UOJM JMUO

December 2025
Volume 15.2

Photo by Vitaly Gariev on Unsplash

ISSN: 2292-650X

UOJM

UNIVERSITY OF OTTAWA JOURNAL OF MEDICINE

JMUO

JOURNAL MÉDICALE DE L'UNIVERSITÉ D'OTTAWA

VOLUME 15 ISSUE 2 DECEMBER 2025

The student-run medical journal of the University of Ottawa

ABOUT US

UOJM is an international peer-reviewed journal led and published by the students of the Faculty of Medicine. We welcome submissions in a variety of areas in biomedical research and feature original research, review articles, news and commentaries, case reports and opinion pieces. Our articles are written in both English and French. We are the only bilingual medical journal in Canada run by students.

Le JMUO est un journal revu, édité et publié par les étudiants de la Faculté de médecine. Nous encourageons les soumissions d'une variété de différents domaines en recherche biomédicale et publions des articles de recherche originale, des articles de revue, des nouvelles et commentaires, des rapports de cas et des pièces d'opinion. Nos articles sont écrits en français et en anglais. Nous sommes la seule revue médicale bilingue au Canada dirigée par des étudiants.

CONTACT INFORMATION

Address:
University of Ottawa Journal of Medicine
Journal Médical de l'Université d'Ottawa
451 Smyth Rd
c/o UGME Room 2046
Ottawa, Ontario, Canada
K1H 8M5

Website: uojm.ca

CORESPONDENCE

Editorial, recruitment and sponsorship correspondence can be made to contact@uojm.ca
Manuscripts can be submitted online via http://uojm.ca
Articles published in the UOJM can be digitally archived and indexed at uO Research: http://www.ruor.uottawa.ca/en

To inquire about receiving print versions of current and past issues of UOJM, contact the Co-Editors in Chief at contact@uojm.ca

JOURNAL STAFF

TABLE OF CONTENTS

UOJM: PREFACE

The University of Ottawa Journal of Medicine (UOJM) is pleased to present Issue 15.2 to our readership. Medicine and healthcare remain central concerns for the people of the Ottawa region and the Canadian population. Across these domains, numerous groups continue to advance research and innovation, and we are proud to support and publish their work.

From novel therapeutic approaches to emerging trends in healthcare delivery, research remains a catalyst for challenging existing practices and guiding future improvements. The high calibre of the articles featured in this issue reflects the commitment of our authors to expanding medical knowledge across a diverse range of topics. Their efforts are strengthened by the ongoing dedication of our reviewers and editorial team, whose contributions ensure the journal maintains its rigorous scholarly standards.

This edition brings together scientific progress, clinical insights, and expert perspectives that address pressing challenges and opportunities in modern medicine. Below is an overview of what readers can expect:

INNOVATING POINT-OF-CARE ULTRASOUND (POCUS) EDUCATION: A NEW ERA OF UNDERGRADUATE MEDICAL EDUCATION AT THE UNIVERSITY OF OTTAWA
This article overviews the Point of-Care Ultrasound (POCUS) curriculum at the University of Ottawa. The authors outline the ongoing success of the curriculum and discuss areas that would benefit from improvement as POCUS adoption becomes more widespread.

MORE BILINGUAL DOCTORS ARE NEEDED IN ATLANTIC CANADA: EXPLORING THE CHALLENGES OF PRACTICING MEDICINE IN RURAL COMMUNITIES AND POTENTIAL SOLUTIONS
This commentary discusses physician supply and retention strategies in Rural Atlantic Canada, with a focus on bilingual physicians. The authors stress the need for broad based strategies to ensure the adequate provision of healthcare for patients regardless of their place of residence.

OPIOID USE IN CHRONIC PAIN PATIENTS AND ITS IMPLICATIONS FOR DEMENTIA AND ALZHEIMER'S DISEASE ONSET: A SCOPING REVIEW
This scoping review examines the current literature on the effects of opioid use on the onset of dementia and Alzheimer's disease in patients with chronic pain. The findings of the review suggest an association between opioid use and an increased risk of onset of dementia or Alzheimer's disease in chronic pain patients, with a generally dose-dependent relationship, predominantly in older populations.

FACTORS ASSOCIATED WITH VACCINE HESITANCY AMONG ADULTS IN PESHAWAR, KHYBER PAKHTUNKHWA, PAKISTAN: A CROSS-SECTIONAL STUDY
This cross-sectional online survey study investigated the factors associated with vaccine hesitancy in Peshawar, Khyber Pakhtunkhwa, Pakistan. The findings of this study highlight the interplay of many factors including gender, age, income levels and encouragement from healthcare workers, on vaccine hesitancy, and authors encourage interventions to promote vaccine uptake.

THE PSYCHEDELIC FRONTIER: A CROSS-SPECIALTY REVIEW OF HEALTHCARE PROVIDERS' ATTITUDES ON PSYCHEDELIC-ASSISTED THERAPY IN THE US
This systematic review of 11 articles assesses healthcare providers' perceptions of Psychedelic-Assisted therapy in the United States. The findings demonstrate that providers hold cautiously favourable views of the therapy and that further interdisciplinary collaboration is required to facilitate integration into routine clinical practice.

EVALUATING THE EFFECT OF A PRE-ARRIVAL CPR CHECKLIST ON RESUSCITATION QUALITY DURING A SIMULATED CARDIAC ARREST
This randomized controlled trial of Canadian emergency medicine residents investigated the effect of a pre-arrival CPR checklist on Resuscitation quality during a simulated cardiac arrest. The findings demonstrated that the implementation of a CPR checklist improved adherence to resuscitation guidelines in a simulated arrest.

UOJM: PREFACE

MEDICAL STUDENT WELLBEING: BREAKING THE CYCLE OF STRESS IN MEDICAL SCHOOL
This article discusses medical student wellbeing and outlines each stage of the stress cycle. The author suggests interventions to mitigate stress and serves as an important resource for learner wellness.

SHOULD WE STILL BE CONCERNED ABOUT SCREEN TIME USE FOR CANADA'S YOUNG CHILDREN? UNDERSTANDING THE RESEARCH LANDSCAPE OF SCREEN TIME AFTER THE COVID-19 PANDEMIC
This commentary addresses the screen time of Canada's pediatric population. The authors discuss the need for further research regarding screen time usage following the COVID-19 pandemic.

DIGITAL LEARNING TOOLS: FINDINGS FROM A NATIONAL SURVEY OF CANADIAN MEDICAL LEARNERS
This cross-sectional survey of Canadian medical students and family medicine residents investigated the use of digital learning tools. The authors demonstrated that educators should focus on learner experience and reducing barriers to improve the delivery of medical education and the adoption of digital learning tools.

XENOTRANSPLANTATION UNVEILED: BREAKTHROUGHS, CHALLENGES, AND PUBLIC PERCEPTIONS
This commentary reviews scientific advancements in xenotransplantation and aims to explain the concept to the public along with its potential challenges.

A PILOT RANDOMIZED CONTROLLED TRIAL OF ANATOMY COLORING BOOKS FOR FIRST-YEAR MEDICAL STUDENTS: IMPACT ON ANXIETY AND ANATOMICAL KNOWLEDGE RETENTION
This randomized controlled trial of first year medical students investigated the effect of anatomy colouring books on anxiety and knowledge retention. The findings demonstrated that the colouring book group had significantly lower levels of anxiety after their anatomy learning, yet there were no statistically significant differences in knowledge retention.

On behalf of the entire team at the University of Ottawa Journal of Medicine, we thank you for contributing to student-led research at the University of Ottawa. We hope you enjoy Issue 15.2 of the University of Ottawa Journal of Medicine.

Jacob Wise and Emily Tran
Co-Editors-in-Chief (2025-2026)

JMUO: PRÉFACE

Le Journal de médecine de l'Université d'Ottawa (JMUO) est heureux de présenter à ses lecteurs le numéro 15.2. La médecine et les soins de santé demeurent des préoccupations centrales pour les habitants de la région d'Ottawa et la population canadienne. Dans ces domaines, de nombreux groupes continuent de faire progresser la recherche et l'innovation, et nous sommes fiers de soutenir et de publier leurs travaux.

Des approches thérapeutiques novatrices aux nouvelles tendances en matière de prestation des soins de santé, la recherche reste un catalyseur qui remet en question les pratiques existantes et guide les améliorations futures. Le haut niveau des articles présentés dans ce numéro reflète l'engagement de nos auteurs à élargir les connaissances médicales dans un large éventail de sujets. Leurs efforts sont renforcés par le dévouement constant de nos réviseurs et de notre équipe éditoriale, dont les contributions garantissent le maintien des normes scientifiques rigoureuses de la revue.

Cette édition rassemble les progrès scientifiques, les connaissances cliniques et les points de vue d'experts qui abordent les défis et les opportunités urgents de la médecine moderne. Voici un aperçu de ce que les lecteurs peuvent attendre :

INNOVATION DANS L'ENSEIGNEMENT DE L'ÉCHOGRAPHIE AU POINT D'INTERVENTION (POCUS) : UNE NOUVELLE ÈRE DANS LA FORMATION MÉDICALE DE PREMIER CYCLE À L'UNIVERSITÉ D'OTTAWA
Cet article présente le programme d'études sur l'échographie au point d'intervention (POCUS) de l'Université d'Ottawa. Les auteurs soulignent le succès continu du programme et discutent des domaines qui pourraient être améliorés à mesure que l'adoption de la POCUS se généralise.

LE CANADA ATLANTIQUE A BESOIN DE PLUS DE MÉDECINS BILINGUES : EXPLORATION DES DÉFIS LIÉS À LA PRATIQUE DE LA MÉDECINE DANS LES COMMUNAUTÉS RURALES ET DES SOLUTIONS POSSIBLES
Ce commentaire examine les stratégies d'approvisionnement et de rétention des médecins dans les régions rurales du Canada atlantique, en mettant l'accent sur les médecins bilingues. Les auteurs soulignent la nécessité de mettre en place des stratégies globales afin de garantir une offre de soins de santé adéquate aux patients, quel que soit leur lieu de résidence.

CONSOMMATION D'OPIOÏDES CHEZ LES PATIENTS SOUFFRANT DE DOULEURS CHRONIQUES ET SES IMPLICATIONS POUR L'APPARITION DE LA DÉMENCE ET DE LA MALADIE D'ALZHEIMER : UNE REVUE EXPLORATOIRE
Cette revue exploratoire examine la littérature actuelle sur les effets de la consommation d'opioïdes sur l'apparition de la démence et de la maladie d'Alzheimer chez les patients souffrant de douleurs chroniques. Les résultats de l'étude suggèrent un lien entre l'utilisation d'opioïdes et un risque accru d'apparition de la démence ou de la maladie d'Alzheimer chez les patients souffrant de douleurs chroniques, avec une relation généralement dose-dépendante, principalement chez les populations âgées.

FACTEURS ASSOCIÉS À L'HÉSITATION VACCINALE CHEZ LES ADULTES À PESHAWAR, DANS LA PROVINCE DE KHYBER PAKHTUNKHWA, AU PAKISTAN : UNE ÉTUDE TRANSVERSALE
Cette étude transversale en ligne a examiné les facteurs associés à l'hésitation vaccinale à Peshawar, dans la province de Khyber Pakhtunkhwa, au Pakistan. Les résultats de cette étude mettent en évidence l'interaction de nombreux facteurs, notamment le sexe, l'âge, le niveau de revenu et les encouragements des professionnels de santé, sur l'hésitation vaccinale, et les auteurs encouragent les interventions visant à promouvoir la vaccination.

LA FRONTIÈRE PSYCHÉDÉLIQUE : UNE REVUE INTERDISCIPLINAIRE DES ATTITUDES DES PRESTATAIRES DE SOINS DE SANTÉ À L'ÉGARD DE LA THÉRAPIE ASSISTÉE PAR PSYCHÉDÉLIQUES AUX ÉTATS-UNIS
Cette revue systématique de 11 articles évalue la perception des prestataires de soins de santé à l'égard de la thérapie assistée par psychédéliques aux États-Unis. Les résultats démontrent que les prestataires ont une opinion prudemment favorable de cette thérapie et qu'une collaboration interdisciplinaire plus poussée est nécessaire pour faciliter son intégration dans la pratique clinique courante.

JMUO: PRÉFACE

ÉVALUATION DE L'EFFET D'UNE LISTE DE CONTRÔLE DE RCP AVANT L'ARRIVÉE SUR LA QUALITÉ DE LA RÉANIMATION LORS D'UN ARRÊT CARDIAQUE SIMULÉ

Cet essai contrôlé randomisé mené auprès de résidents en médecine d'urgence canadiens a étudié l'effet d'une liste de contrôle de RCP avant l'arrivée sur la qualité de la réanimation lors d'un arrêt cardiaque simulé. Les résultats ont démontré que la mise en œuvre d'une liste de contrôle de RCP améliorait le respect des directives de réanimation lors d'un arrêt simulé.

BIEN-ÊTRE DES ÉTUDIANTS EN MÉDECINE : BRISER LE CYCLE DU STRESS À LA FACULTÉ DE MÉDECINE

Cet article traite du bien-être des étudiants en médecine et décrit chaque étape du cycle du stress. L'auteur suggère des interventions pour atténuer le stress et constitue une ressource importante pour le bien-être des apprenants.

DEVRIONS-NOUS ENCORE NOUS PRÉOCCUPER DU TEMPS PASSÉ DEVANT LES ÉCRANS PAR LES JEUNES ENFANTS CANADIENS ? COMPRENDRE LE PAYSAGE DE LA RECHERCHE SUR LE TEMPS PASSÉ DEVANT LES ÉCRANS APRÈS LA PANDÉMIE DE COVID-19

Ce commentaire traite du temps passé devant les écrans par la population pédiatrique canadienne. Les auteurs discutent de la nécessité de poursuivre les recherches sur le temps passé devant les écrans après la pandémie de COVID-19.

OUTILS D'APPRENTISSAGE NUMÉRIQUES : RÉSULTATS D'UNE ENQUÊTE NATIONALE MENÉE AUPRÈS D'APPRENANTS EN MÉDECINE CANADIENS

Cette enquête transversale menée auprès d'étudiants en médecine et de résidents en médecine familiale canadiens a porté sur l'utilisation des outils d'apprentissage numériques. Les auteurs ont démontré que les enseignants devraient se concentrer sur l'expérience des apprenants et la réduction des obstacles afin d'améliorer la prestation de l'enseignement médical et l'adoption des outils d'apprentissage numériques.

LA XÉNOTRANSPLANTATION DÉVOILÉE : PERCÉES, DÉFIS ET PERCEPTIONS DU PUBLIC

Ce commentaire passe en revue les progrès scientifiques en matière de xénotransplantation et vise à expliquer le concept au public ainsi que les défis potentiels qu'il comporte.

UN PILOTE D'ESSAI CONTRÔLÉ ET RANDOMISÉ DES LIVRES DE COLORIAGE D'ANATOMIE POUR LES ÉTUDIANTS EN PREMIÈRE ANNÉE DE MÉDECINE : IMPACT SUR L'ANXIÉTÉ ET LA RÉTENTION DES CONNAISSANCES EN ANATOMIES

Cet essai randomisé contrôlé mené auprès d'étudiants en première année de médecine a étudié l'effet des livres de coloriage anatomiques sur l'anxiété et la rétention des connaissances. Les résultats ont démontré que le groupe ayant utilisé les livres de coloriage présentait des niveaux d'anxiété significativement plus faibles après l'apprentissage de l'anatomie, mais qu'il n'y avait pas de différences statistiquement significatives en termes de rétention des connaissances.

Au nom de toute l'équipe du Journal médical de l'Université d'Ottawa, nous vous remercions de contribuer à la recherche dirigée par les étudiants à l'Université d'Ottawa. Nous espérons que vous apprécierez le numéro 15.2 du Journal de médical de l'Université d'Ottawa.

Jacob Wise et Emily Tran
Co-rédacteurs-en-chef (2025–2026)

Innovating Point-of-Care Ultrasound (POCUS) Education:

A New Era of Undergraduate Medical Education at the University of Ottawa

Photo by Elen Sher on Unplash

Tommy Han[1], Pierre-Marc Dion[1], Michael Y. Woo[1,2,3]

[1] Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada
[2] Clinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, ON, Canada
[3] Department of Emergency Medicine, The Ottawa Hospital, Ottawa, ON, Canada

Correspondence: Tommy Han; than062@uottawa.ca

Date Submitted: September 8, 2023
Date Accepted: March 6, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.6943

Keywords: *point-of-care ultrasound, undergraduate medical education, competency-based medical education, curriculum innovation*

ABSTRACT

The University of Ottawa's Point-of-Care Ultrasound (POCUS) curriculum in Undergraduate Medical Education (UGME) serves as a strong foundation for the increasing expectations of POCUS proficiency in Postgraduate Medical Education and clinical practice. Our program has seen notable successes, particularly in the realms of medical student engagement, educational innovation, and interdisciplinary support. These successes are evidenced through robust student participation in curriculum development and implementation, research with national and international presentations, and interest groups. The success of this curriculum continues to have the support from UGME and many departments within the institution. This support is illustrated by the active involvement of faculty members in POCUS teaching, POCUS research initiatives and financial investments into POCUS equipment.

As we transition to Competency-Based Medical Education and incorporate Entrustable Professional Activities, our curriculum requires ongoing refinement. Key areas for development include formalizing clerkship objectives, diversifying assessment methods, and leveraging technology for future clinical practice. To evaluate the effectiveness of this curriculum, a plan for program evaluation will be implemented. This will include regular feedback from students and faculty to assess POCUS objective relevance, and formative/summative assessments to monitor learner competence and skill acquisition.

While the POCUS curriculum at the University of Ottawa marks significant strides in medical education, a focused approach toward addressing these evolving demands will further solidify its role as a cornerstone in preparing future clinicians.

RÉSUMÉ

Le curriculum sur l'échographie au point d'intervention (POCUS) de l'Université d'Ottawa dans le cadre des études médicales de premier cycle (EMPC) sert de base solide pour répondre aux attentes croissantes en matière de maîtrise de POCUS dans la formation médicale postdoctorale et la pratique clinique. Notre programme a connu des succès notables, en particulier dans les domaines de l'engagement des étudiants en médecine, de l'innovation pédagogique et du soutien interdisciplinaire. Ces succès se traduisent par une forte participation des étudiants à l'élaboration et à la mise en œuvre du programme, par des recherches présentées à l'échelle nationale et internationale, et par la création de groupes d'intérêt. Le succès de ce programme continue de bénéficier du soutien de l'EMPC et de nombreux départements au sein de l'établissement. Ce soutien est illustré par la participation active des membres du corps professoral à l'enseignement, aux initiatives de recherche et aux investissements financiers dans l'équipement, le tout dans le cadre de POCUS.

Alors que nous passons à une formation médicale basée sur les compétences et intégrons des activités professionnelles confiables, notre curriculum nécessite des améliorations continues. Les domaines clés à développer comprennent la formalisation des objectifs du stage, la diversification des méthodes d'évaluation et l'exploitation de la technologie pour la pratique clinique future. Afin d'évaluer l'efficacité de ce programme, un plan d'évaluation sera mis en œuvre. Il comprendra des commentaires réguliers des étudiants et du corps enseignant afin d'évaluer la pertinence des objectifs du POCUS, ainsi que des évaluations formatives/sommatives pour contrôler les compétences et l'acquisition des aptitudes des apprenants.

Si le programme POCUS de l'Université d'Ottawa marque une avancée significative dans l'enseignement médical, une approche ciblée visant à répondre à ces exigences en constante évolution renforcera encore son rôle de pierre angulaire dans la formation des futurs cliniciens.

