither competent nor incompetent |
| | ☐Somewhat competent |
| | ☐Extremely competent |
| Other (rate/specify if there are other conditions you would like to rate your competence/comfort with) | ☐Extremely incompetent |
| | ☐Somewhat incompetent |
| | ☐Neither competent nor incompetent |
| | ☐Somewhat competent |
| | ☐Extremely competent |
| 7. Do you or a close friend/family member have a disability? | ☐Yes ☐No |
| 8. Please indicate your year in medical school? | ☐1 ☐2 ☐3 ☐4 ☐> 4 |
| 9. Are you Hispanic/Latinx? | ☐Yes ☐No |
| 10. Please indicate your race (select all that apply) | ☐White American |
| | ☐Black or African American |
| | ☐Native American or Alaska Native |
| | ☐ Asian American, Native Hawaiian, or Pacific Islander |
| | ☐Middle Eastern or North African |
| | ☐Two or more races |
| | ☐I do not wish to answer |
| **End of survey** | |

# The Diet Quality of Medical Students in the United States During the Early COVID-19 Pandemic

Mira Yousef,[1] (ID) Birgit Khandalavala.[2] (ID)

## Abstract

**Background:** Medical students report lacking the knowledge to conduct nutrition counseling for patients and practice good dietary quality in their personal life. This cross-sectional study describes the dietary quality of medical students at one Midwestern College of medicine during the early COVID-19 pandemic in the United States of America. **Methods:** Cross-sectional study based on a survey applied to medical students (n=102) during spring 2020. We used the Rapid Eating Assessment for Participants–Shortened (REAP-S) to asses dietary quality during the COVID-19 pandemic. The response rate was 27%. The primary outcome was to obtain total mean REAP-S scores and identify variables related to poor diet quality. **Results:** A mean REAP-S score of 30.5, SD=3.9 (range 13-39) was obtained (67% of ideal dietary quality). Body weight remained the same for 54.9% of students, 25.7% gained weight, and 18.8% lost weight during the late spring of 2020. Students with BMI < 24.9 kg/m2 (mean REAP-S score of 31.6±3.6) had a significantly better dietary quality (p < 0.001) compared to students with BMI > 25 kg/m2 (mean REAP-S score of 28.9±3.9). Students with a self-reported "less healthy" diet (mean REAP-S=28.2±3.3) had significantly worse dietary quality (p < 0.001) compared to those who either maintained a healthy diet (mean REAP-S=31.1±3.8) or improved diet (mean REAP-s=31.9±3.6). Of note, 89.2% of students indicated that they want to improve their diet. **Conclusion:** The dietary quality of participants was found to be sub-optimal during the early COVID-19 pandemic, potentially impacting our future medical workforce's long-term health adversely.

**Key Words:** Medical students; Diet; Body mass index; COVID-19 pandemic; Diet surveys. (Source: MeSH-NLM).

## Introduction

A healthy diet is critical for good health, the mitigation of the chronic disease and optimal functioning for the general population, as well as for future healthcare providers.[1] Despite the growing crisis of chronic disease prevalence in healthcare in the United States (US) driven by poor lifestyle choices, medical student education has been well documented to be deficient in delivering comprehensive nutrition training for many years.[2-4] Graduating medical students have reported lacking the knowledge and skills necessary to conduct adequate nutrition counseling for patients.[4] Furthermore, in a recent study of first-year medical students, a discrepancy between knowledge and self-practice of good dietary quality was found.[5] There is a significant evidence-practice gap between the nutrition education provided to medical students and the students' nutrition knowledge, skills, and attitudes needed for the comprehensive care of patients.[6] It is anticipated that such deficiencies may have profound and dire health-related adverse outcomes for the patient population, particularly as the obesity epidemic continues to escalate even further, with continued higher rates projected in the upcoming decade.[7] In addition, poor self-nutrition care could portend poorer health outcomes for future healthcare providers.[5]

The optimal overall quality of a diet may have a greater impact on health than the more reductionistic view of individual macronutrients in the diet, such as just one food group or food item, and as a result, indices of healthy eating to determine dietary quality have been developed.[8] The Healthy Eating Index (HEI) has been developed by the Center of Nutrition Policy and Promotion to monitor the diet quality of the US population and aligns with the National guidelines from the US Dietary Guidelines for Americans. The HEI is regularly updated to remain consistent with newer recommendations.[8] Since the HEI is a lengthy tool, a team of researchers developed and validated the Rapid Eating Assessment for Participants (REAP) to improve nutrition training in US medical schools.[9,10] In 2004, the REAP was further shortened to the Rapid Eating Assessment for Participants-Shortened Version (REAP-S), and in addition, was validated against nutrient intakes using the 1998 Block Food Frequency Questionnaire in 110 medical students.[11] Moreover, the REAP-S survey can assess the dietary quality of food intake in a clinical or research setting, requires less than 10 minutes to complete without the need for trained staff to deliver or interpret results, and has negligible costs, unlike the lengthier and more cumbersome HEI.[11] In a previous study, including omnivores, the

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[1] BA. College of Medicine, University of Nebraska Medical Center, United States.
[2] MBBS. Department of Family Medicine, University of Nebraska Medical Center, United States.

**About the Author:** *Mira Yousef is currently a 3rd year medical student at the University of Nebraska Medical Center in Omaha, NE, a 4-year program. She is a member of an enhanced medical education track focused on underserved health.*

**Correspondence:**
Mira Yousef.
Address: 1400 R St, Lincoln, NE 68588, United States
Email: mira.yousef@unmc.edu

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REAP-S was used in a US population and correlated with metabolic outcomes.[9,10] Prior to the outbreak of the COVID-19 pandemic, there were no reports addressing dietary quality from medical students in the United States.

During the COVID-19 pandemic in 2020, emerging international reports indicated that healthy eating was declining in the general population.[12,13] In the US, medical students were not considered essential workers and in-person teaching and clinical activities were terminated at the University of Nebraska Medical Center on 16th March 2020.[14] The medical university campus was closed, and medical students were asked to isolate themselves at home while teaching and transitioned to remote learning only until the end of June 2020. While this period was not a strictly enforced "lockdown", normal life abruptly came to a complete halt across this midwestern state, and only essential services were kept open. Eating meals away from home was drastically reduced due to the closing of restaurants and cafeterias, restricted travel, and fear of being in public areas. Medical students now had more time and access to healthy cooking in their home kitchens, with groceries stores remaining open. On the contrary, less healthy eating patterns and poor diet quality, such as skipping breakfast, increasing sugary foods, and snacking at home, could be an issue.

There was a gap in the knowledge of the dietary quality of medical students in the US and its impact on health during this unprecedented time in modern history, and as far as we can tell, there are no similar studies published in the literature. Hence, the goal of our study was to investigate dietary quality using the REAP-S at a US midwestern college of medicine, at the end of the three-month isolation at home period, due to the COVID-19 pandemic. Our overarching goal was to determine any significant changes in dietary quality and body weight and to inform future mitigation strategies if adverse effects from the early course of the COVID-19 pandemic on medical students were observed.

## Methods

### Study Design
This was a cross-sectional single-center study. Special consent was obtained from the Dean of the College of Medicine and the COVID-19 research task force. Institutional Review Board (IRB #492-20-EX) clearance was granted from the affiliated university medical center.

### Study Population/Participants
The study population of medical students was chosen since no previous study has been done on this population. This information would add important new data for early targeted interventions if an adverse impact of the COVID–19 pandemic was observed.

The study population consisted of medical students with active Email addresses on file (*n*=383) enrolled at the University of Nebraska Medical Center College of Medicine for the upcoming 2020-2021 academic year. Fourth-year medical students could no longer be reached since they had already graduated, reducing the

number of potential participants. The complete medical college program consists of four years of medical school with approximately 130 students per class. The study was conducted at the end of June 2020, when medical students had been learning remotely and isolated at home for the previous three months (March-June 2020). Medical students who were diagnosed with COVID-19 (n=2) were excluded from the study as dietary quality may have been significantly impacted due to sickness and loss of taste and smell.

### Study Process
Three hundred and eighty-three e-mails inviting participation were sent to all enrolled medical students with instructions for accessing the web-based survey. Surveys remained open for two weeks. A reminder e-mail was sent at the end of the first week. Participants were asked to reference an average week in June 2020 when answering the survey questions to specifically target diet quality during the pandemic. Responses were captured anonymously in a secure database.

### Survey Tool
The 16-item, self-reported REAP-S questionnaire was used to measure dietary quality. The survey asks about food consumption during the week prior to the survey to be recalled by the study participant. Only the first 13 questions are scored and capture eating behavior, dietary patterns and types and quantities of food groups eaten. Each question is scored on a 3-point Likert scale (range 1-3 for each question). Total possible scores for the 13 questions range from 13-39, with higher scores indicative of better diet quality. Questions 14 through 16 of the REAP-S are not captured in the total score and collect information on current cooking and eating habits (eating at home versus eating out) and the willingness to improve eating patterns.[9,10] Sociodemographic questions on race, ethnicity, marital status, and current Body Mass Index (BMI) categories were included in the preface of the survey. Four additional questions were added to capture changes due to the COVID-19 pandemic, as described in *Table 1*.

*Table 1.* Additional Survey Questions to Assess Changes in Diet Quality during the Pandemic.

| |
|---|
| 1. "How has your diet changed during the period of time in which most Americans were isolated due to the Covid-19 pandemic (approximately March-June 2020)?" *Answer options*: a. "less healthy diet," b. "about the same," or c. "healthier diet." |
| 2. "Since the COVID-19 pandemic started, I have…" *Answer options*: a. "Lost weight" b. "Gained weight" c. "Remained the same weight" or d. "I don't know or prefer not to answer." |
| 3. "Have you been diagnosed with COVID-19 in the last three months?" Answer options:  a: "yes" or b. "no." |
| 4. "How willing are you to make changes in your eating habits in order to be healthier?" *Answer options*: a. "Very unwilling" b. "Somewhat unwilling" c. "Neither willing nor unwilling" d. "Somewhat Willing" d. "Very Willing." |

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## Outcomes

The study's primary outcome was to obtain total mean REAP-S scores for all medical students as a single cross-sectional cohort study group. Secondary outcomes included two sub-analyses. The first sub-analysis compared the mean REAP-S scores in a self-reported BMI groups. We categorized BMI of all the medical students into two the BMI categories consisting of 1. BMI < 24.9 kg/m$^2$ (normal weight and below) and 2. BMI > 25 kg/m$^2$ (overweight and obese). The second sub-analysis similarly compared the mean REAP-S scores in self-reported change in diet categories from pre-pandemic to end of isolation at home, March – June 2020. The three sub-groups based on the question on change in diet were a. "less healthy," b. "about the same," or c. "healthier."

## Statistical Analysis

For the statistical analysis, data are reported as mean ± standard deviation. Monte Carlo significance for the Pearson Chi-Square and the Fisher's Exact Test were conducted due to the smaller sample size. The significance levels ($p$-values) were set at 0.05 (two-tails). Partial correlation analyses were used for differences between groups using the one-way Analysis of Variance (ANOVA) and Tukey test. Statistical Package for the Social Sciences (SSPS) system version 25.0 was utilized for all statistical proceedings.

## Results

Invitations for survey participation with a link to the anonymous database were emailed to all enrolled 383 medical students, and 104 medical students responded (response rate of 27%). Two medical students reported COVID-19 infections and were excluded; hence 102 surveys were evaluated (*Figure 1*). As expected from the predominantly Caucasian racial makeup of a US midwestern state, 88.2% of the medical students reported their race as being Caucasian, and 11.9% were African American or other races. 78.4% were not married, 19.6 % were married, 1% were divorced, and another 1% preferred not to answer. 55.4% of students declared to have remained the same weight over the three months of isolation at home, while 25.7% reported weight gain and 18.8% reported a weight loss. 58 students (58.5%) were in the BMI category < 24.9 kg/m$^2$ and 40 (40.4%) were in the BMI category > 25kg/m$^2$. The remaining students either preferred not to report their BMI (1 student) or had incomplete survey responses and were excluded (3 students).

The mean REAP-S scores are provided for each item and tabulated for the study group (*Table 2, Table 3*). During an average week of June 2020, the mean REAP-S score was 30.5 (Standard deviation: ±) ±3.9 for all the medical students, with a possible range of 13-39. There was no significant difference between the average scores of any of the individual question items, with the average being 2.3 (with a possible range of 1-3). Statistical analyses using ANOVAs did not reveal any significant difference in mean REAP-S scores between race, ethnicity, or marital status.

*Figure 1.* Process Flow Diagram of Survey Participants.
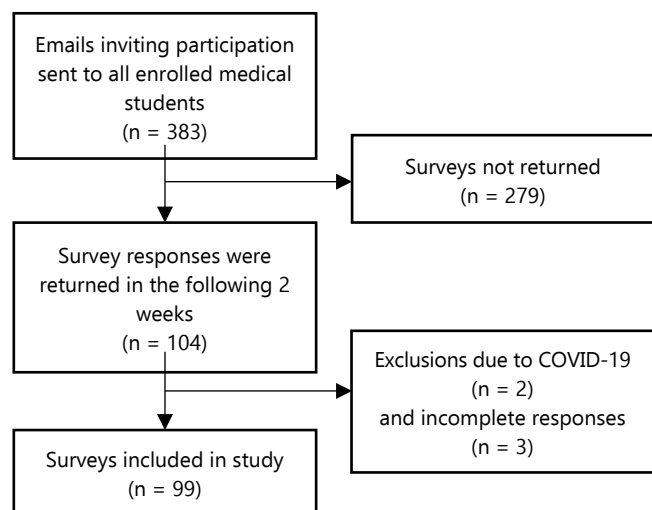


Our first sub-analysis compared the mean REAP-S scores for medical students ($n$ = 99 with complete data) between self-reported BMI groups, and one student preferred not to report BMI (*Table 4*). 58 (58.5%) of medical students with BMI < 24.9 kg/m$^2$ had a mean REAP-S score of 31.6±3.6, compared to 40 (40.4%) medical students with BMI >25 kg/m$^2$ and a mean REAP-S score of 28.9±3.9. This difference in mean REAP-S scores between the two BMI categories was found to be significantly different ($p$ < 0.001).

The second sub-analysis compared the mean REAP-S scores for medical students ($n$ = 99 with complete data) between self-reported changes in diet quality categories during the stay-at-home period (*Table 4*). The group consisting of 30 (30.3%) medical students that reported a decline in their diet to "less healthy" had mean REAP-S scores of 28.2±3.3. The 38 (38.4%) medical students who maintained a healthy diet had a mean REAP-S score of 31.1±3.8, and 31 (31.3%) medical students who reported improvement in their diet had a mean REAP- S score of 31.9±3.6. There was no statistically significant difference in mean REAP-S scores between those who indicated their diet did not change and those who indicated their diets were "more healthy," while there was a significant difference in mean REAP-S scores in the group that had a decrease in the diet quality due to more unhealthy options compared to their peers who were able to maintain or even improve diet ($p$ < 0.001).

A combined 91 students (89.2%) indicated that they would be "somewhat willing "or "very willing" to change eating habits to be healthier (*Figure 2*). Willingness to make changes in eating habits ranged from 5 students (4.9%) rating their willingness as "very unwilling," 3 students (2.9%) as "somewhat unwilling," 2 students (2.0%) as "neither willing nor unwilling." 43 students (42.2%) stated that they are "somewhat willing" and 49 students (48.0%) were "very willing" to change eating habits in order to be healthier.

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*Table 2.* Rapid Eating Assessment for Participants-Shortened Version (REAP-S) Mean Response Scores Among Study Participants.

| Survey Questions, n (%) | Usually/Often [1] | Sometimes [2] | Rarely/Never or Does not apply to me [3] | Mean (SD) |
|---|---|---|---|---|
| Skip breakfast? | 32 (31.4) | 17 (16.7) | 53 (52.0) | 2.21 (0.89) |
| Eat 4 or more meals from sit-down or take out restaurants? | 12 (11.8) | 23 (22.5) | 67 (65.7) | 2.54 (0.70) |
| Eat less than 2 servings of whole grain products or high fiber starches a day? | 13 (12.9) | 39 (38.6) | 49 (48.5) | 2.36 (0.70) |
| Eat less than 2 servings of fruit a day? | 16 (15.7) | 45 (44.1) | 41 (40.2) | 2.25 (0.71) |
| Eat less than 2 servings of vegetables a day? | 14 (13.7) | 47 (46.1) | 41 (40.2) | 2.26 (0.69) |
| Eat or drink less than 2 servings of milk, yogurt, or cheese a day? | 19 (18.6) | 39 (38.2) | 44 (43.1) | 2.25 (0.75) |
| Eat fried foods such as fried chicken, fried fish, French fries, fried plantains, tostones or fried yuca? | 12 (11.9) | 47 (46.5) | 42 (41.6) | 2.30 (0.67) |
| Add butter, margarine or oil to bread, potatoes, rice or vegetables at the table? | 16 (15.7) | 45 (44.1) | 41 (40.2) | 2.25 (0.71) |
| Eat sweets like cake, cookies, pastries, donuts, muffins, chocolate and candies more than 2 times per day. | 14 (13.7) | 48 (47.1) | 40 (39.2) | 2.25 (0.68) |
| Drink 16 ounces or more of non-diet soda, fruit drink/punch or Kool-Aid a day? | 1 (1.0) | 9 (8.8) | 92 (90.2) | 2.89 (0.34) |
| Eat more than 8 ounces (see sizes below) of meat, chicken, turkey or fish per day? | 34 (33.7) | 40 (39.6) | 27 (26.7) | 1.93 (0.78) |
| Use regular processed meats (like bologna, salami, corned beef, hotdogs, sausage or bacon) instead of low-fat processed meats (like roast beef, turkey, lean ham; low-fat cold cuts/hotdogs)? | 6 (5.9) | 20 (19.6) | 76 (74.5) | 2.69 (0.58) |
| Eat regular potato chips, nacho chips, corn chips, crackers, regular popcorn, nuts instead of pretzels, low-fat chips or low-fat crackers, air-popped popcorn? | 14 (13.7) | 36 (35.3) | 52 (51.0) | 2.37 (0.72) |

*Table 3.* Mean Rapid Eating Assessment for Participants-Shortened Version (REAP-S) Scores in Healthy Weight and Overweight or Obese Participants.

| Body Mass Index category (BMI) (kg/m$^2$) | Frequency, n (%) | Mean REAP-S Score (SD) | p value | Mean Difference | 95% CI of Mean Difference |
|---|---|---|---|---|---|
| BMI < 24.9 kg/m$^2$ | 58 (58.5) | 32 (3.6) | $p<0.001$ | 2.7 | 1.2-4.3 |
| BMI > 25.0 kg/m$^2$ | 40 (40.4) | 28 (3.9) | | | |
| Prefer not to answer | 1 (1.0) | N/A | | | |

*Table 4.* Mean Rapid Eating Assessment for Participants-Shortened Version (REAP-S) Scores in Self-Reported Health Rating of Diet Categories.

| Health rating during isolation | Frequency, n (%) | Mean REAP-S Score (SD) | p value |
|---|---|---|---|
| It was less healthy than before | 30 (30.3) | 28.2 (3.4) | *$p<0.001$ |
| It was about the same as before | 38 (38.4) | 31.1 (3.8) | |
| It was more healthy than before | 31 (31.3) | 31.9 (3.6) | |

*Legend:* * Those who indicated that their diet was less healthy during quarantine had significantly lower average REAP-S scores than those who said their diet was about the same and those who said their diet was "healthier".

*Figure 2.* Willingness of Medical Student Participants to Make Healthy Changes in their Eating Habit.
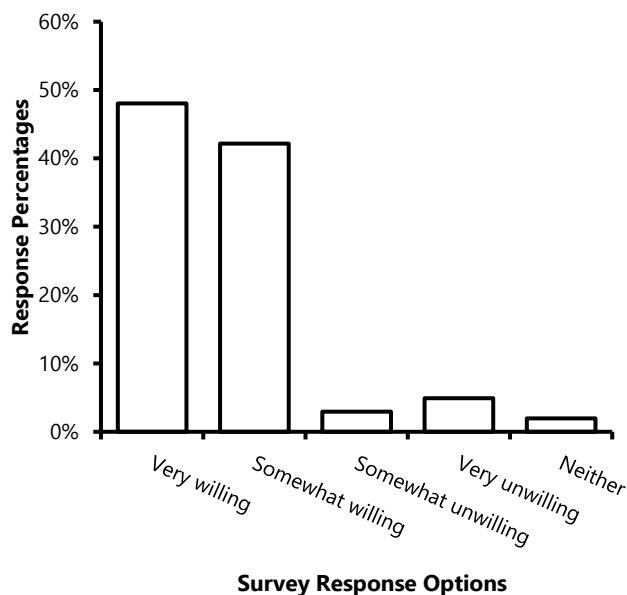


*Legend:* Survey response from 102 participants

## Discussion

This is the first study to report on the preliminary negative impact of home isolation on a single cohort of US medical students due to the COVID-19 pandemic during the late spring of 2020. The overall dietary quality of this cohort of medical students was noted to be suboptimal, with low REAP-S scores and even lower dietary quality scores noted in the subgroup of medical students with overweight and obesity compared to their peers with normal weight. Not entirely unexpectedly, a third of the medical students reported an improvement in their diet during the pandemic, but the REAP-S scores from this sub-group cannot confirm a change in dietary quality from the population's baseline. The dietary quality was lower in those medical students who had self-declared "less healthy" changes during the COVID-19 pandemic compared to their peers who reported being able to maintain a healthy diet or even improve their diet. While most medical students maintained their weight, a little over a quarter of the medical students reported weight gain in these three months, and a minority reported weight loss.

In the most recent 2015 Healthy Eating Index, the HEI score for younger adults in the general population, is 58.3 out of a possible range of 0-100 points (58.3%). The average REAP-S score of our surveyed medical students was 30.5, with a range of possible scores from 13-39 (67%). HEI scores ranging from 51-80% of the total score reflect diets that "need improvement." Our study would concur with findings from the HEI regarding the general population that this cohort of US medical students also consuming a suboptimal dietary quality. Though marginally, the dietary quality of medical students is better than the normal population, in such a highly educated group, there were no ideal

scores, indicating that all medical students could improve their dietary quality.

A particular strength of our study was the use of the REAP-S tool, which was previously validated for medical students.[9,10] The survey could be conducted virtually and safely during the pandemic. The REAP-S survey tool has many benefits and has been well studied; it has been found to correlate to dietary quality as measured by the premier standard of US dietary quality, the HEI,[8] and with well-documented markers of dietary quality such as the nutrient density of the diet,[15] the Potential Renal Acid Load (PRAL)[16], urine pH[17] and plasma vitamin C concentrations.[18,19]

Additionally, lower scores on the REAP-S have been found to be directly associated with metabolic abnormalities, including obesity, hypertension, lipid abnormalities and insulin resistance.[10] Prior to the pandemic, the mean REAP-S score for young and healthy university students with normal weight, consuming a typical omnivorous diet was 32 (range 13-39).[9] The students with REAP-S scores below 32 were detected to have significant metabolic abnormalities.[18] By comparison, the mean REAP-S score from our similar cohort was 30.5, indicating that this cohort of midwestern medical students could be at an increased metabolic risk.

Our findings determined that medical students who are overweight or obese have a significantly poorer dietary quality than their normal-weight peers. These groups of medical students who are overweight or obese could be even more likely to be at higher increased future metabolic risk and experience greater weight gain, as observed in a recent small study on patients with obesity, the majority of whom gained significant weight within a month of the pandemic.[13] Similarly, the subgroup of students that self-reported a significant decline in their diet during the pandemic had a lower dietary quality score and could be at additional risk of metabolic disorders such as insulin resistance and hyperlipidemia.[10]

A majority of medical students in this study cohort did not report weight gain; however, a little over a quarter did note weight gain, while a smaller minority had weight loss. Any weight gain is well known to be difficult to keep off and long-term consequences may develop.[20] Our observation of the adverse impact of the isolation period of the pandemic on diet was similar to that seen in an Australian study of university students reporting 20% excess eating during the pandemic isolation.[12] We did not find similar percentages of weight loss seen in the study reported from medical students from Croatia.[21]

The limitations of any self-reported diet survey are well known to include self-reporting bias and under-reporting. [22] Faulty recall is another issue, and in one international COVID-19 study, the Block Food Frequency Questionnaire was used, but due to greater inherent error of bias recall, the authors of this study elected not to pursue this as a survey tool.[23] Limitations due to the brevity of

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the survey may have led to the omission of further details on family composition, the impact of stress, socioeconomic status and other confounders that may have impacted diet quality and lifestyle changes. We were also limited by the restrictions and special permission for medical student research as well as new COVID-19 research requirements. We recognized the additional stress levels of medical students due to remote learning, the COVID-19 pandemic, and overstretched resources, and as a result, kept the survey items to the minimum.[13,22] We also could not include the fourth-year medical students who had graduated in the middle of June 2020, reducing the number of potential participants.

Since the time of our study, there have been new and more comprehensive surveys available from international studies on COVID-19, but these have not been validated by US medical students.[22,24] We anticipate that these tools can be used in future studies.

The overwhelming positive response to our question on the willingness to change eating habits was indicative of the large gap in nutritional training and self-practice of healthy eating in US medical students. Our study highlights and reinforces the need for greater education on nutrition and self-care for our medical trainees and future clinical health care workforce.[6,25] In the US, curricula and programs such as Nutrition in Medicine, Healthy Kitchen, and Culinary Medicine have been helpful.[26-28]

Local facilities can be incorporated, as demonstrated by the culinary medicine program at Tulane University, and at our institute, we have collaborated with a local culinary institute to help with medical student education.[28,29] At the global level, the World Health Organization (WHO) has established diet recommendations such as reducing snacking, eating breakfast and good dietary quality meals to optimize health throughout the COVID-19 pandemic.[30] A comprehensive multi-level framework of action to support nutrition and food security during the COVID-19 pandemic, using the various levels of ecological health modes from the individual, community level, national level, and global level has been developed to serve as a guideline.[25]

The dietary quality of medical students at one midwestern US college of medicine was found to be suboptimal during the early part of the COVID-19 pandemic. We anticipate that the results of our study can be used to inform future interventions on improving the quality of medical students' diet, and eventually translate into improved delivery of nutritionally enhanced clinical care to patients. We advocate medical schools enhance nutritional teaching and self-practice skills to bridge the knowledge-practice gap. It is critical to optimize the health of our future healthcare workforce, particularly during times of extreme stress.

## Summary – Accelerating Translation

*Title:* **The Diet Quality of Medical Students in the United States during the Early COVID-19 Pandemic**

*Main Problem to Solve:* Medical students report lacking the knowledge to conduct nutrition counseling for patients and practice good dietary quality in their personal life.

*Aim of Study:* This cross-sectional study describes the dietary quality of medical students at one midwestern college of medicine during the early COVID-19 pandemic.

*Methodology:* Medical students (n = 102) enrolled at the time of this study in the spring of 2020 were surveyed utilizing the Rapid Eating Assessment for Participants–Shortened (REAP-S). The response rate was 27%.

*Results:* One hundred and two medical students were included. A mean REAP-S score of 30.5 (67% of ideal dietary quality) was obtained. Body weight remained the same for 54.9% of students, 25.7% gained weight, and 18.8% lost weight during the late spring of 2020. Students with BMI < 24.9 kg/m2 had a significantly better dietary quality than those with BMI > 25 kg/m2. Students with self-reported "less healthy" diets had significantly worse dietary quality than those who either maintained a healthy or improved diet. Of note, 89.2% of students indicated that they want to improve their diet.

*Conclusion:* The dietary quality of participants was found to be sub-optimal during the early COVID-19 pandemic, with potential to adversely impact the long-term health of our future medical workforce.

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# Prevalence and Correlates of Internet Gaming Disorder Among an Advanced Level Student Population from Colombo, Sri Lanka

Minura Manjitha Manchanayake,[1] Thalpe Guruge Madara Malsirini,[1] Ashan Manelka Vithanage,[1] Dushyanthi Jayawardene.[2]

## Abstract

**Background:** Internet Gaming Disorder (IGD) is rising in many low and middle-income countries owing to the increasing popularity of electronic gaming and technology availability among adolescents. However, the epidemiology of IGD in South Asia remains largely unknown. We aimed to determine IGD's prevalence and associations, including motivations for gaming, among a Sri Lankan school-going population. **Methods:** A cross-sectional study was conducted among Advanced Level students aged 16-18 attending four Colombo Educational Zone schools. Of the 412 randomly sampled recruits, 395 consenting participants filled a pretested questionnaire exploring gaming habits, motivations, and psychosocial factors. English and Sinhala versions of the Internet Gaming Disorder Scale Short-Form (IGDS9-SF) were used, and IGD was identified if ≥5 items in the scale were endorsed. The Sinhala IGDS9-SF demonstrated acceptable internal consistency reliability, and its factorial validity was affirmed via Confirmatory Factor Analysis. **Results:** Among the sample, 81.5% (n=322) were gamers. A majority of these gamers preferred mobile gaming (64.0%) and Multiplayer Battle Royale games (27.0%). The prevalence of IGD was 5.06% (95% CI = 2.90–7.22) and was significantly higher (p<0.05) among males, who constituted 52.4% of the sample. Daily weekday gaming for ≥6h, low involvement in student societies, poor relationship with parents, escape motive, and fantasy motive were positively associated with IGD, and the Competition motive was negatively associated with IGD in multivariable analyses. **Conclusion:** The prevalence of IGD was considerably high in our student population and is associated with specific motives, poor parent-child relationships, and low extra-curricular involvement.

**Key Words:** Internet Gaming Disorder; Addictive Behavior; Motivation; Adolescent Psychiatry; Community Psychiatry (Source: MeSH-NLM).

## Introduction

Electronic gaming is a healthy recreational activity which confers several cognitive, motivational, emotional, and social benefits and is gaining popularity as a source of entertainment among adolescents.[1] Pathological gaming, however, is a type of maladaptive behavior and is described as "Internet Gaming Disorder" (IGD) under Section III of the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5), where it is defined as a pattern of persistent and recurrent participation in electronic gaming leading to significant impairment or distress as indicated by five or more of nine core symptoms exhibited over a year. The specified symptoms include pre-occupation with games, withdrawal, tolerance, lack of control, loss of interest in previous hobbies, continued excessive use despite knowledge of psychosocial problems, deception of family members and/or others, use of games to gain relief from negative emotions and jeopardizing important relationships or opportunities due to gaming behavior. The condition was also recognized by the World Health Organization and described as "Gaming Disorder" in the latest International Classification of Diseases (ICD-11).[2]

Despite its name, IGD applies to both online and offline gaming activity.[3] It should be noted that Internet Addiction Disorder (Problematic Internet Use) and IGD are two distinct entities.[4,5]

IGD is a debilitating condition with consequences spanning the physical, mental, and social aspects of a person's wellbeing.[6] Depressive symptoms, lower academic achievement,[7] and increased physical aggression are consequences of pathological gaming.[8] Other associated comorbid psychopathologies include attention deficit hyperactive disorder, obsessive-compulsive disorder, and anxiety.[6,9] Psychosocial issues such as peer problems,[10] poor relationship with parents and teachers,[11] and low self-esteem[12,13] are higher among gamers with IGD. Poor sleep quality and sleep-related problems,[14] reduced interest in schoolwork,[15,16] and extra-curricular activities are also linked to IGD.[17] Gamers with IGD are more likely to prefer massively multiplayer online role-playing games (MMORPGs) and first-person shooter (FPS) games among other genres.[18] Case reports suggest that problematic gaming may be associated with a preference for newer genres such as Battle Royale (BR) games as

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well.[19] Increased gaming time[15,20,21] and low involvement in sports and exercise[22] adds to the risk of developing IGD. Furthermore, the possession of gaming consoles, a powerful internet connection,[20] and an earlier age of first playing games are also implicated.[23] Gaming motives are important predictors[12,24] and mediators of psychopathology in gamers with IGD.[25] Seven motives have been identified, namely: escape, fantasy, coping, skill development, recreation, competition and social.[26]

The global pooled prevalence of IGD is 3.05%,[27] and the prevalence rates reported range from 0.21-57.5%.[28] IGD is predominantly seen in males and is higher among adults than younger adolescents, although the prevalence decreases with increasing age among adults.[29] The prevalence is lower among European populations compared to South-East Asian populations, with rates as low as 1.6% reported from representative European samples[17] and as high as 10.1% in South-East Asia.[30] The prevalence of IGD was 3.5% in a study done among a sample of 15-19-year-old school-going adolescents[31] and 3.6% among a sample of medical students from India.[32]

The literature pertaining to the psychological aspects of electronic gaming is scarce in the South Asian region. Evidence from Sri Lanka has thus far been limited to case reports such as that done by Chandradasa and Rodrigo in 2017, where IGD was described in four adolescents aged 13-16 years presenting to a Sri Lankan tertiary care hospital.[33] In this light, we aim to address this regional evidence gap by investigating the prevalence of IGD in a Sri Lankan school-going adolescent population, using a simple validated screening tool that can be used in native settings. We also aim to describe the role of interindividual and student-specific factors and the role of gaming motivations which have not been adequately explored in the extant literature.

## Methods

### Study Design and Setting
A descriptive cross-sectional study with an analytical component was conducted among four conveniently selected national schools located in Colombo, the commercial capital of Sri Lanka. Being national schools, the students hail from around the country and therefore the population is diverse, and representative of the multi-ethnic demographic of Sri Lanka. Ethics approval was obtained from the Ethics Review Committee of the Faculty of Medicine, the University of Colombo, prior to the recruitment of participants (Reference No. MFC/AL/2016/911).

### Sample Size
A sample size of 355 was deemed necessary at a confidence level of 95% and a 5% margin of error for a finite population of 4500 students. An estimated proportion of 50% was considered in the calculation to arrive at a maximum sample size.[34]

### Participants
Sri Lankan school education is offered in four stages which are namely: Primary (Grades 1-5), Junior Secondary (Grades 6-9), Senior Secondary (Grades 10-11) and Collegiate or Advanced Level (A/L) (Grades 12-13). At the end of Grade 13, students face the General Certificate of Education (A/L) examination in their preferred stream (e.g., Biological Science, Physical Science, Commerce, Arts, etc.), which also serves as the entrance test to state universities. For our study, we recruited a total of 412 students aged 16-18 years studying in the A/L classes of the respective schools. Random cluster sampling was used in order to prevent selection bias, with a class of students constituting a cluster. The exclusion criteria included absence on the day of data collection, failure to provide informed written consent and assent, presence of known cognitive impairment/ co-morbid psychopathology interfering with the reliability of responses and filling the questionnaire incompletely/incoherently. Based on these criteria, 17 participants were excluded due to absence (n=4), failure to return the consent and assent forms (n=2) and incompletely/incoherently filled questionnaires (n=11), with 395 students finally included in the study, resulting in a response rate of 95.87%.

### Study Procedure
Data collection was done throughout September 2020. Permission was initially obtained from the Zonal Education Director and Principals of the selected schools before approaching the selected classes for data collection. The investigators approached the students during the free timeslots in their academic timetables. The study's objectives and procedure were described before distributing the consent forms, which were to be signed by the parents. Informed assent was obtained from participating students. Students who returned the completed consent and assent forms were given the questionnaire in their preferred language (English/Sinhala). Personal details such as name and residential address were not requested to ensure anonymity. The investigators were present at the time of data collection to answer any queries raised by the participants, although the participants were not allowed to discuss the contents of the questionnaire amongst themselves to prevent information bias.

### Measures and Variables
The study employed a self-administered questionnaire, which was pre-tested among 32 A/L students from the Galle district. The questionnaire consisted of three sections.

Section A explored sociodemographic and academic characteristics, as well as the average hours of sleep obtained each night in the past week. Extra-curricular involvements, including sports, aesthetics and student societies, were assessed on a scale of 0-3, with higher values implying greater levels of involvement. Involvement in online learning activities, positive attitude regarding parent-child and teacher-student relationships, lack of satisfaction with one's physical appearance and the presence of few/no friends were assessed by single items graded on a five-point Likert scale, with higher values indicating greater levels of agreement. Self-esteem was assessed with a

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Single-Item Self-esteem Scale graded on a similar five-point scale.[35] Gaming habits and preferences, including the preferred genre and device, were also explored in this section. The game that was played for the longest duration over the past year was used to identify the preferred gaming genre.

Section B consisted of the Internet Gaming Disorder Scale–Short Form (IGDS9-SF), which consists of nine items graded on a five-point Likert scale. Each item corresponds to one of nine DSM-5 diagnostic criteria.[36] A forward-backward translation protocol was used to develop the Sinhala IGDS9-SF, and content validity was assessed by a panel of experts from the National Institute of Mental Health, Sri Lanka (*Supplementary material*). Positive cases of IGD were identified based on the endorsement of five or more items in the IGDS9-SF scale, with a score of 4/5 or 5/5 considered an item's endorsement.

Section C incorporated the Motives for Online Gaming Questionnaire (MOGQ). The items are divided into seven subscales which correspond to the seven gaming motives.[26] Each item is graded on a five-point scale, and scores of the relevant items were tallied to provide a subscale score, with higher scores denoting greater degrees of motivation.

### Statistical Analysis
The internal consistency of all scales was assessed using the Cronbach's alpha test and $\alpha \geq 0.7$ was considered acceptable. Factorial, validity of the Sinhala IGDS9-SF scale was assessed via factor analyses. Mean, standard deviation (SD), counts and proportions were used to describe the general characteristics of the sample.

Bivariate analyses were conducted using chi-square and fisher's exact tests to identify associations of IGD status. A p-value of <0.05 was considered statistically significant at a confidence level of 95%. The Shapiro-Wilk and Kolmogorov-Smirnov tests revealed a non-normal distribution of the IGDS9-SF scores, and so correlational analyses of the IGD score and MOGQ subscale scores were done using Spearman's Rank ($r_s$) coefficients.

Multivariable analyses were then conducted using binary logistic regression with the IGD status as the dependent variable. All significant bivariate associations were initially entered into the initial model, and a forward method of entry was used to obtain the final model, which retained only significant variables. To verify the linearity assumption, the continuous variables were tested via the Box-Tidwell test. Multicollinearity was excluded by assessing the Variance Inflation Factors, which were <2.5. Exponentiated beta coefficients were presented as odds ratios with a 95% confidence interval (CI) for each variable. Statistical analyses were conducted using Version 26.0 of the Statistical Package for the Social Sciences and Version 1.2.27.0 of jamovi.

## Results
### Validity and Reliability of Scales
The English and Sinhala questionnaires were filled by 183 and 139 gamers, respectively. The internal consistency reliability of the

Sinhala IGDS9-SF was good ($\alpha$=0.854) and acceptable ($\alpha$=0.77) in the English IGDS9-SF. The alpha estimates were not significantly increased by excluding any of the items, and inter-item correlations were acceptable (0.15-0.5). The Cronbach's Alpha values of the MOGQ subscales were acceptable (0.763-0.818 for the Sinhala version and 0.663–0.803 for the English version).

The Factorial Validity of the Sinhala IGDS9-SF scale was assessed using factor analyses. The adequacy of the sample size was initially verified with the Keiser-Meyer-Olkin measurement, which was acceptable at 0.886. The Bartlett's Test of Sphericity was significant ($x^2$=412, df=36, p<0.001). The Exploratory Factor Analysis done with a Varimax rotation on the nine items revealed a one-factor solution with an Eigenvalue threshold of one. This was further affirmed by examination of the Scree plot. The unidimensional structure was further assessed by Confirmatory Factor Analysis. The test for exact fit was significant ($x^2$=44.9, df=27, p<0.05) and other fit indices were acceptable (Comparative Fit Index = 0.954, Tucker-Lewis Index = 0.939 and Root Mean Square Error of Approximation = 0.069). All factor loadings were statistically significant (p<0.001) and ranged from 0.455-0.733.

These results affirm that the Sinhala IGDS9-SF scale measures a unidimensional construct, like its validated English counterpart.

### Descriptive Analysis of Sample Characteristics
The general and gaming-related characteristics of the sample are described in *Table 1*. The mean age was 17.22 years (SD=0.54), and 52.4% of the participants were male. Most participants reported a monthly income of LKR 100,000–199,999 (31.6%, n=125) and had one sibling in the family (53.4%, n=211). Most of the students studied in the English medium (51.6%, n=204) and followed commerce subjects (32.9%, n=130). A majority reported high involvement in online learning activities (60.0%, n=237) and slept 6-7 hours every night (57.0%, n=225).

Of the 395 participants, 322 identified themselves as "gamers" (81.5%). A gamer was defined as an individual who had intentionally played electronic games for any duration of time, offline/online, using any device during the past 12 months. A majority played games for ≤1h every day during the weekdays (53.4%, n=172) and weekends (40.7%, n=131). Most of the students started to play games when they were 8-10 years old (24.8%, n=80) and preferred online multiplayer games (50.9%, n=164) and gaming on mobile phones (64.0%, n=206). The favorite genre was Multiplayer Battle Royale (27.0%, n=87) among 11 identified gaming genres (*Figure 1*).

### Prevalence of IGD and Bivariate Analyses
The prevalence of IGD was 5.06% (95% CI = 2.90–7.22) among the total study population and 6.21% (95% CI = 3.58–8.85) among the gamers. *Table 2* presents the cross-tabulated characteristics associated with IGD.

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*Table 1.* Frequency Distribution of Sample Characteristics.

| | Count | % |
|---|---|---|
| **Ethnicity (n=395)** | | |
| Sinhala | 306 | 77.5 |
| Tamil | 46 | 11.6 |
| Muslim | 37 | 9.4 |
| Burgher | 6 | 1.5 |
| **Monthly Income in LKR (n=395)** | | |
| <20,000 | 8 | 2.0 |
| 20,000 – 49,999 | 41 | 10.4 |
| 50,000 – 99,999 | 111 | 28.1 |
| 100,000 – 199,999 | 125 | 31.6 |
| 200,000 or more | 110 | 27.8 |
| **Number of siblings (n=395)** | | |
| None | 49 | 12.4 |
| One | 211 | 53.4 |
| Two | 104 | 26.3 |
| Three or more | 31 | 7.8 |
| **Stream of study (n=395)** | | |
| Biological Science | 88 | 22.3 |
| Physical Science | 97 | 24.6 |
| Commerce | 130 | 32.9 |
| Arts | 70 | 17.7 |
| Other (Miscellaneous) | 10 | 2.5 |
| **Hours of sleep per day (n=395)** | | |
| Less than four | 14 | 3.5 |
| Four to five | 118 | 29.9 |
| Six to seven | 225 | 57.0 |
| Eight or more | 38 | 9.6 |
| **Weekday gaming hours (n=322)** | | |
| One or less | 172 | 53.4 |
| Two to three | 91 | 28.3 |
| Four to five | 39 | 12.1 |
| Six to seven | 18 | 5.6 |
| Eight to ten | 2 | 0.6 |
| **Weekend gaming hours (n=322)** | | |
| One or less | 131 | 40.7 |
| Two to three | 101 | 31.4 |
| Four to five | 55 | 17.1 |
| Six to seven | 23 | 7.1 |
| Eight to ten | 9 | 2.8 |
| Eleven or more | 3 | 0.9 |
| **Starting age of gaming (n=322)** | | |
| Less than five years old | 26 | 8.1 |
| Five to seven years old | 35 | 10.9 |
| Eight to ten years old | 80 | 24.8 |
| 11 to 13 years old | 76 | 23.6 |
| 14 to 16 years old | 69 | 21.4 |
| Started recently | 36 | 11.2 |
| **Preferred Device (n=322)** | | |
| Personal Computer | 63 | 19.5 |
| Mobile Phone | 206 | 64.0 |
| Tablet | 24 | 7.5 |
| Gaming Console | 29 | 9.0 |
| **Type of Games (n=322)** | | |
| Online Multiplayer | 164 | 50.9 |
| Online Single Player | 49 | 15.2 |
| Offline Single Player | 109 | 33.9 |

*Figure 1.* Distribution of gamers in the sample according to the preferred game genre (n=322).
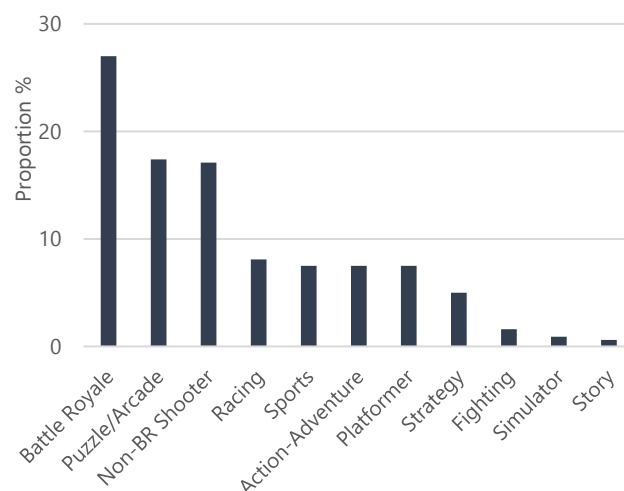


IGD was significantly higher ($\chi^2$=7.04, p<0.05) among males. The proportion of Sinhala medium students with IGD (9.2%, n=14) was significantly higher ($\chi^2$=4.45, p<0.05) than that among English medium students (3.5%, n=6). The only extra-curricular activity associated with IGD was involved in student societies. Students reporting no/minor involvement in such activities (8.8%, n=17) were significantly more likely to have IGD ($\chi^2$=5.46, p<0.05) than those reporting moderate/major involvements (2.3%, n=3). Poor quality of relationships with parents and teachers were also significantly linked to IGD (p<0.001). Furthermore, the proportion of IGD gamers who were dissatisfied with their physical appearances (14.9%, n=10) was found to be significantly higher ($\chi^2$=12.66, p<0.05) than those who were satisfied/neutral. Playing games for ≥6h during the weekdays and weekends was significantly associated with IGD (p<0.001). Furthermore, gamers who preferred BR games (13.8%, n=12) were more likely to have IGD ($\chi^2$=11.76, p<0.05) than those who preferred other genres (3.4%, n=8). Associations pertaining to the preferred type of games, gaming device, and starting age were not significant.

All correlations between the IGDS9-SF score and the MOGQ subscales were significant (p<0.001). The Escape motive correlated strongly with the IGD score ($r_s$ = 0.616). There were moderate positive correlations between IGD score and the social ($r_s$ = 0.514), coping ($r_s$ = 0.513) and fantasy ($r_s$ = 0.451) motives, while the correlations with the skill development ($r_s$ = 0.398), recreation ($r_s$ = 0.389) and competition motives ($r_s$ = 0.367), were positive but weak.

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**Original Article**

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*Table 2.* Bivariate Analysis of Factors Associated with Internet Gaming Disorder.

| Characteristic | No IGD | | IGD | | Total | Significance |
|---|---|---|---|---|---|---|
| | n=302 | % | n=20 | % | n=322 | |
| **Age** | | | | | | $\chi^2$ = 0.768 |
| 16 - 17 | 214 | 93.0 | 16 | 7.0 | 230 | p = 0.381 |
| 18 | 88 | 95.7 | 4 | 4.3 | 92 | |
| **Sex** | | | | | | **$\chi^2$ = 7.037** |
| Male | 165 | 90.7 | 17 | 9.3 | 182 | **p = 0.008** |
| Female | 137 | 97.9 | 3 | 2.1 | 140 | |
| **Ethnicity** | | | | | | |
| Sinhala | 232 | 93.2 | 17 | 6.8 | 249 | p = 0.582* |
| Other | 70 | 95.9 | 3 | 4.1 | 73 | |
| **Income (LKR)** | | | | | | $\chi^2$ = 0.20 |
| <100,000 | 116 | 93.5 | 8 | 6.5 | 124 | p = 0.888 |
| ≥100,000 | 186 | 93.9 | 12 | 6.1 | 198 | |
| **No. of Siblings** | | | | | | $\chi^2$ = 1.721 |
| One or less | 195 | 95.1 | 10 | 4.9 | 205 | p = 0.19 |
| Two or more | 107 | 91.5 | 10 | 8.5 | 117 | |
| **Medium** | | | | | | **$\chi^2$ = 4.446** |
| Sinhala | 138 | 89.8 | 14 | 9.2 | 152 | **p = 0.035** |
| English | 164 | 96.4 | 6 | 3.5 | 170 | |
| **Stream** | | | | | | $\chi^2$ = 0.084 |
| Science | 146 | 94.2 | 9 | 5.8 | 155 | p = 0.772 |
| Non-science | 156 | 93.4 | 11 | 6.6 | 167 | |
| **Hours of sleep** | | | | | | $\chi^2$ = 0.439 |
| Five or less | 97 | 95.1 | 5 | 4.9 | 102 | p = 0.507 |
| More than five | 205 | 93.2 | 15 | 6.8 | 220 | |
| **Sports** | | | | | | $\chi^2$ = 0.02 |
| None/Minor | 186 | 93.9 | 12 | 6.1 | 198 | p = 0.888 |
| Moderate/Major | 116 | 93.5 | 8 | 6.5 | 124 | |
| **Unions** | | | | | | **$\chi^2$ = 5.455** |
| None/Minor | 177 | 91.2 | 17 | 8.8 | 194 | **p = 0.02** |
| Moderate/Major | 125 | 97.7 | 3 | 2.3 | 128 | |
| **Aesthetics** | | | | | | $\chi^2$ = 1.689 |
| None/Minor | 151 | 92.1 | 13 | 7.9 | 164 | p = 0.194 |
| Moderate/Major | 151 | 95.6 | 7 | 4.4 | 158 | |
| **Online Learning** | | | | | | $\chi^2$ = 0.956 |
| Low | 42 | 95.5 | 2 | 4.5 | 44 | p = 0.620 |
| Moderate | 77 | 91.7 | 7 | 8.3 | 84 | |
| High | 183 | 94.3 | 11 | 5.7 | 194 | |
| **Parent-Child** | | | | | | |
| Poor relationship | 8 | 61.5 | 5 | 38.5 | 13 | **p = 0.001*** |
| Neutral | 36 | 97.3 | 1 | 2.7 | 37 | |
| Good relationship | 258 | 94.9 | 14 | 5.1 | 272 | |
| **Teacher-Student** | | | | | | |
| Poor relationship | 12 | 75.0 | 6 | 33.3 | 18 | **p = 0.001*** |
| Neutral | 67 | 97.0 | 2 | 2.9 | 69 | |
| Good relationship | 223 | 94.1 | 12 | 5.1 | 235 | |
| **Self-appearance** | | | | | | **$\chi^2$ = 12.66** |
| Satisfied | 136 | 97.8 | 3 | 2.2 | 121 | **p = 0.002** |
| Neutral | 109 | 94.0 | 7 | 6.0 | 105 | |
| Not satisfied | 57 | 85.1 | 10 | 14.9 | 61 | |
| **Number of friends** | | | | | | $\chi^2$ = 1.341 |
| Many | 225 | 94.5 | 13 | 5.5 | 238 | p = 0.512 |
| Moderate | 42 | 93.3 | 3 | 6.7 | 45 | |
| None/Few | 35 | 89.7 | 4 | 10.3 | 39 | |
| **Self-esteem** | | | | | | $\chi^2$ = 3.501 |
| Low | 27 | 100 | 0 | 0 | 27 | df = 2 |
| Moderate | 88 | 90.7 | 9 | 9.3 | 97 | p = 0.174 |
| High | 187 | 94.4 | 11 | 5.6 | 198 | |

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**Table 2 (continued).** Bivariate Analysis of Factors Associated with Internet Gaming Disorder.

| Characteristic | No IGD | | IGD | | Total | Significance |
|---|---|---|---|---|---|---|
| | n=302 | % | n=20 | % | n=322 | |
| Weekday gaming hours | | | | | | |
| Less than 6h per day | 290 | 96.0 | 12 | 4.0 | 302 | **p < 0.001*** |
| 6h or more per day | 12 | 60.0 | 8 | 40.0 | 20 | |
| Weekend gaming hours | | | | | | |
| Less than 6h per day | 276 | 96.2 | 11 | 3.8 | 287 | **p < 0.001*** |
| 6h or more per day | 26 | 74.3 | 9 | 25.7 | 35 | |
| Preferred type | | | | | | $\chi^2 = 0.819$ |
| Online Multiplayer | 152 | 93.1 | 12 | 7.3 | 164 | p = 0.664 |
| Online Single Player | 47 | 95.6 | 2 | 4.1 | 49 | |
| Offline Single Player | 103 | 93.8 | 6 | 5.5 | 109 | |
| Preferred genre | | | | | | **$\chi^2 = 11.76$** |
| Battle Royale | 75 | 86.2 | 12 | 13.8 | 87 | **p = 0.001** |
| Other | 227 | 96.6 | 8 | 3.4 | 235 | |
| Preferred device | | | | | | $\chi^2 = 0.745$ |
| Mobile Phone | 195 | 94.7 | 11 | 5.3 | 206 | p = 0.388 |
| Other | 107 | 92.2 | 9 | 7.8 | 116 | |
| Starting age of gaming | | | | | | $\chi^2 = 0.013$ |
| 10 years or less | 132 | 93.6 | 9 | 6.4 | 141 | p = 0.91 |
| Older than 10 years | 170 | 93.9 | 11 | 6.1 | 181 | |

**Legend**: *Fisher's exact test was conducted. Significant associations (p<0.05) are given in bold.

## Multivariable analysis

The factors retained in the final binary logistic regression model are shown in **Table 3**. The Hosmer and Lemeshow test revealed an acceptable fit of the data ($\chi^2$=4.24; df=8; p=0.835). The model was found to be significant ($\chi^2$=63.64; df=7; p<.001) and explained 48.4% (Nagelkerke $R^2$) of the variance in IGD status. Gaming daily for six hours or more during the weekdays was associated with almost seven-fold higher odds of having IGD (95% CI = 1.735 – 27.569). Furthermore, no/minor involvement in student-based societies and poor parent-child relationships positively predictive IGD status. While the escape and fantasy motives were positively predictive, every unit increase of the competition motive score was associated with 17.6% lesser odds of having IGD (95% CI = 0.703–0.967).