INTRODUCTION

In the last decade, point-of-care ultrasonography (POCUS) has emerged as a core competency in many different medical specialties[1]. Clinicians use POCUS as a non-invasive diagnostic tool to complement clinical assessments. In contrast to other imaging modalities, POCUS has several distinct advantages. In addition to being non-ionizing, it can be implemented at the bedside to provide rapid diagnosis and treatment as well as optimize safety of invasive procedures[2]. Since the New England Journal of Medicine published a review article on POCUS, there has been widespread adoption of POCUS across clinical specialities[21]. This includes but is not limited to disciplines such as Family Medicine, Emergency Medicine, Intensive Care and Anesthesiology[22-24]. Bedside ultrasound has helped clinicians narrow down differential diagnoses in settings of acute dyspnea, shock, and abdominal pain[22]. Additionally, its utility extends to the outpatient settings, where POCUS has been utilized to aid the diagnosis of medical conditions such as cholelithiasis, achilles tendon rupture, ascites, and fetal breech presentation[25,26].

Moreover, the versatility and portability of POCUS has revolutionized healthcare delivery, particularly in underserved and marginalized communities[3,4]. In these settings, where access to healthcare services and resources may be limited, POCUS has the potential to significantly improve patient care and health outcomes. Its cost-effectiveness and immediate diagnostic ability makes it an invaluable tool in resource-limited environments, enabling treatment initiation that could otherwise be delayed due to lack of access to certain diagnostic modalities.

POCUS has become a core competency for Emergency medicine, General Internal Medicine, Anesthesia, and Critical care, with potential to integrate into numerous other specialties[27-30]. As POCUS takes a more prominent role in various medical fields, graduating medical students should have a basic understanding and competency in bedside imaging. As a result, POCUS education has been gradually integrated into curricula across Canadian medical schools[5,6]. In addition to being an important clinical skill, POCUS has several benefits to medical education and has been shown to improve students' physical exam proficiency and increase their knowledge of anatomy and physiology[7–9]. This article provides an overview of the current integration of POCUS in Undergraduate Medical Education (UGME) at the University of Ottawa.

OVERVIEW OF THE POCUS CURRICULUM

The current UGME POCUS curriculum at the University of Ottawa is divided into two main stages of learning: clerkship and pre-clerkship.

Pre-clerkship

In pre-clerkship, the primary goal is for students to understand the basics of POCUS image generation and interpretation. At this stage, the learning objectives are linked to learning the basic principles of ultrasound, including knobology, artifacts, selection of transducer, and ultrasound imaging limitations. For instance, knobology refers to basic operation of an ultrasound machine such as adjusting gain, depth and focus to create optimal images. Conversely, artifacts are features in ultrasound images generated from interaction of ultrasound waves with tissue, machine settings or probe positioning. Artifacts can be useful diagnostic aids that enable clinicians to identify pathology on ultrasound images. These fundamental concepts are important to understand in order to effectively generate and interpret ultrasound in a clinical setting.

Students have also been taught how to scan standardized patients and interpret normal ultrasound findings, focusing on the following systems: cardiac, respiratory, thyroid/neck, musculoskeletal, gastrointestinal/abdominal, and vascular. Through learning objectives and virtual modules, students are also able to appreciate basic science concepts within the study of POCUS such as anatomy, physiology, and pathology

Clerkship

In the clerkship stage, the goal is for students to learn how to use POCUS in real clinical settings and utilize this tool to complement patient assessments. There is currently a lack of specific POCUS learning objectives in the clerkship curriculum. While POCUS exposure is present in clerkship, it is not delivered in a standardized manner as teaching varies depending on the clinical rotation. During clerkship rotations, students have the opportunity to spend time with clinicians who have incorporated POCUS into their practice, enabling clerks to receive real-time training in identifying scenarios where such imaging techniques are applicable. Furthermore, students can finetune their judgement regarding which diagnostic imaging technique is most appropriate for a given clinical scenario while also appreciating a tool's limitations.

Teaching Modalities

The UGME POCUS curriculum is delivered through a variety of teaching modalities. These include didactic lectures, physician skill development (PSD) sessions, self-directed learning, peer teaching through the POCUS interest groups (IG), and bedside teaching on clerkship rotations. The primary POCUS teaching method at the University of Ottawa has been PSD sessions[10]. PSD sessions are small-group scanning sessions composed of six to eight students led by a POCUS expert. These sessions allow for hands-on training where students can practice scanning standardized patients with direct guidance and feedback from a trained clinician. PSD sessions have been shown to increase students' confidence with their clinical skills and POCUS knowledge[11]. Self-directed learning encompasses a broad variety of resources students can access. This includes the University of Ottawa Brightspace POCUS modules that cover the ultrasound basics, instructional videos and cases that can be seen in the **Appendix**. An example of an emergency medicine POCUS case can be seen in **Figure 1**. Additionally, there are also instructional eBooks, notably Dr. Zacchary Fredette (uOttawa Faculty of Medicine) introductory POCUS manual[12]. Furthermore, the POCUS IG, composed of a small group of medical students provide optional scanning workshops and small teaching sessions. Lastly, in clerkship, students spend time with providers trained in POCUS and practice various scans in clinical settings such as the emergency medicine, anesthesiology, and internal medicine. Student's gain exposure to how POCUS is used to narrow down a differential diagnosis, observe ultrasound-guided procedures, and learn to differentiate normal scans from pathological ones.

Overall, the UGME POCUS curriculum at the University of Ottawa's effectively blends foundational knowledge and hands-on practice, employing a variety of teaching modalities to prepare medical students for real-world clinical applications. However, as POCUS continues to evolve, so too must the educational approaches that support it.

FUTURE DIRECTIONS AND CHALLENGES

The POCUS curriculum at the University of Ottawa has seen considerable integration and advancement. Despite these strides, there remain challenges and opportunities for further refinement.

Learning Objectives

One of the most pressing concerns is the absence of formalized learning objectives in the clerkship stage. While the pre-clerkship stage is well-structured, the clerkship stage is less defined, making it difficult for students to develop POCUS competency in clinical settings. This is particularly evident beyond Emergency Medicine rotations, where stu-

Case 3: Emergency Medicine

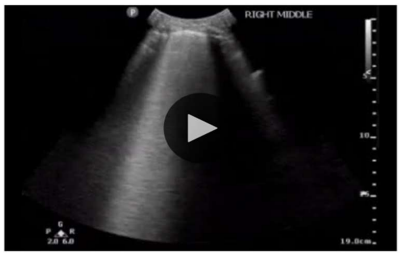
A 38-year-old male presents to the emergency department with a 3-day onset of fever, productive cough and shortness of breath. He has a past medical history of hypertension. His vital signs are: temperature 38.3°C, RR 25/min, HR 110/min, BP 120/80 mmHg and O_2 saturation is 92%.

On physical exam, there are crackles on the right lung on auscultation.

What is your most important differential diagnosis?

Which POCUS exams do you conduct?

Lung ultrasound (right side only)



Source: The POCUS Atlas

R4 lung zone

Source: Tambelli, R. The POCUS Atlas

L4 lung zone

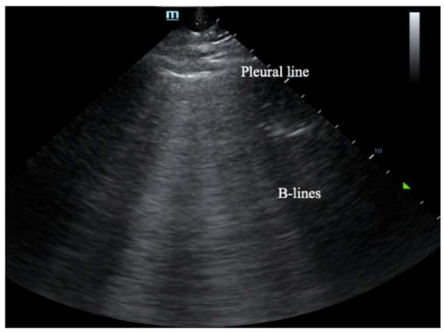
Source: CDEL4 - Dr. Pageau

POCUS Interpretation?

Ultrasound findings indicate right-sided multifocal pneumonia.

Lung Ultrasound

- L4 lung zone ultrasound is normal.
- R4 lung zone ultrasound shows parenchymal consolidation with air bronchograms (b).
- Lung ultrasound demonstrates an absence of A-lines and greater than 3 B-lines in an intercostal space on the right side. This is indicative of a localized lung abnormality (a).



(a)
Source: The POCUS Atlas

(b)
Source: Tambelli, R. PLAPS consolidation. The POCUS Atlas.

Figure 1: The University of Ottawa Brightspace Module Example

dents have little POCUS exposure and fewer opportunities to develop their POCUS competency. To address this gap, the University is moving towards a spiral curriculum where core topics are revisited more than once at different stages of medical education. This is advantageous compared to the current curriculum where core topics are just visited once. This model is complemented by online modules accessible to students before, during, and after lectures or clerkship rotations, reinforcing learning through repetition[13].

Moreover, there is an ongoing shift towards competency-based UGME. POCUS is well-positioned to align with this model, particularly incorporating Entrustable Professional Activities (EPAs) like EPA1 ("Perform a patient history and physical examination") and EPA11 ("Perform general procedures"). These EPAs provide a structured framework for evaluating student competence in key tasks and would further encourage students to seek POCUS opportunities in order to fulfill formal objectives[14]. Such an approach would ensure that students demonstrate required competencies in POCUS under supervision before transitioning to unsupervised practice.

Hands on procedures

Another area for improvement is the curriculum's limited focus on hands-on teaching of ultrasound-guided procedures. This deficiency is likely due to the general scarcity of such procedures within the existing curriculum. Incorporating more hands-on procedures and offering ample opportunities for practice under expert supervision could bridge this gap. Simulation technology offers a promising avenue for achieving this in a low-risk environment[15,16].

Student Assessment

Assessment of students also warrants attention. The current methods primarily consist of multiple-choice exams and self-assessments on Brightspace modules. While these methods are valid, they may not fully capture the practical skills required to perform POCUS. Including a POCUS logbook, Objective Structured Clinical Examinations and frequent feedback sessions could provide a more comprehensive evaluation of students' abilities and areas requiring improvement[17].

Resource Constraints

Technological and resource constraints pose another challenge. The current teaching model predominantly uses expensive cart-based ultrasound systems. These are not only costly but also limited in number, restricting opportunities for in-person teaching. An emerging solution is remote learning through web-based modules and virtual training platforms. These have proven effective, particularly during the COVID-19 pandemic, in delivering comparable educational outcomes to in-person training[18]. The transition from cart-based systems to more affordable handheld ultrasound (HHU) devices can significantly augment POCUS education. These devices, which can be connected to smartphones or tablets, offer an affordable alternative and have been endorsed for producing "comparable" images to traditional machines[19]. The goal is for every medical student to have a HHU for their duration of the training including Postgraduate Medical Education (PGME) and eventual clinical practice.

Demand for POCUS tutors

Lastly, there is an increasing demand for qualified POCUS tutors, currently exceeding the supply. Tutors are mostly from the Departments of Emergency Medicine, Anesthesia, Radiology, and Internal Medicine. It is important to note that POCUS supports an inter-professional educational model that includes many Sonographers as tutors, which also helps with this demand. Here is an initiative to further diversify the pool of educators by including faculty from other specialties especially the Department of Family Medicine and implementing a train-the-trainer model. Such an approach would create a sustainable educational environment better equipped to meet growing needs[20].

While the UGME POCUS curriculum at the University of Ottawa has made significant advances, further improvements are needed. Addressing these challenges involves formalizing clerkship objectives, enriching hands-on training, enhancing assessment methods, leveraging technology, and expanding the educator pool. The shift towards competency-based UGME and the inclusion of EPAs offer promising frameworks for the curriculum's future evolution.

CONCLUSION

The University of Ottawa's UGME POCUS curriculum serves as a pivotal foundation for PGME, aligning with rising POCUS demands for clinical training. This is substantiated by strong student engagement in research, publications, and IGs, coupled with robust backing from UGME and various departments within the Faculty of Medicine. As we transition to CBME and incorporate EPAs, the curriculum is well-positioned but necessitates ongoing fine-tuning. Areas for focus include formalizing clerkship objectives, di-

versifying assessment methods, and leveraging technology advancements for broader educational impact. In summary, while making significant strides, targeted improvements will further solidify the curriculum's role in preparing future clinicians.

REFERENCES

1. Biggerstaff SC, Silver AM, Donroe JH, Dversdal RK. The POCUS Imperative. Journal of Graduate Medical Education. 2023;15(2):146-149.
2. Díaz-Gómez JL, Mayo PH, Koenig SJ. Point-of-care ultrasonography. New England Journal of Medicine. 2021;385(17):1593-1602.
3. Rominger AH, Gomez GAA, Elliott P. The implementation of a longitudinal POCUS curriculum for physicians working at rural outpatient clinics in Chiapas, Mexico. Critical Ultrasound Journal. 2018;10:1-8.
4. Buonsenso D, De Rose C. Implementation of lung ultrasound in low-to middle-income countries: a new challenge global health? European Journal of Pediatrics. 2022;181(1):1-8.
5. Steinmetz P, Dobrescu O, Oleskevich S, Lewis J. Bedside ultrasound education in Canadian medical schools: a national survey. Canadian Medical Education Journal. 2016;7(1):e78.
6. Ma IW, Steinmetz P, Weerdenburg K, et al. The Canadian medical student ultrasound curriculum: a statement from the Canadian ultrasound consensus for undergraduate medical education group. Journal of Ultrasound in Medicine. 2020;39(7):1279-1287.
7. Khoury M, Fotsing S, Jalali A, Chagnon N, Malherbe S, Youssef N. Preclerkship point-of-care ultrasound: image acquisition and clinical transferability. Journal of medical education and curricular development. 2020;7:2382120520943615.
8. Wong CK, Hai J, Chan KYE, et al. Point-of-care ultrasound augments physical examination learning by undergraduate medical students. Postgraduate Medical Journal. 2021;97(1143):10-15.
9. Rathbun KM, Patel AN, Jackowski JR, Parrish MT, Hatfield RM, Powell TE. Incorporating ultrasound training into undergraduate medical education in a faculty-limited setting. BMC Medical Education. 2023;23(1):263.
10. Afonso N, Amponsah D, Yang J, et al. Adding new tools to the black bag—introduction of ultrasound into the physical diagnosis course. Journal of general internal medicine. 2010;25:1248-1252.
11. Rempell JS, Saldana F, DiSalvo D, et al. Pilot point-of-care ultrasound curriculum at Harvard Medical School: early experience. Western Journal of Emergency Medicine. 2016;17(6):734.
12. Fredette, Zacchary. L'essentielle échographie : un guide étudiant. Affaires francophones, Université d'Ottawa; 2021. https://www.lulu.com/shop/zacchary-fredette/lessentielle-%C3%A9chographie-une-introduction/ebook/product-6kypm6.html?page=1&pageSize=4
13. Teichgräber U, Ingwersen M, Ehlers C, et al. Integration of ultrasonography training into undergraduate medical education: catch up with professional needs. Insights into Imaging. 2022;13(1):1-8.
14. group AE working. AFMC entrustable professional activities for the transition from medical school to residency. Education for primary care Ottawa (Canada): Association of Faculties of Medicine of Canada. Published online 2016:1-26.
15. Parks AR, Atkinson P, Verheul G, LeBlanc-Duchin D. Can medical learners achieve point-of-care ultrasound competency using a high-fidelity ultrasound simulator?: a pilot study. Critical ultrasound journal. 2013;5(1):1-6.
16. Murray S, Trinder K, Kolbenson L, Katulka J, Olszynski P. Virtual Supervision of Third Year Medical Students Using Handheld POCUS Devices and Cloud-based Image Archiving Provides Opportunity for Feedback and Skill Improvement. POCUS journal. 2023;8(1):60.
17. DeBiasio C, Pageau P, Shefrin A, Woo MY, Cheung WJ. Point-of-Care-ultrasound in undergraduate medical education: a scoping review of assessment methods. The Ultrasound Journal. 2023;15(1):30.
18. Maw AM, Huebschmann AG, Mould-Millman NK, Dempsey AF, Soni NJ. Point-of-care ultrasound and modernization of the bedside assessment. Journal of graduate medical education. 2020;12(6):661-665.
19. Soni NJ, Boyd JS, Mints G, et al. Comparison of in-person versus tele-ultrasound point-of-care ultrasound training during the COVID-19 pandemic. The ultrasound journal. 2021;13(1):1-7.
20. Khoury M, Sethuraman S, Wilson S. Peer-Led Point-of-Care Ultrasound; A Potential Ally to Rural Medicine. University of Ottawa Journal of Medicine. 2019;9(2):38-45.
21. Díaz-Gómez, J. L., Mayo, P. H., & Koenig, S. J. (2021). Point-of-Care Ultrasonography. New England Journal of Medicine, 2021;385(17):1593–1602.
22. Choi, W., Cho, Y. S., Ha, Y. R., et al. Role of point-of-care ultrasound in critical care and emergency medicine: update and future perspective. Clinical and Experimental Emergency Medicine, 2023;10(4):363–381.
23. Andersen, C. A., Holden, S., Vela, J., et al. Point-of-Care Ultrasound in General Practice: A Systematic Review. Annals of Family Medicine, 2019;17(1):61–69.
24. Naji, A., Chappidi, M., Ahmed, A., Monga, A., & Sanders, J. Perioperative Point-of-Care Ultrasound Use by Anesthesiologists. Cureus, 2021;13(5):e15217.
25. Wagner, M., Shen-Wagner, J., Zhang, K. X., et al. Point-of-Care Ultrasound Applications in the Outpatient Clinic. Southern Medical Journal, 2018;111(7):404–410.
26. Knights, S., Prasad, S., Kalafat, E., et al. Impact of point-of-care ultrasound and routine third trimester ultrasound on undiagnosed breech presentation and perinatal outcomes: An observational multicentre cohort study. PLoS Medicine, 2023;20(4):e1004192.
27. Specialty Committee. Anesthesiology Competencies. The Royal College of Physicians and Surgeons of Canada. Published Online 2017:1-18. Accessed online Feb 18, 2024.
28. Specialty Committee. Emergency Medicine Competencies. The Royal College of Physicians and Surgeons of Canada. Published Online 2018:1-20. Accessed online Feb 18, 2024.
29. Specialty Committee. Internal Medicine Competencies. The Royal College of Physicians and Surgeons of Canada. Published Online 2018:1-28. Accessed online Feb 18, 2024.
30. Specialty Committee. Critical Care Medicine Competencies. The Royal College of Physicians and Surgeons of Canada. Published Online 2019:1-17. Accessed online Feb 18, 2024.

Conflicts of Interest Disclosure
There are no conflicts of interest to declare.

APPENDIX

The University of Ottawa Brightspace POCUS Modules (accessible to uOttawa students only due to Brightspace uOttawa restrictions):

POCUS Module Topic	Brightspace Link
Cardiac	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/4061480/View
Respiratory	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/5136943/View
Abdomen	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/4553252/View
Musculoskeletal	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/4866972/View
Vascular	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/4280027/View
Neck	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/4470354/View
Central Venous Catheterization	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/4053200/View
POCUS cases	https://uottawa.brightspace.com/d2l/le/content/252787/viewContent/4840341/View

More Bilingual Doctors are Needed in Atlantic Canada: Exploring the Challenges of Practicing Medicine in Rural Communities and Potential Solutions

Photo by John McArthur on Unplash

Katrina Esteireiro[1], Justin Brass[2]

[1] Department of Biology, Queen's University, Kingston, ON, Canada
[2] Faculty of Behavioural Sciences, Yorkville University, Toronto, ON, Canada

Correspondence: Katrina Esteireiro; katrinaesteireiro7@gmail.com

Date Submitted: September 2, 2024
Date Accepted: November 23, 2024
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7276

Keywords: *maritime healthcare; bilingual doctors; rural medicine*

ABSTRACT

This commentary explores the complex and multifaceted issue of physician supply and retention in rural Atlantic Canada, with a particular focus on bilingual physicians. Rural communities face significant challenges, including professional isolation, overwhelming workload, housing shortages, and difficulties in maintaining work-life balance. Bilingual physicians encounter additional pressures, particularly in serving French-speaking patients, compounded by a lack of targeted support programs. These, however, can be offset through strategic solutions that include improved access to continuous education, supportive work environments, and the use of other healthcare professionals such as nurse practitioners (NPs) and physician assistants (PAs). We also want to emphasize the potential for both partnership models, such as those in Quebec, and for locum opportunities to promote physician commitment to rural practice. Additionally, international recruitment, combined with financial benefits like student loan forgiveness, is discussed as one of the viable strategies for physician recruitment and retention. By implementing these measures, Atlantic Canada could achieve the objective of having a more resilient health care system-that supports physicians professionally and provides quality care for rural and bilingual communities. The commentary indeed stresses the need for an approach based on wide grounds to ensure equal medical care to all residents irrespective of geography.

RÉSUMÉ

Cette analyse se penche sur la question complexe et à multiples facettes de l'offre et de la rétention des médecins dans les régions rurales du Canada atlantique, avec un accent particulier sur les médecins bilingues. Les communautés rurales sont confrontées à des défis importants, nota-

mment l'isolement professionnel, une charge de travail écrasante, une pénurie de logements et des difficultés à maintenir un équilibre travail–vie personnelle. Les médecins bilingues sont confrontés à des pressions supplémentaires, liées notamment à l'accueil de patients francophones, aggravées par l'absence de programmes de soutien ciblés. Ces obstacles peuvent toutefois être compensés par des solutions stratégiques comprenant un meilleur accès à la formation continue, des environnements de travail favorables et le recours à d'autres professionnels de la santé tels que les infirmiers et infirmières praticien(ne)s (IP) et les adjoint(e)s au médecin (AM). Nous souhaitons également souligner le potentiel des modèles de partenariat, tels que ceux du Québec, et des possibilités de remplacement pour promouvoir l'engagement des médecins dans la pratique rurale. En outre, le recrutement international, conjugué à des avantages financiers tels que l'annulation des prêts étudiants, est considéré comme l'une des stratégies viables pour le recrutement et la fidélisation des médecins. Par la mise en œuvre de ces mesures, le Canada atlantique pourrait atteindre l'objectif d'un système de soins de santé plus résilient, qui soutienne les médecins sur le plan professionnel et fournisse des soins de qualité aux communautés rurales et bilingues. Ce commentaire souligne en effet la nécessité d'une approche fondée sur une large base pour garantir l'égalité des soins médicaux à tous les résidents, indépendamment de leur situation géographique.

INTRODUCTION

Major barriers to accessing health care extend across rural areas in Canada. Whereas 18% of Canadians live in rural communities, only 8% of the total physician workforce serves these regions.[1] More specifically, in the maritime provinces, almost half of its population lives in a non-urban region, and access to primary care continues to be a major concern.[2] Among those, a few French-speaking minority communities are found to have insufficient access to health care services in their own language, especially in New Brunswick.[3] For instance, 30% of New Brunswick residents report French as their first language, with 21% of provincial residents without a primary care provider.[4,5] The concordance of language between patients and physicians facilitates patient-oriented practice and minority language-speaking populations have reduced treatment adherence and poorer health outcomes.[6] Therefore, deeper analyses of contemporary barriers to rural physician retention and potential solutions could improve healthcare delivery for linguistic minorities in Atlantic Canada.

CHALLENGES FACING BILINGUAL RURAL DOCTORS

Rural communities in Atlantic Canada have a difficult time attracting and retaining physicians.[1] For bilingual physicians, the situation is even more complex. It is multi-factorial, with personal and professional challenges that reflect unfavorably on rural practice.

Professional Isolation and Limited Opportunities for Career Advancement

Feelings of isolation are a major professional challenge that rural physicians experience.[7] Contrary to their urban colleagues, a rural doctor could feel lonely working in a setting with limited peer support and fewer opportunities for professional growth.[8] This isolation can be devastating for bilingual physicians as they may have fewer opportunities to interact with colleagues who speak the same language or share the same cultural background. Limited career development opportunities serve as a significant deterrent as rural physicians typically have reduced access to continuing education programs and specialized training, causing stagnation.[8] This renders it difficult to remain informed about recent developments in the field of medicine and sustain interest in their work.[8]

Large Patient Rosters and Lack of Support

High workloads have been cited as a major contributor to exhaustion and burnout among rural physicians nationally.[9] Notably, previous studies have identified that rural northern physicians work on average 50.82 hours per week, while their urban southern counterparts report an average work week of 38.56 hours.[10] High workloads are further amplified by a lack of cross-sectional support for health professionals, including nurses, specialists and administrative personnel.[11] In fact, the problem of high staff turnover further exacerbates this challenge; rural healthcare facilities struggle to maintain a stable workforce.[4,12] As a result, physicians in rural areas are stretched too thin most of the time, whereby there is hardly enough time to attend to patients in need, let alone for professional development and personal care.[8,9] This could pose additional challenges for bilingual physicians who may be asked to serve an even larger patient population including French-speaking ones, adding more to their volume of work.

Housing Shortage and Social Isolation

Adding to the physicians' decision to move or not to rural areas is the issue of housing shortage.[4,13] Finding a place to live may be one of the biggest barriers, especially for

physicians with families.[8,14] Lack of available and affordable housing can prevent physicians from accepting positions in rural areas or contribute to dissatisfaction and an early departure among those who do. Social isolation is another significant factor.[4] Rural communities often lack the social amenities and cultural activities that many physicians and their families seek, making their personal life less satisfying. For a bilingual physician, it may mean social isolation due to a lack of community with whom one can share their language and cultural background.

Difficulty in Maintaining Professional Boundaries

The multidimensional role of a physician frequently puts doctors in situations that stretch professional boundaries to their limits within small and closely knit communities.[15] Many physicians often report a need to negotiate multiple relationships, sometimes simultaneously-including physician-patient but also community and social relationships. This can blur the lines of traditional boundaries and raise ethical dilemmas that make it increasingly difficult to establish and maintain appropriate professional distance.[15] This challenge is heightened for the bilingual physician in smaller communities where they might be one of the few French-speaking medical professionals. It is just this closeness that heightens the difficulty of separating one's roles and therefore increases the chance of boundary issues and conflicts of interest. These issues must be addressed to uphold professional boundaries.

Burnout and Work-Life Balance

A major issue for rural doctors is the challenge to achieve a balance that could successfully maintain both their professional responsibilities and personal life. Rural medical practices often tend to be extremely demanding in nature, requiring long work hours, heavy workloads, and limited access to support from fellow professionals.[8] These factors all combine to favor a particularly increased risk of burnout among rural practitioners.[9] Furthermore, most general practitioners from these settings report that they cannot work part-time or have regular, scheduled breaks, which increases their levels of stress and overall dissatisfaction with their job. This is even more important in the case of bilingual physicians since their ability to communicate with French-speaking patients can raise even greater pressure on them to meet the needs of a diverse patient population. With increased demand for their services, their workload and stress increases, making the balance of life and work very difficult.

EXPLORING SOLUTIONS FOR PHYSICIAN RECRUITMENT AND RETENTION IN RURAL ATLANTIC CANADA

Addressing the challenge of physician recruitment and retention in rural regions, especially bilingual physicians, requires a multi-pronged approach. This has been highlighted by several strategies that have shown promise in improving physician retention and ensuring that rural communities get the healthcare they need.

Continuing Professional Education and Development

One of the most practical physician retention strategies in rural communities is continuing education and professional development.[8] Professional isolation in rural communities often spawns stagnation and burnout.[8,9] The option for ongoing learning through online courses or regional conferences may alleviate this problem. Reimbursement of travel expenses associated with these educational opportunities further incentivizes participation.[8] For rural physicians, the ability to stay updated on medical advancements and expand their skill capacity is important.

Collegial Support and Positive Work Environments

Another important factor is creating a positive and supportive work environment for doctors in rural areas. Regular professional gatherings, mentorship programs, and virtual networks provides collegial support and connects rural physicians with their colleagues based elsewhere.[8] An enabling work environment includes adequate staffing, which can be ensured through the recruitment of nurse practitioners and physician assistants to help share the workload.[16,17] These health professionals will relieve the workload from physicians and allow them to focus on complicated cases thus improving job satisfaction.

Partnership Programs and Locum Opportunities

Programs such as those offered in Quebec, where medical students are matched early in their career with rural communities, have had success in increasing physician interest in pursuing rural practices.[18] Recently, the New Brunswick provincial government has added four additional seats for medical students at Centre de formation médicale du Nouveau-Brunswick a Université de Sherbrooke medical education site, further highlighting a pressing need to train providers who can serve the Francophone community.[19] Expanding such initiatives into Atlantic Canada may be a way of creating the next generation of bilingual physicians committed to rural practice.[20] Similarly, providing opportunities for locum practice allows physicians to test rural prac-

tice on a temporary basis, often eventually extending this to long-term commitment as they experience the community and its needs.[20] International physician recruitment would also allow these underserved communities to acquire additional care. These physicians often are well-experienced and more likely to stay if provided with support in the form of a student loan forgiveness or repayment programs.[20] These financial incentives give rural practice a more attractive opportunity, especially to those well-endowed with educational debt.

CONCLUSION

The issue of low supply and retention of physicians, especially bilingual physicians in rural areas of Atlantic Canada, is complex and multilayered. The professional isolation is very high in these communities, with unbearable workloads, social limitations, housing shortages, and issues related to work-life balance. These challenges can deter bilingual physicians as they cope with the added pressure for service provision to their French speaking patients and practically non-existing focused support programs. However, these are surmountable challenges with appropriate strategic solutions in place. Although housing shortages and reduced access to cultural activities may deter rural practise, there are tangible solutions and policies that academic centres and the provincial government can implement to encourage physicians to serve rural communities. Better access to opportunities for continuing education and professional development, supportive practice environments, and the employment of health professionals such as NPs and PAs can greatly alleviate the stresses facing rural physicians. Partnership models, such as those that are thriving in Quebec, and availability of locums can also facilitate greater physician investment in rural practices. Further, international recruitment combined with other financial incentives like student loan forgiveness could help attract and retain physicians willing to serve these areas. By implementing these solutions, Atlantic Canada can develop a more resilient health system-one that not only attracts physicians but also supports them in providing higher-quality care to rural and bilingual communities. This broad-based approach is important to ensure that residents, irrespective of their place of residence, get the medical attention they need and deserve.

REFERENCES

1. Wilson CR, Rourke J, Oandasan IF, Bosco C. Progress made on access to rural health care in Canada. Can Fam Physician. 2020 Jan;66(1):31. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC7012120/
2. Government of Canada, Statistics Canada. Population growth in Canada's rural areas, 2016 to 2021 [Internet]. 2022 [cited 2024 Nov 8]. Available from: https://www12.statcan.gc.ca/census-recensement/2021/as-sa/98-200-x/2021002/98-200-x2021002-eng.cfm
3. Beauchamp J, Bélanger M, Schofield A, Bordage R, Donovan D, Landry M. Recruiting doctors from and for underserved groups: Does New Brunswick's initiative to recruit doctors for its linguistic minority help rural communities? Can J Public Health. 2013 Jun 6;104(6 Suppl 1).
4. Collin S, Johnson C, Dubé A, Laforest ME, Lauzier M, Landry MH, et al. Addressing the shortage of health professionals in official language minority communities to strengthen retention strategies for the benefit of New Brunswick francophone and Acadian communities: protocol for a mixed methods design. JMIR Research Protocols. 2023 May 3;12(1). Available from: https://www.researchprotocols.org/2023/1/e41485
5. New Brunswick Health Council. Access to primary care in New Brunswick [Internet]. [cited 2024 Nov 8]. Available from: https://nbhc.ca/surveys/access-primary-care-new-brunswick
6. de Moissac D, Bowen S. Impact of language barriers on quality of care and patient safety for official language minority Francophones in Canada. J Patient Exp. 2019 Mar;6(1):24–32.
7. Szafran O, Myhre D, Torti J, Schipper S. Factors perceived to influence rural career choice of urban background family physicians: A qualitative analysis. Can Med Educ J. 2020 Jul 15;11(3). Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC7378147/
8. Asghari S, Aubrey-Bassler K, Godwin M, Rourke J, Mathews M, Barnes P. Factors influencing choice to practise in rural and remote communities throughout a physician's career cycle. Can J of Rural Med. 2017;22(3). Available from: https://www.cfpc.ca/CFPC/media/Resources/Rural-Practice/CJRM-RuralPractice2017.pdf
9. Canadian Medical Association. CMA 2021 National Physician Health Survey [Internet]. The Association; 2022 August 24. Available from: https://digitallibrary.cma.ca/link/digitallibrary17
10. Wenghofer EF, Kam SM, Timony PE, Strasser R, Sutinen J. Geographic variation in FP and GP scope of practice in Ontario: Comparative provincial study. Can Fam Physician. 2018 Jun;64(6). Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC5999252/
11. Anaraki NR, Mukhopadhyay M, Karaivanov Y, Wilson M, Asghari S. Living and working in rural healthcare during the COVID-19 pandemic: a qualitative study of rural family physicians' lived experiences. BMC Primary Care. 2022 Dec 22;23:335. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC9773678/
12. Kulig JC, Kilpatrick K, Moffitt P, Zimmer L. Recruitment and retention in rural nursing: it's still an issue! Nurs Leadership. 2015 Jun;28(2):40–50.
13. Kumar S, Clancy B. Retention of physicians and surgeons in rural areas-what works? J Public Health (Oxf). 2021 Dec 10;43(4).
14. DeMaio P, Ali A, Waddell K, Bain T, Dass R, Grewal E, et al. Rapid synthesis: features and impacts of approaches to provide or enhance access to childcare and/or housing for the recruitment and retention of professionals in the care economy [Internet]. Hamilton (ON): McMaster Health Forum; 2024 Mar 8 [cited 2025 Jan 3]. Available from: https://www.mcmasterforum.org/about-us/products/project/features-and-impacts-of-approaches-to-provide-or-enhance-access-to-childcare-and-or-housing-for-the-recruitment-and-retention-of-professionals-in-the-care-economy
15. Miedema B, Hamilton R, Fortin P, Easley J, Tatemichi S. The challenges and rewards of rural family practice in New

Brunswick, Canada: lessons for retention. Rural and Remote Health. 2009 May 25;9(2). Available from: https://www.rrh.org.au/journal/article/1141/
16. Roots A, MacDonald M. Outcomes associated with nurse practitioners in collaborative practice with general practitioners in rural settings in Canada: a mixed methods study. Hum Resour Health. 2014 Dec 11;12(1):69. Available from: https://doi.org/10.1186/1478-4491-12-69
17. Shute LA. The role of physician assistants in rural emergency departments of Manitoba. The Journal of Canada's Physician Assistants. 2019 Jan 7;1(2):3–13. Available from: https://ojs.lib.umanitoba.ca/index.php/jcpa/article/view/675
18. LeBlanc G. Toward an improved health system in French in New Brunswick. New Brunswick: Government of New Brunswick; 2010. Available from: https://www2.gnb.ca/content/dam/gnb/Departments/h-s/pdf/en/Publications/TowardImprovedHealthSystemInFrench.pdf
19. Government of New Brunswick. Funding for four additional medical seats in Moncton. 2022. Available from: https://www2.gnb.ca/content/gnb/en/news/news_release.2022.10.0566.html
20. Russell D, Mathew S, Fitts M, Liddle Z, Murakami-Gold L, Campbell N, et al. Interventions for health workforce retention in rural and remote areas: a systematic review. Human Resources for Health. 2021 Aug 26;19(1):103. Available from: https://doi.org/10.

Acknowledgements
The author would like to express their gratitude to the UOJM editors, and all the researchers at the University of Ottawa who are striving for dissemination of accurate and significant research through their remarkable contributions to this society.

Conflicts of Interest Disclosure
There are no conflicts of interest to declare.

Opioid Use in Chronic Pain Patients and Its Implications for Dementia and Alzheimer's Disease Onset: A Scoping Review

Tina Shaghaeefallah[1], Isabella Boesgaard[1], Milena Bogdan[2], Kian Mazidi[1]

[1] Department of Biochemistry; Department of Anatomy and Cell Biology, Western University, London, ON, Canada

[2] Department of Biochemistry; Department of Microbiology and Immunology, Western University, London, ON, Canada

Correspondence:
Tina Shaghaeefallah;
tinashf@gmail.com

Date Submitted: October 1, 2024
Date Accepted: April 25, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7290

Keywords: *opioids, chronic pain, dementia, Alzheimer's disease*

ABSTRACT

Objective: The aim of this scoping review was to examine the current literature on the effects of opioid use influencing the onset of Alzheimer's disease (AD), the most common form of dementia, in patients with chronic pain.

Methods: A comprehensive literature search was conducted using MESH and keywords searches across PUBMED, MEDLINE (OVID), and EMBASE databases. Studies were included if they evaluated both chronic pain and opioid use in relation to dementia or AD onset, reported dementia or AD as either primary or secondary outcomes, and employed primary qualitative or quantitative research designs. Exclusion criteria included articles not published in English, those focusing on acute pain without a chronic component, studies addressing general cognitive decline without specific mention of dementia or AD, and studies investigating opioid use without consideration of chronic pain or dementia/AD as an outcome.

Results: A total of six articles met the inclusion criteria. The majority of the findings indicated an association between opioid use and the onset of dementia or AD in chronic pain patients, with a generally dose-dependent relationship, particularly in populations aged over 50. One study did not establish a causal link between opioid use and dementia onset, while another found an association between chronic pain and dementia independent of opioid use.

Conclusion: This review suggests that opioid use may be linked to an increased risk of dementia onset in chronic pain patients, predominantly in older populations, and that this relationship appears to be dose-dependent. However, further investigation is required to establish causality.

RÉSUMÉ

Objectif : L'objectif de cette étude de la portée était d'examiner la littérature actuelle sur les effets de la consommation d'opioïdes sur l'apparition de la maladie d'Alzheimer (MA), la forme la plus courante de démence, chez les patients souffrant de douleurs chroniques.

Méthodes : Une recherche documentaire exhaustive a été menée à l'aide de MESH et de mots-clés dans les bases de données PUBMED, MEDLINE (OVID) et EMBASE. Les études ont été incluses si elles évaluaient à la fois la douleur chronique et l'utilisation d'opioïdes en relation avec la démence ou l'apparition de la MA, si elles rapportaient la démence ou la MA comme résultat primaire ou secondaire, et si elles utilisaient des modèles de recherche qualitatifs ou quantitatifs primaires. Les critères d'exclusion comprenaient les articles non publiés en anglais, ceux portant sur la douleur aiguë sans composante chronique, les études traitant du déclin cognitif général sans mention spécifique de la démence ou de la MA, et les études examinant la consommation d'opioïdes sans tenir compte de la douleur chronique ou de la démence/MA comme résultat.

Résultats : Au total, six articles répondaient aux critères d'inclusion. La majorité des résultats indiquaient une association entre la consommation d'opioïdes et l'apparition de la démence ou de la MA chez les patients souffrant de douleur chronique, avec une relation généralement dose-dépendante, en particulier chez les populations âgées de plus de 50 ans. Une étude n'a pas établi de lien de causalité entre la consommation d'opioïdes et l'apparition de la démence, tandis qu'une autre a mis en évidence une association entre la douleur chronique et la démence indépendamment de la consommation d'opioïdes.

Conclusion : Cette étude suggère que la consommation d'opioïdes pourrait être associée à un risque accru de démence chez les patients souffrant de douleurs chroniques, principalement chez les personnes âgées, et que cette relation semble être dose-dépendante. Cependant, des recherches supplémentaires sont nécessaires pour établir un lien de causalité.