## Discussion

To our knowledge, this is the first study which describes the prevalence of IGD in a Sri Lankan adolescent population and is one of few conducted in the South Asian region. In addition to the disease burden, we have discussed IGD from the perspective of school-going students by focusing on interindividual factors such as the parent-child, teacher-child relationships, and the role of academic and extra-curricular activities, which are unique to this population and often overlooked by researchers. Understanding the interplay between motivation and addiction enables early identification of at-risk gamers at a community level. However, previous studies have described these motivations in relation to adult populations,[12,24,25] and so, our study

**Table 3.** Multivariable Logistic Regression Model Retaining Significant Associations of Internet Gaming Disorder (n=322).

| Variable | β | Odds Ratio (95% CI) | p value |
|---|---|---|---|
| Involvement in student societies [a]: None/Minor | 1.985 | 7.277 (1.420 – 37.288) * | 0.017 |
| Parent-Child Relationship [b] | | | 0.003 |
| Poor | 2.625 | 13.81 (2.571 – 74.174) ** | 0.002 |
| Neutral | -2.058 | 0.128 (0.009 – 1.85) | 0.131 |
| Escape | 0.283 | 1.327 (1.108 – 1.588) ** | 0.002 |
| Competition | -0.183 | 0.833 (0.713 – 0.973) * | 0.021 |
| Fantasy | 0.190 | 1.209 (1.058 – 1.382) ** | 0.005 |
| Daily Weekday Gaming Hours [c]: 6 hours or more | 1.934 | 6.917 (1.735 – 27.569) ** | 0.006 |

**Legend:** * Significant at p<0.05. ** Significant at p<0.01. [a] Reference category is Moderate/Major involvement. [b] Reference category is Good Relationship. [c] Reference category is Less than 6 hours.

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furthers the field by describing the specific motivations that drive gaming addiction among an adolescent population. Furthermore, the Sinhala IGDS9-SF, translated from the original English version, was found to be a potentially valid and reliable tool that can be used among native speakers in future studies.

The prevalence of IGD in our study was 5.06%, which is greater than the global pooled prevalence of 3.05%,[27] but is lower than the pooled South-East Asian prevalence of 10.1%.[30] It is also higher than the prevalence reported from India, i.e., 3.5-3.6%,[31,32] although this may be explained by the strict diagnostic criteria adopted in these studies. Our prevalence resembles that among Thai high-school students, which is 5.4%.[37]

Male gamers were significantly more likely to have IGD than females, which is consistent with the existing research.[29] This is partly explained by the fact that males spend more time gaming and prefer high-risk genres, whereas most female gamers favor low-risk casual games. Maladaptive cognitions such as the overvaluation of virtual rewards may also explain the higher prevalence of IGD among males.[38]

Of the academic characteristics explored, the only significant association was the language of study, with Sinhala medium students being more likely to have IGD. Poor sleep is a known association of IGD.[20] In our study, however, reduced sleep hours was not linked to IGD. In fact, some studies report higher sleep hours among IGD gamers in high-school student populations.[37] This could be explained by the regular sleep schedules students are compelled to adhere to, owing to early school commencement hours.

Although low exercise is cited as a risk factor,[22] a low involvement in sports was not associated with IGD in our study, which may be explained by the lack of opportunities for sports activities owing to lockdowns amid the COVID-19 pandemic. A lack of interest in recreational activities is a known correlate,[17] and our findings reflect this as IGD gamers were more likely to report low involvement in student societies.

Gamers with IGD also had poor interpersonal relationships with their parents and teachers. These interindividual factors, which are associated with internet addiction,[11] appear to be linked to IGD. We did not find the number of friends to be a significant association with IGD, which supports the notion that despite real-life social exclusion, online gaming can facilitate social interactions,[39] with IGD gamers reporting more friends than non-IGD counterparts in some studies.[16]

We also found that IGD gamers were significantly more likely to be dissatisfied with their self-appearance, which may explain the tendency to idolize in-game avatars with idealized physical forms.[40] Although low self-esteem is commonly described among IGD gamers,[12,13] this was not a significant association in our study,

and so, it is conceivable that the feeling of virtual achievement may have a positive influence on a gamer's self-esteem.

Daily weekday gaming for ≥6h daily was retained as a significant association in multivariable analyses, highlighting the role of excessive gameplay in disordered gaming. Excessive gaming, however, is not tantamount to disordered gaming, with certain studies failing to show increased gameplay as a significant association.[12] Although MMORPG and FPS games are traditionally implicated with disordered gaming,[18] in our study, most of the gamers (27.0%) preferred Multiplayer Battle Royale games such as "PUBG" and "Fortnite," which was also linked to IGD. Most gamers in our study (64.0%) preferred mobile phones to traditional gaming devices such as personal computers and consoles.[20] The mobile phone is indeed an emerging gaming device in middle-income countries like Sri Lanka, with the number of mobile connections increasing by 2.2 million from January 2019 to January 2020,[41] although a preference for mobile gaming was not associated with IGD.

Escape and fantasy were positively predictive of IGD, which echoes existing work on gaming motivations.[12] However, competitiveness had a negative effect in our model, which is, described as a positive predictor among women in the cited study. Escape refers to "escaping from problems in the real world" and fantasy entails "stepping out of one's usual identity, trying new identities in a different fantasy world", while competition represents the motive of "competing with and defeating others to feel a sense of achievement".[26]

## Limitations

Our findings should be interpreted with caution. First, we acknowledge the limited generalizability of our results which may apply to the four selected national schools. The study's cross-sectional design does not allow temporal interpretation of associations as true predictors or consequences of disordered gaming. IGD was diagnosed using the IGDS9-SF scale, a validated psychometric tool. This is less accurate than the structured clinical interview, which is the gold standard of diagnosis. We also admit the possibility of recall bias and reduced answering accuracy as participants were expected to report gaming practices over a period of 12 months. Furthermore, the study was conducted amid the COVID-19 pandemic, so the data presented here may not reflect the "pre-COVID normal" where students were not compelled to follow online lessons owing to countrywide lockdowns. Despite these limitations, our study has set an important precedent for future studies both nationally and regionally.

## Conclusions

Gaming addiction is an emerging public health challenge in our student population. The Sinhala IGDS9-SF was found to be a potentially valid and reliable tool. IGD was significantly higher among male gamers and was associated with a poor parent-child relationship, low extra-curricular involvement, increased daily

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weekday gaming and specific gaming motives. These associations should be considered when planning preventive interventions and awareness programs targeting high-risk groups. The inclusion of gaming motivations in the psychological assessment of at-risk gamers will facilitate screening efforts, as gaming time alone is insufficient in distinguishing disordered gaming from non-pathological high involvement. IGD should be considered a serious public health problem that is emergent in school-going adolescent populations and we recommend further studies exploring this condition in nationally/regionally representative samples.

## Summary – Accelerating Translation

නව යෞවුන් වියේ දරුවන් අතර ඉලෙක්ට්‍රොනික/ විද්‍යුත් ක්‍රීඩා ජනප්‍රිය වීම සහ තාක්ෂණික මෙවලම් වැඩියෙන් සතුව තිබීම හේතුවෙන් බොහෝ අඩු සහ මධ්‍යම ආදායම් ලබන රටවල විද්‍යුත් ක්‍රීඩා ආබාධය (Internet Gaming Disorder/IGD) වැඩිවෙමින් පවතී. IGD යනු ඇමරිකානු මනෝවිකිත්සක සංගමයේ (American Psychiatric Association) DSM-5 වර්ගීකරණයේ සහ ලෝක සෞඛ්‍ය සංවිධානයේ ICD-11 වර්ගීකරණයේ (Gaming Disorder ලෙස) සඳහන් වී ඇති මානසික ආබාධයකි. මෙම තත්වය හේතුවෙන් බොහෝ දරුවෝ මානසික අවපීඩනය, කාංසාව හා නින්ද ආශ්‍රිත ගැටලු වලින් පෙළෙති. තවද ඔවුන්ගේ අධ්‍යාපනික කටයුතු මෙම තත්වය නිසා අඩාල විය හැකියි. දකුණු ආසියාවේ IGD හි ව්‍යාප්තිය නොදන්නා තරම් ය. එබැවින්, ශ්‍රී ලංකාවේ පාසල් යන සිසුන් අතර IGD හි ව්‍යාප්තිය සහ ඒ හා ආශ්‍රිත පෙළඹවීම් (Motivations) ඇතුළු සාධක කිහිපයක් අපගේ පර්යේෂණය තුලින් නිර්ධාරණය කිරීම අපගේ අරමුණයි.

කොළඹ අධ්‍යාපන කලාපයේ ජාතික පාසල් හතරක ඉගෙනුම ලබන, වයස අවුරුදු 16-18 අතර උසස් පෙළ සිසුන් මෙම පර්යේෂණය සිදු කිරීම සඳහා තෝරාගන්නා ලදි. අහඹු ලෙස බදවා ගත් සිසුන් 412 දෙනෙකුගෙන්, සිසුන් 395ක් පර්යේෂණයට සහභාගි වීමට කැමැත්ත පල කළේ ය. එසේ කැමැත්ත පල කළ සිසුන් විසින් විද්‍යුත් ක්‍රීඩා ක්‍රියාකාරකම් හා සබැඳි පුරුදු (ක්‍රීඩාවන්හි යෙදෙන කාලය, කැමති ක්‍රීඩා වර්ග, ආදිය), පෙළඹවීම් සහ මනෝ සාධක රාශියක් ගවේෂණය වන ප්‍රශ්නාවලි පුරවන ලදි. විද්‍යුත් ක්‍රීඩා ආබාධය හඳුනා ගැනීම සඳහා Internet Gaming Disorder Scale – Short Form (IGDS9-SF) නැමැති ප්‍රශ්නාවලිය අප යොදා ගත් අතර එම ප්‍රශ්නාවලියේ වගන්ති 9න් වගන්ති 5කට 4/5 හෝ 5/5 ලෙස ප්‍රතිචාර දැක්වූවහොත් එම සිසුවාට විද්‍යුත් ක්‍රීඩා ආබාධය තිබෙනු යැයි අප විසින් තීරණය කරන ලදි.

සහභාගි වූ සිසුන්ගෙන් 81.5% ක් විද්‍යුත් ක්‍රීඩා වල යෙදී තිබුණේය. ඉන් බහුතරයක් ජංගම දුරකථනයෙන් (64.0%) ක්‍රීඩා කළ අතර, PUBG® වැනි "Battle Royale" වර්ගයේ ක්‍රීඩාවන්ට (27.0%) වැඩිපුර කැමැත්තක් පල කරන ලදි. සහභාගි වූ වන්ගෙන් 5.06% කට අන්තර්ජාල ක්‍රීඩා ආබාධය (IGD) තිබෙනු යැයි අප විසින් සොයාගන්නා ලදි. විද්‍යුත් ක්‍රීඩාවන්හි යෙදෙන සිසුන් අතර එහි ව්‍යාප්තිය 6.21% කි. මෙම තත්වය පිරිමි සිසුන් අතර වැඩියෙන් දැකගැනීමට හැකිවීම විශේෂත්වයකි. තවද දිනකට පැය 6කට වඩා ක්‍රීඩා කිරීම, දෙමව්පියන් හා සමග දුර්වල සම්බන්ධතාවයක් තිබීම, ශිෂ්‍ය සංගම් ආශ්‍රිත කටයුතු වල අඩුවෙන් නියැලීම යනාදිය IGD හා සබැඳි සාධක ලෙස අප විසින් සොයාගන්නා ලදි. ජීවිතයේ ගැටලු සහගත තත්වයන්ගෙන් මිදීමට හෝ ඇන්ටිසි ලෝකයකට පලායෑමේ චේතනාවන්ගෙන් ක්‍රීඩා කරන සිසුන් අතර මෙම තත්වය වැඩියෙන් දැකගැනීමට හැකි වූ අතර තරගකාරී මනෝභාවයකින් ක්‍රීඩා කරන සිසුන් අතර මෙම තත්වය අඩුවෙන් දැකගැනීමට අපට හැකි විය.

IGD යනු සමාජයේ අලුතින් පැන නැගී ඇති මනෝසෞඛ්‍ය ගැටලුවකි. විද්‍යුත් ක්‍රීඩාවන්හි නියැලෙන සුලුතරයකට පමණක් IGD ඇති විය හැකි වුවද, ශිෂ්‍යයෙන් වැඩිවෙන විද්‍යුත් ක්‍රීඩක ප්‍රජාව හමුවේ මෙය සැලකිය යුතු කාරණාවකි. එබැවින්, මෙම පර්යේෂණය තුලින් සොයාගෙන ඇති සාධක ඉලක්ක වන ලෙස ප්‍රජා සෞඛ්‍ය වැඩපිළිවෙත් නිර්මාණය විය යුතු යැයි අපේ නිර්දේශය යි.

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# Original Article

Manchanayake MM, et al.

Prevalence and Correlates of Internet Gaming Disorder Among an
Advanced Level Student Population from Colombo, Sri Lanka

## Supplementary Material

### The English Internet Gaming Disorder Scale – Short Form (IGDS9-SF)

These questions will ask about your gaming activity during the **past year** (i.e., the **last 12 months**). By gaming activity, we understand any gaming-related activity played either from a computer/laptop or a gaming console or any other kind of device (e.g., mobile phone, tablet, etc.), both online and/or offline. There are no right or wrong answers.

Read each of the given statements and put an "X" on the appropriate number. **1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Very Often**

| | | | | | | |
|---|---|---|---|---|---|---|
| **1.** | Do you feel preoccupied with your gaming behavior? (Some examples: Do you think about previous gaming activity or anticipate the next gaming session? Do you think gaming has become the dominant activity in your daily life?) | 1 | 2 | 3 | 4 | 5 |
| **2.** | Do you feel more irritability, anxiety or even sadness trying to either reduce or stop your gaming activity? | 1 | 2 | 3 | 4 | 5 |
| **3.** | Do you feel the need to spend increasing amounts of time engaged in gaming in order to achieve satisfaction or pleasure? | 1 | 2 | 3 | 4 | 5 |
| **4.** | Do you systematically fail when trying to control or stop your gaming activity? | 1 | 2 | 3 | 4 | 5 |
| **5.** | Have you lost interest in previous hobbies and other entertainment activities due to your engagement with the game? | 1 | 2 | 3 | 4 | 5 |
| **6.** | Have you continued your gaming activity despite knowing it was causing problems between you and others? | 1 | 2 | 3 | 4 | 5 |
| **7.** | Have you deceived any of your family members or others because of the amount of your gaming activity? | 1 | 2 | 3 | 4 | 5 |
| **8.** | Do you play in order to temporarily escape or relieve a negative mood (e.g., helplessness, guilt, anxiety)? | 1 | 2 | 3 | 4 | 5 |
| **9.** | Have you jeopardized or lost an important relationship, job or an educational opportunity because of your gaming activity? | 1 | 2 | 3 | 4 | 5 |

### The Sinhala Internet Gaming Disorder Scale – Short Form (IGDS9-SF)

**පසුගිය වසර තුළ (එනම් පසුගිය මාස 12 තුළ)** ඔබගේ විද්‍යුත් ක්‍රීඩා ක්‍රියාකාරකම් (Electronic Gaming Habits) පිළිබඳව මෙම ප්‍රශ්න මාලාවෙන් අසනු ලැබේ. මෙහිදී විද්‍යුත් ක්‍රීඩා ක්‍රියාකාරකම් ලෙස පරිගණක/ ලැප්ටොප් හෝ PlayStation®, X-box® වැනි කොන්සෝලයකින් හෝ ඕනෑම උපකරණයකින් (උදා: ජංගම දුරකථන, ටැබ්ලට් ආදිය මගින්) සිදු කරන ක්‍රීඩා සැලකිල්ලට ගනිමු. මෙහිදී අන්තර්ජාලයට සම්බන්ධ වී හෝ නොවී සිදු කරන ක්‍රීඩා දෙවර්ගයම සැලකිල්ලට ගනිමු. මෙම ප්‍රශ්න වලට නිවැරදි හෝ වැරදි පිළිතුරු නොමැත.

ලබා දී ඇති සෑම ප්‍රකාශයක්ම කියවා සුදුසු අංකයට "X" ලකුණ යොදන්න. **1 = කිසිවිටක නැත, 2 = කලාතුරකින්, 3 = සමහර අවස්ථා වලදී, 4 = බොහෝ අවස්ථා වලදී, 5 = සැමවිටම පාහේ**

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | ඔබ විද්‍යුත් ක්‍රීඩා (පරිගණක/ ලැප්ටොප් හෝ කොන්සෝලයකින් හෝ ජංගම දුරකථන, ටැබ්ලට් ආදිය මගින් සිදු කරන ක්‍රීඩා) වලට චුවමනාවට වඩා අවධානය යොමු කරන්නේද? (උදාහරණ කිහිපයක්: ඔබ පෙර යොමු වුනු ක්‍රීඩා වාර ගැන සිතන්නේද? නැතහොත් ඊළඟ ක්‍රීඩා වාරය අපේක්ෂාවෙන් සිටින්නේද? ඔබේ දෛනික ජීවිතයේ ඉලෙක්ට්‍රොනික ක්‍රීඩා වල යෙදීම ප්‍රමුඛතම ක්‍රියාකාරකම බවට පත්ව ඇතැයි ඔබ සිතනවාද?) | 1 | 2 | 3 | 4 | 5 |
| 2 | ඔබගේ විද්‍යුත් ක්‍රීඩා ක්‍රියාකාරකම් අඩු කිරීමට හෝ නැවත්වීමට උත්සාහ කරන විට වැඩි කෝපයක්, කාංසාවක් හෝ දුකක් දැනෙනවාද? | 1 | 2 | 3 | 4 | 5 |
| 3 | තෘප්තියක් හෝ සතුටක් ලබා ගැනීම සඳහා විද්‍යුත් ක්‍රීඩාවන්හි වැඩි වැඩියෙන් කාලය ගත කිරීමේ අවශ්‍යතාවය ඔබට දැනෙනවාද? | 1 | 2 | 3 | 4 | 5 |
| 4 | ඔබගේ විද්‍යුත් ක්‍රීඩා ක්‍රියාකාරකම් පාලනය කිරීමට හෝ නැවැත්වීමට උත්සාහ කිරීමේදී ඔබ අසමත් වෙනවාද? | 1 | 2 | 3 | 4 | 5 |
| 5 | විද්‍යුත් ක්‍රීඩාවන්හි යෙදීමේ ප්‍රතිඵලයක් ලෙස පෙර විනෝදාංශ සහ වෙනත් විනෝදාත්මක ක්‍රියාකාරකම් කෙරෙහි ඇති උනන්දුව ඔබට අහිමි වී තිබේද? | 1 | 2 | 3 | 4 | 5 |
| 6 | ඔබ විද්‍යුත් ක්‍රීඩාවන්හි යෙදෙන නිසා ඔබ සහ අනෙක් පුද්ගලයින් අතර ගැටලු ඇති වන බව ඔබ දැන සිටියද ඔබ විද්‍යුත් ක්‍රීඩාවන්හි දිගටම නියැලී සිටියේද? | 1 | 2 | 3 | 4 | 5 |
| 7 | ඔබ විද්‍යුත් ක්‍රීඩාවන්හි යෙදෙන කාලය පිළිබඳව ඔබගේ පවුලේ සාමාජිකයන් හෝ වෙනත් අය ඔබ රවටා තිබේද? | 1 | 2 | 3 | 4 | 5 |
| 8 | ඔබ විද්‍යුත් ක්‍රීඩාවන්හි යෙදෙන්නේ සෘණාත්මක මනෝභාවයකින් (උදා: අසරණභාවය, වරදකාරී හැඟීම්, කාංසාව ආදියෙන්) තාවකාලිව පැන යාමට හෝ සහනයක් ලබා ගැනීමටද? | 1 | 2 | 3 | 4 | 5 |
| 9 | ඔබ විද්‍යුත් ක්‍රීඩා හේතුවෙන් වැදගත් පුද්ගල සම්බන්ධතාවයන් හෝ අධ්‍යාපනික අවස්ථා හෝ රැකියා අවස්ථා අහිමි කරගෙන හෝ අවදානමට ලක් කරගෙන තිබේද? | 1 | 2 | 3 | 4 | 5 |

# Knowledge, Prevention, and Practice of Heat Strokes Among the Public in the United Arab Emirates

Mohamad Baraa Alebaji,[1] Tasnim Hossam Elzini,[1] Haneen Basim Ali Shahin,[1] Abdelwahab Bashir Mohamed Suleiman,[1] Harshitha Richard,[1] Raed Imad Aldin Dali.[1]

## Abstract

**Background:** Heat stroke is a predictable and preventable occurrence. Public awareness of the condition and preventative practices are essential in hot and humid regions. This study aims to assess the level of awareness (knowledge, prevention, and management) of heat stroke among United Arab Emirates (UAE) residents. **Methods:** This is a survey-based study of knowledge and practices of heat stroke in a random sample of adults (≥18 years) in four different cities in the UAE. Each correct answer was equal to one point, and total and average scores were calculated, with the average score used as the cutoff point. Multivariate logistic regression was used to identify factors associated with below-average awareness. **Results:** A total of 402 people participated in the study, with an average age of 33±12 years, and 48.5% were female. Only 1 person achieved a perfect score, and 0.7%, 10%, and 17.7% achieved above-average scores in knowledge, practices, and management, respectively. Seven percent of participants had never heard of a heat stroke. A third of participants (32%) were unaware that severe heat strokes could lead to death. Males are at a higher risk of having a poor level of knowledge (Odds ratio [OR]=1.65; 95% confidence interval [95%CI]=1.10-2.47). The older the population, the poorer the knowledge of heat stroke was (OR=1.39, 95%CI=1.03–1.89). **Conclusion:** The results of this study show that a huge proportion of the population in the UAE does not have sufficient knowledge about heat stroke, its prevention, and management. Governmental institutes should increase awareness of heat stroke.

**Key Words:** Health Knowledge, Attitudes, Practice; Heat stroke; Prevention; Saudi Arabia; Heat wave (Source: MeSH-NLM).

## Introduction

Heat stroke is a frequent adolescent life-threatening condition that affects individuals across all ethnic groups and has a severe impact on both physical and psychological health.[1] It is a medical emergency that can result in higher rates of morbidity and fatality, with a mortality rate of 71%.[2,3] Excessive heat is a significant weather risk related to a higher ratio of mortality and morbidity all over the world.[4] It is a condition caused by overheating body temperature and central nervous system (CNS) dysfunction, which can include combativeness, hallucination, seizures, and coma.[4] Generally, this problem occurs due to prolonged heat exposure or any physical exertion in high temperatures.

Prolonged exposure to heat, which can result from an amalgamation of extrinsic thermal surroundings, occupational heat provenance, and internal heat creation through excessive muscle effort, can result in various conditions recognized as heat-related illnesses. Signs and symptoms of heat stroke include fever, rapid breathing, heart palpitations, dizziness, and an altered mental state.[5] The risk of developing a heat stroke increases when wearing dark-colored clothing during hot weather and being dehydrated by not drinking adequate amounts water to balance fluid lost through sweating. It can cause problems like acute failure of vital organs and even death.[6]

Mortality and morbidity rates from heat stroke are related to the duration of the temperature exposure, public education on heat illnesses, behavioral interchanges, imposed rests and fluid protocols, acclimatization, and organized provisions of cooling facilities in hot areas. Therefore, the condition can be prevented and managed to avoid a fatal outcome.[7] The prognosis of patients is connected to the degree and duration of hyperthermia. As a result, aside from prevention, quick cooling is the most crucial feature in managing heat stroke.[8]

Although several studies recommend that patients with heat stroke should be treated with ice water or cold-water immersion, there is evidence that evaporative cooling is just as effective.[9] Heat-related illnesses are becoming more common as the world warms, and they are recognized in tropical regions such as most Arab countries.[10] Heat stroke is common and avoidable, and therefore sufficient awareness about knowledge and practices regarding heat strokes is essential in an extremely high-temperature country such as the UAE.[11]

# Original Article

Sufficient awareness regarding heat-related illnesses could assist in identifying and treating these disorders at an early stage. Numerous factors influence the public's key performance parameters (KPP), including the local climate, people's socioeconomic status, and general public behaviors. KPP data can be considered as the indicator of heat wave awareness in a specified and limited area. The study's main objective is to assess the knowledge, prevention, and practices amongst the public in the UAE, regarding general awareness of heat stroke.

## Methods

This was an analytical study done in the College of Medicine at the University of Sharjah, UAE, from January 2020 to December 2020. The Ethical Review Board of the University of Sharjah, UAE approved the study (Ref# REC-20-01-22-01).

The sample size was calculated according to the Epi-Info, version 3.5.1, by taking the expected prevalence of knowledge at 50%. The worst acceptable frequency was 12.3%, and the confidence interval of 95%. After adding 20% of the non-response rate, the minimum sample size was 377; however, 500 participants were invited to the study. All genders, aged more than 18 years, were included through random sampling of public places. The cities included were Abu Dhabi, Ajman, Dubai, and Sharjah. The interview used a structured questionnaire of 37 questions in four domains: demographics (9 questions), knowledge (18 questions), practices, and management of heat strokes (10 questions). The total mean score was 17.06, and therefore 17 was used as a cutoff point. Any total score below 17 was below average and any score of 17 and above was considered as average and above (*Figure 1*).

A wide spectrum of questions asked determined which aspect of knowledge about heat strokes the community lacks, whether it was prevention, signs and symptoms of a heat-related illness, or risk factors. The correct answer was equal to one point, and this point system was used to calculate the total scores. The average of the total scores was then used to determine good and poor knowledge.

v26 was the program used for analysis. Total (all questions), knowledge, and practice scores were calculated. The Chi-Square test was used for comparative analysis of sociodemographic characteristics with average and below-average scores. The null hypothesis was rejected by a p-value of less than 5%, which was considered statistically significant. The average total score was taken as the cut-off point for good and poor knowledge (KPM). Multivariate logistic regression analysis was run using gender, age, nationality, and occupation as covariates. The results were expressed as an odds ratio (OR) and a 95% confidence interval (95%CI). The dependent variable was coded as 0 for above-average knowledge and 1 for below-average knowledge.

## Results

In this study, 500 participants were invited, of which 402 participated. The response rate was 80.4%. Out of 402, 207 (51.49%) were male, and 195 (48.51%) were female. The study participants were divided into three groups based on age. The mean age of the participants was 33.45 ±12.2 years. The majority of the participants, 178 (44.27%), were aged 18–25. Half of the participants (204, 50.74%) were Arabs by nationality. Regarding occupation, most of the participants, 159 (39.58%), were in business, sales, and engineering categories. The majority of the participants, 345 (85.82%), were from Abu Dhabi. *Table 1* shows the demographic data of the participants. In our study, occupations were divided according to heat exposure; 40% were business, sales, and engineering jobs, which were the most exposed; 32% were governmental and medical jobs, which were moderately exposed; and finally, 29% were students who were considered to be the least exposed. We compared the knowledge, practices, and management scores between the cities tested. Thirty-two percent of the sample did not know that severe heat strokes can lead to death.

Our results showed that only one person in the entire sample achieved a perfect score on knowledge, management, and practices. Moreover, 0.7%, 10%, and 17.7% of the total sample achieved a score above-average in knowledge, practices, and management, respectively. Most of the participants (52%) did not follow sufficient preventative measures to meet the set average practice score. Moreover, 50% and 47% of the sample had below-average scores in total and knowledge scores, respectively. It is also considerable to note that 7% of the sample have never heard of a heat stroke before. As expected, there was a strong correlation between the chosen sources of knowledge of the participants and how that affected their knowledge and total scores. For the participants who chose "medical" as their source of knowledge, 70.6% achieved an above-average score on the knowledge test (p=0.61). Only 47% of those who chose "family and friends" as their source of knowledge achieved an average or above-average total score (*Table 2*).

*Figure 1.* Mean Total Score of Participants in the Study.

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*Table 1*. Demographic Data of the Participants (n=402).

| Variable | Frequency (%) |
|---|---|
| Gender | |
| Male | 207 (51.49) |
| Female | 195 (48.51) |
| Age group | |
| 18-25 years | 178 (44.27) |
| 26-35 years | 143 (35.57) |
| >36 years | 81 (20.14) |
| Nationality | |
| Local | 62 (15.46) |
| Arabs | 204 (50.74) |
| Non- Arabs | 136 (33.83) |
| Occupation | |
| Business, sale, engineers | 159 (39.58) |
| Students | 115 (28.60) |
| Medical, government, education | 128 (31.84) |
| Place of residence | |
| Abu-Dhabi | 345 (85.82) |
| Dubai | 13 (3.23) |
| Sharjah | 34 (8.5) |
| Ras Al Khaimah | 9 (2.23) |
| Umm AL Qaiwain | 1 (0.24) |

*Table 2*. Cross Tabulation of the Demographic Data with the Average Score of Knowledge, Practice, and Management.

| Characteristic | Heat stroke knowledge, treatment, management score | | p-value |
|---|---|---|---|
| | Below average | Above average | |
| Age, mean (SD) | 32.39 (10.5) | 34.51 (11.9) | 0.01[+] |
| Sex, n (%) | | | 0.07[*] |
| Female | 86 (44.1) | 109 (55.9) | |
| Male | 116 (56.0) | 91 (43.9) | |
| Nationality, n (%) | | | 0.12[‡] |
| Local | 54 (87.0) | 8 (12.9) | |
| Arabs | 104 (51.0) | 100 (49.0) | |
| Non-Arabs | 84 (61.7) | 52 (38.1) | |
| **Occupation**, n (%) | | | <0.001[‡] |
| Business, sale, engineers | 95 (59.7) | 64(40.6) | |
| Students | 90 (78.2) | 25 (21.8) | |
| Medical, government, education | 79 (61.7) | 49 (37.6) | |

*Legend:* [+] t-test; [*] Fisher's exact test; [‡] Chi-square test.

Only 58% of the participants drank water when thirsty, and even 44% did not know that they should give water to a victim suffering from a heat stroke. Finally, there was a relationship between the place of residence and the average score of the participants (p=0.02); participants from Abu Dhabi got 34.2% above the average total score, while Dubai and Sharjah got 24.8% and 27.2%, respectively.

Results of multivariate logistic regression analysis revealed that males are at higher risk of having a poor level of knowledge (OR=1.65; 95%CI=1.10-2.47, p=0.01) and the older the population, the poorer the knowledge about heat stroke (OR=1.39, 95%CI=1.03-1.89, p=0.03). Nationality and occupation were not associated with a below-average level of heat stroke knowledge (*Table 3*).

*Table 3.* Predictors of Below-Average Heat Stroke Knowledge Among the Participants: Multivariate Logistic Regression Analysis.

| Variable | Odds Ratio | 95% Confidence Interval | p-value |
|---|---|---|---|
| Gender: Male | **1.65** | **1.10 - 2.47** | **0.01** |
| Age | **1.39** | **1.03 - 1.89** | **0.03** |
| Nationality | 1.08 | 0.79 - 1.46 | 0.62 |
| Occupation | 1.09 | 0.83 - 1.43 | 0.52 |

## Discussion

This was a cross-sectional study performed in different cities in the UAE to identify the public's awareness of heat stroke among adults. Heat stroke is common in summer in the UAE, where the environmental temperature is extremely hot and humid compared to the rest of the world's regions. It is a dangerous disorder produced by the body's overheating and is linked to a high rate of death and morbidity due to its sequelae, including critical organ damage. Participants who cited medical experts as their primary source of information, as well as Arab nationalities, scored higher than the other nationals. In addition, Abu Dhabi outperformed all other cities. In general, the percentage of participants who scored above average on knowledge, prevention, and practices of heat strokes was low, and our findings revealed that a large segment of the community in the UAE lacks adequate understanding of heat strokes, their prevention, and management.

Studies from other regions have recognized that heat stroke has severe adverse effects on the human body that may lead to long-lasting abnormalities.[12,13] A heat wave came upon the metropolitan city of Karachi, Pakistan, in 2015, resulting in the deaths of hundreds of residents in this city.[14] The general public in the UAE is aware of this worsening condition but does not have sufficient knowledge regarding its management and control. Worldwide and nationally, inadequate research has been conducted to ascertain the public's knowledge, prevention, and practices regarding heat strokes. In our study, just one person

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achieved a perfect score on knowledge, management, and practices, while 52% of the participants did not follow sufficient preventative measures to meet the set average practice score.

Most participants believe that avoiding outdoor activities can prevent heat strokes, which contradicts the findings of a study conducted in the United States.[15] The Arab nationals achieved good knowledge, practice, and management scores with regards to heat stroke compared to other nationals. They consider fever and vomiting to be the major symptoms of heat stroke, which are in good correlation with studies conducted in China.[16,17] 32% of our study participants were unaware of the worse consequences of heat strokes. During the heat strokes, most participants did not know that victims of heat strokes should be given water and need to be moved under shade. In hot weather, people should wear an umbrella when heading out, drink plenty of water, limit their outdoor activities, and protect their heads with a damp towel as a preventive measure. While studying the demographic characteristics, we found that males are at a higher risk of having a poor level of knowledge (OR=1.65). This finding was in good correlation with the study by Li et al.[15] Old age was also associated with poorer knowledge of heat strokes (OR=1.39), which is in good correlation with the findings of a study by Wang et al.[16] and in contrast to another study by Li et al.[15]

Nowadays, social media is a source of information for many people across the globe, and access to it is extremely easy, especially for those in high-income areas. This could be a reason why people in high-income countries are more conscious of the current state of the global environment than people in low- and middle-income ones.[12,13,15] Individuals, local governments, and national institutions must all work more to improve the KAP about heatwaves by using mass and social media such as radio, television, newspapers, and the internet, as highlighted in other studies.

The limitations of the study include those of a cross-sectional study design. In addition, a high percentage of participants were young, not all seven Emirates were covered, and the questionnaire was conducted in only two languages (English and Arabic). However, this is the first approach to the topic in the region and the country's official language is Arabic, which allowed us to cover most of the target population.

**Conclusion**

Our results showed that a huge proportion of the population in the UAE did not have sufficient knowledge about heat stroke, prevention, and management. The data showed that people with medical sources of knowledge had the highest scores in terms of knowledge and practices. Unfortunately, those with information from medical sources were one of the minorities, which explains why many people did not have optimal knowledge about heat strokes. Based on these findings, we request our healthcare sectors and governmental institutes to increase awareness of heat stroke among UAE residents by using media outlets, medical staff, and even medical students to help prevent heat strokes in the UAE.

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# Burnout Among First-Year Medical Students During COVID-19 Pandemic in Mexico: A Cross-Sectional Study

Sofía Jezzini-Martinez,[1] Javier Humberto Martinez-Garza,[2] Alejandro Quiroga-Garza,[2] Pablo Patricio Zarate-Garza,[2] Guillermo Jacobo-Baca,[2] Jorge Gutierrez-De la O,[3] David de la Fuente-Villarreal,[2] Yolanda Salinas-Alvarez,[3] Rodrigo Enrique Elizondo-Omaña,[2] Santos Guzman-Lopez.[2]

## Abstract

**Background:** The coronavirus pandemic is an international public health emergency without precedence in modern history. It represents a challenge to students' academic and psychological stability due to the changes it caused in daily life. This study aimed to evaluate the prevalence and level of burnout in medical students caused by the academic and psychological instability that the pandemic represents. **Methods:** A prospective cross-sectional study was designed using the Maslach Burnout Inventory-Student Survey (MBI-SS). This evaluated the emotional exhaustion due to study demands, cynicism, and negative self-academic efficacy. This study was based in the school of medicine of the Universidad Autonoma de Nuevo Leon (UANL) in Monterrey, Mexico, during the Spring semester of 2020. **Results:** A total of 154 (93 women and 61 men) first-year medical students participated (response rate of 36.4%). Burnout was identified in 14.9% (n=23), and high emotional exhaustion in 53.9% (n=83). Burnout was almost 4 times more likely to develop in men than in women (aOR = 4.8; 95% Confidence Interval=1.7-13.3) when considering age as a covariable in the multivariable model. **Conclusion:** Further epidemiological studies of burnout syndrome in medical students are needed, and schools should consider promoting mental health and making programs available for their students to help overcome the emotional and social challenges during the pandemic.

**Key Words:** Psychological burnout; COVID-19; Pandemic; Medical students (Source: MeSH-NLM).

## Introduction

Burnout is a psychological syndrome produced by professional exhaustion and chronic stress based on three main domains: excess emotional exhaustion, excessive depersonalization, and reduced personal achievement.[1] In the academic context, the three main domains that evaluate the presence of burnout syndrome are emotional exhaustion, cynicism, and self-academic efficacy. Emotional exhaustion refers to feelings of being overextended and depleted of one's emotional resources. Cynicism is a cynical, detached response to other people and themselves. Negative self-academic efficacy evaluates a reduction in personal accomplishment and feeling less competent in their academic performance.[2-3] The Maslach Burnout Inventory has been the most used instrument in the scientific community to evaluate burnout syndrome in the general population. The General Survey version (MBI-GS) was designed to assess burnout in work contexts.[4-5] Based on the assumption that students experience an equivalent form of exhaustion, the MBI-GS was adapted to survey university students, creating the Maslach Burnout Inventory-Student Survey

(MBI-SS).[6] The application of the MBI-SS shows students can experience high levels of emotional exhaustion, depersonalization or cynicism, and negative self-academic efficacy. Each domain assesses different symptoms and conducts.

During the last years, burnout has increased its incidence as a common phenomenon among medical students, residents, and doctors with less than 5 years of experience compared to the general population.[7] Recent observations suggest the appearance of burnout during the first years of medicine has increased,[8] and that at least half of the students will suffer burnout at some point in their medical studies.[3,9] These high statistics suggest that evaluating burnout syndrome is important in medical students. Addressing the problem at the right time can improve their academic performance and reduce the risk of developing further emotional instability, fatigue, and drug use.[10-11]

The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) pandemic, also known as COVID-19, has changed people's lives across the globe. From the mandatory self-isolation

[1] Fourth-year Medical Student, Department of Human Anatomy, School of Medicine, Universidad Autónoma de Nuevo Léon, Monterrey, Mexico.
[2] MD. PhD. Universidad Autónoma de Nuevo Léon, Monterrey, Mexico.
[3] MD. Universidad Autónoma de Nuevo Léon, Monterrey, Mexico

**About the Author:** *Sofía Jezzini-Martínez is a fourth-year medical student of a six-year program. She is member of the anatomy research group in the Department of Human Anatomy, School of Medicine at the Universidad Autónoma de Nuevo León, Monterrey, Nuevo León, México. She currently works on several research projects oriented towards bone and joint anatomy, and medical education.*

**Correspondence:**

Santos Guzman-Lopez

Address: Pedro de Alba S/N, Niños Héroes, Ciudad Universitaria, San Nicolás de los Garza, NL, Mexico

Email: dr.santos.anato@gmail.com

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time and use of face masks to a forced transition from face-to-face education to online platforms, changing the environment in which educators and students interact.[12] These sudden outbreaks can precipitate new psychiatric symptoms and aggravate pre-existing mental illnesses.[13] During today's pandemic, the general population has reported increased feelings of anxiety, depression, post-traumatic stress disorder, obsessive-compulsive disorder, insomnia, and suicide.[13] Apart from the psychiatric consequences to the general population, it has been proved that social isolation has substantially increased the suicide risk in older people during the pandemic. Understanding the severity of the problem leads to finding common solutions, such as suicide prevention, dissemination of scientific information, promoting self-help, positive coping, reducing isolation through technology, and developing telehealth.[14]

The medical community has suffered an important increase in the amount of work during the COVID-19 pandemic. Several studies have evaluated burnout in physicians during the pandemic, reporting that on average, 76% of medical residents had reported burnout during these times.[15-16] In contrast to medical residents and specialists, and few have addressed the psychological burden and pressures on students due to the closure of facilities and schools around the world.[17-19]

We hypothesized the students would present high levels of emotional exhaustion and burnout levels because, during the pandemic, the risk of developing COVID-19 and the change in learning methods will accentuate their previous stress. The objective of this study was to evaluate the prevalence and level of burnout in first-year medical students during the COVID-19 pandemic.

## Methods

A cross-sectional study was designed to establish the burnout prevalence in first-year medical students; enrolled in the 2020 spring semester of the Human Anatomy course. The study was based in the school of medicine of the Universidad Autonoma de Nuevo Leon (UANL) in Monterrey, Mexico, which has a 6-year program and a 19-week anatomy course during the first year.[20]

The eligibility criteria were to be enrolled in the human anatomy course during the pandemic COVID-19 and be at least 18 years old. The students enrolled in the Gross Human Anatomy course were second-semester medical students, and they had presential (face-to-face) courses in the previous semester. We determined as an estimated sample size that the enrollment of 139 first-year medical students would provide a power of 97.5% to detect the prevalence of burnout at least 10%, using a two-sided test with a type I error of 0.05.

An online survey was advertised on the human anatomy department's official website during the spring semester's last week (June 22 to June 26, 2020). The survey contained an online informed consent where the students had the opportunity to deny their participation in the study or answer voluntarily. The age and sex of the students were collected, then the Maslach Burnout Inventory-Student Survey (MBI- SS)[21-22] was applied, which consisted of 15 questions corresponding to the evaluation of emotional exhaustion (five items), cynicism (four items), and academic efficacy (six items) (Supplement 1). The scores described the frequency with which the student felt identified with each expression, from 0 (never) to 6 (always). Results from the three domains were classified as follows: emotional exhaustion: low (0-9), moderate (10-14), or high (>14); cynicism: low (0-1), moderate (2-6), or high (>6); and academic effectiveness: low (<22), moderate (23-27), or high (>28). [21-22]

Due to the anonymity of the survey, all participants were provided with the information for psychological support through the student mental healthcare programs provided by the University through the Department of Psychiatry of the University Hospital.

Responses from all questionnaires were registered in a database using 2020 Microsoft Excel for Mac, version 16.43 (Microsoft Corp., Redmond, WA). These were then analyzed using SPSS statistical package, version 25.0 (SPSS Inc., Chicago, IL). The Kolmogorov-Smirnoff test was used to evaluate the normality of the data. Quantitative variables were summarized using central tendency and dispersion measures, and qualitative variables in frequencies and percentages. A student's t-test was used to compare quantitative variables. A Pearson's Chi-Squared test was run, and odds ratios (OR) and 95% confidence intervals (CI) were calculated to determine associations in qualitative variables. Adjusted OR (aOR) were calculated after including age as a covariate in a multivariable regression model. Variables with a p-value of <0.05 in the univariate analysis were included in the multivariate. A statistical threshold of <0.05 was used throughout. The study was approved by the University's ethics and research committees with the registration number AH20-0003.

## Results

A total of 154 first-year medical students were included on the study, 60.3% (n =93) were female and 39.6% (n=61) were male (response rate 36.4%). The ages ranged between 18 and 24 years, and the mean age was 18.9 ± 0.9 years. Based on the MBI-SS definition, 14.9% (n=23) of the study participants were found to have burnout syndrome, 53.9% (n=83) scored high on emotional exhaustion, 16.9% (n=26) scored high cynicism, and 34.4% (n=53) scored low on academic effectiveness (*Table 1, Figure 1*): Men had a statistical tendency towards lower academic effectiveness (p=0.037) and increased cynicism (p=0.003) than women, as well as a higher incidence of burnout (26.6% vs 7.5%, p=0.001).

Men were 3 times more likely to develop burnout than women (aOR: 4.3; 95% CI [1.6-11.3]) in the bivariable analysis and almost 4 times more likely (aOR: 4.8 95% Confidence Interval=1.7-13.3) after adjustment by age (*Table 2*).

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*Table 1.* Categorization by Domain and Severity of Burnout Syndrome.

| Domain, n (%) | Level | Total (n=154) | Female (n=93) | Male (n=61) | *P-value* |
|---|---|---|---|---|---|
| Emotional exhaustion, n (%) | Low-moderate | 71 (46.1) | 48 (51.6) | 23 (37.7) | 0.090 |
| | High | 83 (53.9) | 45 (48.4) | 38 (62.3) | |
| Cynicism, n (%) | Low-moderate | 128 (83.1) | 84 (90.3) | 44 (72.1) | 0.003* |
| | High | 26 (16.9) | 9 (9.7) | 17 (27.9) | |
| Academic efficacy, n (%) | Low-moderate | 53 (34.4) | 26 (28.0) | 27 (44.3) | 0.037* |
| | High | 101 (65.6) | 67 (72.0) | 34 (55.7) | |
| Burnout, n (%) | Yes | 23 (14.9) | 7 (7.5) | 16 (26.2) | 0.001* |
| | No | 131 (85.1) | 86 (92.5) | 45 (73.8) | |

*Legend:* All values are expressed are the number of participants and percentages between parenthesis (%). Female sex is the comparator. *Statistically significant with a p-value of <0.05. Burnout two-dimensional (Defined as high emotional exhaustion and cynicism).

*Table 2.* Association Between Gender and Burnout Syndrome.

| Burnout | Univariable | Bivariable | p value | Multivariable | p value |
|---|---|---|---|---|---|
| Female | 7 (7.5) | - | - | - | - |
| Male | 16 (26.2) | 4.3 (1.6-11.3) | 0.001* | 4.8 (1.7-13.3) | 0.002* |

*Legend:* All values expressed in number of participants and percentages between parenthesis (%). Female gender is the comparator. *Statistically significant with a p-value of <0.05. Burnout two-dimensional (Defined as high emotional exhaustion and cynicism). Multivariable analysis after age adjustment.

## Discussion

The coronavirus pandemic caused the need to establish quarantine around the world. Students were forced to transition from face-to-face learning to fully online learning, restrained to their homes, and experienced a constant fear of being infected. Facing these daily-life changes can impact the mental health of the students as well as their academic performance due to the increased amount of stress exposure.

In this cross-sectional study, the burnout prevalence was 14.9% among first-year medical students enrolled in the human anatomy course. There was a high (53.9%) prevalence of emotional exhaustion. Men were more likely to experience lower academic effectiveness, increased cynicism, and burnout. Previously studies had addressed burnout syndrome; however, their focus was on student involvement in clinical scenarios rather than prevalence. A study in Switzerland 2020 surveyed medical students and residents involved in COVID-19 scenarios and their non-involved peers to determine anxiety, depression, and burnout levels. Both medical students and residents reported lower levels of anxiety, depression, and burnout, compared with their non-involved peers.[17] In 2016, the prevalence of burnout among medical students was evaluated at a Mexican University before the COVID-19 pandemic.[23] They used the MBI questionnaire, reporting a lower prevalence of 5.2% for moderate burnout syndrome (vs 14.9% in the present study). Although the study included first to sixth-year students rather than only first-year students, it can be hypothesized that the pandemic is an influencing factor for increased burnout prevalence. Other associated factors involved, such as attending university for the first time, living away from home and drug use, should also be considered.

*Figure 1.* Domains of Burnout Syndrome.
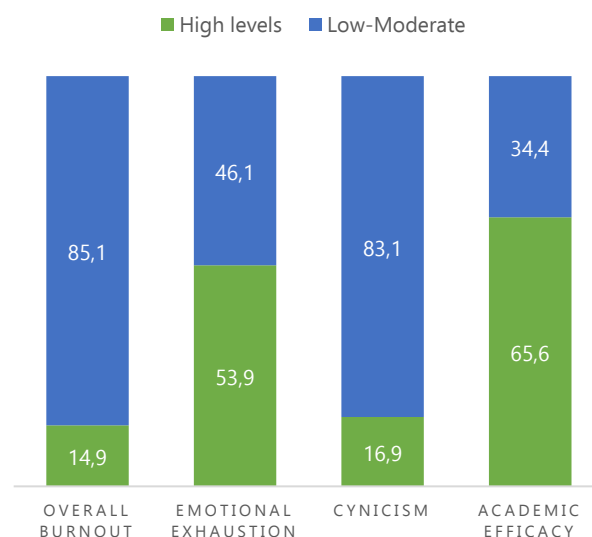


*Legend:* All values are expressed in percentages. Burnout two-dimensional (Defined as high emotional exhaustion and cynicism).

Assessing the prevalence of burnout syndrome in medical students is important because early intervention can prevent the development of future psychiatric disorders. Suffering even from only one of the three domains that make up the syndrome can lead to the appearance of negative effects related to the learning process, and physical symptoms such as drowsiness, fatigue, migraine, emotional instability, and even increased alcohol and drug use[12-13]. In the United States 2020, a study reported that 71% of college students had increased stress, anxiety, and depressive

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thoughts due to COVID-19 associated with difficulty concerning, sleeping disruption, decreased social interactions and increased concerns about academic performance.[24] These symptoms have a negative impact on the academic development of the student and their health, serving as a predictive factor for the increased risk of suicide and dropping out of medical studies.[25]

The results of this study demonstrate that at least 14.9% of our medical students are at risk of developing the negative effects of burnout syndrome. Bearing in mind, participants do not need to have been impacted in all domains of burnout to be at risk for negative impacts. To support these students at the end of the study, we provide the information for psychological support through the student mental healthcare programs provided by the University through the Department of Psychiatry of the University Hospital.

The main limitation of this study was that it did not evaluate associated factors that may cause burnout symptoms such as drug or alcohol consumption, cigarette smoking, economic or family status, stress, poor peer interactions and support, lower levels of physical activities, among others. There is a lack of a control group (prior to the pandemic); therefore, the high prevalence of burnout can only be hypothesized as due to the pandemic but cannot be objectively shown. The survey was only answered by 154 students enrolled in the human anatomy course of more than 500. The mean age (18.9 years) is younger than in other medical schools, and maturity may also influence the prevalence.

Although the University already has psychological support made available through the student mental healthcare programs, accessing these may present a challenge. The programs were designed for face-to-face interaction with trained psychologists, and when necessary, a psychiatrist. Due to the high levels of burnout and the several emotional challenges that the pandemic represented, the Department of Psychiatry started to receive free-of-charge all medical students who wanted counseling through a hybrid method. Students could decide between virtual or face-to-face. With the beginning of the COVID-19 pandemic, counseling needed to be adapted to an online format that benefits the students. Universities should encourage their students to exercise and obtain quality sleep, as both have been associated with prevention and reduced levels of burnout.[25] In a university with over 7,000 students total, mental health programs need to be increased and adapted to social distancing norms.

The results of this study demonstrated that the burnout prevalence during the pandemic is 14.9% among first-year medical students in a Mexican medical school. A high prevalence (53.9%) of emotional exhaustion was present, and a significantly higher risk to present burnout in male students (*Figure 1*). These findings suggest that advocacy and interventions to improve mental health in medical students are important considering the impact of this syndrome on the quality of life. Academic performance may also be affected by the course-based changes implemented due to the COVID-19 pandemic.