INTRODUCTION

Chronic pain, usually defined as pain persisting for more than three months, is a prevalent condition affecting millions globally, with significant implications on quality of life and healthcare systems.[1] Annually, approximately one in ten adults are diagnosed with chronic pain, and the global burden of this condition is increasing.[2] In recent years, research has begun to explore a potential link between chronic pain and cognitive decline, with some studies reporting a 42% increased risk of dementia, including Alzheimer's disease (AD), among chronic pain patients.[3] Furthermore, an increased number of parts of the body experiencing chronic pain have been associated with a heightened risk of all-cause dementia.[4]

Mechanistic explanations for the observed connection between chronic pain and cognitive decline have centered on pain-in- duced neuroinflammation and dysfunction in brain regions, such as the frontal cortex and the locus coeruleus (LC), potentially leading to neurodegeneration.[3] Chronic pain has also been shown to activate neuroinflammatory pathways in the brain through prolonged release of pro-inflammatory cytokines (such as IL-1β, TNF-α, and IL-6), and exacerbate cortisol release from the hypothalamic-pituitary-adrenal (HPA) axis, ultimately impairing the hippocampus.[5,6] These neurodegenerative processes overlap with those observed in Alzheimer's disease (AD), where abnormal amyloid beta and tau deposition causes neuroinflammation, dysfunction in neurogenesis, and hippocampal degeneration, ultimately leading to memory loss.[7] One study found individuals with chronic pain maintained a 42% higher risk of dementia, including Alzheimer's disease (AD). Furthermore, an increased number of chronic pain sites has been associated with a heightened risk of all-cause dementia.[4] However, the evidence remains mixed, as some studies have failed to establish a relationship between chronic pain and the long-term risk of dementia as seen by Rouch et al. (2022), while Tian et al. (2023) and Wang et al. (2024) were able to find significant risk increase for AD in chronic pain patients.[3,4,8] The inconsistency between studies may stem from differences in study design, population characteristics, follow-up duration, and methods used to assess pain and outcomes. Beyond the possibility that chronic pain itself may contribute to cognitive decline, there is growing consideration that a class of medications used to manage pain—opioids—might also be playing a role. Opioids are a class of drugs favoured by physicians in the management of chronic pain as this class of drugs provides strong pain relief, is well studied and the dosage for patients is well established. This makes them the preferred treatment for pain, as the pain relief is instantaneous when compared to alternative forms of treatment like physical therapy, and because the side effects and legal status of opioids are more established across many countries in comparison to drugs like cannabinoids.[9,10] When used as directed by a physician, prescription opioids provide relief from pain and exert their analgesic effects by acting on μ-opioid receptors in the nervous system.[11] Beyond the perspective of pain relief, many physicians favour the prescription of opioids to patients with chronic pain as they produce a mild sedation and a sense of well-being or euphoria that aids in the reduction of anxiety and promotes good sleep. Some physicians even believe that it is unreasonable to leave a patient to suffer from chronic pain and that withholding the prescription of opioids is similar to withholding treatment.[10,12]

While opioids are effective in alleviating pain, the long-term cognitive effects of opioid use remain controversial. Some studies suggest a potential link between opioid use and an increased risk of dementia, particularly in older populations. This corresponds to the clinical understanding that dementia primarily affects individuals aged 65 and older, however risk of dementia also increases with age.[13] For example, research indicates that individuals aged 75 to 80 who use opioids may have a 1.39-fold higher risk of developing dementia.[14] However, the literature remains inconclusive, as findings are mixed—while some studies suggest a potential link between opioid use and the onset of AD or other dementias, others have failed to establish a significant association, making it unclear whether a true effect exists.[15] This inconsistency highlights the need for a deeper understanding of the relationship between chronic pain, opioid use, and cognitive decline. It remains unclear whether the observed cognitive effects are primarily driven by chronic pain itself, opioid use, or the interaction between the two. Given the high prevalence of chronic pain, the widespread use of opioids, and the growing aging population, addressing these knowledge gaps is critical to improving patient care and developing preventative strategies against dementia and AD. The objective of this scoping review is to analyze the existing literature examining the relationship between chronic pain, opioid use, and the risk of dementia, including AD. By evaluating studies that consider these factors in combination, this review aims to elucidate which plays a more prominent role in contributing

to cognitive decline. The findings will help inform future approaches to pain management and dementia prevention, ultimately supporting better outcomes for patients at risk of both chronic pain and cognitive impairment.

METHODS

Relevant studies were identified through a systematic search of the electronic databases PUBMED, MEDLINE (OVID), and EMBASE. These databases were selected due to their extensive coverage of biomedical literature and their recognized role in retrieving relevant studies in systematic reviews. Embase and MEDLINE together have been shown to achieve high recall in systematic reviews, retrieving approximately 92.8% of included references, making them foundational for biomedical literature searches.[16] Additionally, previous research has indicated that incorporating databases beyond MEDLINE/PubMed does not significantly alter the included studies or final outcomes of a review.[17] Given the scope of this review, these databases were deemed the most appropriate to ensure comprehensive literature coverage while maintaining methodological feasibility. The search strategy employed a combination of Medical Subject Headings (MESH), title, and abstract terms. Search terms included: ((((“Analgesics, Opioid”[Mesh]) OR “Opiate Alkaloids”[Mesh]) OR (((Opioid*[Title/Abstract]) OR (opiate*[Title/ Abstract])) OR (Pain reliever*[Title/Abstract]))) AND ((“Chronic Pain”[Mesh]) OR (((Chronic pain*[Title/Abstract]) OR (long-term pain[Title/ Abstract])) OR (Non-acute pain[Title/Abstract])))) AND (((“Dementia”[Mesh]) OR “Alzheimer Disease”[Mesh]) OR ((Dementia[Title/Abstract]) OR (Alzheimer*[Title/Abstract])))) Studies were selected based on predefined inclusion and exclusion criteria. The inclusion criteria were: (1) studies examining both chronic pain and opioid use with respect to dementia or AD onset, (2) studies reporting dementia or AD as primary or secondary outcomes, (3) primary studies using qualitative or quantitative designs. The exclusion criteria were: (1) studies not in English, (2) studies focusing solely on acute pain without a chronic component, (3) studies addressing general cognitive decline without specific mention of dementia or AD, and (4) those focusing on opioid use without including chronic pain or failing to mention dementia as an outcome.

After the initial search yielding 753 results (PubMed: 76, MED- LINE: 72, Embase: 605), duplicates were removed, leaving a total of 624 articles. Two independent reviewers screened titles, resulting in 77 articles. An abstract screen reduced this number to 22 articles. After the full-text review, 6 articles remained eligible, with consideration of inclusion and exclusion criteria as shown in **Figure 1**. Discrepancies between reviewers were resolved through consensus. Data extraction focused on study design, population characteristics, opioid types, dosage, chronic pain categorization, and dementia/AD-related outcomes. The studies were evaluated using a scoping review methodology based on the Arksey and O’Malley framework, including five stages: (1) identifying research questions, (2) identifying relevant studies, (3) study selection, (4) data extraction, and (5) summarizing and reporting the results.[18]

RESULTS

This review included six primary studies. The main objective of the studies was to determine the association and relationship between opioids on the incidence of dementia and AD in chronic pain patients. Researchers primarily compared dementia onset in chronic pain patients using opioids with those using non-opioid analgesics or no pain relief at all.[19-24] Some studies also sought to explore dose and duration-dependent effects of opioid use and chronic pain[20,21,24], while others examined age-specific subpopulations to determine if younger or older individuals were more vulnerable to the effects of opioid use on dementia.[23,24] The six primary studies are summarized in **Table 1, Table 2** and **Table 3**, where the dose, duration of treatment with opioids, as well as the impacts of specific age populations and their vulnerability to dementia while using opioids are assessed in greater detail.

These studies, conducted between 2001 and 2022, mainly used data from large cohorts and national health insurance databases. The average age of participants across studies was 68.8 years, with a higher proportion of about 60% female participants compared to males. For the population studied, chronic pain was present at baseline. Various types of chronic pain were considered, including arthropathy/spondylopathy, back and neck pain, pain localized to specific regions such as the facial area, hip, knee, shoulder, and stomach. Additionally, conditions such as osteoarthritis, rheumatoid arthritis were also considered. Neuropathic pain and its variants were also mentioned. The main opioids considered amongst the studies were morphine, fentanyl, oxycodone, buprenorphine, opium, tramadol, methadone, codeine, hydromorphone, dihydroco- deine

and meperidine.[19-24]

In terms of findings, four studies showed a positive association between opioid use in chronic pain patients and increased dementia risk. For instance, the study of Gao et al. (2024) reported that opioid use significantly elevated the risk of dementia in a dose-dependent manner, with higher numbers of opioid prescriptions (over 20) correlating with greater risk.[20] Another study by Bornier et al. (2023) found that chronic pain patients using opioids had a higher incidence of Alzheimer's Disease-Related Dementia (ADRD), and this risk increased with longer durations of opioid use (between 3 and 15 defined daily dose and more than 16 DDDs).[21] Defined daily dose (DDDs) is the cumulative dose over the study period divided by the product's average recommended daily dose to calculate total exposure. In another population of patients with chronic non-cancer pain analyzed by Oh et al. (2024), opioid use was associated with a significantly higher risk of dementia, but this effect was particularly pronounced in individuals aged 60 years and older.[23] Additionally, one study by Sun et al. (2023) showed that the onset of dementia occurred earlier in opioid users

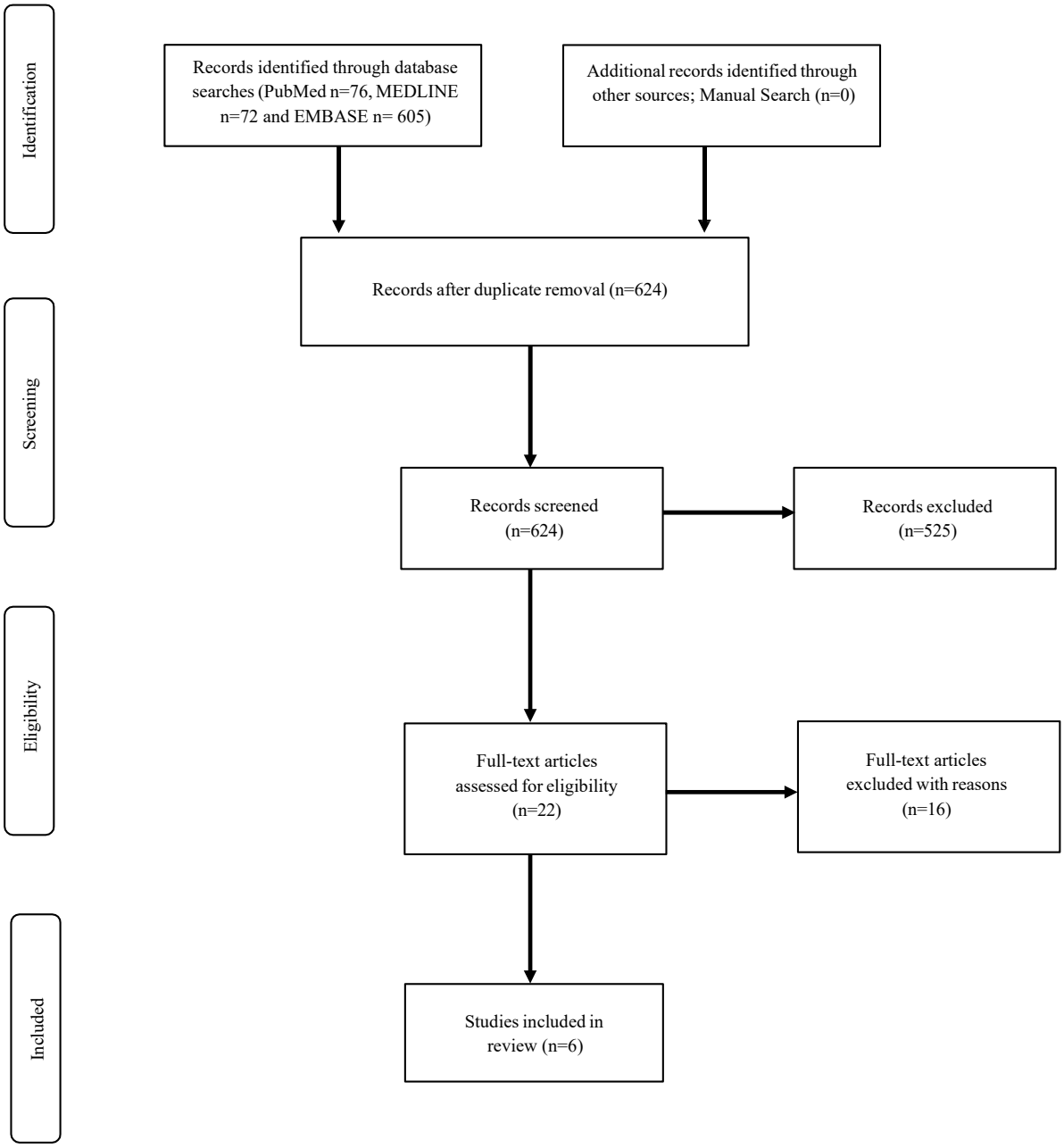


Figure 1. PRISMA Flowchart

Table 1. Summary of findings

Authors	Population	Objectives	Methods	Limitations	Strengths
1. Khalid et al	Older US Medicare beneficiaries with CNCP at baseline, opioids as covariates	Assess the association between CNCP and ADRD risk	Retrospective cohort	Self-report diagnosis of AD and dementia Opioid use used as covariate, not primary independent variable	Examine multisite pain number of sites Controlled for a wide range of potential confounders
2. Gao et al	Patients with CP at baseline, using opioids	Assess the association between regular opioid use with incident dementia and neuroimaging outcomes among CP patients	prospective cohort Case-control (opioid prescriptions) cross-sectional (neuroimaging outcomes)	Observational nature may introduce confounders	Neuroimaging provides visual markers of dementia progression
3. Bornier et al	Pt with CP at baseline, using opioids	Assess the impact of all types of CP and the long-term use of pain medications on the incidence of ADRD	Retrospective cohort	Follow-up bias	Focus on opioid use over time and dose-dependent effects
4. Guo et al	European ancestry GWAS studies on dementia and related conditions. European ancestry GWAS summary statistics on pain-related medication from Wu et al. Summary statistics of CP from Open GWAS and Neale laboratory	Assess the causal relationship between CP, use of analgesics and cognitive status	Bidirectional Mendelian randomization (MR) analysis	MR assumptions (e.g., no pleiotropy) may introduce bias	Only study examining genetic and causal relationships
5. Oh et al	South Korean patients with CNCP as baseline using opioids	Assess the association between opioid use and the development of dementia in CNCP patients	Population- based cohort	Possible distribution bias (only 1.7% of CNCP patients used opioids) CNCP limited musculoskeletal disorders	Large sample size (1,261,682) Analyzed multiple types of dementia (VD, UD and AD)
6. Sun et al	Asian patients with CP at baseline, using opioids	Assess long-term opioid use and dementia risk in patients with CP	Head-to-head propensity score-matched comparative cohort Time-varying cox regression analysis	All Asian population not representative of the general population	Age-stratified analysis Included AD and VD

with chronic pain compared to non-opioid users, with the increased risk appearing after shorter durations of opioid use in those aged 40 years and older compared to younger populations.[24]

Not all findings were consistent, however. The study by Guo et al. (2023), used Mendelian genetic analysis, a type of analysis that investigates the causal correlation between genetic variants and risk factors to a particular disease outcome. This approach was used as it assists in removing genetic biases that can affect observational studies and can establish a better cause and effect relationship between variables. Guo et al. (2023) found no significant causal relationship between opioid use and dementia, though it did report that multisite chronic pain was linked to worsened general cognitive function.[22] This cognitive decline, however, was not specific to dementia or its subtypes. Another study by Khalid et al. (2020) found that chronic pain alone, independent of opioid use, was associated with an increased risk of ADRD.[19]

Moreover, sex-related differences in the association between opioid use, chronic pain, and dementia risk varied across the included studies. Some studies found no significant interaction between sex and dementia risk associated with opioid use (Sun, Gao), while others reported a modestly higher risk in men than women (Oh).[20,24] Specifically, Oh found that opioid use was associated with a 13% higher risk of total dementia in men and a 10% higher risk in women with a similar pattern observed for AD but no significant association with vascular dementia in either sex.[23] Bornier and colleagues found that women with chronic pain had an incidence rate of 12.5 per 1,000 person-years compared to 9.2 in men, a pattern also seen in the control group, suggesting an overall higher baseline risk of ADRD in women.[21] Similarly, Khalid reported that women had a significantly higher incidence of ADRD (6.2%) than men (5.0%) ($P < 0.0001$).[19]

DISCUSSION

Our scoping review explored the relationship between chronic pain, opioid use, and dementia onset across six studies, identifying key themes and some contradictions. A clear theme across all studies is that chronic pain increases the risk of dementia, and this association often increases with the number of pain sites. Regarding opioids, four out of six studies found a significant link between opioid use and increased dementia risk in chronic pain patients[20,21,24,25], with three of these showing a dose-dependent relationship, with higher doses and number of prescriptions linked to greater risk.[20,21,25] One of these studies interestingly saw

Table 2. Study demographics

Study	Time of Data Collection	# Participants (case/control)	Age of cases (SD)	# Sex (case, F/M)
1.	2001–2013	6369/10565	74 (0.07)	4215/2154
2.	2006-2010	17820/53460	58.74 (7.76)	10876/6944
3.	2006-2010	13596/40788	65.6 (10.7)	8386/5210
4.	NA	Multisite chronic pain analysis: 387,649/NA Cognitive function analysis: 22,593/NA dementia analysis: 9,251/248,813 The Alzheimer's disease dataset: 21,982/41,944	NA	NA
5.	2010-2015, Study ended with dementia onset (evaluated from 2016-2022)	21800/1239882	63.8 (11.6)	13534/8266
6.	2004- 2020	20986/20986	81.78 (14.69)	10815/10176

Table 3. Opioid and chronic pain effects on dementia/AD

Study	Opioid Type	Dose-dependent effect of opioid use	CP operationalization	Types of chronic pain	Effects on Dementia
1	NA	NA	Medicare fee-for-service claims	Headache, osteoarthritis, joint, back/neck, and neuropathic pain	Opioid use not significantly associated with ADRD risk NCPC at baseline increased risk for ADRD, with risk rising with more pain conditions
2	NA	Higher prescription number (>20 vs 1-5) associated with dementia risk	Pain for >3 months	Headache, facial, neck/shoulder, back, stomach, hip, knee and general pain	15-year cumulative incidence of opioid use associated with a small but significant increase in dementia risk, particularly with prolonged use.
3	Morphine, oxycodone, tramadol, codeine, fentanyl, others	Duration-dependent, Moderate (>=3 and <= 15 DDDs) and strong (>16 DDDs) opioid Exposure significantly Associated with ADRD frequency	At least 6-months of analgesics use or medical diagnoses of chronic pain according to the International Classification of Disease or by the LTI for chronic pain	Neuropathic, joint/rheumatic & arthropathy/spondylopathy, back, migraine/headache	Chronic pain increased ADRD risk
4	NA	NA	Chronic/Site-specific chronic pain >3 months	Neck, shoulder, headache, hip, stomach/abdominal, back, knee, facial, general and multisite pain	No associations between analgesics use and cognitive function or dementia MCP associated with worse cognitive function, but not dementia. No association of SSCP of general CP with dementia or cognitive decline
5	Fentanyl, morphine, oxycodone, hydromorphone, methadone, codeine, dihydrocodeine and tramadl	NA	CNCP patients (musculoskeletal disorders)	Rheumatoid arthritis, osteoarthritis, low back pain and neck pain	Opioid use associated with 15% higher dementia risk, 15% AD risk and 16% unspecified dementia risk. Only in ≥60 age group
6	Morphine, fentanyl, oxycodone, buprenorphine, hydromorphone, tramadol, codeine, and meperidine.	Higher cumulative opioid use (cDDD) increased risk of dementia	NA	NA	Dementia risk increased significantly for opioid users aged 40+ after 7 years of use, while those aged 30–39 faced risk after 9 years, and those under 30 after 10 years of use

*≥3 and < = 15 DDDs and > 15 DDDs had p values of less than 0.05 and were statistically significant for increased risk of ADRD development according to the Bornier et al. paper. > 15 DDDs was more statistically significant than 23 and < = 15 DDDs for developing ADRD

that compared with persons regularly taking non-opioid analgesics, those taking opioids exhibited lower total grey matter and hippocampal volumes, and higher white matter hyperintensities volumes.[20] Loss of hippocampal volumes has been established as a pathogenesis factor of AD and dementia in previous works.[26,27]

One study that found no association between opioid use and dementia onset only considered opioid use as a covariate without assessing dose nor duration, possibly explaining the discrepancy.[19] Additionally, a Mendelian randomization study found no causal relationship between chronic pain or analgesics and dementia but noted that a higher number of pain sites was linked to general cognitive decline.[22] These findings could stem from the methodology used, suggesting that long-term mechanistic studies, such as those in controlled laboratory settings, may better elucidate causal pathways between chronic pain, opioids, and dementia.