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# Comparative Review of Large Animal Models for Suitability of Proximal Aortic Endovascular Repair

Abhishekh Srinivas,[1] Ming Yii,[2] Julian A. Smith.[3]

## Abstract

The advent of thoracic endovascular aortic repair (TEVAR) heralds a paradigm shift in treating descending aortopathies. TEVAR is viewed as a potential option for ascending aortic dissection (AD) repair. Currently, TEVAR's use in treating ascending aortopathies remains limited. Appropriate animal models are urgently needed to improve our understanding of the endovascular treatment of ascending ADs, also known as Stanford Type-A ADs. This narrative review provides a current literature summary on the subject, including the gross anatomical differences among adult porcine, ovine, and bovine species, compared with those of their human counterparts, as well as specific valvular and coronary vasculature measurement variances. An electronic search of Cochrane Library, PubMed, and Ovid Medline databases from January 1965 to June 2020 was performed. The search was limited to articles published in English. Twenty-three research papers were included in this review. Our findings revealed that whereas macroscopic anatomy remains grossly similar among these species, differences in valvular leaflet shape are present, with porcine and ovine models possessing anatomic characteristics that are comparable to their human counterparts. Inter-species differences concerning the anatomy of the ascending aorta have not been extensively studied, highlighting a literature gap. Conversely, multiple morphological studies have highlighted that porcine coronary vasculature is similar to that of humans. In conclusion, both porcine and ovine species are suitable as appropriate animal models for examining the feasibility of endovascular stent-grafts for ascending ADs. However, given the similarities in coronary and aortic valve anatomy with humans, porcine models are better suited for this purpose.

**Key Words:** Aortic dissection; Endovascular; Ascending aorta; Animal models (Source: MeSH-NLM).

## Introduction

The use of non-human tissues in cardiothoracic medical research has markedly increased over the last five decades as a solution to both the ethical dilemmas posed by using human tissues and the lack of readily available human tissues for creating experimental clinical models.[1] One example of research involving such animal models is seen in a better understanding treatment outcomes for acute aortic dissections (AD), a life-threatening pathology that carries significant mortality rates of over 70% within one week of onset when left untreated.[2,3] Several classifications of ADs currently exist, but arguably perhaps, one of the most commonly used is the Stanford classification system. This system categorizes dissections based on the site of intimomedial tear as either Type-A, defined as any AD involving the ascending aorta, or Type-B, which are ADs not involving the ascending aorta (NB. This review focuses primarily on Type-A ADs).[4]

With few exceptions, managing acute Type-A ADs is touted as a surgical emergency.[5,6] Given the aforementioned high rates of mortality otherwise, there are a few reasons for not following through with operative treatment of Type-A Ads. The main cited reasons are the presence of significant medical comorbidities that affect survival to one year or less, as with very advanced age and frailty, advanced malignancies, or patient/family wishes.[7] The surgical intervention for Type-A ADs has markedly evolved over the years due to the intertwined combination of technological improvements in equipment and a better understanding of its natural history. Currently, open surgical repair (OSR) remains the gold standard of care for this otherwise catastrophic condition.[4,8] However, the advent of thoracic endovascular aortic repair (TEVAR) has heralded a paradigm shift in treatment options for aortic diseases involving the descending aorta. Therefore, TEVAR has been viewed as a potential option for ascending aortic repair, and consequently Type-A AD surgical repair.[9] As a result, selected patients who would otherwise be ineligible for OSR as indicated, which typically comprise up to 20% of all individuals, would benefit from having the opportunity of still receiving life-saving treatment in the form of minimally invasive endovascular techniques.[10]

Various types of endovascular therapies, including branched stent-grafts and valve-carrying conduits, are currently viewed as potential therapeutic options for Type-A ADs.[10] However, the use of these novel therapeutic procedures within a clinical setting remains limited, with isolated case reports and case series

1 BMedSc/MD. Department of Surgery, Monash University, School of Clinical Sciences at Monash Health, Monash Medical Centre, Melbourne, Australia.
2 MBBS, FRACS (Vascular), MPH. Department of Surgery, Monash University, School of Clinical Sciences at Monash Health, Monash Medical Centre, Melbourne, Australia.
3 MBBS, MS, FRACS (Cardiothoracics), FAICD. Department of Surgery, Monash University, School of Clinical Sciences at Monash Health, Monash Medical Centre, Melbourne, Australia.

**About the Author:** *Abhishekh is a junior medical doctor currently working at The Alfred in Victoria, Australia. He is a recent graduate from Monash University, where he also completed a Bachelor of Medical Science (Honors) in ascending aortic dissections from the School of Clinical Sciences at Monash Health.*

**Correspondence:**

Abhishekh Srinivas.

Address: Dept. of Surgery, Monash Medical Centre Level 5, Block E 246, Victoria, Australia.

Email: abhishekhsrinivas@gmail.com

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providing the bulk of currently available literature on patient outcomes. Consequently, appropriate animal models are urgently needed to improve our understanding of the endovascular treatment of Type-A ADs.

While there is a wide amount of published research on the variances of cardiothoracic anatomy in non-human species, no literature review synthesizes this information, highlighting the accelerated need for one to be formulated. Consequently, this review article aims to combat this issue by providing a summary of currently available information on this topic, with a particular focus on determining which animal model amongst those of adult porcine, ovine, or bovine species would be ideal for research pertaining to endovascular treatment of Type-A ADs, relevant to the practicing surgeon. Three broad sections shall be covered, beginning with a discussion on the macroscopic anatomical differences between humans, porcines, ovines, and bovines. The review shall then focus on specific aspects of cardiothoracic anatomy, explicating the valvular, aortic, and coronary vasculature differences. Finally, the suitability of which animal would be best for use as clinical experimental models, from a strictly anatomical standpoint for bettering our understanding of Type-A AD treatment, shall be explored.

## Methods

For this review two databases were used: Ovid Medline and PubMed. Within Ovid Medline, since the term 'Type A aortic dissection' is well known within medical literature (as opposed to its verbatim analogue 'Stanford Type A aortic dissection'), the search string was commenced by initially mapping the keyword 'Endovascular' with the MeSH term 'Type A aortic dissection'. This was followed by using the Boolean operator 'AND'. The keyword 'models' was used, and finally, the Boolean operator 'AND' was used to combine all search strings. Twelve results were obtained from Ovid Medline. For this review, search results were limited to the English language. Furthermore, within PubMed, an advanced search was conducted using the search terms 'endovascular', 'aortic dissection', and 'animal model'. The search yielded 26 articles, which were then analyzed in conjunction with previous results obtained through Ovid Medline. A flowchart of our search strategy and study selection is detailed below.

Finally, images from the University of Minnesota Atlas of Human Cardiac Anatomy were used with permission to obtain a better pictorial representation of the cardiothoracic anatomical variations among the porcine, ovine, and bovine models.

## Results

### Anatomical Considerations for Endovascular Therapy of Type-A Dissections amongst Humans

Despite the advantages of thoracic endovascular aortic repair (TEVAR) use, including the elimination of the need for perioperative cardiopulmonary bypass and the requirement for a major operative incision, such as a sternotomy, there exist certain limitations that prevent its routine use in the current treatment of

Type-A ADs.[4,11-13] Given the paucity of large-scale trials documenting its efficacy and long-term follow-up of patients who receive this modality of treatment, there exists a literature gap in describing the specific limitations of endovascular therapy for ascending aortic pathologies. The anatomical constraints of this novel therapy have been scrutinized and shall now be explored further.

One of the major challenges in successfully treating Type-A ADs with currently available stent-grafts lies in the need to insert a straight device into a curved structure (the aortic arch), which poses a high risk of developing an endoleak. In simplifying landmarks within the complex anatomy of the aortic arch, the Ishimaru classification is commonly used to categorize thoracic aortic 'zones' for stent-grafts.[14]

With Ishimaru's zone classifications, it is essential to ensure a 'safe' distance between the proximal and distal landing zones to facilitate successful stent-graft deployment and avoid catastrophic aortic rupture.[3,15,16] However, this measurement remains dependent on the characteristics of the chosen stent-graft and the surgeon's technical expertise. Consequently, although some variation in what constitutes a 'safe' distance exists, a proposed criterion has been a length of at least 20 mm between the two landing zones to avoid aortic rupture during graft deployment.[16]

Furthermore, problems are also created by the entry dissection tear occurring proximally within Zone 0 as illustrated in *Figure 1*, specifically proximal to the sinotubular junction. A tear occurring within this region would fail to allow endograft deployment in a manner that would allow coronary blood flow to be maintained.[15] Occlusion of the coronary ostia by closed ends of the stent-graft would cause ischemia of the myocardium, resulting in potentially irreversible damage.[17,18] Additionally, those with Type-A ADs extending into the aortic valve would not be suitable for endovascular treatment with conventional stent-grafts, a situation typically observed in 10–20% of patients.[15] At deployment, the tip of the device must cross the aortic valve, which could lead to possible ventricular perforation. Although this would pose a barrier to treatment with currently available stent-grafts, given that they possess a distal cone that prevents their deployment too close to the aortic valve. A proposed method to combat this has been suggested in the form of novel 'valve-carrying conduits'.

Thirdly, variations in the anatomy of the normal aorta may interfere with a wholly endovascular modality of treatment for Type-A ADs. For instance, in patients who have undergone prior coronary artery bypass surgery, the presence of coronary grafts arising directly from the ascending aorta would present an increased risk of myocardial ischemia during endograft deployment.[15,16]

Based on these caveats, it is evident that the anatomy of the ascending aorta, aortic valve, and coronary vasculature are of particular significance in determining an appropriate animal model for Type-A dissection research, which shall be addressed in the following sub-section.

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*Figure 1.* Ishimaru Classification of Various Landing Zones of Proximal Aorta for Endovascular Arch Repair.
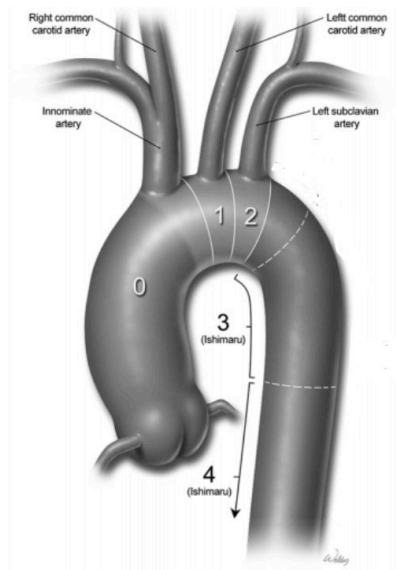


*Legend:* Reference: Zanotti G, Reece TB, Aftab M. Aortic Arch Pathology: Surgical Options for the Aortic Arch Replacement. Cardiol Clin. 2017; 35(3):367-85. *Printed with permission from Baylor College of Medicine.*[14]

*Figure 2.* Plastinated Human (upper left), Ovine (upper right) and Porcine (bottom) Hearts.



*Legend:* Reference: Atlas of Human Cardiac Anatomy, University of Minnesota/© Medtronic. Comparative Anatomy of the Valves. Available from: http://www.vhlab.umn.edu/atlas/comparative-anatomy-tutorial/valves.shtml. Last updated Jan 14,2019; cited Jan 20,2020.[19]

## Introduction and General Cardiac Anatomy

Similar to humans, large mammals' holistic cardiac anatomy is analogous. Four cardiac valves are present with similar structures comparable to most quadruped mammals. Whilst human hearts can appear in various shapes, including elliptical, trapezoidal, and 'valentine', porcine species tend to be valentine-shaped, while the ovine heart varies from valentine to conical in shape, as illustrated in *Figure 2*.[19]

Concerning the hearts of porcine and ovine species, the distance between the posteroinferior base to apex, left lateral base to apex, and the coronary sinuses' length are significantly greater than their human counterparts. Therefore, in conjunction with its larger size, the average human heart maintains a larger organ-to-body weight ratio than both porcine and ovine species. A similar scenario is visible in that of bovines, which possess a nearly identical organ-to-body weight ratio to the ovine species.[19]

## Valvular Anatomy

While the general cardiac anatomy of different hearts remains roughly similar, variations in the four valves exist that distinguish among porcine, ovine, bovine, and human species, despite certain structural similarities. Illustrated in *Table 1*, average aortic valve annulus diameters for humans are identical to those of their porcine counterparts, with the ovine species possessing a slightly narrower annulus on average. Conversely, bovine diameters are nearly 40% greater than their human counterparts, possibly accounted for due to the increased cardiac output within this species.[20]

Additionally, humans have much less muscular attachment surrounding the aortic valve than animal hearts, an indication of their reduced cardiac output.[20] Similarly, the human aortic valve at the annulus level possesses muscular attachment along 43% of its circumference, compared to respective figures of 56%, 60%, and 57% in porcine, bovine, and ovine valves.[20,21] Additionally, a greater amount of myocardial tissue support is also present at the aortic valve's right and left coronary cusp bases, distinguishing all three ovine, bovine, and porcine valves from the human aortic valve. Notably, in clinical trials involving sub-coronary transplantation, this increased muscle mass has resulted in aortic-valvular stenosis.[20]

*Table 1*. Mean Dimensions and Standard Deviations of Aortic Valve Measurement.

| Measurement (mm) | | Human | Porcine | Bovine | Ovine |
|---|---|---|---|---|---|
| Annulus diameter of aortic valve (obturator diameter) | | 26.4 ± 3.15 [20] | 26.6 ± 1.84 [20] | 33.7 ± 2.74 [20] | 25.8 ± 1.29 [20] |
| Leaflet depth | Non-coronary cusp | 9.1 ± 1.66 [20] | 8.9 ± 1.46 [20] | 9.2 ± 1.58 [20] | 7.4 ± 1.36 [20] |
| | Right coronary cusp | 9.8 ± 2.21 [20] | 10.2 ± 1.45 [20] | 9.9 ± 1.21 [20] | 7.6 ± 1.26 [20] |
| | Left coronary cusp | 9.3 ± 1.24 [20] | 8.6 ± 1.56 [20] | 9.9 ± 0.96 [20] | 7.8 ± 1.77 [20] |
| Valvular commissure height | Non-coronary cusp | 18.5 ± 1.96 [20] | 14.9 ± 1.84 [20] | 19.5 ± 1.92 [20] | 13.7 ± 1.52 [20] |
| | Right coronary cusp | 17.5 ± 2.95 [20] | 17.3 ± 2.28 [20] | 19.4 ± 1.57 [20] | 13.4 ± 1.75 [20] |
| | Left coronary cusp | 17.3 ± 2.61 [20] | 16.3 ± 2.00 [20] | 19.1 ± 2.53 [20] | 13.9 ± 1.30 [20] |

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Differences in aortic valve leaflet shape and structure are also present, with only porcine valve leaflet depths comparable to their human analogues, although specimen analysis visualized more inter-species variation between individual leaflets in the former.[20] Variations in leaflet thickness are particularly important to make note of, as thin and fragile leaflets, such as those observed in ovine species, may not be structurally strong enough to support heavy pressure loads during clinical use for long periods.

## Aortic Anatomy

Unlike the aspects of valvular anatomy, studies into the differences in the ascending aorta between human and non-human species have not been extensively performed, highlighting a current literature gap. However, morphometric studies have been documented to determine the largest artery's structural characteristics in mammals. Primarily, compared to the human heart, the porcine heart has only two head branches originating from the aortic arch.

Dimensionally, the diameter of the proximal aorta among porcine species at its largest part is about 21% lesser than that of their human analogues. Notably, unlike their human counterparts, which exhibit a gradual diameter decrease in a tapering fashion, the porcine aortic diameter decreases sharply from the descending thoracic aorta to the abdominal aorta (*Table 2*). Conversely, while studies on the aortic anatomy of ovine species are inadequate, the ascending aorta, while maintaining a similar aortic diameter to that of their human counterparts after accounting for the changes in organ-to-body weight ratio, is relatively short. Its implications shall be discussed in the next section.[27] There is also a marked decrease in the number of elastic lamellae within ovine aorta, greatly reducing its mobility as well.[27]

Finally, the bovine ascending aortic anatomy is the most reviewed of the three non-human species described in this review article. The 'bovine aortic arch' has been described as the single most common congenital aortic anatomic variant within humans as well. While this term itself is a misnomer, it is used to supposedly refer to the variant within bovine species, which is characterized by a common single brachiocephalic trunk trifurcating into bilateral subclavian vessels and a single bicarotid trunk, as opposed to the more common human aortic arch, which splits into a single brachiocephalic trunk, left common carotid, and left subclavian arteries.[28,29]

Similar to their ovine counterparts, little to no research has been done explicating the dimensional differences in the aortic root diameter between bovines and humans, elucidating the need for further research in this area.

## Coronary Anatomy

The suitability of porcine species as an animal model in coronary arterial disease is well established, with multiple morphological studies highlighting that porcine coronary vasculature is similar to humans.[33] In pigs, both coronary arteries arise from the aortic sinuses below the supravalvular ridge, as is observed in human species, with one study highlighting that all tested porcine models showed right coronary artery (RCA) dominance (humans typically exhibit RCA dominance anywhere between 75 to 85%, depending on the chosen study analyzed).[34] However, as with their human counterparts, certain inter-species variants are present and should be considered in choosing a porcine animal model.[34,35]

With regards to the coronary arterial system, in contrast to their porcine and human analogues, ovine species primarily have a left coronary type circulation; ergo, the majority of the myocardium receives its blood supply through branches of the left coronary artery.[36] However, given that ovines do not possess an extensive coronary collateral network, it may be still suitable to use their models for research. More specifically, although there exists considerable literature that is descriptive of specific aspects of ovine cardiac anatomy, little to no comparative research has been conducted to elucidate the differences between ovine and human heart models, highlighting a significant literature gap.[36]

*Table 2*. Dimensions of the Aorta.

| Measurement (mm) | Human | Porcine | Bovine | Ovine |
|---|---|---|---|---|
| Aortic annulus diameter | 23.0 ± 2.5 [21] | 20.0 ± 1.2 [21] | 48.0 ± 0.92 [24] | Not document-ed in adults |
| Thoracic aortic diameter at sinotubular junction | 27.2 ± 3.0 [21] | 20.0 ± 0.9 [21] | Not documented in adults | Not document-ed in adults |
| Abdominal aorta diameter (measured at level of superior mesenteric artery) | 22.0 ± 0.3 [25] | 10.4 [21] | Not documented in adults | Not document-ed in adults |

**Legend:** Standard deviations for abdominal aortic dimensions in pigs were not documented.

*Table 3*. Dimensions of the Coronary Vasculature.

| Measurement (mm) | Human | Porcine | Bovine | Ovine |
|---|---|---|---|---|
| Left coronary ostia diameter | 4.8 ± 0.5 [21] | 5 ± 0.5 [21] | 7.1 ± 1.7 [38] | 5.38 ± 1.59 [39] |
| Right coronary ostia diameter | 3.7 ± 0.9 [21] | 4.7 ± 0.5 [21] | 5.3 ± 1.4 [38] | 1.75 ± 0.44 [39] |
| Coronary collateralization | Limited | Limited | Anomalous | Limited |

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The coronary vasculature of bovine species has also been studied and documented. In all examined animals, the coronary ostia were located beneath the sinotubular junction, as observed with their human counterparts.[37] The dimensions of coronary ostia are listed in *Table 3*, but it is important to note that ovines are one of the most common veterinary species to exhibit coronary artery anomalies, with examples of such abnormalities including coronary-to-pulmonary artery fistulae and anomalous origin of the left coronary artery from the pulmonary trunk. Consequently, their use as animal models to mimic the human coronary system merits scrutiny before findings can be extrapolated.[38,39]

**Suitability for use as Animal Clinical Models in Type-A Aortic Dissection Research**

Having explored the anatomical differences between ovine, bovine, and porcine species, the anatomic feasibility of using these as animal models to better our understanding of Type-A AD treatment options shall now be explored.

Type-A ADs involve the ascending aorta, making this aspect of the model's anatomy significantly important. Bovine aortic anatomy is particularly unhelpful for this pathology, given the marked differences from humans, as elucidated previously.[28] Indeed, the 'bovine aortic arch effect' is an epidemiological term used to highlight the linkage between ascending and thoracic aortic dilatation due to the aortic arch anatomy within bovines, further exemplifying their unsuitability as animal models in this context.[40]

Between the ovine and porcine species, each species seems to share some features with that of humans while exhibiting some differences that affect their use as animal models. For instance, while ovines maintain a uniform aortic diameter similar to that of humans, their short immobile aorta could pose a challenge to graft repair within animal models.[27] Conversely, despite of the larger aorta of pigs, the aortic diameter being nearly a fifth lesser than that of humans could also affect the reproducibility of findings to the latter. Consequently, it is difficult to assess which ovine or porcine models is better for modeling Type-A ADs, at least from the ascending aortic anatomy perspective.

The aortic valvular anatomy is significant when choosing an appropriate animal model, particularly with AD tears extending proximally into the aortic root.[41] As indicated, variations in leaflet thickness are important, as the heavy pressure loads exerted during clinical use can affect the structural stability of the animal model. Consequently, species with relatively thinner valvular commissures, such as in ovines, must be handled with due care. As a result, porcine models are preferred to the other models.

Finally, the coronary vasculature of these animal models also has relevance to the pathology of Type-A ADs, especially with tears arising in the aortic root, or even with any more distal tears causing dissections in the proximal sinotubular junction, both of which would affect the coronary supplies, and thus consequently

cause ischemia of the cardiac musculature. Given that bovine species exhibit the most coronary artery anomalies, their use as an animal model in better understanding the various treatment options for Type-A ADs is hence not justified, given that these findings would not necessarily accurately represent what we might observe in humans.[38,39]

Between porcine and ovine species, the coronary vasculature is similar to that of humans. However, as indicated, much more research has been conducted on the coronary arterial supply of pigs, with little to no comparative research being conducted on their ovine counterparts, and as such, the former takes current precedence when selecting an animal model for Type-A AD research.

**Limitations of this Review & Insights on Future Research**

Comparing ovine, porcine, and bovine cardiac anatomy and their use as animal models will undoubtedly provide important new insights into new endovascular treatment options for Type-A AD. However, as explored in this review, several limitations exist, with a prominent example being the lack of literature on anatomical differences among these species. First, there is a lack of information on the microscopic anatomical differences in cardiac anatomy among species, such as the anatomical variances in the layers of the aorta among porcine, ovine, and bovine species. Additionally, although considerable literature describes either very general or very specific aspects of mammalian cardiac anatomy, little quantitative, truly comparative research has been conducted. These tie into our final limitation, which is the nature of this review itself. As a narrative review, while it provides information about the current state of research and addresses future directions and possible clinical applications, it was limited in comprehensive results analysis. Potentially, a systematic review might yield more comprehensive data and identify any biases or random errors. In the long term, the authors encourage researchers currently using animal models of cardiovascular disease to publish their findings and add to the literature to allow such translation to human interventions.

**Conclusion**

The introduction of intravascular stent-grafts as a surgical treatment option for Type-A ADs represents one of the most successful innovations in cardiothoracic surgery within the last few decades. However, lingering high numbers of patient mortality rates despite surgical intervention highlights the accelerated need for our better understanding of novel treatment options for this disease, explicating the necessity of developing an appropriate animal clinical model. From a strictly anatomical standpoint, bovine species do not meet this need, given the significant variations in aortic arch anatomy, the lack of literature on aortic valvular anatomy, and finally, the significant variation in coronary artery anatomy. However, both porcine and ovine species appear to be suitable options as animal models for proximal aortic endovascular treatment, with the former possessing a slight advantage, given similarities in the coronary

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artery and aortic valve anatomy to their human analogues. The identification of appropriate animal models will provide knowledge for further insight into the available endovascular treatment options for Type-A ADs and consequently needs to be hastened.

## Summary - Accelerating Translation

Open heart surgery has seen a marked evolution over the last century, with improving technologies and advancing surgical techniques providing better outcomes to patients worldwide. In particular, the advent of minimally-invasive surgical repair of one's blood vessels, also known as endovascular repair, has heralded a paradigm shift in this field, providing patients with quicker recovery times and offering life-saving surgery to a significantly larger proportion of people who would otherwise be too frail for such a delicate procedure. The usage of endovascular repair has greatly increased for diseases involving the descending aorta, but has currently been used with limited scope for the ascending aorta, given the latter's proximity to the heart. Consequently, appropriate animal models are urgently needed to improve our understanding of endovascular treatment of ascending aortic dissections, also known as Stanford Type-A ADs, a condition with a mortality rate of nearly 100% if left untreated for longer than a fortnight.

This narrative review aims to provide a current literature summary on the subject, including the gross anatomical differences among adult porcine, ovine, and bovine species, compared with those of their human counterparts, as well as specific valvular and coronary vasculature measurement variances. An electronic search of Cochrane Library, PubMed, and Ovid Medline databases from January 1965 to June 2020 was performed, with the search limited to articles published in English. In total, twenty-three research papers were included and synthesized for this review.

Several conclusions were drawn, with our findings revealing that while macroscopic anatomy remains grossly similar among these species, differences in valvular leaflet shape are present, with porcine and ovine models possessing anatomic characteristics that are comparable to their human counterparts. Inter-species differences, concerning the anatomy of the ascending aorta, remain an area of ongoing research, and have not been extensively studied at present, highlighting a literature gap. Conversely, multiple studies have highlighted that porcine coronary vasculature, or the arteries which supply the heart muscle itself, is similar to that of humans.

In summary, both porcine and ovine species are suitable as appropriate animal models for examining the feasibility of endovascular stent-grafts for ascending ADs. However, given the similarities in coronary and aortic valve anatomy with humans, porcine models are better suited for this purpose.

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# Effects of COVID-19 on Multiple Sclerosis Relapse: A Comprehensive Review

Matthew Topolski,[1] Varun Soti.[2]

## Abstract

Multiple Sclerosis is a chronic inflammatory disease. It is characterized by demyelinating lesions throughout the central nervous system. Patients with multiple sclerosis are a vulnerable population to coronavirus disease-2019 (COVID-19). This review focuses on the effects of COVID-19 on relapse and symptom exacerbation in multiple sclerosis patients and their treatment. It highlights how the blood-brain barrier may be compromised by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), allowing inflammatory mediators and lymphocytes to infiltrate the central nervous system. This may increase the risk of relapse in multiple sclerosis patients. Also, in patients with no prior history of multiple sclerosis, COVID-19 has been found to impact multiple sclerosis onset and pathogenesis. However, more comprehensive research is required to fully understand the interplay between multiple sclerosis and COVID-19.

**Key Words:** Multiple Sclerosis; Coronavirus Disease-2019; COVID-19; SARS-CoV-2; Disease Exacerbation; Blood-Brain Barrier; Neurologic Symptoms (Source: MeSH-NLM).

## Introduction

The coronavirus disease 2019 (COVID-19) first emerged in Wuhan, China, in December 2019.[1] However, COVID-19 rapidly spread across the globe over the next six months and has affected every aspect of healthcare.[2] COVID-19 results from infection by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Although the infection has its main site of pathophysiologic significance at the pulmonary level, a number of multiple sequelae, signs and symptoms, and associated pathologies have been observable in multiple body systems, including the nervous system; there has been a growing number of neurologic problems associated with the SARS-CoV-2 infection, including complications with multiple sclerosis (MS).[3-5]

MS is a chronic inflammatory disease of the central nervous system (CNS) characterized by demyelinating lesions that can lead to various neurologic dysfunction, including cognitive dysfunction, dysesthesia, hyperreflexia, hypoesthesia, paresthesia, and visual deficits (diplopia, nystagmus, and optic neuritis), depending on the location and severity of inflammatory lesions.[6]

The most common disease course in MS is relapsing-remitting multiple sclerosis (RRMS); it is characterized by acute exacerbations of symptoms, followed by more extended periods of remission. These short exacerbations are also called relapses and consist of days to weeks of fully or partially reversible neurologic disability. Principal manifestations of relapses are monocular visual loss, limb weakness and, or sensory loss, double vision, and ataxia.[6]

The exact causes of relapses remain unknown, but relapse rates have been correlated with times of increased stress.[7] Other disease courses of MS involve clinically isolated syndrome (CIS), primary progressive multiple sclerosis (PPMS), and secondary progressive multiple sclerosis (SPMS). The CIS is diagnosed after the first episode of a demyelinating attack. It presents as a neurologic deficit for more than 24 hours. PPMS is a progressive form in which neurologic deficits accumulate in the absence of relapse and do not regress to baseline despite treatment; whereas SPMS often occurs as a later stage of RRMS, where neurologic deficits do not return to baseline after relapses, and deficits accumulate after each relapse.[8]

This review primarily focuses on the RRMS, the most common course characterized by relapses. MS relapse and even its onset have been known to be impacted by viral infections.[7, 9] The stress of a viral infection combined with the host immune response creates a proinflammatory environment and increases the risk of relapse in Persons with Multiple Sclerosis (PwMS). However, the literature is lacking regarding SARS-CoV-2 and its potential impact on the onset and relapse in PwMS. Therefore, this review highlights the neurological effects of COVID-19 on PwMS and its impact on their disease status and symptom exacerbation.

1 Second-year Medical Student. Lake Erie College of Osteopathic Medicine, Elmira, New York 14901, United States.
2 Ph.D. Lake Erie College of Osteopathic Medicine, Elmira, New York 14901, United States.

**About the Author:** *Matthew Topolski is a second-year medical student at Lake Erie College of Osteopathic Medicine, Elmira, NY.*

**Correspondence:**

Varun Soti.

Address: Lake Erie College of Osteopathic Medicine, Elmira, NY 14901, USA

Email: vsoti@lecom.edu

## Methods

### Strategies for Literature Search and Study Selection

We conducted a literature search through the PubMed and EBSCO databases from March 2020 through July 2021 for studies measuring relapses in PwMS who had been infected by COVID-19. Inclusion criteria included: 1) studies being written in English; 2) any case report, retrospective cohort study, and prospective cohort study that included PwMS who were infected with SARS-CoV-2; 3) studies that measured neurologic symptom exacerbation or relapse. We used the following search terms: "Coronavirus Multiple Sclerosis," "Coronavirus MS Relapse," "Coronavirus MS Exacerbation," "COVID-19 Multiple Sclerosis," "COVID-19 MS Relapse," "COVID-19 MS Exacerbation," "SARS-CoV-2 Multiple Sclerosis," "SARS-CoV-2 MS Relapse," "SARS-CoV-2 MS Exacerbation."

Our search resulted in 399 articles in total. Of those, one study was not written in English, 390 were not case reports, retrospective cohort studies, or prospective cohort studies that included PwMS infected with SARS-CoV-2, and one did not measure neurologic symptom exacerbation or relapse. Of the seven studies meeting the inclusion criteria, two were retrospective studies, one was a prospective cohort study, one was an observational study, and three were case reports. The level of evidence for the included studies was determined based on the previous literature.[10] The methodology used in the review is illustrated in *Figure 1*, which is based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[11]

## Results

### Pathophysiology

MS is an autoimmune disease characterized by plaque-like sclerosis found throughout the CNS. Its most common disease course is RRMS, which is identified by symptom exacerbations; during exacerbations, acute demyelinating attacks occur between more prolonged periods of quiescence.[8] Throughout these demyelinating episodes, myelin basic protein (MBP), a critical component of the myelin sheath, is adversely impacted.[12] These inflammatory lesions are more significantly found in the white matter but have also been seen in the gray matter; lesions are widely observed in the periventricular region, juxtacortical areas, infratentorial region, and spinal cord.[13]

The MS diagnosis relies on the dissemination of the disease in space and time as defined by the revised 2017 McDonald criteria.[14] Typical onset of the disease occurs between the ages of 20 and 40 years old; inflammatory lesions are thought to result from pro-inflammatory factors and demyelination that occurs in the CNS after the blood-brain barrier (BBB) has been compromised.[15]

Although the exact mechanism of the autoimmune action against CNS antigens in MS remains undetermined, the bulk of evidence attributes pathology to both the adaptive and innate immune responses in an attack against myelin and oligodendrocytes. Both

*Figure 1.* Method Employed to Search Literature.
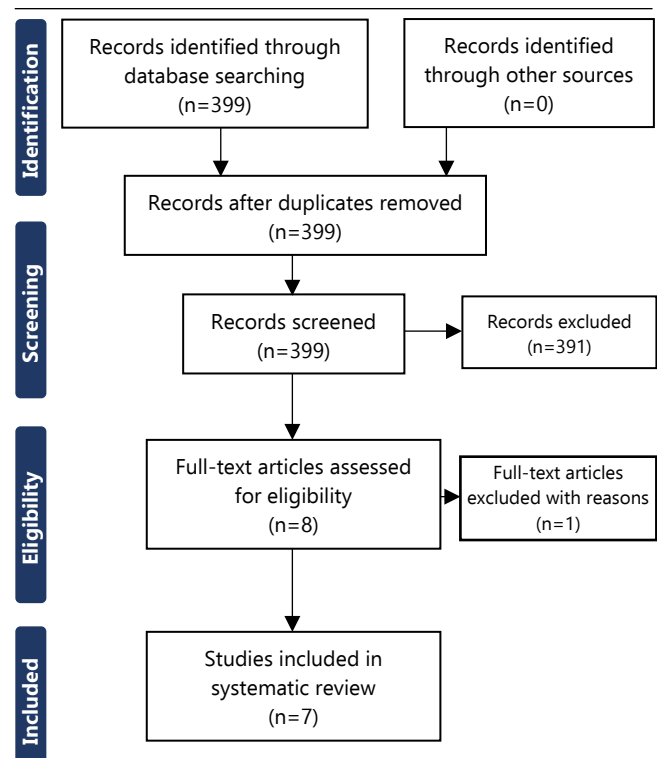


*Legend:* We searched PubMed and EBSCO databases from March 2020 to July 2021. The search terms "Coronavirus Multiple Sclerosis," "Coronavirus MS Relapse," "Coronavirus MS Exacerbation," "COVID-19 Multiple Sclerosis," "COVID-19 MS Relapse," "COVID-19 MS Exacerbation," "SARS-CoV-2 Multiple Sclerosis," "SARS-CoV-2 MS Relapse," "SARS-CoV-2 MS Exacerbation" were utilized. This yielded 399 articles, of which 7 studies meeting the inclusion criteria for this review paper were selected. COVID-19, coronavirus disease 2019; MS, multiple sclerosis; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

clusters of differentiation (CD) 4+ and CD8+ T cells have been found in MS lesions, suggesting cell-mediated immunity in the inflammatory lesions.[16] T cells are the major driving factor of experimental autoimmune encephalitis in a murine MS model. The success of therapies that limit T cell access to the CNS also supports the role of cell-mediated immunity in MS pathology.[17] Moreover, the recent success of B cell-depleting therapies in MS treatment has also suggested a more prominent role of the humoral response in MS pathology.[18] Furthermore, B cells have been shown to activate autoreactive T cells that target the brain.[19]

Macrophages of the innate immune system promote the inflammatory response of T and B cells and execute the tissue damage seen in MS.[6, 20] Microglial cells of the CNS also contribute to pathology through secretion of the inflammatory cytokines, chemokines, and free radicals.[21] The autoimmune mechanism of MS pathogenesis is illustrated in *Figure 2*.

### Effect of Viral Infections in Multiple Sclerosis

Viral infections, mostly considered as the environmental factor, have been known to induce relapses in PwMS. Significantly, upper respiratory infections (URIs) have long been correlated with MS

*Figure 2.* Autoimmune Mechanism of Multiple Sclerosis.
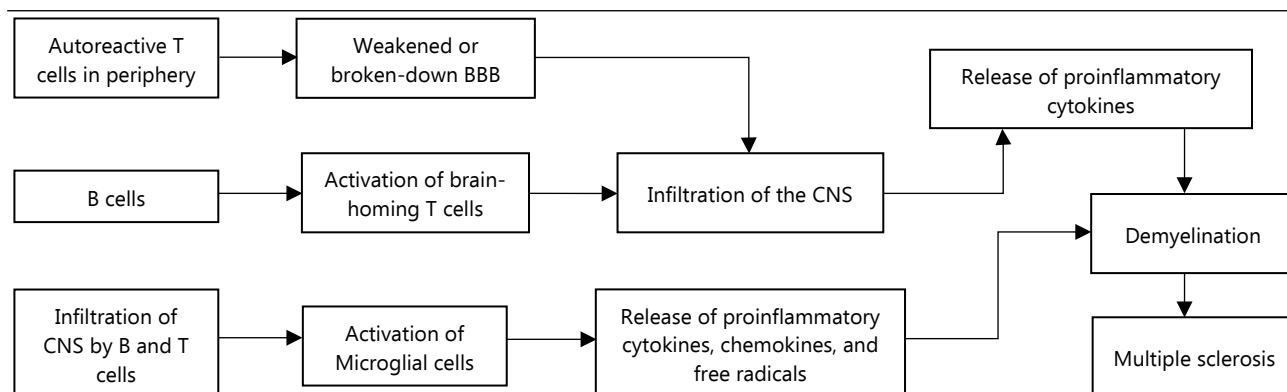


**Legend:** Autoreactive T cells in the periphery infiltrate the CNS through a weakened or broken-down BBB, releasing inflammatory cytokines, attacking myelin and oligodendrocytes, and causing demyelination. B cells activate brain-homing T cells in the periphery, further breaking through the CNS and resulting in demyelination through a similar mechanism. Microglial cells are activated by the infiltration of T and B cells in the CNS, releasing more proinflammatory cytokines, chemokines, and free radicals, contributing to demyelination. BBB, blood-brain barrier; CNS, central nervous system.

relapse risk.[22, 23] The extensive history of viral infection and MS outcomes have been seen in members of the Herpesviridae family, including Epstein-Barr virus, Varicella-Zoster virus, and human herpesvirus 6.[24-27] Also, parainfluenzas, adenoviruses, and coronaviruses have been correlated with the risk of MS relapse.[23, 28] Furthermore, multiple viral infections have been shown to increase the risk for relapse, suggesting a common mechanism across the viral immune response. This could be from increased permeability of the BBB due to antiviral cytokines or molecular mimicry of viral and host proteins.[29]

Coronaviruses have been previously reported to be involved and complicate MS pathophysiological processes. A postmortem study found human coronavirus (HCV) 229E ribonucleic acid (RNA) in CNS tissues of 4 out of 11 MS patients compared to control groups (6 neurological controls and 5 healthy controls). The specific specimens were scraped from white matter plaques, typical gray and white matter, and tissues from the cervical cord.[30] Four of the neurological controls had Alzheimer's disease, one had ischemic vascular disease, and one had subacute meningoencephalitis. Another research group has corroborated the presence of coronavirus RNA in CNS tissues of PwMS. During the autopsy, researchers found that 11 out of 21 MS patients had HCV RNA in their CNS tissue obtained from the cerebral cortex, brainstem, and spinal cord compared to the control group.[31]

Based on these histopathological findings, it can be inferred that HCV compromised the structural integrity of the BBB and invaded the specific CNS areas containing MS lesions, and caused pathophysiological complications in already vulnerable MS patients.[30,31]

Interestingly, not only have coronaviruses been reported to have harmful effects on MS pathophysiology, but also, they have been shown to indirectly promote demyelination through T cell activation in cell lines obtained from MS patients.[32] A study found

that 29% of T cell lines from MS patients showed MBP and HCV 229E cross-reactivity compared to only 1.3% of T cell lines from healthy controls. Furthermore, 4 out of 16 MS patients displayed reciprocal cross-reactivity profiles while none of the healthy controls did.[32] These findings further indicate the possible environmental trigger of coronaviruses on MS pathogenesis and pathophysiology.[30-32] Thus, the SARS-CoV-2 strains are likely to have similar effects to previously studied coronaviruses and other viral infections on MS status.

**COVID-19 and its Neurological Manifestations**
SARS-CoV-2, which causes COVID-19, has a well-described cell entry mechanism.[33] Antigen presentation by antigen-presenting cells (APCs) is crucial to antiviral cell-mediated immunity. A recent study suggests a defect in the MHC class II gene expression for the presentation of SARS-CoV-2 by APCs.[34]

The polymorphic nature of the MHC region of the human genome plays an essential role in individual susceptibility to diseases such as MS.[35] The innate and adaptive immune system response to coronaviruses is integral to the infection's clinical presentation; the innate immune response is triggered by pattern recognition receptors (PRRs), recognition by PRRs triggers a downstream signaling cascade that results in the secretion of inflammatory cytokines such as interferons (IFN), tumor necrosis factor-alpha (TNF-α), interleukin (IL) -1, and IL-6.[35] Humoral immunity to SARS-CoV-2 can be seen through the presence of antibodies directed to the viral surface glycoproteins S protein and N protein of the SARS-CoV-2. APCs trigger the cell-mediated immune response by presenting antigens to virus-specific CD4+ and CD8+ T cell antigen receptors.[36]

Upon activation of the innate and adaptive immune systems by SARS-CoV-2, another massive quantity of proinflammatory cytokines and chemokines are produced from immune effector cells; this immune-mediated cytokine storm has been attributed

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to the severe clinical presentation of acute respiratory distress syndrome in COVID-19 patients.[35, 36] Thus, this cytokine storm could lead to increased permeability through cytokine-mediated inflammation at the BBB. This could be detrimental to more susceptible patients with neurodegenerative conditions, for instance, MS patients.

Beyond the significant respiratory complaints of COVID-19, there has been an increasing number of reported neurological complications of the disease.[37-40] A nationwide retrospective observational study in Italy showed that 72.1% of the 646 patients surveyed reported neurological symptoms during their COVID-19 infection. Headache was the most reported symptom (41.1%), followed by smell (37.9%) and taste (36.8%) impairment.[5] A significant number of people have been reported to develop psychiatric issues, including depression, anxiety, and stress, particularly those with pre-existing mental conditions.[41-43] Moreover, there have also been reports of more serious neurological complications of COVID-19, such as Guillain Barre syndrome and acute transverse myelitis.[44-46] In addition, as mentioned before, some studies have shown the correlation between coronaviruses and demyelination.[47-49]

There have been several proposed mechanisms of coronavirus infection of the nervous system. Viruses have been shown to migrate through retrograde or anterograde neuronal axonal transport.[37, 50] This has also been seen in the olfactory and trigeminal nerves, leading to CNS infection in mouse models.[51] The binding of SARS-CoV-2 to angiotensin-converting enzyme 2 receptors on vascular endothelium may damage the BBB, leading to its entry into the CNS,[52] thus allowing infiltration of the activated immune response into the CNS. The suggested breakdown of BBB by SARS-CoV-2 may shed light on the pathophysiologic mechanism of how MS patients are significantly impacted by COVID-19. Also, PwMS have been considered particularly vulnerable to SARS-CoV-2 infection due to high disability rates and increased susceptibility to infection.[53]

**MS Relapse and COVID-19**

In an observational study of MS patients with COVID-19 (72 MS patients), 21.1% reported neurologic symptoms suggestive of relapse.[54] A retrospective cohort study by Etemadifar et al. found 7.14% of the 56 PwMS experienced a relapse from the period of two weeks before and six months after recovering from COVID-19.[55]

Another retrospective study assessing 41 PwMS found an increased relapse rate of 0.017 attacks per "at-risk" week compared to 0.007 attacks per week during a not "at-risk" period of the two years prior. The "at-risk" period was defined as the two weeks before and five weeks after COVID-19 infection.[56] A more extensive study performed in the United Kingdom found 57% of PwMS (230/404) experienced MS exacerbation during the time of their COVID-19 infection.[57] The key findings of some studies about MS relapse in PwMS infected with SARS-CoV-2 are summarized in *Table 1.*

Although these studies present evidence of relapse in MS patients with COVID-19, there is a tremendous variation in the percentage of MS patients suffering from relapse between the studies. This might be attributed to the patient age group and MS status; older patients, in general, have a weaker immune system, and MS geriatric patients placed on disease-modifying therapies (DMTs) are at an even greater risk of contracting infection, let alone SARS-CoV-2.[58] Thus, had the clinical trials controlled for the age and MS status, there is a more likelihood for more extensive and enormous evidence of MS relapse in COVID-19 PwMS.

In addition to these studies, three case reports described recent or concurrent COVID-19 infection with an initial MS event and diagnosis. A 27-year-old female presented with MS symptoms, including dysesthesia, hyperreflexia, and hypoesthesia six months after developing COVID-19. The patient was diagnosed with MS that was confirmed by gadolinium-enhancing lesions on the magnetic resonance image (MRI) and the presence of oligoclonal bands in her cerebrospinal fluid (CSF).[59] The temporal relationship between MS and COVID-19 could be explained by SARS-CoV-2-induced processes.

In another case report, a 29-year-old female with a history of asthma presented with COVID-19 symptoms, including anosmia, dysgeusia, asthenia, and proximal myalgias in her limbs that disappeared within a week after developing COVID-19. She presented two weeks later with a ten-day history of right visual acuity deficits (typical MS symptom). SARS-CoV-2 Immunoglobulin (Ig) M/ IgG immunological testing was positive, confirming past infection of the virus. Oligoclonal bands were present in CSF. MRI displayed optic nerve lesions with contrast enhancement and sparse demyelinating lesions in the brain, confirming MS.[60] Before contracting SARS-CoV-2, the patient did not have a medical history of MS, and within two weeks of infection, she exhibited MS symptoms and received a confirmed MS diagnosis. Hence, there is a possibility, and unbeknownst to the investigators, the patient might have been genetically predisposed to developing MS. And exposure to SARS-CoV-2 would have triggered MS pathogenesis and resulted in her clinical manifestations.

Yet another case report of a 28-year-old male presented with a two-day history of binocular diplopia was found to have MS and COVID-19 infection concurrently. The patient's COVID-19 symptoms of sore throat, cough, anosmia, and headache had started two weeks before diplopia,[61] indicating a possible link between MS onset and SARS-CoV-2 infection. However, more research is required to investigate and understand the relationship between MS onset/pathogenesis and COVID-19.

The research findings are evidence of COVID-19's role in symptom exacerbation in PwMS. Infection with SARS-CoV-2 can lead to MS onset and pathogenesis and trigger complex pathophysiological changes, resulting in a relapse in MS patients.

*Table 1*. Multiple Sclerosis Relapse in COVID-19 Patients.

| Studies | Level of Evidence | Patients | Study Findings | Study Bias | p-value |
|---|---|---|---|---|---|
| Barzegar et al. (2021) – Retrospective cohort study | 3 | 41 RRMS with COVID-19 | • Five patients (12.2%) displayed neurological symptoms consistent with relapse during the at-risk period of SARS-CoV-2 infection.<br>• The study demonstrated increased risk of relapse of these patients during their at-risk period compared to the previous 2 years during the not at-risk period. | • Study did not compare results of SARS-CoV-2-infected PwMS to non-infected PwMS.<br>• Instead, this study compared the at-risk period (2 weeks before through 5 weeks after infection) to the not at-risk period (previous 2 years). | 0.034 |
| Etemadifar et al. (2021) – Retrospective cohort study | 3 | 125 RRMS patients (56 with COVID-19 and 69 without COVID-19) | • Study reported a lower incidence rate of neurological symptom exacerbation in the PwMS with COVID-19 (7.14%) in the six months following confirmed infection with SARS-CoV-2 compared to PwMS without COVID-19 in the six months measured from Jun 1, 2020 – November 1, 2020 (26.09%). | • Participants were contacted biweekly through telephone surveys. This likely increased the likelihood of exaggerated reporting of symptoms. | 0.006 |
| Fragoso et al. (2021) – Case report | 4 | 1 PwMS | • Study of a healthy individual who was diagnosed with MS six months after having COVID-19.<br>• The temporal relationship of the COVID-19 onset and MS diagnosis are thought to be related. | • Six months post SARS-CoV-2 infection is a substantial time to develop MS independent of any viral infection let alone SARS-CoV-2.<br>• Many other factors could have played a role in disease onset in that time. | Not applicable |
| Garjani et al. (2021) – Prospective cohort | 3 | 404 PwMS (277 RRMS, 65 SPMS, 39 PPMS, 23 Non-defined MS) | • Study showed 230/404 PwMS (56.9%) and COVID-19 reported symptom exacerbation during or soon after infection with SARS-CoV-2 from July 20, 2020, through January 25, 2021. | • Study did not have a control group of PwMS who were not infected with SARS-CoV-2.<br>• Use of an online questionnaire to assess symptom exacerbation could have led to increased responses of symptom exacerbation.<br>• The study's protocol did not require PwMS with confirmed SARS-CoV-2 diagnosis. Patients who had symptoms consistent with COVID-19 were included in the study.<br>• Study included patients with SPMS, PPMS, and non-defined types of MS rather than just RRMS patients. | No statistically significant difference between PwMS with COVID-19 who reported MS symptom exacerbation versus PwMS with COVID-19 who did not report MS symptom exacerbation. |
| Moore et al. (2021) – Case report | 4 | 1 PwMS | • Patient presented with concurrent MS onset and SARS-CoV-2 infection. | • Patient presented in case had glaucoma and underwent prior laser ablation treatment. This could have impacted the retinal ganglionic cells and triggering structural changes in the blood-brain barrier, most likely predisposing him to developing MS. This was not adequately addressed by the authors. | Not applicable. |

*Table 1* (**continued**). Multiple Sclerosis Relapse in COVID-19 Patients.

| Studies | Level of Evidence | Patients | Study Findings | Study Bias | p-value |
|---|---|---|---|---|---|
| Palao et al. (2020) – Case report | 4 | 1 PwMS | • Patient presented with signs of MS onset (visual acuity deficits and periventricular lesions on the MRI). She had symptoms of COVID-19 (anosmia and ageusia) 2-3 weeks prior to presentation. Serological testing revealed immunoglobulin M and G antibodies to SARS-CoV-2. This suggests MS onset after recent infection with SARS-CoV-2. | • The authors assumed the MS pathogenic process started prior COVID-19 disease. <br> • The SARS-CoV-2 PCR testing protocol in the cerebrospinal fluid was not properly validated. | Not applicable. |
| Parrota et al. (2020) – Observational study | 3 | 76 patients: <br> 72 PwMS <br> [55 RRMS, 17 progressive MS (SPMS, PPMS)] and 4 with related disorders (chronic relapsing inflammatory optic neuropathy, myelin oligodendrocyte glycoprotein-immunoglobulin G–associated disorder spectrum disorder, neurosarcoidosis, and neuromyelitis optica) | • Study measured clinical outcomes in PwMS and related conditions after infection with SARS-CoV-2. <br> • 21.1% of study participants reported neurological symptoms suggestive of a relapse. | • Patients were not randomly selected. <br> • Study included four participants who were not diagnosed with MS. <br> • Authors did not make any statistically significant comparisons between study groups. | Not reported. |

*Legend:* %, percentage; COVID-19, coronavirus disease 2019; MRI, magnetic resonance imaging; MS, multiple sclerosis; PwMS, persons with multiple sclerosis; RRMS, relapsing remitting multiple sclerosis; p-value, probability value; PPMS, primary progressive multiple sclerosis; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; SPMS, secondary progressive multiple sclerosis.

However, there are several limitations to the interpretations of these studies' results *(Table 2)*. First, the definition of relapse or exacerbation varies between studies. A couple of research studies used a formal definition of relapse involving the new onset of symptoms lasting more than 24 hours. However, one study defined relapse as any neurologic symptom that suggested a recurrence. Second, the period utilized to measure COVID-19-related exacerbations was not consistent. One research group used a period of two weeks before COVID-19 infection to six months after the illness, while another group only utilized the duration patients were infected with COVID-19 as the time frame for measuring relapse. Future studies enrolling larger cohorts with a clear definition of MS relapse and a consistent timeframe for measuring MS relapse will be required to draw further inferences.

**Treatment of MS Patients with COVID-19**

Treating COVID-19 patients with MS safely and effectively is critical partly because MS patients are on DMTs, which can be a crucial risk factor for COVID-19. Patients on immunomodulating therapies have been shown to have an increased risk of developing COVID-19 but not necessarily the increased risk of severity of COVID-19.[62] Despite an increased risk of COVID-19, some studies have shown better prognoses for COVID-19 in MS patients treated with B cell-depleting therapies such as Ocrelizumab and Rituximab measured by the severity of symptoms.[63, 64] The results of these studies suggest that a suppressed immune system limits the body's harmful response to SARS-CoV-2 infection. Another study demonstrated a decreased risk of COVID-19 in patients being treated with IFN and glatiramer acetate.[65] While these findings are optimistic, other studies have found that treatment of MS with sphingosine-1-phosphate modulators (Fingolimod) has shown a more significant severe disease course of COVID-19.[66] The worst clinical outcomes of SARS-CoV-2 infection have been seen in PwMS who are not on any DMTs and PwMS with comorbidities associated with worsened outcomes such as male gender, obesity, and advanced age.[67]

*Remdesivir*

There have not been any studies regarding the treatment of COVID-19 in PwMS. Although the treatment of COVID-19 patients depends on the individual clinical presentation, only one drug (up to the writing of this review) has received the full United States Food and Drug Administration (FDA) approval for the treatment of COVID-19 patients—Remdesivir. It is a parenteral antiviral drug acting as an adenosine analog to disrupt viral RNA production through host RNA-dependent RNA polymerase.[68] However, to our knowledge, there has not been any research reporting the use, benefits, and adverse effects of Remdesivir in COVID-19 patients with MS or other patients on DMTs.