Previous research has primarily focused on the effects of either opioids or chronic pain on cognitive decline and dementia separately. Several studies have specifically linked opioid use to an increased risk of dementia. For instance, a study in Australia demonstrated that chronic opioid use in patients aged 65-69 was associated with worse cognitive function in the Mini Mental State Examination.[28] This test consists of 11 questions designed to test 5 areas of cognitive function: calculation, registration, recall, attention and orientation. Similarly, a national cohort study in Israel found that individuals aged 75-80 who were exposed to opioids had an increased risk of dementia onset and those with heavy opioid use were found to have an increased risk of all-cause dementia.[14,29]

The physiologic mechanisms for opioids potentially being involved in the onset of dementia exist as it is known that the opioid system plays a crucial role in modulating sensory, emotional, cognitive functions, and addictive behaviors. Dysregulation can affect neurotransmitters (acetylcholine, norepinephrine, GABA, glutamate, serotonin) linked to AD. Opioid receptor dysfunction may also lead to increased amyloid-beta (Aβ) production, tau hyperphosphorylation, neuroinflammation, degeneration of cholinergic neurons, and cognitive impairment—all hallmark characteristics of AD.[30] Additionally, alterations in opioid receptor signaling have been linked to elevated levels of BACE1 and γ-secretase enzymes, further contributing to abnormal amyloid-beta accumulation and disease progression.[29,30]

Opioid use may also contribute to dementia by causing structural changes in the brain's white matter, particularly in the corpus callosum, which connects the brain's hemispheres and supports cognitive communication. Prolonged opioid use further disrupts these pathways, potentially accelerating neurodegenerative processes characteristic of dementia. In opioid-dependent individuals, decreased integrity in pathways linked to the amygdala reduces connectivity in key regions, like the anterior insula and nucleus accumbens, affecting emotional regulation and memory.[31] However, not all studies support a definitive link between opioid use and dementia. Some research has suggested that carefully titrated doses of opioids may not cause extensive memory impairment and, in certain cases, may even improve memory.[32] Another study found no significant association between opioid use and increased risk of AD, even with prolonged use or high cumulative doses.[15] Thus, while opioids may play a role in dementia pathogenesis for certain populations, other factors like dosage, duration of use, and individual variability need further investigation to draw conclusive connections.

Emerging research also highlights chronic pain as a significant, yet often overlooked, risk factor for dementia, including AD.[33] Studies suggest that pain experienced in multiple sites may substantially increase the likelihood of developing dementia. For instance, individuals with chronic pain in several locations were found to have a higher risk of both all-cause dementia and AD, emphasizing the need to address pain as part of dementia prevention strategies.[4,34,35] Interestingly, it has been found that it's not the severity of pain, but rather how much the pain disrupts daily life—known as pain interference—that has the strongest link to dementia risk.[36]

To our understanding, our review is one of the first to focus on the existing literature analyzing the risk of dementia onset associated with opioid use specifically in chronic pain patients. This approach allowed us to attempt to isolate the impact of opioids on dementia risk, reducing the effect of chronic pain itself acting as a confounding factor.

The studies in our review exhibit strong methodological rigor by controlling for confounding variables like age, gender, and comorbid conditions, enhancing the robustness of their findings. Large sample sizes, some over a million

participants, provide high statistical power and enhance generalizability. Advanced methodologies, such as neuroimaging and genetic testing, add depth by offering direct insights into structural and functional brain changes and revealing causal relationships. These varied approaches provide complementary evidence, bolstering the credibility of the conclusions on the complex relationship between opioid use, chronic pain, and dementia risk.

The reviewed studies demonstrate several key strengths, of- fering valuable insights into the relationship between chronic pain, opioid use, and the risk of dementia. Oh et al. (2024) and Sun et al. (2023) leveraged large datasets, with Oh et al.'s study drawing from the South Korean NHIS database, which included over 1.2 million patients, giving the study significant statistical power.[23,24] Similarly, Sun et al. (2023) employed advanced statistical techniques, including propensity score matching and time-varying Cox regression analyses, which provided stronger control for confounding variables and improved the accuracy of the association between long-term opioid use and dementia risk.[24] Gao et al. (2024) incorporated neuroimaging data to analyze dementia progression in chronic pain patients, providing visual evidence of the cognitive changes associated with opioid use.[20] This objective marker allowed for a more direct assessment of the biological changes in the brain related to opioid use and chronic pain. The use of a variety of chronic pain types across the studies, from musculoskeletal pain to neuropathic pain, further strengthens the research by accounting for different pain profiles, as shown in Bornier et al.'s study, which considered the long-term effects of opioids across multiple pain conditions.[21] The inclusion of age-stratified analyses in studies like Sun et al. (2023) and Oh et al. (2024) is another major strength.[23] This approach helped identify specific age-related vulnerabilities, showing that older patients were more suscepti- ble to early dementia onset with opioid use. Additionally, Guo et al. (2023) utilized Mendelian randomization, a genetic approach that helped explore causal relationships between opioid use, chronic pain, and cognitive function.

While this method's assumptions can be difficult to verify, it provides an innovative way of disentangling the genetic and environmental contributions to the observed associations, thus expanding the scope of analysis beyond traditional observational designs.[22] Despite the strengths, several limitations temper the findings of these studies. A significant limitation across most of the studies is their reliance on observational designs, which hinders the ability to establish definitive conclusions. For instance, Bornier et al. (2023) and Khalid et al. (2020) relied on data derived from self-reported or claims-based sources.[19,21] This introduces potential bias and misclassification, particularly in diagnosing dementia and tracking opioid use, where inaccuracies in reporting could distort the observed relationships. Moreover, the operational definitions of chronic pain and opioid use varied across studies. Some, like Oh et al. (2024), focused exclusively on musculoskeletal disorders, potentially limiting the applicability of their findings to patients with other forms of chronic pain.[23] This variability in the scope of chronic pain definitions makes direct comparisons between studies more challenging and reduces the generalizability of the results to broader chronic pain populations. Another limitation is the geographic and demographic scope of several studies. Sun et al. (2023), for example, focused solely on Asian populations, and Borner et al. (2023) focused on the French population, which may limit the external validity of the findings to more diverse populations.[24] Differences in healthcare systems, opioid prescribing practices, and population genetics could also affect the outcomes observed, making it difficult to apply these findings universally. In studies such as Guo et al. (2023), the use of Mendelian randomization introduces its own set of limitations. While powerful for causal inference, the assumptions of this method—such as no pleiotropy—are difficult to confirm and could lead to biased estimates of causal relationships.[22] Dementia studies often define "older populations" as those aged 65 and older, but this study included individuals aged 40 and up, introducing variability. This broad range fails to distinguish between early-onset dementia and age-related cognitive decline. Clear age group definitions are crucial for understanding the link between chronic pain, opioid use, and dementia risk.

Despite the methodological strengths across the included studies, several limitations affect the interpretability and generalizability of their findings. Many relied on self-reported data for opioid use and pain severity, which can introduce recall bias and limit the accuracy of exposure assessment. Furthermore, while specific opioids and chronic pain conditions were often considered in isolation, few studies directly compared their relative impacts on dementia risk. This gap hinders our ability to discern whether certain opioids or pain subtypes are more neurotoxic. The inherent difficulty in objectively measuring chronic pain adds another layer of complexity—higher opioid dosages may simply reflect

more severe or widespread pain rather than a causal link to cognitive decline. Inconsistencies in how chronic pain was defined and categorized across studies further complicate cross-study comparisons. Some studies restricted their definitions to musculoskeletal pain, while others included neuropathic or mixed pain conditions, reducing coherence across the literature. These methodological differences emphasize the need for standardized definitions and more objective pain assessments in future research.

Our review was limited to reviewing associations, and not causation. Future research could focus on studying this relationship more closely, potentially using in vivo models or mechanistic studies to establish causality. Another avenue of exploration could involve analyzing objective measures for assessing chronic pain, such as neuroimaging techniques, quantitative sensory testing or inflammatory markers that may correlate with pain levels. These methods could provide a more accurate understanding of pain levels beyond self-reported measures. Moreover, the inconsistent results on sex-related differences should further be studied. Potential explanations worth exploring could be differences in opioid prescribing patterns, pain perception, hormonal influences, social determinants of health and healthcare utilization between men and women. Future research should also explore how sociodemographic factors influence opioid use and dementia risk. Investigating these could improve personalized pain management strategies.

CONCLUSION

This review demonstrates that opioid use in chronic pain patients is generally associated with an increased risk of dementia, with the relationship appearing to be dose-dependent and particularly pronounced in older populations. The findings are significant because they suggest that both chronic pain and opioid use contribute to cognitive decline, emphasizing the need to address both factors in dementia prevention strategies, especially for vulnerable older adults. However, the literature remains inconsistent, with some studies failing to establish a clear link between opioid use and dementia, likely due to differences in study designs, populations, and pain definitions. These limitations highlight the need for more research to establish causality, explore the mechanisms underlying these relationships, and develop objective and consistent methods for assessing chronic pain. Future studies should also investigate the differential effects of various opioid types and pain conditions on dementia risk to inform more targeted and effective pain management practices.

REFERENCES

1. Dydyk AM, Conermann T. Chronic Pain [Internet]. Available from: https:// www.ncbi.nlm.nih.gov/books/NBK553030/
2. Goldberg DS, McGee SJ. Pain as a global public health priority. BMC Public Health. 2011 Dec;11(1):770.
3. Wang Z, Sun Z, Zheng H. Association between chronic pain and dementia: a systematic review and meta-analysis. Eur J Ageing. 2024 Dec;21(1):17.
4. Tian J, Jones G, Lin X, Zhou Y, King A, Vickers J, et al. Association between chronic pain and risk of incident dementia: findings from a prospective cohort. BMC Med. 2023 May 4;21(1):169.
5. Cao S, Fisher DW, Yu T, Dong H. The link between chronic pain and Alzheimer's disease. J Neuroinflammation. 2019 Nov 6;16(1):204. doi: 10.1186/s12974-019- 1608-z. PMID: 31694670; PMCID: PMC6836339.
6. Vachon-Presseau E, Roy M, Martel MO, Caron E, Marin MF, Chen J, Albouy G, Plante I, Sullivan MJ, Lupien SJ, Rainville P. The stress model of chronic pain: evidence from basal cortisol and hippocampal structure and function in humans. Brain. 2013 Mar;136(Pt 3):815-27. doi: 10.1093/brain/aws371. PMID: 23436504.
7. Geigenmüller JN, Tari AR, Wisloff U, Walker TL. The relationship between adult hippocampal neurogenesis and cognitive impairment in Alzheimer's disease. Alzheimers Dement. 2024 Oct;20(10):7369-7383. doi: 10.1002/alz.14179. Epub 2024 Aug 21. PMID: 39166771; PMCID: PMC11485317.
8. Rouch I, Edjolo A, Laurent B, Dartigues J, Amieva H. Chronic pain and long- term dementia risk in older adults: Results from a 24-year longitudinal study. Int J Geriat Psychiatry. 2022 May;37(5):gps.5713.
9. Khalid N, Patel P, Singh A. Cannabis Versus Opioids for Pain. [Updated 2023 Aug 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK573080/
10. Ambrose KR, Golightly YM. Physical exercise as non-pharmacological treatment of chronic pain: Why and when. Best Pract Res Clin Rheumatol. 2015 Feb;29(1):120-30. doi: 10.1016/j.berh.2015.04.022. Epub 2015 May 23. PMID: 26267006; PMCID: PMC4534717.
11. Philipps J, Ford M, Bonnie R. Pain Management and the Opioid Epidemic: Balancing Societal and Individual Benefits and Risks of Prescription Opioid Use. [Internet]. 2017. Available from: https://www.ncbi.nlm.nih.gov/ books/NBK458655/
12. Fields HL. The doctor's dilemma: opiate analgesics and chronic pain. Neuron. 2011 Feb 24;69(4):591-4. doi: 10.1016/j.neuron.2011.02.001. PMID: 21338871; PMCID: PMC3073133.
13. Corrada MM, Brookmeyer R, Paganini-Hill A, Berlau D, Kawas CH. Dementia incidence continues to increase with age in the oldest old: the 90+ study. Ann Neurol. 2010 Jan;67(1):114-21. doi: 10.1002/ana.21915. PMID: 20186856; PMCID: PMC3385995
14. Levine SZ, Rotstein A, Goldberg Y, Reichenberg A, Kodesh A. Opioid Exposure and the Risk of Dementia: A National Cohort Study. The American Journal of Geriatric Psychiatry. 2023 May;31(5):315–23.
15. Taipale H, Hamina A, Lampela P, Tanskanen A, Tiihonen J, Karttunen N, et al. Is Alzheimer's Disease Associated with Previous Opioid Use? Pain Medicine. 2018 Nov 1;19(11):2115–21.
16. Bramer WM, Rethlefsen ML, Kleijnen J, Franco OH. Optimal database combinations for literature searches in systematic

reviews: A prospective exploratory study. Systematic Reviews. 2017 Dec 6; 6(1):245
17. Wynanda A. van Enst, Rob J.P.M. Scholten, Penny Whiting, Aeilko H. Zwinderman, Lotty Hooft. Meta-epidemiologic analysis indicates that MEDLINE searches are sufficient for diagnostic test accuracy systematic reviews. Clinical Epidemiology. 2014 Nov; 67(11):1192-1199
18. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. International Journal of Social Research Methodology. 2005 Feb;8(1):19–32.
19. Khalid S., Sambamoorthi U., Innes K.E. Non-cancer chronic pain conditions and risk for incident alzheimer's disease and related dementias in community-dwelling older adults: A population-based retrospective cohort study of united states medicare beneficiaries, 2001-2013. Int J Environ Res Public Health. 2020;17(15):1–19.
20. Gao Y, Su B, Ding L, Qureshi D, Hong S, Wei J, et al. Association of Regular Opioid Use With Incident Dementia and Neuroimaging Markers of Brain Health in Chronic Pain Patients: Analysis of UK Biobank. Am J Geriatr Psychiatry. 2024 Sep;32(9):1154–65.
21. Bornier N., Mulliez A., Chenaf C., Elyn A., Teixeira S., Authier N., et al. Chronic pain is a risk factor for incident Alzheimer's disease: a nationwide propensity-matched cohort using administrative data. Front Aging Neurosci. 2023;15((Bornier, Mulliez, Chenaf, Teixeira, Authier, Bertin, Kerckhove) Department of Agricultural Statistics, Uttar Banga Krishi Viswavidyalaya, West Bengal, Cooch Behar, India):1193108.
22. Guo X, Hou C, Tang P, Li R. Chronic Pain, Analgesics, and Cognitive Status: A Comprehensive Mendelian Randomization Study. Anesth Analg. 2023 Oct 1;137(4):896–905.
23. Oh TK, Song IA. Impact of prescribed opioid use on development of dementia among patients with chronic non-cancer pain. Sci Rep. 2024 Feb 9;14(1):3313.
24. Sun M, Chen WM, Wu SY, Zhang J. Long-Term Opioid Use and Dementia Risk in Patients With Chronic Pain. J Am Med Dir Assoc. 2023 Sep;24(9):1420- 1426.e2.
25. Schuff N, Woerner N, Boreta L, Kornfield T, Shaw LM, Trojanowski JQ, et al. MRI of hippocampal volume loss in early Alzheimer's disease in relation to ApoE genotype and biomarkers. Brain. 2009 Apr;132(4):1067–77.
26. Dawe RJ, Yu L, Arfanakis K, Schneider JA, Bennett DA, Boyle PA. Late- life cognitive decline is associated with hippocampal volume, above and beyond its associations with traditional neuropathologic indices. Alzheimer's & Dementia. 2020;16(1):209–18.
27. Neelamegam M, Zgibor J, Chen H, O'rourke K, Bakour C, Rajaram L, et al. The effect of opioids on the cognitive function of older adults: results from the Personality and Total Health through life study. Age and Ageing. 2021 Sep 11;50(5):1699–708.
28. Dublin S, Walker RL, Gray SL, Hubbard RA, Anderson ML, Yu O, et al. Prescription Opioids and Risk of Dementia or Cognitive Decline: A Prospective Cohort Study. J American Geriatrics Society. 2015 Aug;63(8):1519–26.
29. Tanguturi P, Streicher JM. The role of opioid receptors in modulating Alzheimer's Disease. Front Pharmacol. 2023 Mar 1;14:1056402.
30. Cai Z, Ratka A. Opioid System and Alzheimer's Disease. Neuromol Med. 2012 Jun;14(2):91– 111.
31. Upadhyay J, Maleki N, Potter J, Elman I, Rudrauf D, Knudsen J, et al. Alterations in brain structure and functional connectivity in prescription
32. Kamboj SK, Conroy L, Tookman A, Carroll E, Jones L, Curran HV. Effects of immediaterelease opioid on memory functioning: a randomized-controlled study in patients receiving sustained-release opioids. European Journal of Pain. 2014 Nov;18(10):1376–84.
33. Kao PH, Jang FL, Ho CH, Chen YC, Hsu CC, Lin HJ, et al. Chronic Pain Increases the Risk of Dementia: A Nationwide Population-Based Cohort Study. 2021;(24):849– 56.
34. Innes KE, Sambamoorthi U. The Association of Osteoarthritis and Related Pain Burden to Incident Alzheimer's Disease and Related Dementias: A Retrospective Cohort Study of U.S. Medicare Beneficiaries. JAD. 2020 Jun 2;75(3):789–805.
35. Khalid S, Sambamoorthi U, Umer A, Lilly CL, Gross DK, Innes KE. Increased Odds of Incident Alzheimer's Disease and Related Dementias in Presence of Common Non-Cancer Chronic Pain Conditions in Appalachian Older Adults. J Aging Health. 2022 Mar;34(2):158–
36. Ezzati A, Wang C, Katz MJ, Derby CA, Zammit AR, Zimmerman ME, et al. The Temporal Relationship between Pain Intensity and Pain Interference and Incident Dementia. CAR. 2019 Feb 4;16(2):109–15.

Conflicts of Interest Disclosure

There are no conflicts of interest to declare.

Factors Associated with Vaccine Hesitancy Among Adults in Peshawar, Khyber Pakhtunkhwa, Pakistan: A Cross-Sectional Study

Muhammad Idrees[1,2], Ismael Afolabi[1], Haroon Afridi[3], Mahd Afridi[4], Hafiz M. Fawad[3]

[1] Faculty of Health Science, University of Ottawa, Ottawa, ON, Canada

[2] Human Infection Challenge-Vaccine (HIC-Vac), Imperial College London, London, United Kingdom

[3] Khyber Medical College, Peshawar, Pakistan

[4] The Fazaia Ruth Pfau Medical College (FRPMC), Karachi, Pakistan

Correspondence:
Muhammad Idrees;
idreesafridi2800@gmail.com

Date Submitted: January 23, 2025
Date Accepted: July 16, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7366

Keywords: *vaccine hesitancy, socio-demographic factors, healthcare worker influence, Peshawar, Pakistan*

ABSTRACT

Objective: To assess socio-demographic attributes, healthcare workers' encouragement and income status as predictors of vaccine hesitancy among adults in Peshawar, Pakistan.

Methods: The study was a cross-sectional design employing an online survey to obtain data from participants from Peshawar, Pakistan. We used binary logistic regression to ascertain the extent of the association between vaccine hesitancy and independent predictors including age, gender, marital status, education, healthcare worker encouragement, and income level. We set the level of significance at p≤.05.

Results: The study sample consisted of 398 participants with a mean age of approximately 48.05 years. The gender distribution was relatively balanced, with 205 males (51.5%) and 193 females (48.5%). Out of the total participants, 270 individuals (67.8%) accepted the vaccine, while 128 individuals (32.2%) declined it. Males were more likely to be vaccine hesitant than females (OR=2.42,95%CI:1.34-4.38). Healthcare worker encouragement reduced vaccine hesitancy (OR = 0.11, 95% CI: 0.06-0.20). Individuals aged 46-60 showed higher vaccine hesitancy compared to those aged 18-30 (OR = 3.55, 95% CI: 1.44-8.73). Low-income earners were more likely to be vaccine-hesitant than higher-income earners (OR = 5.34, 95% CI: 2.07-13.80). Marital status and education level were not significantly associated with vaccine hesitancy.

Conclusion: This study highlights the complex interplay of factors influencing vaccine hesitancy in Peshawar, Pakistan. Gender, age, income level, and healthcare worker encouragement significantly influence vaccine acceptance. These findings call for targeted interventions to tackle vaccine hesitancy pragmatically and promote vaccine uptake in the Peshawar region of Pakistan.

RÉSUMÉ

Objectif : Évaluer les caractéristiques sociodémographiques, l'encouragement des professionnels de santé et le niveau de revenu comme prédicteurs de l'hésitation vaccinale chez les adultes à Peshawar, au Pakistan.

Méthodes : L'étude était une étude transversale utilisant un sondage en ligne pour obtenir des données auprès de participants de Peshawar, au Pakistan. Nous avons utilisé une régression logistique binaire pour déterminer le degré d'association entre l'hésitation vaccinale et des prédicteurs indépendants, notamment l'âge, le sexe, l'état civil, le niveau d'éducation, l'encouragement des professionnels de santé et le niveau de revenu. Nous avons fixé le niveau de signification à p ≤ 0,05.

Résultats : L'échantillon de l'étude était composé de 398 participants dont l'âge moyen était d'environ 48,05 ans. La répartition par sexe était relativement équilibrée, avec 205 hommes (51,5 %) et 193 femmes (48,5 %). Sur l'ensemble des participants, 270 personnes (67,8 %) ont accepté le vaccin, tandis que 128 personnes (32,2 %) l'ont refusé. Les hommes étaient plus susceptibles d'hésiter à se faire vacciner que les femmes (OR = 2,42, IC à 95 % : 1,34-4,38). Les encouragements des professionnels de santé ont réduit l'hésitation vaccinale (OR = 0,11, IC à 95 % : 0,06-0,20). Les personnes âgées de 46 à 60 ans ont montré une plus grande hésitation vaccinale que celles âgées de 18 à 30 ans (OR = 3,55, IC à 95 % : 1,44-8,73). Les personnes à faibles revenus étaient plus susceptibles d'hésiter à se faire vacciner que celles à revenus élevés (OR = 5,34, IC à 95 % : 2,07-13,80). La situation matrimoniale et le niveau d'éducation n'étaient pas associés de manière significative à l'hésitation vaccinale.

Conclusion : Cette étude met en évidence l'interaction complexe des facteurs influençant l'hésitation vaccinale à Peshawar, au Pakistan. Le sexe, l'âge, le niveau de revenu et les encouragements des professionnels de santé influencent de manière significative l'acceptation de la vaccination. Ces résultats appellent à des interventions ciblées pour lutter de manière pragmatique contre l'hésitation vaccinale et promouvoir la couverture vaccinale dans la région de Peshawar au Pakistan.

INTRODUCTION

Vaccines have been proved elixir for the infectious diseases that previously cost millions of human lives. The unprecedented COVID-19 pandemic further emphasized the utmost significance of vaccines. Vaccines have saved an estimated 154 million lives over the last 50 years and are highly cost-effective, saving US$16 for every dollar spent on healthcare, wages, and productivity losses[1,2]. Despite such pivotal potential to change the health landscape of the country, the world is encountering a new threat that made its way into top 10 threats to global health named as , "vaccine hesitancy" [1]. Vaccine Hesitancy has been referred to as the delay in acceptance or refusal of vaccines despite availability of vaccination services" [2].

In general, Pakistan is believed to have a long history of vaccine hesitancy, rooted in its decades-long national struggle against terrorism [3]. As a result, lingering negative beliefs about vaccines often hinder the population-wide acceptance of vaccination interventions in the country [4]. A recent COVID-19-related study in Pakistan supports this trend, with about half of the respondents exhibiting vaccine hesitancy, largely due to beliefs that the vaccine may cause long-term side effects or even death [5].

Existing empirical research indicates significant demographic disparities in vaccine hesitancy. For example, previous studies indicate that younger adults (18-29 years) consistently show higher vaccine hesitancy rates compared to older age groups [6]. Similarly, gender difference may play a role in vaccine hesitancy, as men are more likely to get a vaccine than women [7]. In previous studies conducted by Ali [8] and Sheikh [5], it was revealed that women tended to be vaccine hesitant due to fear of the vaccine causing infertility. Moreover, educational attainment has a profound impact on vaccination perception, with individuals holding a bachelor's degree or higher demonstrating greater vaccine acceptance [9]. Another important factor is marital status, with married people frequently having greater immunization rates than single people [10]. This trend is particularly pronounced among younger adults and those with lower education levels, who may be more skeptical about vaccine efficacy and safety profile [11,12].

Additionally, income disparities significantly influence hesitancy, with lower-income populations showing greater resistance to vaccination [13]. A study in New Jersey found that household income was one of the strongest predictors of COVID-19 vaccination [14]. Evidence from Pakistan also portends that individuals from low economic classes are more likely to demonstrate vaccine hesitancy [15]. Lastly, healthcare workers play a crucial role in influencing public opinion and confidence regarding vaccines, making their encouragement vital in addressing vaccine hesitancy among the general population. Their recommendations have a substantial positive influence on patients' vaccination decisions [16]. Healthcare workers can employ tailored communication strategies to address individual concerns and misconceptions about vaccines [17]. A study by Opel et al. highlighted that effective communication by health care providers significantly improves parental vaccine acceptance, emphasizing the critical role of provider-patient interactions in public health initiatives [18]. This finding is corroborated by a study on health workers in Pakistan [19].

Given the prevailing issue of vaccine hesitancy in Pakistan, many of the factors identified in previous studies may also resonate in Peshawar, a city that has been at the forefront of polio vaccination efforts. However, historical, cultural, and political challenges have long hindered vaccination efforts in the region. Efforts to promote polio vaccination in Peshawar have often been met with skepticism, exacerbated by incidents of violence [20]. This issue may persist, as evidenced by a recent study on COVID-19 vaccination in various Pakistani cities, including Peshawar, where approximately three-quarters of respondents expressed willingness to vaccinate against COVID-19, but only 17% had registered for vaccination [21]. This raises significant concerns about the ongoing presence of vaccine hesitancy.

Undoubtedly, the success of vaccination interventions requires a comprehensive understanding of the factors associated with vaccine hesitancy, as vaccine intention is context-specific [21,22]. It is therefore imperative to understand the predictors of vaccine hesitancy in Peshawar to inform culturally tailored interventions aimed at improving vaccine acceptance for vaccine-preventable diseases in the region. We hypothesize that certain socio-demographic factors, economic factors, and subjective norms (e.g., healthcare worker influence) will be significantly associated with vaccine hesitancy among the adult population in Peshawar, Pakistan.

METHODS

Study Design and Sample Estimation

This study utilized a cross-sectional survey to assess vaccine hesitancy in Peshawar, Pakistan. We used the Yamane formula for finite populations to estimate the sample size, considering the total population of Peshawar, as reported in the 2023 census, which is 4,267,198. [23]:

$$n = N / (1 + N * e^2)$$

Where:

- n = sample size
- N = population size (4,267,198)
- e = margin of error (commonly set at 0.05)

Substituting the values:

$n = 4,267,198 / (1 + 4,267,198 * 0.05^2) = 398$

We recruited approximately 398 respondents based on this formula. Data collection continued until the desired sample size was achieved. This ensured a sufficient and diverse sample to reflect the socio-cultural and demographic dynamics of Peshawar.

Study Setting

Peshawar, the capital of Khyber Pakhtunkhwa Province, with a population of 4.2 million has been selected for its distinct demographic profiling. People from different parts of the province, Khyber Pakhtunkhwa, come together in Peshawar, and it is thus a melting pot of various socio-cultural dynamics that influence health behaviors, attitudes, and perception and therefore the population is representative of the region's (Khyber Pakhtunkhwa) attitude toward vaccination. Peshawar has been the epicenter of polio vaccination efforts, but it still faces resistance to vaccination for historical, cultural, and political reasons. The efforts to promote vaccinations against Polio vaccination in Peshawar have often been met with skepticism, exacerbated by incidents of violence [24].

Data Collection

Data was collected using an online survey distributed through social media, WhatsApp groups, and emails. A combination of convenience and snowballing sampling techniques was employed. Respondents were encouraged to share the survey link with their personal and social networks after completing the survey, until the desired sample size was ascertained. The demographic variables collected included age, gender, marital status, education level coupled with health care worker encouragement and income level disparity.

Vaccine Hesitancy Measurement

Vaccine hesitancy was measured as the primary dependent variable. Respondents were asked a direct question regarding their vaccination status and attitudes towards vaccines. The question used to measure vaccine hesitancy was:

- "Have you ever hesitated or refused to take a vaccine despite the availability of vaccination services?" (Yes/No)

Variables

Independent Variables:

- Age (continuous, grouped into categories: 18-30, 31-45, 46-60, 60+)
- Gender (Male/Female)
- Marital Status (Single/Married/Divorced/Widowed)
- Education (Less than High School/High School/College/Postgraduate)
- Healthcare Encouragement (Yes/No)
- Income Level (Lower/Middle/Higher)

Dependent Variable:

- Vaccine Hesitancy (Yes/No)

Statistical Analysis

The data were analyzed using logistic regression to identify the independent predictors of vaccine hesitancy. However, prior to logistic regression, chi-square tests of independence were used to explore relationships between categorical variables such as gender, education level, and trust in healthcare providers. Since the likelihood of type I error increases with increasing number of variables, Bonferroni correction was therefore applied to adjust the alpha level.

Adjusted alpha=α/n

Where:

- α is the original significance level (0.05),
- n is the number of comparisons (6 in our case).

By dividing the original alpha level (0.05) by the number of comparisons, the adjusted alpha was calculated as 0.0083. This more stringent threshold of 0.0083 was used to control the risk of Type I errors. The analyses were performed using Jamovi project (2022) which is free, open access robust tools for statistical analysis [25].

Ethical Considerations

Ethical approval for this study was obtained from the Peshawar District Health Office's ethical review board with reference No: PDH/2024/09. The research was conducted

through an online survey with voluntary participation. Participants were fully informed about the study's purpose, assured of their right to withdraw at any time, and no sensitive personal information was collected to ensure confidentiality and ethical compliance.

Logistic Regression Model Equation

The logistic regression model for vaccine hesitancy with the variables Age, Gender, Marital status, Education, Healthcare_Encouragement and Income level is given by:

$$\log (p / (1 - p)) = \beta 0 + \beta 1 * \text{Age} + \beta 2 * \text{Gender} + \beta 3 * \text{Marital status} + \beta 4 * \text{Education} + \beta 5 * \text{Healthcare\_Encouragment} + \beta 6 * \text{Income Level}$$

Where:

- p is the probability of being vaccine hesitant.
- Log (p / (1 – p)) is the log odds of the probability of being vaccine hesitant.
- β0 is the intercept of the model.
- β1, β2, β3, β4, β5 and β6 are the coefficients for the six independent variables.

Before fitting the logistic regression model to examine vaccine hesitancy based on data from a cross-sectional survey, we will first verify several key hypotheses to ensure the validity and reliability of our model. These hypotheses, specific to logistic regression, include:

Absence of Multicollinearity: Regression coefficient values may significantly shift because of multicollinearity, rendering our result untrustworthy and unreliable. Therefore, to detect multicollinearity, we will examine the Tolerance and Variance Inflation Factor (VIF). High VIF values (typically greater than 05) indicate problematic multicollinearity, which requires addressing before proceeding with the model fitting. Moreover, value of tolerance close to value of 1 is in acceptable range.

Presence of outliers: To identify influential data points in our survey data, we will examine Cook's distance values. A Cook's distance exceeding the value of 1 indicates that a particular data point is highly influential and could disproportionately affect the model's estimates. The Cook's distance values are always less than 1 guarantees the absence of outliers.

To measure the goodness of fit of our logistic regression, we will use McFadden's R^2.

RESULTS

The demographic characteristics of the participants is delineated in **Table 1**. The majority were aged 31–45 years (35.7%) and 46–60 years (41.5%), with 22.8% aged over 60. The gender distribution was relatively balanced, with 205 males (51.5%) and 193 females (48.5%). Most respondents were married (69.8%), and 30.2% were single. Regarding education, 44.7% had college-level education, 29.1% had less than high school education, and 26.2% completed high school. Among the 330 respondents who

Table 1. Demographic Characteristics of Survey Respondents

Characteristic	Category	Frequency (n)	Percentage (%)
Age Group	31–45 years	142	35.7
	46–60 years	165	41.5
	Over 60 years	91	22.8
Gender	Male	245	61.6
	Female	153	38.4
Marital Status	Married	278	69.8
	Single	120	30.2
Education	College-level	178	44.7
	Less than High School	116	29.1
	High School or Equivalent	104	26.2
Income Level	Higher Income	205	62.1
	Low Income	125	37.9
Healthcare Encouragement	Yes	245	61.6
	No	153	38.4
Vaccine Hesitancy	Accepted	270	68
	Declined	128	32

provided income data, 62.1% reported higher income levels, while 37.9% had low income. Healthcare encouragement was viewed as an influential factor by participants, with 61.6% believing it could positively impact their vaccine hesitancy, while 38.4% did not share this opinion. Vaccine acceptance was seen in 68% of respondents, while 32% exhibited hesitancy or refusal.

Before undertaking our logistic regression analysis, we verified the absence of multicollinearity and outliers, as these can significantly affect the validity and interpretability of our model. As shown in **Table 2**, all variables have VIF and tolerance values close to 1, suggesting that multicollinearity is not a concern in our model.

The mean and median Cook's distance values as shown in **Table 3** are both 0.00, with a maximum value of 0.05. These values are well below the threshold of 1, indicating that there are no influential outliers in our dataset.

The ROC curve (**Figure 1**) provides a graphical representation of the trade-off between the model's sensitivity (true positive rate) and specificity (true negative rate) across various decision thresholds for vaccine hesitancy. The AUC value of 0.86 reflects the overall discriminatory power of the model. This performance far exceeds the baseline of random guessing (AUC = 0.5).

The overall model fit statistics as depicted in **Table 4** demonstrate that the model adequately explains the variance in vaccine hesitancy. Our model deviance is 293.60,

Table 2. Collinearity Statistics

	VIF	Tolerance
Gender	1.04	0.96
Marital_Status	1.03	0.97
Education	1.02	0.98
Healthcare_Encouragement	1.10	0.91
Age_Group	1.02	0.98
Income level	1.02	0.98

Table 3. Descriptives for Cook's Distance

	Cook's distance
N	330
Missing	68
Mean	0.00
Median	0.00
Standard deviation	0.01
Minimum	0.00
Maximum	0.05

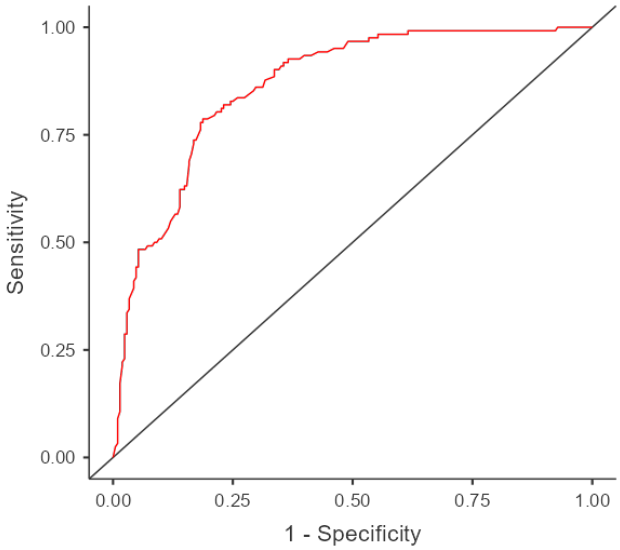


Figure 1. ROC Curve showing the trade-off between the model's sensitivity (true positive rate) and specificity (true negative rate) across various decision thresholds for vaccine hesitancy

with an Akaike Information Criterion (AIC) of 321.60 and a Bayesian Information Criterion (BIC) of 374.79 indicates the goodness of fit of predictive model. McFadden's R^2 value is 0.32 (> 0.2 is considered as safe), indicating that approximately 32% of the variance in vaccine hesitancy is explained by the predictors included in the model. The chi-square test is highly significant ($\chi^2 = 141.20$, df = 13, $p < .001$), further underscores that the model significantly predicts vaccine hesitancy.

Before running the logistic regression, Chi-Square tests were run to examine the associations between vaccine hesitancy and several variables as depicted in **Table 5**. Gender ($\chi^2 = 10.47$, $p < .001$), healthcare worker encouragement ($\chi^2 = 71.30$, $p < .001$), age group ($\chi^2 = 14.59$, $p = .002$), and income level ($\chi^2 = 48.14$, $p < .001$) all showed significant associations with vaccine hesitancy. However, marital status ($\chi^2 = 1.49$, $p = .685$) and education level ($\chi^2 = 8.17$, $p = .043$) were not significantly related to vaccine hesitancy. These results suggest that factors such as gender, education, healthcare encouragement, age, and income are important predictors of vaccine hesitancy, which will be further explored in the logistic regression analysis.

The analysis revealed several significant predictors of vaccine hesitancy as can be seen from the **Table 6**. Gender emerged as a significant factor, with males exhibiting high-

Table 4. Model Fit Measures

					Overall Model Test		
Model	**Deviance**	**AIC**	**BIC**	**R^2_{McF}**	**χ^2**	**df**	**p**
1	293.60	321.60	374.79	0.32	141.20	13	<.001

Table 5. Chi-Square Test Results

Variable	χ^2	df	P	N
Gender	10.47	1	**<.001**	398
Marital Status	1.49	3	.685	398
Education	8.17	3	.043	398
HCW_Encouragement	71.30	1	**<.001**	398
Age Group	14.59	3	**.002**	398
Income Level	48.14	2	**<.001**	330

Table 6. Model Coefficients - Vaccine Hesitancy

						95% Confidence Interval	
Predictor	**Estimate**	**SE**	**Z**	**p**	**Odds ratio**	**Lower**	**Upper**
Intercept	-2.29	0.83	-2.74	**0.006**	0.10	0.02	0.52
Gender:							
Male – Female	0.88	0.30	2.91	**0.004**	2.42	1.34	4.38
Marital_Status:							
Married – Divorced	0.58	0.53	1.09	0.275	1.79	0.63	5.10
Single – Divorced	0.07	0.56	0.12	0.905	1.07	0.35	3.23
Widowed – Divorced	-0.23	0.67	-0.34	0.731	0.79	0.21	2.97
Education:							
High School – College	0.55	0.41	1.33	0.184	1.73	0.77	3.87
Less than High School – College	0.66	0.43	1.52	0.129	1.93	0.83	4.52
Postgraduate – College	0.14	0.62	0.23	0.815	1.15	0.34	3.87
Healthcare_Encouragement:							
Yes – No	-2.23	0.32	-7.01	**< .001**	0.11	0.06	0.20
Age_Group:							
31-45 – 18-30	-0.15	0.48	-0.31	0.758	0.86	0.34	2.21
46-60 – 18-30	1.27	0.46	2.76	**0.006**	3.55	1.44	8.73
60+ – 18-30	0.68	0.44	1.55	0.121	1.97	0.84	4.65
Income level:							
Low Income – Higher Income	1.68	0.48	3.46	**< .001**	5.34	2.07	13.80
middle income – Higher Income	-1.80	0.89	-2.01	**0.044**	0.17	0.03	0.95

Note. Estimates represent the log odds of "Vaccine_Hesitancy = Declined" vs. "Vaccine_Hesitancy = Accepted"

er odds of vaccine hesitancy compared to females (Estimate = 0.88, SE = 0.30, p = 0.004). The odds ratio of 2.42 (95% CI: 1.34 to 4.38) indicates that males are more than twice as likely to be vaccine hesitant as females.