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*Table 2.* Variations Between Research Studies on MS Patients with COVID-19.

| Studies | Period measured for PwMS with COVID-19 | Definition of relapse |
|---|---|---|
| Parrota et al. (2020) | March 16, 2020 - April 30, 2020 | Neurologic symptom recurrence suggestive of a relapse |
| Etemadifar et al. (2021) | Two weeks before and six months after COVID symptoms | Development of a new neurologic abnormality or worsening of a pre-existing symptom for more than 24 hours |
| Barzegar et al. (2021) | Two weeks before until five weeks after COVID-19 onset | Worsening of pre-existing symptoms or developing new symptoms, in the absence of fever, lasting at least 24 hours, after at least 30 days of improvement and stability, confirmed by presence of gadolinium enhancement on MRI |
| Garjani et al. (2021) | During or soon after COVID infection July 20, 2020 – January 25, 2021 | Development of new MS symptoms, worsening of pre-existing MS symptoms, or experiencing both |
| Fragoso et al. (2021) | Six months | New diagnosis by McDonald criteria |
| Palao et al. (2020) | Two weeks | New diagnosis by McDonald criteria |
| Moore et al. (2021) | Two weeks | New diagnosis by McDonald criteria |

*Legend:* PwMS, persons with multiple sclerosis; MRI, magnetic resonance image.

*Immunization*

The National Multiple Sclerosis Society currently recommends that most PwMS get vaccinated for COVID-19.[69] The consensus of previous inactivated vaccines in PwMS is that these vaccinations are safe and recommended for most PwMS.[70] Still, there is less known about live-attenuated vaccinations in PwMS. Vaccine safety and efficacy in PwMS can be primarily attributed to the DMTs of the patient. With many DMTs suppressing the immune system, a weakened vaccine response leads to decreased immunity. Furthermore, live-attenuated vaccines can be contraindicated in patients receiving immunosuppressive treatment due to the potential for vaccine-transmitted disease.[71, 72]

Treatment with IFN-beta, Glatiramer acetate, Teriflunomide, Natalizumab, and Fumarates have not been shown to decrease efficacy in other inactivated vaccines and are not expected to show reduced effectiveness in the COVID-19 vaccine.[73] The worst vaccine efficacies are seen in patients taking B cell-depleting therapies such as Ocrelizumab, Rituximab, and Alemtuzumab.[74-76] For patients on these therapies, the timing of vaccines and treatment is a crucial determining factor of vaccine efficacy.[71, 77]

The three vaccines approved by the FDA in the United States are the *BNT162b2 vaccine* developed by Pfizer-BioNTech, the *messenger RNA-1273 vaccine* developed by Moderna, and the *Ad.26.COV2.S vaccine* by Janssen Biotech, Inc., a Janssen Pharmaceutical company of Johnson & Johnson. Thus far, few studies have been conducted regarding vaccine safety and efficacy in PwMS.

In a large observational study, 555 PwMS were vaccinated with at least one dose of the *BNT162b2 vaccine* (435 received both doses). No life-threatening reactions or anaphylaxis events were reported after either dose. Common adverse effects were injection site pain, fatigue, headache, muscle/joint pain, and flu-like symptoms. Of the 388 RRMS patients who received the first dose, 2.1% experienced a relapse within 10-19 days after injection. Of the 306 RRMS patients who received the second dose, 1.6% experienced a relapse within 14-21 days of injection. These rates were compared to corresponding periods of previous years of RRMS patients who presented for acute relapses in 2017, 2018, 2019, and 2020. The number of acute relapses divided by the number of patients in these years was 2.7%, 2.9%, 2.6%, and 2.3%, respectively.[78] Thus, this study did not demonstrate any increased risk of relapse in patients who received the Pfizer vaccine.

## Conclusion

SARS-CoV-2 can increase the relapse rates in MS patients, most likely by compromising the structural integrity of the BBB. Although, based on these study findings, it is evident that SARS-CoV-2 can trigger MS onset and pathogenesis, more research will be needed to further understand the underlying pathophysiologic dynamics between COVID-19 and MS. Even though COVID-19 vaccines have been safer in MS patients and have not altered MS status, a further understanding of the relationship between COVID-19 and MS is crucial in managing MS patients with COVID-19 on immunomodulating therapies.

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# Clinical Considerations in the Approach to Vancomycin-Resistant *Enterococci*: A Narrative Review

John W. Beale,[1] Marina Durward-Diioia.[2]

## Abstract

Vancomycin-Resistant *Enterococci* (VRE) increasingly colonize and infect assorted patient populations throughout the world, maintaining a continual reservoir of opportunistic pathogens with varying antibiotic resistance. Here we present the current general epidemiology and classification of these pathogens within the scope of healthcare-associated infections (HAIs). Risk factors for colonization and conditions for subsequent infection are reviewed, along with infection characteristics. Current infection control protocols and their effectiveness, selected evidence-based medical therapies, and ongoing research into alternative therapies are summarized.

**Key Words:** Vancomycin-resistant enterococci; Enterococcus faecalis; Enterococcus faecium; Vancomycin resistance; Healthcare-associated infection; Nosocomial infection (Source: MeSH-NLM).

## Introduction

First identified in the United Kingdom and France during the 1980s, *Enterococci* possessing vancomycin-resistance (VRE) colonizes patients in the United States (U.S.) at increasing rates.[1,2] Infections stemming from VRE colonization account for approximately 30% of all healthcare-associated *Enterococci* infections in the U.S.[3] During the late 2000s, VRE-related hospitalizations doubled in the U.S. alone.[1] Worldwide reported VRE surveillance data varies widely by continent and country. Reports from Africa are diverse, with the published prevalence of VRE among human isolates varying from 2.5% to 44.3%.[4] 2016 data from the European Antimicrobial Resistance Surveillance Network (EARS-Net) reported that between 25% and 50% of surveillance isolates of *E. faecium* from Ireland, Eastern, and Southern Europe were positive for VRE.[5] While a U.S. Centers for Disease Control (CDC) report in 2019 showed decreasing cases over the last several years from 84,800 confirmed VRE infections in hospitalized patients in 2012 to 54,500 cases in 2017; the prevalence of vancomycin resistance is still alarmingly high at 30% of all healthcare-associated infections.[6] Variable surveillance data from Asia and Australasia suggest a low prevalence of VRE compared to Europe and the U.S. for instance, a 5-year study in Singapore found a prevalence of vancomycin resistance in isolates at 0.4-0.7%, but these rates appear to be increasing.[7] The variable yet increasing prevalence of vancomycin resistance should concern physicians, scientists, and patients worldwide.

Colonization rate increases may be attributed to *Enterococci*'s natural habitat and genetic structure. One of many bacterial species composing normal human enteric microbiota,

*Enterococci* gaining vancomycin-resistance are perfectly positioned for enhanced opportunistic pathogenicity. *Enterococci* already possess intrinsic resistance to many antibacterial agents, including β-lactams and aminoglycosides.[8–10] Existence with other commensal bacteria provides ample opportunities for acquiring vancomycin resistance via transposition of resistance-containing plasmids.[11–13] Nine different phenotypes – VanA, VanB, VanC, VanD, VanE, VanG, VanL, VanM, and VanN – named for the *vancomycin-resistance gene* (*van*) expressed currently describe degrees of vancomycin-resistance and pathogenicity within *Enterococci*.[11,14,15] For example, *E. faecium* most frequently expresses the *vanA* gene and thus is most frequently associated with the Van*A* phenotype, which identifies the highest vancomycin resistance and, consequently, the highest pathogenicity.[10,14] The VanB phenotype identifies expression of the *vanB* gene and an intermediate level of vancomycin-resistance that, while less pathogenic, still commonly appears in surveillance cultures of patient populations.[10,15–17] VanC phenotype *Enterococci* express the *vanC* gene and possess much lower vancomycin-resistance.[10,15] VRE are thus a family of variably-resistant opportunistic pathogens, with *E. faecium* and *E. faecalis* being the most commonly identified.[8–10,18] Increasing VRE prevalence intensifies the need to quickly identify patients at risk for colonization and infection to treat colonized and infected patients with the potential to lower overall colonization rates.

This review aims to present the general epidemiology and medical management of healthcare-associated VRE infections. In order to clarify the variable at-risk patient populations, we

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[1] Fourth-year Medical Student, Idaho College of Osteopathic Medicine, Meridian, Idaho, United States.
[2] Ph.D., West Virginia School of Osteopathic Medicine, Lewisburg, West Virginia, United States.

**About the Author:** *John W. Beale is currently a fourth-year medical student at the Idaho College of Osteopathic Medicine in Meridian, ID, USA, a four-year program.*

**Correspondence:**
John W. Beale.
Address: 1401 E Central Dr, Meridian, ID, 83642, United States.
Email: mdiioia@osteo.wvsom.edu

# Review

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reviewed essential factors for colonization. We recently reported conditions for subsequent infection, followed by a review of infection control protocols, which are of heightened importance in health care settings. Further, recent updates to the pharmacological interventions and alternative therapies, including rebiosis, are discussed and compared.

## Methods

A narrative review of English language literature from 1994 to August 2019 was utilized to assess the historical development of vancomycin resistance within the *Enterococcus* family. This timeline was revisited prior to publication and updated to include the time frame to March 2022. Scale for Assessment of Narrative Review Articles (SANRA) was used to guide appropriate research methods.[19] The primary research method was an online search conducted in September 2019 on Google Scholar and PubMed. Search terms included: vancomycin resistance OR vre OR "vancomycin-resistant" OR multidrug-resistant OR mdro OR infec* AND enterococc* OR "E. faecalis" OR "E. faecium" OR "enterococcus faecalis" OR "enterococcus faecium" OR microbiome OR microbiota. Meta-analyses and systematic reviews were given a narrower time frame, namely the past 10 years compared to case reports or series and other literature reviews or position papers. This allowed for more recent data on current treatment practices and protocols while allowing a broader scope for assessing the historical development and response to vancomycin-resistant *Enterococci*. The competencies of evidence-based medicine were utilized when developing inclusion/exclusion criteria.[20] These competencies include recognizing a problem, retrieving and critically appraising the literature, and intergrating information found. Papers dealing specifically with human models were preferred; however, some animal model studies were included due to a lack of data with human models.

Inclusion required:
1. Title or abstract inclusion of at least two of the search term(s) OR
2. Significant (two+ pages) discussion of at least two of the search terms within the body of the paper OR
3. Position papers whose content would apply to at least two of the search terms, even if not explicitly stated.

Exclusion required:
1. Any paper published more than 25 years ago at the time of search (1994 or earlier)
2. Any meta-analysis or systematic review published more than 10 years ago at the time of search (2009 or earlier)
3. Any paper that contained only one search term and failed to meet the inclusion criteria outlined above
4. Any paper that included one or more search terms whose primary focus was either another form of drug resistance or another species of bacteria (e.g., methicillin-resistant *Staphylococcus aureus*).

## Results and Discussion

### Colonization and Infections

Colonization, or the incorporation of a microorganism into a host, occurs through the interaction of the host with a reservoir of that microorganism. Studies by Hamel *et al.* in 2010 and Kaki *et al.* in 2014 identified VRE colonized patients and contaminated surfaces within hospitals or care centers as possible VRE reservoirs.[21,22] *Enterococci* inhabit every human colon, but colonization with VRE rarely occurs among healthy populations.[23] Further, in a recent large study (n=674 including controls) of healthcare personnel and their rates of colonization with multi-drug resistant organisms (MDROs), Decker *et al.* found that there were not any healthcare workers or control subjects positive for VRE colonization, including those in contact with MDRO+ patients.[24] A meta-analysis of 37 studies found that 10% of patients in Intensive Care Units (ICU) are already colonized with VRE at admission, and an additional 10% were colonized during their ICU stay.[23,25] A meta-analysis of dialysis patients, who are typically immunocompromised in the U.S. found that more than 6% are colonized with VRE.[26]

VRE colonization risk is multifactorial. Recent high-dose antibiotic use, especially vancomycin, is the most frequently identified risk factor in multiple studies.[13,22,26] Surgical, oncological, and dialysis patients demonstrate increased risk, especially when recovery requires ICU services.[3,10,23,25–28] Patients sharing a room with a VRE colonized patient have a one in three chance of becoming colonized during hospitalization.[21,22,29] Acquired immunodeficiency from Human Immunodeficiency Virus (HIV) infection or medically-induced immunosuppression may also increase VRE colonization risk.[18,27,28,30–32]

Immunocompromised patients requiring recurrent medical interventions within a hospital or long-term care center thus comprise both the highest risk group for colonization and the potentially largest VRE reservoir.[3,33] Patients in these circumstances are prime for a VRE-mediated infection when a critical lapse in immune function occurs. For example, Brennen *et al.* found only 1% of colonized patients in a nursing facility develop VRE infections.[34] Yet Zaas *et al.* reported that 13% of colonized oncology patients develop VRE infections.[35] In a 2008 study, Zirakzadeh *et al.* found that hematopoietic stem cell transplant (HSCT) patients colonized with VRE have a significantly higher 100-day mortality rate (45%) compared to non-colonized patient controls (25%) and are more prone to develop VRE bacteremia (27%) than non-colonized patients (0%).[30] Colonized dialysis patients demonstrate significantly higher VRE infection risk than to non-colonized patients, especially when recently hospitalized.[26] A 2013 meta-analysis by Ziakas *et al.* found that among ICU patients, VRE infection rates among those colonized can be anywhere from 0%-45%, yet the infection rate for non-colonized patients consistently stayed below 2%.[23] As recently as 2018, Freedberg *et al.* found that VRE colonization was associated with a 19% increased risk for death (P<.01) and a 22% increased risk of infection (P<.01).[25] Infection rate discrepancies indicate a

predisposition among VRE-colonized patients to acquire a VRE infection after a major medical procedure.

VRE infections generally correlate with either the location or method of medical intervention (*Figure 1*). VRE infections may localize around surgical incisions with limited spread to adjacent tissues.[27] VRE meningitis, while rare, may complicate cranial surgical procedures in colonized patients.[9,18,36] VRE urinary tract infections (UTIs) commonly afflict colonized patients with indwelling catheters.[27] Peritoneal dialysis in patients colonized with VRE may result in VRE peritonitis.[9,26,37] Up to 10% of patients undergoing HSCT or solid organ transplants that develop VRE bacteremia may experience VRE infective endocarditis.[9,18,31] These patients may also be more likely to progress to septic shock.[30,32]

All VRE infections cause significant increases in morbidity and mortality when compared to similar infections with vancomycin-sensitive *Enterococci* (VSE).[10,25,26,30] Mortality rates for surgical patients with VRE bacteremia may be as high as 67%, nearly double the rate for matched control patients.[30,33] VRE infections among leukemia patients may result in mortality rates as high as 73%.[18] Mortality rates among VRE-infected allogeneic HSCT recipients with VRE infections vary between 45% and 80%, depending on the infection.[30]

*Figure 1.* Common Locations of Medical Procedures with Resulting VRE-Mediated Infections.
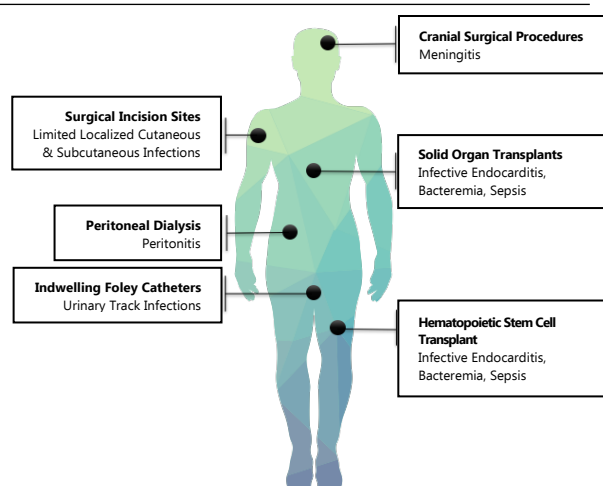


**Legend:** Note the localized nature of the resulting infections, with two significant exceptions: Solid organ transplant and hematopoietic stem cell transplant (HSCT). Patients undergoing these major medical interventions are more likely to suffer from systemic VRE-mediated infections such as: bacteremia, infective endocarditis (IE), sepsis and possible progression and worsening to septic shock. This may be due to the highly vascular nature of both solid organs and bone marrow which facilitate the systemic spread of VRE in susceptible patients.

**Infection Control Protocols**
Alarmingly high mortality rates underscore the extensive research and discussion surrounding VRE infection control protocols. The CDC published recommendations for identifying and preventing VRE colonization in the mid-1990s.[27,28] Recommendations

included: active patient surveillance using perianal swabs, culture on selective media, using gloves and gowns for universal contact precautions (CP), and isolating VRE-colonized patients during treatment.[27,28] These recommendations became the standard in hospital-based VRE infection control protocols, and for other multidrug-resistant organisms (MDROs). Numerous studies since the CDC's guidelines were published have evaluated the effectiveness and limitations of these infection control measures, as discussed below.

Active surveillance of high-risk patients, typically those hospitalized in the intensive care unit or receiving intravenous antibiotic therapy, has been a mainstay of infection control; however, limitations primarily involve the time required to culture the surveillance swabs. Cultures take 48 to 72 hours to grow, during which time yet undetected VRE may colonize additional patients.[17,38] In 2017, Holzknecht *et al.* demonstrated that Polymerase Chain Reaction (PCR) assay for the *vanA* and/or *vanB* genes might significantly reduce the time required to identify VRE-colonized patients (eight hours for PCR assay compared to 48-72 hours for culture). Very recent PCR assay development has led to a vastly reduced time frame of two hours to identify VRE, though costs and availability issues remain.[39] This is built on the work of Paule *et al.*, which showed in 2003 that PCR of the *vanA* gene demonstrates a high specificity (99.7%) and sensitivity (87.1%) for identifying VRE (compared to about 60% sensitivity for swab and culture).[16,17,38,40] Decreased detection time may lead to the earlier implementation of universal CP and isolation, thus preventing further VRE exposure in unprotected patients and healthcare workers.

Studies evaluating universal CP in VRE infection control protocols contain positive but non-specific findings. Research by Calfee *et al.* in 2003 confirmed the work done earlier by Montecalvo *et al.* in 1999, reporting a 50% decrease in the incidence of VRE colonization following CP implementation.[27,38,41] Research by Slaughter *et al.* in 1996 affirmed the use of universal CP; however, they could find no additional reduction in VRE colonization when using gloves and gowns compared to gloves alone.[42] More recent studies by Harris *et al.* in 2013 and Morgan *et al.* in 2015 argue for the continued use of universal CP for MDROs, including VRE, while acknowledging that the clinical research supporting such practice is still lacking.[43–45] Recent research by Eichel *et al.* found that CP did not alter the transmission rates of VRE nor the rate of VRE bacteremia while hand and environment hygiene were maintained.[46]

VRE patient isolation protocols focus on maintaining the standard of care. Montecalvo *et al.* and Calfee *et al.* both reported isolation as a component of successful VRE colonization reduction; however, the degree of benefit that isolation alone provided remains unquantified.[27,38,41] Unlike gloves or surveillance cultures, which cause little to no harm to patients, isolation protocols may actually cause harm to patients. In 2003, Stelfox *et al.* reported that isolated patients experience two adverse events during

treatment compared to one for non-isolated patients.[47] The charts of isolated patients contained fewer vital sign records, fewer physician progress notes, and elevated complaint and dissatisfaction levels at discharge.[47] While evidence supports isolation as a component of VRE infection control protocols; concerted efforts must ensure these patients receive the same standard of care during treatment compared to their non-isolated counterparts.

The CDC continually updates practice guidelines for VRE and other MDROs, advocating for the effective use of infection control measures in a multi-disciplinary approach that emphasizes prevention as well as treatment.[48] Prevention methods include sterilizing medical equipment, using anti-bacterial washes on patients, and hand hygiene.[48] In 2019, Messler et al. reported that octenidine-based body washing reduced VRE colonization by 65% in a German surgical ICU population.[40] This infection control technique, alongside established recommendations, may combat rising VRE colonization rates more effectively.

## Medical Management

Despite the best efforts of healthcare teams and continual refinement of infection control protocols, VRE infections continually plague susceptible patients. Proper culture and resistance profiling of patient isolates are essential to ensure patients receive the most appropriate course of treatment. Few effective antibacterial agents remain to treat vancomycin-resistant enterococcal infections. *Table 1* summarizes commonly cited medical therapies that are now or have been indicated for VRE infections, including their class and mechanism of action. Currently, the only antibiotic approved by the U.S. Food and Drug Administration (FDA) for medical management of VRE-mediated infections is linezolid, an oxazolidinone. While only bacteriostatic to VRE, linezolid has been successfully used as a monotherapy in several VRE infective endocarditis cases.[13,31] VRE-mediated UTIs and central nervous system infections also respond well to

linezolid monotherapy.[13,36] Daptomycin, a cyclic lipopeptide, has a bactericidal action against VRE in certain disease states and may be used for both VRE-mediated UTIs and infective endocarditis.[8,13,32] A recent comparison study revealed that linezolid was associated with a significantly lower rate of clinical failure compared to the standard dose of daptomycin.[49] The same study found that higher doses of daptomycin may overcome some of the clinical failures.

A recent study by Kelly et al. found that most patients receiving daptomycin for VRE infections had no side effects at a dose of 8-12mg/kg/day.[50] Further, a cost analysis found that these therapies are similar, with linezolid being slightly more cost-effective in the U.S.[51] Other medications once indicated for VRE infections, such as chloramphenicol and quinupristin/dalfopristin, have fallen into disuse due to low bacteriostatic/bactericidal activity or side effects requiring cessation of medical therapy.[13,30]

Current VRE antimicrobial therapy relies heavily on two primary agents: linezolid and daptomycin, both of which have a normal incidence of notable adverse events in patients. Linezolid can lead to the central nervous system and gastrointestinal symptoms in up to 9.8% of patients, including headache, nausea, vomiting, and diarrhea.[52] Daptomycin is reported to be associated with myopathies at higher doses, neuropathy, and acute eosinophilic pneumonia, though this is considered rare.[53,54] Additionally, both linezolid and daptomycin use can lead to anemia, thrombocytopenia, and renal insufficiency in patients.[55] The prevalence of these adverse events underscores the importance of antibiotic development against VRE.

The World Health Organization (WHO), CDC, and other national and international organizations continually urge pharmaceutical and academic entities to develop novel regimens.[6,56] VRE resistance to linezolid, though currently a rare occurrence, only accentuates the need for new approaches to VRE infection

*Table 1.* Medical Therapies Indicated for VRE infections.

| Medication | Class | Mechanism | Reported VRE Efficacy | Monotherapy or Combination |
|---|---|---|---|---|
| **Linezolid** | Oxazolidinone | Protein synthesis inhibitor – Binds the 23S subunit of ribosomal 50S unit | *IE, UTI, Meningitis, Peritonitis, Bacteremia | Monotherapy |
| **Daptomycin** | Lipopeptide (cyclic) | Cell membrane depolarizer – Inhibits membrane functionality, decreasing DNA, RNA, and protein synthesis | IE, UTI | Monotherapy or in combination with Ceftaroline |
| **Tedizolid** | Oxazolidinone | Protein synthesis inhibitor – Binds the ribosomal 50S unit | Bacteremia, IE | Monotherapy |
| **Tigecycline** | Glycylcycline | Protein synthesis inhibitor – Binds the ribosomal 30S unit | UTI, Meningitis | Monotherapy |
| **Quinupristin/Dalfopristin** | Streptogramin | Protein synthesis inhibitor – Binds the ribosomal 50S unit | Bacteremia, Meningitis, IE | Combination |
| **Chloramphenicol** | Amphenicol | Protein synthesis inhibitor – Binds the ribosomal 50S unit | Bacteremia, Meningitis | Monotherapy |

*Legend:* *IE= infective endocarditis, UTI = urinary tract infection.

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management.[8,13] A new oxazolidinone, tedizolid, may be efficacious against linezolid-resistant VRE strains, though the FDA does not currently approve it for that indication.[13,32] Recent investigations into the use of oritavancin, a lipoglycopeptide, and omadacycline, a tetracycline, are showing significant efficacy against VRE in small studies, though more coordinated clinical studies are required.[57–59] *In vitro* studies exploring combinations of daptomycin and ceftaroline, a fifth-generation cephalosporin, showed promise against VRE infections; however, Chuang *et al.* in 2017 found no significant difference in mortality between patients receiving the combination therapy compared to daptomycin monotherapy.[8,13,56]

High mortality rates underscore the need for effective antibiotics against VRE.[27] Two studies examining VRE bacteremia in transplant patients reported 80% and 100% mortality rates despite treatment with linezolid, daptomycin, and quinupristin/dalfopristin.[13,30] While VRE infection may not have been the sole cause of death in all instances, reported mortality rates would not have been this high without VRE infection.[27,30,32] Further research must focus on finding alternative antimicrobial therapies or combination therapies that provide more significant efficacy against VRE infections.

### Potential Therapies

New research into alternative treatment options is producing promising results. Our current understanding of the human microbiome and its synergistic effects on health has led to new, targeted treatment modalities affecting several physiological processes, including metabolism and the immune response.[60,61] Colonic dysbiosis, or the disruption of normal enteric microbiota favoring opportunistic infections, is a proven component of disease pathogenesis in *Clostridioides difficile* infections, irritable bowel syndrome, and Crohn's disease.[60,61] Currently, research examining the links between colonic dysbiosis and VRE colonization is underway by multiple groups.[60–64] This research may lead to new treatment paradigms that can reduce VRE colonization rates, morbidity, and mortality associated with VRE infections.