Our findings also indicate that marital status is not a significant predictor of vaccine hesitancy. Specifically, the odds of vaccine hesitancy for married versus divorced individuals (OR = 1.79, 95% CI: 0.63–5.10, p = 0.275), single versus divorced individuals (OR = 1.07, 95% CI: 0.35–3.23, p = 0.905), and widowed versus divorced individuals (OR = 0.79, 95% CI: 0.21–2.97, p = 0.731) were all insignificant. Furthermore, education level does not significantly influence vaccine hesitancy, with all comparisons among education groups yielding non-significant results. For instance, the odds ratios for high school versus college (OR = 1.73, 95% CI: 0.77–3.87, p = 0.184) and less than high school versus college (OR = 1.93, 95% CI: 0.83–4.52, p = 0.129) suggest no substantial differences.

However, healthcare encouragement had a profound effect on vaccine hesitancy. Individuals who received healthcare encouragement were significantly less likely to be vaccine-hesitant compared to those who did not (Estimate = -2.23, SE = 0.32, p < .001). The odds ratio of 0.11 (95% CI: 0.06 to 0.20) indicates a substantial decrease in vaccine hesitancy among those encouraged by healthcare providers.

Similarly, age is also associated with the vaccine hesitancy. Our study indicates that individuals aged 46-60 were significantly more likely to be vaccine-hesitant compared to those aged 18-30 (Estimate = 1.27, SE = 0.46, p = 0.006, OR = 3.55, 95% CI: 1.44 to 8.73). There were no significant differences between other age groups.

Lastly, income level showed significant effects on vaccine hesitancy. Specifically, low-income individuals were significantly more likely to be vaccine-hesitant compared to higher-income individuals (Estimate = 1.68, SE = 0.48, p < .001). The odds ratio of 5.34 (95% CI: 2.07 to 13.80) indicates that low-income individuals have substantially higher odds of declining vaccines jab. Conversely, middle-income individuals were less likely to be vaccine-hesitant compared to higher-income individuals (Estimate = -1.80, SE = 0.89, p = 0.044, OR = 0.17, 95% CI: 0.03 to 0.95).

DISCUSSION

This current study offers pertinent insights into the variables influencing vaccine hesitancy among a relatively large sample of the inhabitants of Peshawar, Pakistan. Our findings highlight the value of healthcare professionals' support in lowering vaccine hesitancy and point to significant socioeconomic and demographic components of the issue. These results can be utilized to create targeted public health initiatives to raise vaccination rates in similar sociocultural contexts.

Our findings reveal that gender significantly influences vaccine hesitancy, with males exhibiting over twice the odds of being hesitant compared to females. This is in contrast with prior research where women often display greater health-seeking behaviors and trust in healthcare interventions [26,27]. The unique sociocultural context of Peshawar, where men are often the primary decision-makers in households, may explain this deviation [28]. Therefore, it is important to understand that these dynamics are critical for tailoring gender-sensitive communication strategies to improve vaccine uptake.

Ironically, our analysis indicates that marital status was not significantly associated with vaccine hesitancy. Comparisons among married, single, and widowed individuals, relative to divorced individuals, revealed no meaningful differences in hesitancy levels. This finding is not consistent with previous research suggesting that marital status may influence health behaviors, often due to spousal support or shared decision-making [29]. However, in the context of Peshawar region, Khyber Pakhtunkhwa, cultural and societal factors might diminish the role of marital status as a determinant since male advice takes precedence in the family affairs [30]. Since our study also found that males were more vaccine hesitant, the concept of shared decision-making within families often defaults to the male perspective as the head of the household, further amplifying their influence on vaccination decisions.

Our findings suggest that education level does not significantly influence vaccine hesitancy. These results stand in contrast to several previous studies that have reported significant associations between education level and vaccine attitudes. For instance, a rapid systematic review found that lack of high school education was the strongest predictor of COVID-19 vaccine hesitancy across U.S. counties [31]. Similarly, a study reported that adults with

higher education levels were more likely to get vaccinated and express confidence in vaccine safety and efficacy [32]. A comprehensive study by Solís Arce et al. found that while vaccine acceptance was generally higher among more educated groups worldwide, patterns of vaccine hesitancy varied across countries [32]. Our findings of non-significant differences between education groups are intriguing and may be attributed to specific characteristics of our study population that differ from those in previous research, warranting further investigation.

Individuals who received encouragement from healthcare providers were significantly less likely to be vaccine-hesitant, with an odds ratio of 0.11 (95% CI: 0.06 to 0.20), indicating a substantial decrease in hesitancy compared to those who did not receive such encouragement. When healthcare providers actively encourage vaccination, it can help reduce vaccine hesitancy by providing trusted, evidence-based information and addressing concerns directly. This finding is consistent with previous study that showed that health care provider can influence decision of mother to vaccinate their kids [33].

Age group was found to significantly influence vaccine hesitancy, with individuals aged 46-60 being more likely to be vaccine-hesitant compared to those aged 18-30. The odds ratio of 3.55 (95% CI: 1.44 to 8.73, $p = 0.006$) indicates that individuals in the 46-60 age group were more than three times as likely to express hesitancy. This aligns with previous studies that suggest older adults may have more entrenched beliefs and greater exposure to vaccine-related misinformation [34]. However, no significant differences were found between other age groups, indicating that hesitancy may not increase steadily with age, but rather may be more pronounced in specific cohorts. These findings highlight the need for targeted interventions for middle-aged adults, especially in addressing their concerns and providing tailored information that resonates with their experiences and needs.

The findings regarding the relationship between income level and vaccine hesitancy reveal a complex pattern that warrants careful consideration. Low-income individuals demonstrated significantly higher odds of vaccine hesitancy compared to their higher-income counterparts. This aligns with previous research indicating that lower socioeconomic status is often associated with increased vaccine hesitancy [35,36].

Strengths and Limitations

This study has a few strengths. The sample size of 398 participants guarantees a comprehensive representation of the sociocultural and demographic characteristics of Peshawar. The validity and reliability of the results is increased by using logistic regression analysis in conjunction with thorough consideration of multicollinearity and outliers. Furthermore, the study's statistical rigor is strengthened using the Bonferroni adjustment for multiple comparisons.

The study does, however, have certain shortcomings. Selection bias may have been created by using an online poll that was disseminated via emails, WhatsApp groups, and social media, thereby underrepresenting people with low levels of digital literacy or internet access. Therefore, future studies should consider capturing interviewer-administered supplementary data on vaccine hesitancy by collaborating with community organizations, healthcare providers, and community leaders, among others, to ensure the inclusion of underrepresented eligible population. Similarly, offering incentives could help encourage maximum participation of underrepresented groups in the supplementary data collection.

The study's cross-sectional design makes it impossible to establish a causal link between vaccine reluctance and the factors that were found. Additionally, the results may not be as applicable to other areas with distinct sociocultural contexts due to the study's exclusive emphasis on Peshawar. Response bias may also be introduced by measuring vaccination hesitancy using self-reported data. Despite these limitations, the study provides valuable insights into the complex factors influencing vaccine hesitancy in Peshawar, offering a foundation for future research and targeted public health intervention.

CONCLUSION

This study has highlighted the factors that stand apart with previous global research by taking into consideration the socio-cultural context of Peshawar region in Pakistan. Notably, males in this region exhibited higher vaccine hesitancy compared to females, which contrasts with global research trends, underscoring the need for interventions to be aligned with the unique socio-cultural context of Peshawar. Our study indicates that improving vaccine uptake requires tailored strategies that address socioeco-

nomic gaps, leverage the power of healthcare providers, and concentrate on male-targeted communication. Lastly, qualitative research could also offer deeper understanding of the cultural and contextual factors influencing vaccine hesitancy in this population.

REFERENCES

1. WHO. Ten threats to global health in 2019. 2019 [Internet]. 2019; Available from: https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019
2. MacDonald NE. Vaccine hesitancy: Definition, scope and determinants. Vaccine. 2015 Aug 14;33(34):4161–4164.
3. Polio vaccination controversy in Pakistan - PubMed [Internet]. [cited 2025 Mar 9]. Available from: https://pubmed.ncbi.nlm.nih.gov/31526731/
4. Khan YH, Mallhi TH, Alotaibi NH, Alzarea AI, Alanazi AS, Tanveer N, Hashmi FK. Threat of COVID-19 Vaccine Hesitancy in Pakistan: The Need for Measures to Neutralize Misleading Narratives. Am J Trop Med Hyg. 2020 Aug;103(2):603–604. PMCID: PMC7410483
5. Sheikh NS, Touseef M, Sultan R, Cheema KH, Cheema SS, Sarwar A, Siddique HZ. Understanding COVID-19 vaccine hesitancy in Pakistan: The paradigm of confidence, convenience, and complacency; A cross-sectional study. PloS One. 2023;18(8):e0289678. PMCID: PMC10431607
6. Syan SK, Gohari MR, Levitt EE, Belisario K, Gillard J, DeJesus J, MacKillop J. COVID-19 Vaccine Perceptions and Differences by Sex, Age, and Education in 1,367 Community Adults in Ontario. Front Public Health. 2021 Sep 22;9:719665. PMCID: PMC8494003
7. Ishimaru T, Okawara M, Ando H, Hino A, Nagata T, Tateishi S, Tsuji M, Matsuda S, Fujino Y. Gender differences in the determinants of willingness to get the COVID-19 vaccine among the working-age population in Japan. Hum Vaccines Immunother. 2021;17(11):3975–3981. PMCID: PMC8827630
8. Ali S, Sophie R, Imam AM, Khan FI, Ali SF, Shaikh A, Farid-ul-Hasnain S. Knowledge, perceptions and myths regarding infertility among selected adult population in Pakistan: a cross-sectional study. BMC Public Health. 2011 Oct 4;11(1):760.
9. Kyla Thomas, Jill Darling, Alwyn Cassil. COVID-19 Vaccine Hesitancy: Education Divide Widens. USC Dornsife Cent Econ Soc Res – Underst Coronavirus Am Track Study Wave 23 Early Febr 2021 [Internet]. 2021; Available from: https://healthpolicy.usc.edu/evidence-base/education-is-now-a-bigger-factor-than-race-in-desire-for-covid-19-vaccine/
10. Liu H, Nowak GR, Wang J, Luo Z. A National Study of Marital Status Differences in Early Uptake of COVID-19 Vaccine among Older Americans. Geriatrics. 2023 Jun 28;8(4):69. PMCID: PMC10366868
11. Gerretsen P, Kim J, Caravaggio F, Quilty L, Sanches M, Wells S, Brown EE, Agic B, Pollock BG, Graff-Guerrero A. Individual determinants of COVID-19 vaccine hesitancy. PLOS ONE. Public Library of Science; 2021 Nov 17;16(11):e0258462.
12. Muhajarine N, Adeyinka DA, McCutcheon J, Green KL, Fahlman M, Kallio N. COVID-19 vaccine hesitancy and refusal and associated factors in an adult population in Saskatchewan, Canada: Evidence from predictive modelling. PLOS ONE. Public Library of Science; 2021 Nov 12;16(11):e0259513.
13. Vlasak D, Dinero RE, Roitman NA. Vaccine hesitancy at both ends of the socioeconomic spectrum: a new paradigm for understanding the role of systemic inequity. J Public Health Emerg [Internet]. AME Publishing Company; 2023 Dec 25 [cited 2024 Dec 27];7(0). Available from: https://jphe.amegroups.org/article/view/9493
14. Kim B, Hong S, Kim S. Are they still determining? Analysis of associations among ethnicity, gender, socioeconomic status, neighborhood factors, and COVID-19 vaccination. Front Commun [Internet]. Frontiers; 2023 Apr 4 [cited 2024 Dec 27];8. Available from: https://www.frontiersin.org/journals/communication/articles/10.3389/fcomm.2023.1040797/full
15. Mehmood Q, Ullah I, Hasan MM, Kazmi SK, Ahmadi A, Lucero-Prisno DE. COVID-19 vaccine hesitancy: Pakistan struggles to vaccinate its way out of the pandemic. Ther Adv Vaccines Immunother. 2022 Feb 10;10:25151355221077658. PMCID: PMC8841903
16. Lip A, Pateman M, Fullerton MM, Chen HM, Bailey L, Houle S, Davidson S, Constantinescu C. Vaccine hesitancy educational tools for healthcare providers and trainees: A scoping review. Vaccine. 2023 Jan 4;41(1):23–35. PMCID: PMC9688224
17. Goje O, Kapoor A. Meeting the challenge of vaccine hesitancy. Cleve Clin J Med. Cleveland Clinic Journal of Medicine; 2024 Sep 1;91(9 suppl 1):S50–S56. PMID: 39231603
18. Opel DJ, Mangione-Smith R, Robinson JD, Heritage J, DeVere V, Salas HS, Zhou C, Taylor JA. The Influence of Provider Communication Behaviors on Parental Vaccine Acceptance and Visit Experience. Am J Public Health. American Public Health Association; 2015 Oct;105(10):1998–2004.
19. Malik A, Malik J, Ishaq U. Acceptance of COVID-19 vaccine in Pakistan among health care workers. PLOS ONE. Public Library of Science; 2021 Sep 15;16(9):e0257237.
20. Wahid B, Kumari B, Saifullah KM, Idrees M. The History and Current Killings of Polio Vaccinators in Pakistan: A Need for Targeted Surveillance Strategy. Asia Pac J Public Health. 2023 Mar;35(2–3):183–188. PMCID: PMC10185917
21. Khan AA, Abdullah M, Aliani R, Mohiuddin AF, Sultan F. COVID-19 vaccine hesitancy and attitudes in Pakistan: a cross-sectional phone survey of major urban cities. BMC Public Health. 2023 Jun 9;23(1):1112.
22. Larson HJ, Cooper LZ, Eskola J, Katz SL, Ratzan S. Addressing the vaccine confidence gap. Lancet Lond Engl. 2011 Aug 6;378(9790):526–535. PMID: 21664679
23. Yamane T. T. Yamane Statistics: an introductory analysis (second ed.), Harper and Row, New York (1967). 1967; Available from: https://scholar.google.com/scholar_lookup?title=Statistics%3A%20an%20introductory%20analysis&publication_year=1967&author=T.%20Yamane
24. Wahid B, Kumari B, Saifullah KM, Idrees M. The History and Current Killings of Polio Vaccinators in Pakistan: A Need for Targeted Surveillance Strategy. Asia Pac J Public Health. 2023 Mar;35(2–3):183–188. PMCID: PMC10185917
25. The Jamovi Project. The jamovi project (2022). jamovi. (Version 2.3) [Computer Software]. Retrieved from https://www.jamovi.org. [Internet]. JAMOVI Org; 2022. Available from: https://www.jamovi.org.
26. Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, Kimball S, El-Mohandes A. A global survey of potential acceptance of a COVID-19 vaccine. Nat Med. 2021 Feb;27(2):225–228. PMCID: PMC7573523
27. Solís Arce JS, Warren SS, Meriggi NF, Scacco A, McMurry N, Voors M, et al. COVID-19 vaccine acceptance and hesitancy in low- and middle-income countries. Nat Med. 2021;27(8):1385–1394. PMCID: PMC8363502
28. Ali TS, Krantz G, Gul R, Asad N, Johansson E, Mogren I. Gender roles and their influence on life prospects for women in urban Karachi, Pakistan: a qualitative study. Glob Health Action. 2011 Nov 2;4:10.3402/gha.v4i0.7448. PMCID: PMC3208374
29. Nindrea RD, Usman E, Katar Y, Sari NP. Acceptance of COVID-19 vaccination and correlated variables among global populations: A systematic review and meta-analysis. Clin Epidemiol Glob Health. 2021;12:100899. PMCID: PMC8559452
30. Khan W, Khan J, Gul A, Naz A. Masculinity and family violence: an investigation into the Pakhtuns' violent masculinities in parental & spousal relations. 2022 Mar 15 [cited 2025 Jan 3]; Available from: https://zenodo.org/records/7627699
31. Wang Y, Liu Y. Multilevel determinants of COVID-19 vaccination hesitancy in the United States: A rapid systematic review. Prev Med Rep. 2022 Feb 1;25:101673.
32. Lupu D, Tiganasu R. Does education influence

COVID-19 vaccination? A global view. Heliyon. 2024 Jan 19;10(3):e24709. PMCID: PMC10837567
33. Greyson D, Bettinger JA. How do mothers' vaccine attitudes change over time? SSM - Qual Res Health. 2022 Dec 1;2:100060.
34. Malik AA, McFadden SM, Elharake J, Omer SB. Determinants of COVID-19 vaccine acceptance in the US. EClinicalMedicine. 2020 Sep;26:100495. PMCID: PMC7423333
35. Borga LG, Clark AE, D'Ambrosio C, Lepinteur A. Characteristics associated with COVID-19 vaccine hesitancy. Sci Rep. Nature Publishing Group; 2022 Jul 20;12(1):12435.
36. Government of Canada SC. Sociodemographic disparities in COVID-19 vaccine uptake and vaccination intent in Canada [Internet]. 2022 [cited 2025 Jan 3]. Available from: https://www150.statcan.gc.ca/n1/pub/82-003-x/2022012/article/00004-eng.htm

Conflicts of Interest Disclosure

There are no conflicts of interest to declare.

The Psychedelic Frontier: A Cross-Profession Review of Healthcare Providers' Attitudes on Psychedelic-Assisted Therapy in the US

Stefan Sampy[1], Rohan Sampy[2]

[1] Schulich School of Medicine & Dentistry, Western University, London, ON, Canada

[2] Department of Biomedical and Molecular Sciences, Queen's University, Kingston, ON, Canada

Correspondence:
Stefan Sampy;
stefansampy@gmail.com

Date Submitted: May 2, 2025
Date Accepted: July 4, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7456

Keywords: *healthcare provider attitudes, psychedelics, psychedelic-assisted therapy, PAT, psychotherapy*

ABSTRACT

Psychedelics, historically used for transcendent experiences, have garnered renewed interest for their potential therapeutic applications, particularly in treating mental health conditions such as depression, PTSD, and addiction. Despite initial enthusiasm in the mid-20th century, the War on Drugs led to a decades-long hiatus in research. However, recent studies have demonstrated promising clinical outcomes, reigniting interest in integrating psychedelic-assisted therapy (PAT) into modern medical practice. This review examines healthcare professionals' attitudes toward PAT, exploring how these attitudes vary across professions. A systematic literature review of 11 relevant articles, drawn from PubMed, Medline OVID, and EMBASE, assessed U.S. healthcare professionals' perceptions of PAT, focusing on attitudes and concerns. Healthcare professionals expressed cautiously favorable attitudes toward PAT, supporting further research and education, while concerns centered on potential psychiatric and neurocognitive risks, addiction relapse, and a lack of trained providers. The review also highlighted the importance of increasing awareness, training, and education in psychedelic medicine, with guidelines from the American Psychedelic Practitioners Association (APPA) emphasizing licensure and continued professional development. Despite some limitations, including an overrepresentation of psychiatrists and psychologists in the literature, this review underscores the importance of interdisciplinary collaboration and further research to facilitate PAT's integration into clinical practice.