Clinical application of current research offers two different therapeutic approaches: primary rebiosis and secondary rebiosis. Primary rebiosis consists of integrating probiotic species, or components of these species, within the human microbiome to restore normal immune function and prevent seeding by opportunistic pathogens such as VRE.[61–63] Secondary rebiosis consists of integrating a donor microbiome *en totum* to a dysbiotic individual, most commonly accomplished via Fecal Microbiota Transplant (FMT).[60,64] This procedure isolates and purifies a healthy donor sample for direct implantation into a dysbiotic colon.[60,61]

Primary rebiosis shows encouraging results in both animal models and preliminary clinical trials. A 2018 study by Wasilewska *et al.* of *Streptococcus* and *Lactobacillus* in mouse models

confirms earlier reports that probiotic regimens have a two-fold benefit in combating enteric-related infections: modulating colonic immune responses to favor healthy gut microbiota and enhancing immune response against opportunistic pathogens within intestinal lymphoid tissues.[65] Research by Li *et al.* of *Lactobacillus* extracellular vesicles in worm models suggests that components of this probiotic species alone may be effective in treating VRE colonization.[63] Kim *et al.* studied *Blautia producta* in mouse models suggesting that administration in a newly colonized host may restore natural resistance to VRE colonization after antibiotic administration.[66] A 2019 retrospective analysis by Borgmann *et al.* of probiotic therapy conducted in Ingolstadt, Germany, suggests that adding the probiotics *Saccharomyces boulardii* and *Escherichia coli* Nissle to traditional antibiotic regimens reduces VRE transmission in stroke and trauma patients without any adverse side effects.[62] Following the implementation of probiotic regimens, VRE colonization rates dropped from 78 patients per year to 51 per year, an overall 35% reduction.[62] These studies highlight the potential impact of primary rebiosis as an emerging VRE therapy that may improve the efficacy of existing antimicrobial regimens.

Secondary rebiosis via FMT may be effective in reducing VRE colonization where other methods have proven ineffective. First employed in refractory *Clostridium difficile* infections in 2013, FMT has shown surprising efficacy.[60,61] Research utilizing mouse model FMT treatments for VRE colonization reduced overall VRE load, though the effect was transient.[64] In 2018, Davido *et al.* performed the largest human trial to date utilizing FMT as a treatment to decolonize VRE, resulting in seven of eight initial study patients remaining VRE free 3 months post-FMT.[64] Ongoing trials will assess whether these limited but encouraging results will hold up in larger clinical studies.[67] FMT has been shown to be relatively safe, with the most common side-effects being mild and self-limiting increases in flatulence, changes in bowel regularity, and abdominal bloating and tenderness.[68] Identification and screening of healthy donor material play a large role in mitigating the risks associated with the procedure.[68] Directly replacing a patient's colonized colonic microbiome with a healthy, VRE-free microbiome may provide the means to greatly reduce the functional reservoir of VRE and prevent continued colonization.

### Conclusion

Since physicians have identified vancomycin-resistant *Enterococci*, our understanding of this family of multidrug-resistant, opportunistic pathogens has grown exponentially. While this body of evidence has grown, we are still looking for the most appropriate measures to limit the spread of antibiotic-resistant infections. Clinical cases and meta-analyses have provided clues into the reservoirs of VRE and the patient populations most at risk from VRE colonization. Incredibly high morbidity and mortality rates have prompted the development of VRE infection control protocols that have been implemented, studied, and critiqued for their relative effectiveness. Further, the development of cost-effective rapid diagnostic testing may limit

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the spread of unidentified VRE infections in healthcare settings. Current medical therapies for VRE infections are unfortunately limited and resistance to linezolid has been reported but is not widespread as of yet, adding credence to the cries of the WHO, CDC, and others for new antimicrobial therapies. Ongoing research into the human microbiome has provided two potentially promising alternative therapy choices, primary and secondary rebiosis. Though both are still in development, the potential benefits of replacing a defective microbiome with a healthy and balanced population of normal non-pathogenic microbes highlight how increased understanding of our own being may provide the key to discovering how to control and contain vancomycin-resistant *Enterococci* without the risk of additional antimicrobial resistance. The evidence we have reviewed here suggests the necessity of a multifactorial approach to VRE: combining surveillance of at-risk populations, infection control measures, rapid diagnostics, and safe therapies.

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**Review**

Beale JW, et al.                    Clinical Considerations in the Approach to Vancomycin-Resistant Enterococci: A Narrative Review

# Mental Illness and Addiction: Lessons from the County Hospital Inpatient Psychiatric Ward

Thomas F. Fusillo.[1] iD

## Abstract

There is often a stark difference in how people interpret their first exposures to physical illness versus mental illness and addiction medicine. Many times, there is a tendency to sympathize with physical illness but separate ourselves from mental illness and addiction. I have slowly learned to see myself in each of my patients, regardless of diagnosis. In this experience, I describe what it is like to interact with and care for psychiatric patients and how my thoughts on their care changed during my inpatient psychiatric rotation.

**Key Words:** Psychiatry; Addiction medicine; Schizophrenia; Psychosis; Delusions (Source: MeSH-NLM).

## The Experience

Sometime during the sixteenth century, a group of prisoners was being led to execution past the onlooking John Bradford, a proponent of the English Reformation. When Bradford saw the group pass, he spoke the now-famous words, "there, but for the grace of God, goes John Bradford."[1] Since then, English and literature scholars have found those words to mean to both the religious and non-religious that "I too, like someone seen to suffer misfortune, might have suffered a similar fate, but for God's mercy."[2] Similarly, my interpretation of the phrase is that anything can happen to anybody, good or bad, and that includes myself; I am not precluded from any potential misfortune.

During my third year of medical school, my required psychiatry rotation took place at the inpatient psychiatry ward of my local county hospital. There were several other prominent hospitals in the area, but being one of the few public hospitals, many low income and court-ordered individuals ended up there. This brought patients from across the psychiatric and addiction spectrum to the hospital, from moderate depression to severe schizophrenia, from intravenous methamphetamine users to patients with delirium tremens from alcohol withdrawal. Many of these patients were considered "potential for violence," "elopement precaution," and "routine suicide watch."

Admittedly, for my first week or so on the unit, I found myself wondering how a human being could become so mentally troubled. How could a 62-year-old man have delusions of his backyard being under attack by foreign countries? How could a 34-year-old man be so paranoid as to believe that government agents were following him around with a video camera? How could a 41-year-old woman be so addicted to Adderall that she

was found by the police vandalizing a golf course naked while in a psychotic state? These were all questions I asked myself regularly, without any semblance of an answer.

It was not until I started asking these patients about their lives before their diagnoses or addictions that I started to get some answers to my existential questions. I would commonly find myself talking with some of the younger patients about sports, video games, and other hobbies we had in common. During those conversations, I often forgot how different our current situations appeared. These were people who had normal and even successful lives, not too dissimilar from mine. They had siblings, husbands, wives, parents, and children just like me. They went to school and had jobs just like I did. Yet somehow, they were the patient, and I was the student.

About midway through my clinical psychiatry rotation, I realized, just as John Bradford had realized centuries before me, that I could have been that one schizophrenic patient or that bipolar patient, or that patient with drug addiction. These are conditions that can strike anyone. I am not "safe" from these misfortunes. The future makes no promises as to who, whether it is someone close to me or even myself, may one day become one of these patients. This lack of certainty of who we may become may not change how I live my life, but it does change how I view many of those suffering from mental illness.

Our society is often quick to judge those with mental illness and addiction. We assume the mentally ill all have some overarching risk factor that the rest of us do not; thus, we do not need to worry about falling down similar paths. We tend to blame the misfortunes of addicts on their "mental weakness" and, even

1 M.S., Third-year Medical Student, Des Moines University College of Osteopathic Medicine, Des Moines, IA, United States.

**About the Author:** *Thomas Fusillo is currently a third-year medical student. He previously graduated from Northwestern Law School and The University of Texas at Austin.*

**Correspondence:**

Thomas F. Fusillo.

Address: Munroe, 3200 Grand Ave, Des Moines, IA 50312, United States

Email: thomas.f.fusillo@dmu.edu

worse, tend to believe they deserve any misfortunes that come their way. But what about cancer patients? What about tobacco users with chronic obstructive pulmonary disease and respiratory illnesses? What about COVID-19 patients? We do not blame any of them for their diseases and conditions. This occurs even though we know that both mental illnesses, such as schizophrenia and major depression,[5] and many cancers,[6] each have genetic and hereditary components. They both have predictive elements. However, for some reason, we sympathize with the latter patients but overlook and blame the mentally ill and addicted. I believe that we, as an international society, can and should adopt a more holistic view of all our patients, not just the physically ill.

Multiple studies over the past several decades show that medical students, on average, tend to become less empathetic during their school years and that this trend continues through residency.[7-8] I can personally attest as a third-year medical student that I have had to continually battle back against the temptation of treating medicine purely as an objective science rather than treating the person behind that science as a human being with emotion. It seems plausible that this ever-increasing challenge of empathy is one of the reasons so many of us might find it challenging to relate with the mentally ill and addicted.

In the United States alone, nearly one million Americans have died from drug overdose since the year 2000, and the rate continues to rise. The country's declining average life span has mainly been attributed to increasing overdose numbers. On an annual basis, nearly 12% of Americans misuse illegal drugs every year.[3] When it comes to mental illness, 21% of U.S. adults experienced mental illness in 2020, and 5.6% of U.S. adults experienced severe mental illness in that same time frame. Additionally, 6.7% of U.S. adults experienced both mental illness and a coexisting substance use disorder in 2020.[4]

Although my psychiatry rotation has come to an end, my time with patients who may be battling some form of mental illness is just beginning. Seeing ourselves in our patients rather than judging them based on pathology is a practice that can take an entire career to hone but will hopefully be well worth it. As future physicians, we all have a responsibility to our patients to put aside our preconceived notions, provide excellent care, and above all else, do no harm.

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# A Comparison of Australian and American Medical School Admission Experiences

Jack B. Ding,[1] Xin L. Xiao,[2] Zachary I. Merhavy,[3] David Fahim,[4] Cheney E. Merhavy,[5] Thomas C. Varkey.[6]

## Abstract

Attaining admission into medical school has been described as a very competitive process by successful matriculants. The processes that medical schools use to classify applicants can greatly differ among institutions. These systemic differences flow over onto the applicant level, such that individuals from different geographic regions can have varied and diverse application experiences depending on local medical school admissions protocols. This piece compares the medical school admission processes of Australia and the United States of America, in the form of a narrative recount of a successful medical school matriculant in each country, with the individual experiences of matriculants from alternative pathways blended into the piece. The authors discovered significant differences in admissions protocols between the two countries, with the greatest differences revolving around admissions exams, applicant profile (high school students versus college students), degree types, and alternative entrance pathways.

**Key Words:** Premedical Student; Medical Student; Medical School; Medical Education (Source: MeSH-NLM).

## Introduction

Australia and the United States of America (USA) share significant similarities in language and culture, given that both have a mainly English-speaking population and are relatively new countries with colonial heritage. Gaining acceptance into medical school in either country is highly competitive. Over a period of 15 years, there were around 580,000 applicants to US medical schools, of which 260,000 ultimately enrolled (45%).[1] While there is a paucity of comparable Australian data, one study noted that only 38% of first-time applicants who were extended an interview to medical schools in the largest Australian state matriculated in the 2013 to 2014 cycle.[2] There are notable differences in medical school admission processes between the two countries. For example, about half of all Australian medical schools recruit applicants who are in their final year of high school for entry into 5 to 7-year medical school courses. In contrast, the rest recruit applicants holding undergraduate degrees into 4-year courses.[3] Those that do the former are referred to as 'undergraduate medical schools which are generally regarded as the 'traditional' path to medical school, while the latter is called 'postgraduate medical school.' In contrast, all US schools require an undergraduate degree as a pre-requisite to entering medical school. Two other major differences include US osteopathic medical education and US citizens attending foreign medical schools. Osteopaths in the US will have attained all requirements to practice as medical doctors,

whereas osteopathy in Australia is a different degree with no medical training. Australian citizens very rarely pursue medical education abroad. In contrast, nearly 3000 US citizen IMGs entered US residency training in 2018.[4]

These systemic differences in admission protocol ultimately flow over onto the individual level and define each student's admission experiences. *Table 1* summarizes the similarities and differences in our experiences. *Table 2* summarizes the UCAT, GAMSAT, and MCAT admission tests.

## Experience Report

A total of six medical students from Australia and the US were virtually introduced to one another by a mutual connection in September 2021. We shared our admissions experiences with Australian and US allopathic, US osteopathic, and international medical schools through WhatsApp, Zoom, and Google Docs. The two Australian and US 'traditional' applicants penned a classic vignette of their experiences. The remaining members blended their experiences into these two vignettes to provide a succinct, multi-faceted overview of our journeys into medical school.

### A Student with a Traditional Australian Medical School Admissions Experience

I am a traditional medical student at an undergraduate Australian

## Experience

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medical school. I wanted to become a physician for as long as I can remember, and pursuing this career as early as possible made perfect sense. I consolidated on this goal in my junior year (11th grade) of high school, first enrolling in senior year (12th grade) subjects that count toward my ATAR (SAT equivalent) as part of an accelerated curriculum. I also purchased numerous third-party resources for the UCAT (MCAT equivalent).

I started UCAT preparation over a year before my anticipated test date, as applicants can only take it once a year, meaning I only effectively had one attempt per intake cycle to take it. This was the standard strategy for traditional AU undergraduate applicants, typically aged 17 or 18 with strong prior academic performance. As I entered my senior year (12th grade), I noticed diminished academic collaboration between medical school aspirants in my classes. In hindsight, I attribute this to the competitive nature of the undergraduate medicine admissions processes and the high weighting assigned to ATAR performance. I dedicated about 4 hours of after-hours study on school days and about 8 hours a day over the weekend. Due to the academic rigor, I had limited time for non-academic experiences during the school week. Across the four mid-term breaks in the year, I engaged in shadowing and volunteer experiences. By the year-end, I scored a 99.5 ATAR percentile and 95 percentile in the UCAT. I realized these scores were very average for matriculating undergraduate medical students and therefore applied to every undergraduate medical school in the country.

Table 1. Comparison of Medical School Landscape in Australia and the United States of America.

|  | **Australia** | **United States of America** |
|---|---|---|
| **Local applicant landscape** | Allopathic medical schools | Allopathic medical schools, osteopathic medical schools, international medical schools |
| **Applicant recruitment** | High school students and undergraduate graduates | Primarily undergraduate students/graduates |
| **Medical entrance exam** | UCAT (undergraduate schools), GAMSAT (postgraduate schools) | MCAT |
| **Selection factors** | Primarily academic (ATAR or GPA) and interview | Primarily academic (GPA) and interview. Extracurricular experiences such as volunteering, research, letters of recommendation, personal statement, work record also play a role |

Legend: ATAR: Australian Tertiary Admission Rank; GAMSAT: Graduate Medical School Admissions Test; GPA: Grade point average; MCAT: Medical College Admission Test; UCAT: University Clinical Aptitude Test

Eventually, six schools responded with Multiple Mini Interview (MMI) interview offers. An MMI interview consists of several short interviews that are evaluated independently and are the norm for Australian medical schools. After completing the interview process, I nervously investigated the two main backup options applicants had if they failed to receive an admission offer in their senior year (12th grade). The first option was to redo Year 12 and ideally score a higher ATAR and UCAT. Alternatively, I could enroll in an undergraduate course to be admitted to a postgraduate medical school upon completing the degree.

Notably, there are no dedicated 'pre-medical' tracks in Australia, though certain courses are saturated with students competing for a medical seat. This is not to say postgraduate medical schools are primarily occupied by applicants who failed to receive an undergraduate seat. I was told that the premise of postgraduate medical education was to select more holistic and mature candidates who hailed from all walks of life.[5] After an agonizing 2-month wait, I thankfully received a medical school offer in my home state.

Table 2. Overview of Content on the UCAT, GAMSAT, and MCAT Medical School Selection Tests.

| **University Clinical Aptitude Test (UCAT) Overview – Australia** | | |
|---|---|---|
| **Subtest** | **Task** | **Time limit** |
| Verbal reasoning | 44 MCQs | 26 minutes, 15 seconds |
| Decision making | 29 MCQs | 38 minutes, 45 seconds |
| Quantitative reasoning | 36 MCQs | 30 minutes |
| Abstract reasoning | 55 MCQs | 16 minutes, 15 seconds |
| Situational judgment | 69 MCQs | 32 minutes, 30 seconds |
| **Graduate Medical School Admissions Test (GAMSAT) – Australia** | | |
| **Section** | **Task** | **Time limit** |
| Reasoning in humanities and social sciences | 47 MCQs | 70 minutes |
| Written communication | 2 written essays | 65 minutes |
| Reasoning in biological and physical sciences | 75 MCQs | 150 minutes |
| **Medical College Admissions Test (MCAT) Overview – US** | | |
| **Section** | **Task** | **Time limit** |
| Biological and biochemical foundations of living systems | 59 MCQs | 95 minutes |
| Chemical and physical foundations of biological systems | 59 MCQs | 95 minutes |
| Psychological, social, and biological foundations of behavior | 59 MCQs | 95 minutes |
| Critical analysis & reasoning skills | 53 MCQs | 90 minutes |

Legend: MCQs: Multiple choice questions.

**A Student with a Traditional US Medical School Admissions Experience**

I am a traditional medical student at a US medical school. I have been passionate about medicine for as long as I can remember. During my college years, I revolved my life around gaining a medical seat and was enrolled in a Bachelor of Science degree. However, many of my pre-medical peers were enrolled in humanities degrees. I took the MCAT (GAMSAT equivalent) in the summer before my senior year (4th year undergraduate) and scored a 510 (84th percentile). Because most of my time was dedicated to studies and extracurricular activities, such as shadowing and volunteering experiences, I did not forge strong friendships with other pre-medical students. I finished my degree with a 3.71 GPA and applied to 16 medical schools through the portal. I was required to include a personal statement, a list of personal experiences, my MCAT score, and my college transcripts. Every school sent secondary applications to me, with detailed questions that I filled out. Finally, three medical schools extended MMI interview invitations to me. Following this process, I experienced an agonizing wait of several months, knowing that my scores were very modest for most MD schools. During this time, I thought about the option of studying medicine abroad. I had heard that some Caribbean medical schools might use a more holistic review process. They typically also have a lower barrier for entry and more streamlined selection processes, and may also be more liberal with scholarship offers. I may have even

begun my studies a semester earlier due to how swiftly some schools process applications. The primary drawback is that many schools may be of uncertain quality, and I could face additional hardships returning to the US for licensure. The other option I could have contemplated was DO schools, which would have involved applying through a separate application portal. Indeed, I was interested in a holistic approach to patients and was charmed by the tenets of osteopathic manipulative medicine. Both options tended to attract more non-traditional applicants and those with more diverse life experiences. Finally, I received an offer in March of my senior college year (4th-year undergraduate).

**Conclusion**

To conclude, there are key differences in medical school admission processes between Australia and the US. This has a flow-over effect on the individual experiences of applicants. While both students in this paper were from a traditional background, their experiences are by no means wholly representative of their cohorts. Rather, their narrative accounts serve best as adding dimension, perspective, and depth to the discussion and debate on medical school admission processes. Future qualitative interview studies on medical school applicants and their admission experiences would help set a formal research analysis of this topic and help identify common themes in applicant experience across a wider sample pool.

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# Experience of a Medical Intern in a Secondary Healthcare Hospital in Mexico

Jonathan Dazaeth Delgado Sánchez.[1] (ID)

## Abstract

In Mexico, medical training consists of 4 or 5 years of studies on a university campus, one year of undergraduate internship and one year of social service. The undergraduate internship is the theoretical-practical academic portion that takes place in the clinical field and is part of the curriculum of the medical career. Normally, students would expect to be able to choose a hospital with subspecialties or with prestige in their region but no matter the type of hospital, the important thing is their attitude towards their work and education

**Key Words:** Internship and Residency; Medical student; Personal Narrative (Source: MeSH-NLM).

## The Experience

In Mexico, medical training consists of 4 or 5 years of studies on a university campus, one year of undergraduate internship and one year of social service. The undergraduate internship is the theoretical-practical academic portion that takes place in the clinical field and is part of the medical degree curriculum. The undergraduate medical intern or medical intern is a student enrolled in an institution of higher education that meets the academic, administrative, and legal requirements to perform the undergraduate internship.[1]

Medical interns are medical students who perform a rotating internship for one year after their university training. They are essential to the functioning of the healthcare services, thus avoiding the collapse of the national health system in Mexico. Everyone strives to be accepted to a "good" site; however, there are multiple external variables that influence the outcome, such as the number of students graduating per year, the number of universities, the number of hospitals available, and the historical context being experienced (e.g., the COVID-19 pandemic).

There is no consensus on the criteria for a good medical internship site, however, the current literature describes that most medical interns choose the sites closest to their home because the costs and transportation time increase with foreign sites.[2–5] The reality is that we are pressured by teachers, doctors, peers, or family members with the trite idea that a good internship site equals a better undergraduate internship. By not being accepted to one of those honorable or recognized institutions, there is a sense of defeat in choosing sites far from home, at less recognized institutions, or with fewer patients.

What happens when you have to do this clinical year in a small hospital or secondary healthcare hospital? I chose the Hospital General de Pabellón de Arteaga, a second-level care hospital in Mexico. Its services are limited to emergency services, psychology, nutrition, epidemiology, internal medicine, general surgery, gynecology, pediatrics, radiology, traumatology, neonatal intensive care, and reproductive health.[6] The hospital has approximately 40 beds between all these services. There were 9 medical interns with a schedule from 7:00 am to 3:00 pm, in which we had 2-month rotating cycles through the main services of the hospital. However, after 3:00 pm, a team of 3 people was in charge of supporting the hospital during the afternoon and night shifts. Every third day 3 people have a 32 hours shift. The team of interns is shown in (*Figure 1*).

Many medical interns in Mexico dream of seeing and participating in third-level procedures, sub-specialist-led surgeries, or having different medical specialties in their hospital.

In a secondary healthcare hospital, procedures are limited to the resources and specialties that are available on the unit. A small hospital or one with few subspecialties means is considered a bad place for this important year in our training in Mexico. With regard to having few inpatients, we are allowed to deepen our knowledge and skills with feedback from the physician and resident physicians. On the contrary, in many small hospitals or rural areas, the number of patients exceeds the hospitals' capacity allowing the intern to find constant moments of learning and

[1] Seven-year Medical Student. Autonomous University of Aguascalientes, Aguascalientes, México. Social Service Physician of Research. Center for Research and Teaching in Economics, Aguascalientes, México.

**About the Author:** *Autor is a currently a seven-year medical student of University of Aguascalientes medical school, Aguascalientes, Mexico of a seven-year program. He was editor in chief of CIMMEF, journal of AMMEF A.C.*

**Correspondence:**

Jonathan Dazaeth Delgado Sánchez.

Address: Avenida Universidad 940, Ciudad Universitaria, 20100 Aguascalientes, Mexico

Email: dazaethsanchez@gmail.com

practice. In my hospital, the obstetrics and gynecology service has the highest number of patients seeking care for an obstetric event in the evenings. Spending a full night in cesarean sections is common, conducting labor and delivery. This shows that any hospital is a good place for undergraduate medical internships, regardless of the number of patients or type of specialties they have.

Is medical training in a tertiary hospital better? Overcoming the expectation of being in a larger hospital was difficult and I needed a reality check. I found it a great opportunity to study a smaller number of patients in-depth. It was important to have time to critically read scientific articles and the space for medical training with specialists and resident physicians.

Another virtue of being in a small hospital, and perhaps peculiar in my case, is the type of clinical rotation in the hospital services. In most hospitals in Mexico, intern teams rotate for 2 months in the main services offered by their hospital. During this time, they must concentrate on their service.

The case of my hospital is different; the number of interns per generation is 5 to 8, who are divided into 3 teams (*Figure 1*). In the morning shifts from 7:00 am to 3:00 pm, each one works in an assigned service for 2 months, but after that time, a team of interns works in the evening and night shifts for all the hospital services. This may seem like a lot of work; however, there were good and bad days. On good days our only job was to monitor admitted patients and support scheduled surgeries on the afternoon shift, but on bad days we had to support delivery care, cesarean sections, neonatal resuscitation, emergency department consultation, Foley catheter placement, wound suturing, etc. This was a great opportunity to practice different things over the course of a year.

In a secondary healthcare hospital, do you only see common diseases? The epidemiology of the reason for consultation and care is different by region and hospital. Being at a secondary healthcare hospital provides the tools to know what you can solve and what should be referred immediately. Despite that, many rare conditions can be found at this level of care. Examples include Mondor´s syndrome, thanatophoric dysplasia, Loxosceles reclusa bite, granulomatosis with polyangiitis, cyclic vomiting syndrome, and arthrogryposis multiplex congenita. The key to making these diagnoses with the limited resources available in the physical exam and health assessment that allow for timely referral to another level of care. In the absence of all the resources to confirm a diagnosis, referrals are usually made to other hospitals that have the corresponding services to confirm the diagnosis (e.g., the genetics service).

Is research possible in a secondary healthcare hospital? In my hospital, there is no fund that directly supports research led by an

*Figure 1.* Medical Interns and Resident Physicians of the General Hospital of Pabellón de Arteaga.



undergraduate internal medicine physician, but it does provide us with the following items:
1. Computer equipment with the software needed for research (Mendeley, R software, Epi Info™, etc.)
2. A period of time in the hospital to do research.
3. Resident physicians or specialist physicians with the interest to support research projects.

No matter where you are, research is always a possibility. So far, I have had the opportunity to work on the report of two clinical cases and a narrative review, which are in the research process.

Regardless of the type of hospital you are in, I suggest 7 points:
1. Be a proactive person.
2. Study your patients' diagnoses and ask about your uncertainties
3. Research and publish your work.
4. Share your information with your colleagues and have a dialogue.
5. Learn and teach.
6. Use the technological tools at your fingertips, computer or smartphone.
7. Guarantee the best working conditions for your colleagues and for you through a proactive and respectful dialogue with the corresponding authorities in your hospital.

In my perception, if you have a good attitude to learn, are proactive, and take advantage of all the opportunities that come your way, you can achieve great results regardless of the type of hospital in which you find yourself. For all its structural flaws, the undergraduate medical internship provides a year of opportunity to complete 5 years of study. I hope my small experience can help you understand the benefits of this scenario. There are no small opportunities for big people, there are people who accomplish their goals with all the possibilities they find.

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