RÉSUMÉ

Les psychédéliques, historiquement utilisés pour des expériences transcendantes, suscitent un regain d'intérêt en raison de leurs applications thérapeutiques potentielles, en particulier dans le traitement de troubles mentaux tels que la dépression, le syndrome de stress post-traumatique et la toxicomanie. Malgré l'enthousiasme initial au milieu du 20e siècle, la guerre contre la drogue a entraîné une interruption de plusieurs décennies dans la recherche. Cependant, des études récentes ont démontré des résultats cliniques prometteurs, ravivant l'intérêt pour l'intégration de la psychothérapie assistée par psychédéliques (PAP) dans la pratique médicale moderne. Cette revue examine les attitudes des professionnels de santé à l'égard de la PAP, en explorant comment ces attitudes varient selon les professions. Une revue systématique de la littérature portant sur 11 articles pertinents, tirés de PubMed, Medline OVID et EMBASE, a évalué la perception des professionnels de santé américains à l'égard de la PAP, en se concentrant sur leurs attitudes et leurs préoccupations. Les professionnels de santé ont exprimé des attitudes favorables mais prudentes à l'égard de la PAP, soutenant la poursuite de la recherche et de l'éducation, tout en exprimant des préoccupations centrées sur les risques psychiatriques et neurocognitifs potentiels, la rechute de la dépendance et le manque de prestataires formés. La revue a également souligné l'importance de sensibiliser, de former et d'éduquer davantage dans le domaine de la médecine psychédélique, avec des directives de l'American Psychedelic Practitioners Association (APPA) mettant l'accent sur l'octroi de licences et le développement professionnel continu. Malgré certaines limites, notamment une surreprésentation des psychiatres et des psychologues dans la littérature, cette revue souligne l'importance de la collaboration interdisciplinaire et de la poursuite des recherches pour faciliter l'intégration de la PAP dans la pratique clinique.

INTRODUCTION

Psychedelics are broadly defined as psychoactive substances that alter perception, cognition, and affect by acting on neural circuits in the brain.[1] Often, this can induce profound changes in consciousness, including visual and auditory hallucinations, ego dissolution, and mystical experiences.[2] These compounds can be classified into several pharmacological groups based on their primary mechanism of action. The classical serotonergic psychedelics, such as lysergic acid diethylamide (LSD), psilocybin (found in "magic mushrooms"), and N,N-dimethyltryptamine (DMT, the active compound in ayahuasca), primarily act as agonists or partial agonists at the 5-HT2A serotonin receptor, leading to increased cortical entropy and altered thalamocortical processing.[1,3] Ayahuasca, in particular, is a brew containing DMT and a monoamine oxidase inhibitor (MAOI) such as harmaline, which prevents the breakdown of DMT in the gut and liver, thereby extending its psychoactive effects from minutes to several hours.[4] In contrast, 3,4-methylenedioxymethamphetamine (MDMA) is classified as an empathogen-entactogen rather than a classical psychedelic; it primarily increases synaptic availability of serotonin, dopamine, and norepinephrine, fostering emotional openness and reduced fear processing—effects that have made it especially promising in the treatment of post-traumatic stress disorder (PTSD).[5] Additionally, substances such as ketamine, often considered a dissociative anesthetic, modulate glutamatergic neurotransmission via NMDA receptor antagonism, producing rapid-acting antidepressant effects and dissociative states.[6] Understanding these neuropharmacological distinctions is essential for clinicians and researchers evaluating the therapeutic potential of psychedelic-assisted therapies across diverse clinical settings.

For nearly 3000 years, humans have used psychedelic substances to access altered states of consciousness, providing mystical and transcendental experiences.[7] While traditionally linked to shamanic practices, modern scientific exploration of psychedelics began in 1938 with the synthesis of LSD by Swiss chemist Albert Hofmann, who also ingested the substance before his celebrated bicycle-ride home.[8] Profoundly affected by its psychological effects, Hofmann became a lifelong advocate for its potential therapeutic value. Through his writings and scientific advocacy, particularly in his memoir *LSD: My Problem Child*, Hofmann emphasized the importance of studying psychedelics within a medical and psychiatric framework. His influence helped shift early scientific attitudes from skepticism to curiosity, laying the groundwork for subsequent research into their clinical applications.[9] Since then, psychedelics have created both division and unity among those who were aware of their mind-altering effects.

The 1950s saw a surge in medical interest, with psychiatrists using LSD to treat tens of thousands of patients for conditions such as depression and substance use disorders.[10-12] As medical use grew, so did illicit use, and some viewed psychedelics as politically revolutionary, allowing these substances to shape the counterculture of the United States (US) in the 1960s.[8] In response to rising drug use, President Richard Nixon's War on Drugs, launched in 1971, led to the criminalization of psychedelics, effectively halting research and clinical applications for nearly two decades.[11,13,14]

Following years of advocacy from psychologists and psychiatrists, rigorous studies exploring the clinical utility of psychedelics have now expanded significantly.[8] In an era marked by growing mental health concerns and a crisis around "Deaths of Despair" (suicide, overdose, alcoholism), both of which were only exacerbated by the COVID-19 pandemic, the stage is set for psychedelics to transition from a taboo topic to one of therapeutic significance.[15,16] Research into LSD, psilocybin, MDMA, and ayahuasca has shown promise in treating conditions such as treatment-resistant depression, PTSD, autism, chronic pain, assisting in end-of-life care, and even in modulating the gut-brain axis.[17-21]

In light of the therapeutic potential of psychedelics, questions arise as to how modern medical professionals view the use of these substances in treating patients. While some research has assessed general attitudes among healthcare providers, there is a notable gap in literature examining profession-specific perspectives. Considering both that healthcare professionals were the primary drivers of the renaissance surrounding psychedelics and that many illnesses appear with complex comorbidities, the functioning of the interdisciplinary healthcare team has inevitably become tied to understanding the various current opinions in using psychedelic-assisted therapy (PAT). This review aims to assess current attitudes toward PAT across different healthcare professions, with the goal of enhancing interdisciplinary communication, informing clinical decision-making, and ultimately improving patient care.

METHODS

Article Collection

Articles were collected from the electronic databases PubMed, Medline OVID and EMBASE. The search involved a combination of MeSH (Medical Subject Headings), keywords, and title and abstract searches, utilizing a mix of terms related to 'historical perceptions & attitudes', 'psychedelic substances' and 'psychedelic-assisted therapy', that are outlined in **Table 1**.

Article Selection

The inclusion criteria for this study encompassed articles that 1) were published in English; 2) focused on healthcare providers in the U.S.; and 3) discussed the attitudes of various healthcare providers toward psychedelic-assisted therapies. Articles were excluded if they: 1) focused on populations other than healthcare providers; 2) focused on non-American healthcare providers; and 3) were not fully published articles at the time of this study (including abstracts and posters) or had been retracted. The article selection process is illustrated in **Figure 1**.

RESULTS

Following the initial search criteria, a total of 430 papers were collected (PubMed: 315, OVID Medline: 41, EMBASE: 74). Then, 47 duplicates were removed leaving 383 papers for further screening. Next, a title review was conducted which reduced the relevant articles to 53. An abstract review condensed the article number to 20 and a deeper manuscript review resulted in 6 papers. Finally, a manual search on Google yielded 6 additional articles for a total of 12 articles that fit within the research aim and inclusion criteria. Articles were excluded based on a predetermined exclusion criterion. One of the six manually identified articles had restricted access; despite efforts to contact the original author, the full text could not be obtained, reducing the final article count to 11. A summary of the findings from each article is detailed in **Table 2**.

Common Attitudes, Concerns and Predictive Factors

The final set of 11 articles comprised two systematic reviews, one interview thematic analysis and eight cross-sectional surveys. Overall, healthcare professionals expressed cautiously favorable attitudes towards PATs.[23-25] Common positive attitudes toward psychedelic therapies included broad support for further research and education, legalization of psychedelics for recreational and medical use and its potential as an alternative therapy for patients experiencing existential struggles.[22-32] Common concerns expressed by healthcare professionals included long-term psychiatric and neurocognitive damage, addiction relapse, ethical considerations, lack of research, lack of trained providers and financial costs.[22-29,31] Predictors of more positive attitudes toward PATs included greater awareness of PAT research, increased knowledge of psychedelics, younger age, male gender, and personal experience with psychedelics.[22,25-27,29,30,32]

Profession-Specific Attitudes Towards PAT

The healthcare professionals in this review encompassed psychologists, psychiatrists, social workers, counsellors, addiction specialists and mental health providers. There were no clear differences in positive attitudes across the professions with all expressing a degree of support for the therapeutic potential of PAT and the need for further research, education and training.

However, there were notable differences regarding the

Table 1. MeSH Terms and Keywords Used in the Literature Search

Category	MeSH Terms & Keywords
Historical Perceptions & Attitudes	Historical Perception, Health Humanities, Clinical Medicine, Attitude to Health, Cultural Evolution, Social Determinants of Health, Psychiatric History, Society and Health, Public Opinion, Cultural Views, Attitudes toward psychedelics, Social Perception, Psychedelic Stigma, Public Attitudes, Historical Views, Psychedelic Perception
Psychedelic Substances	Psychedelic Substances, Psychotropic Drugs, LSD, Lysergic Acid Diethylamide, Psilocybin, MDMA, 3,4-methylenedioxymethamphetamine, Dimethyltryptamine, Ayahuasca, Ketamine, Microdosing
Psychedelic-assisted Therapy	Psychedelic Therapy, Treatment-resistant Depression, Psychedelic-Assisted Therapy, Psychedelic Research, Psychedelic Psychiatry, Mental Health Treatment, Psychotherapy, Psychedelic Treatments, LSD therapy, Psilocybin Therapy, MDMA Therapy, Therapeutic Psychedelics, Psychedelic Medicine, Psychedelic Integration, Psychedelic drug research

MeSH – Medical Subject Heading; LSD – Lysergic Acid Diethylamide; MDMA –3,4-methylenedioxymethamphetamine

concerns of various healthcare professionals. Psychologists and psychiatrists were concerned with the psychiatric and neurocognitive risks of psychedelic use.[23,25] Addiction specialists were apprehensive about the addictive potential of psychedelics and the risk of relapse in patients with substance use disorders.[24,31] Social workers emphasized the necessity of psychological support in the administration of PAT, while mental health providers expressed concerns about the shortage of trained personnel.[27]

Unsurprisingly, each of the professionals' concerns were closely tied to their own profession demonstrating a profession-specific bias that influenced attitudes toward PAT. This implicit bias could affect the way clinicians make decisions about healthcare policies regarding the implementation of PAT, demonstrating the need for interdisciplinary consultation.[33] Negative media reporting of psychedelics may further compound existing biases by providing readily available information for clinicians to disprove the therapeutic potential of PAT.

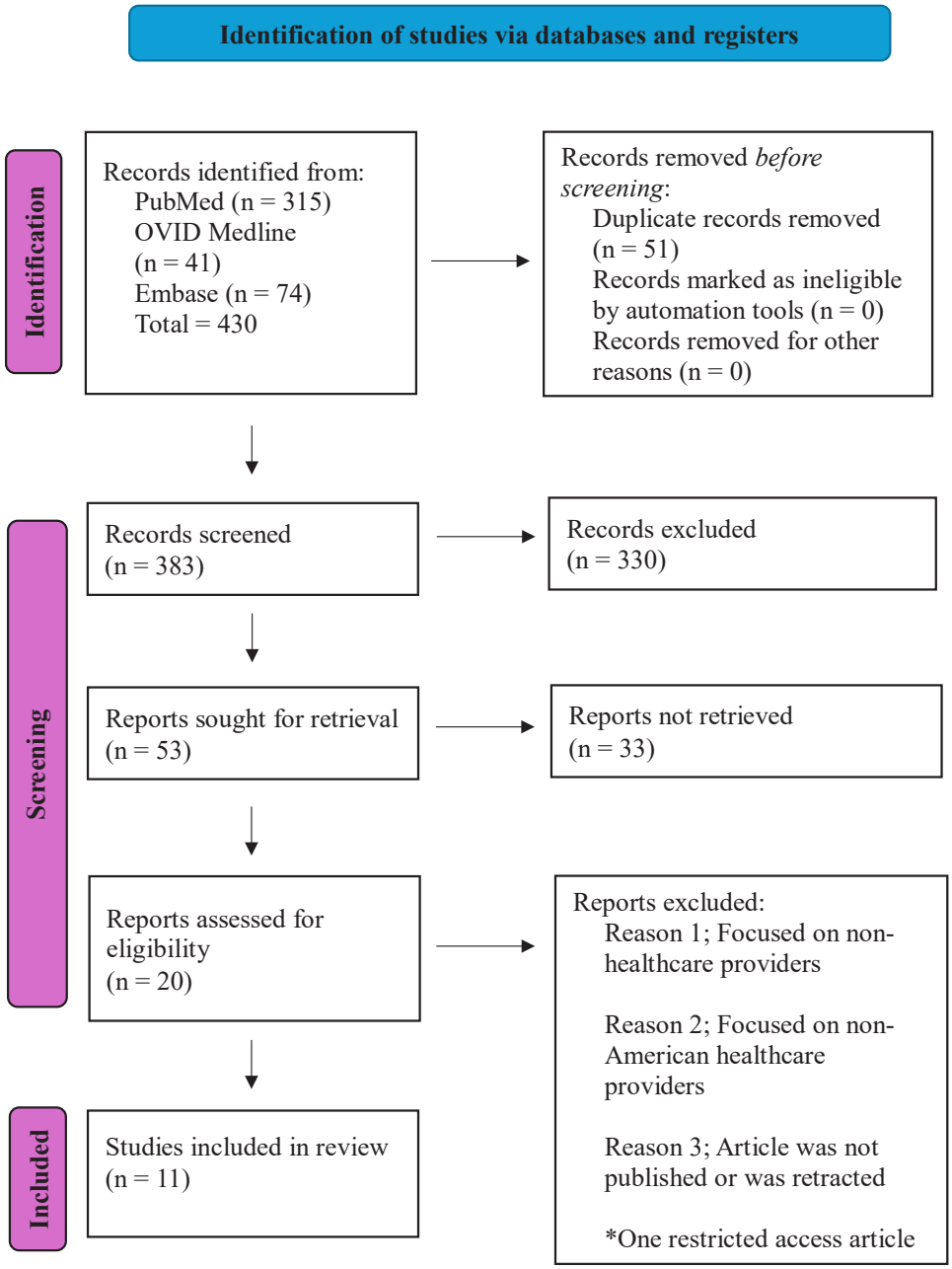


Figure 1. PRISMA flowchart for article selection

Table 2. Summary of Various Healthcare Providers' Attitudes Toward PAT (11 articles)

Author	Study Design	Healthcare Profession	Healthcare Providers' Attitudes & Perspectives	Study Limitations
Barta et al.[22]	Systematic Review (n=9 studies)	Undisclosed	-Greater awareness of PAT led to more receptive attitudes -Unreceptive attitudes over risks, ethics, media portrayals, practical barriers and stigma -Supported further research and education on PAT	-Exclusion of culturally diverse attitudes (such as traditional healers) -Mostly White participants limiting generalizability -Only studied four countries
Davis et al.[23]	Survey (n=366)	Clinical Psychologists	-Cautiously favorable attitude due to psychiatric and neurocognitive risks -Lack of understanding on psychedelics -Support for consultation and further research	-Low sample size creating sampling bias -Self-report, social desirability and stigma could influence results -Only surveyed clinical psychologists -Type 1 errors
Kim & Suzuki[24]	Survey (n=145)	Addiction Specialists	-Overall positive attitudes -Significant support for legalization -Concern for addictive potential -Greater awareness of PAT research led to more receptive attitudes	-Low response rate (32.4%) and sample size -Self-selection bias limited generalizability -Type 1 errors -Did not assess how clinical practice settings affect attitudes -Did not account for nonclassical psychedelics (e.g. Ibogaine)
Kucsera et al.[25]	Survey (n=237)	Psychiatrists, Psychologists, Therapists, Social Workers	-Limited knowledge on psychedelics and counselling -Supported further research, recreational & medical use and therapeutic potential -Concern over psychiatric risks -Uncomfortable discussing the effects of use -Increased knowledge led to more receptive attitudes	-Selection bias -Only included participants from California limiting generalizability -Self-report measures of clinical practice could lead to misclassification
Hearn et al.[26]	Survey (n=223)	Counselling Professionals	-No clear stance on PAT -Expressed concern over psychiatric and cognitive risks -Supported therapeutic potential -Older age and experience led to less positive attitudes -Females had less positive attitudes than males -Personal use of psychedelics led to more positive attitudes	-Low response rate (10%) -Self-selection bias -Did not assess counsellors' knowledge on psychedelics -Most participants from Wyoming and Ohio -Respondents were mostly White (83%) limiting generalizability -Did not analyze psychedelic-specific risks or stigma
Wang et al.[27]	Survey (n=879)	Physicians, Nurses, Mental Health Providers (MHPs)	-Supported therapeutic potential and legalization of psilocybin and MDMA, favoring psilocybin -Low knowledge on therapeutic use, risks, and pharmacology -Concern over untrained providers, cost, and contraindications	-No delineation between psilocybin-containing mushrooms and clinical grade psilocybin affecting attitudes -Convenience sampling and self-reports may create sampling and selection bias

			-Psychedelic use, increased knowledge, younger age, and profession predicted receptivity	-More psilocybin research than MDMA -Most participants were White females, limiting generalizability
Niles et al.[28]	Thematic Analysis of Interviews (n=19)	Physicians, Nurses, Psychologists, Social Workers	-Supported further research and access to PAT -Allows patients to reframe existential struggles -Alternative therapy to sedation or MAID -Concern over insufficient research & education, stigma, addiction and long-term risks -More negative attitudes toward LSD compared to psilocybin and ketamine -Difficult to integrate PAT into existing treatments	-Convenience and snowball recruiting methods may create sampling bias -Sample was skewed towards younger and less experienced clinicians who may have more positive attitudes -Minimal racial diversity limiting generalizability
Wells et al.[29]	Systematic Review (n=29 studies)	Psychiatrists, Doctors, Psychologists, Counsellors, Therapists, Support Workers	-Mixed beliefs on therapeutic potential -Male gender, younger age, and personal use predicted favourable attitudes -Supported more research and education -Concerns about legal status, funding, access, side-effects, and implementation -Limited knowledge on therapeutic application, risks and benefits	-Some studies had poorly outlined rationales, low sample sizes, unjustified data collection tools and incomplete reporting -Search criteria was adjusted after search which could have led to missing articles -Some of the included studies did not address the original research objectives
Reynolds et al.[30]	Survey (n=245)	Cancer healthcare practitioners	-Potential benefits for cancer patients -Supported PAT research including spiritual and Indigenous perspectives -Previous research experience predicted referrals to PAT trials -More experienced doctors were less likely to support further PAT research	-Attitudes were not stratified by different U.S states -Convenience and snowball recruiting methods could have led to self-selection bias limiting generalizability
Szpak et al.[31]	Survey (n=146)	Peer Recovery Coaches, Addiction Recovery Coaches	-Supported the use of psychedelics for substance use disorder (SUD) -Supported additional training and education -Concern over harmful effects, addiction relapse and legalization -Participants using 12-step programs were concerned about harmful effects -Personal history of psychedelics led to greater support for use in SUD treatment	-Low response rate (13.5%) -Participants only came from Massachusetts limiting generalizability -Sample participants were too homogenous -Did not consider how work settings or specific psychedelics could influence attitudes -Self-users were not controlled for, biasing attitudes
Sims and Holzworth[32]	Survey (n=168)	Social Workers	-Overall positive attitudes -Personal use, previous training, being male, and non-Christian predicted positive attitudes -Low knowledge on delivering psychedelics with psychological support, but willing to learn	-Convenience sampling led to unrepresentative sample population and self-selection bias -Personal use of psychedelics was not controlled for, biasing attitudes

PAT – Psychedelic-assisted Therapy; MDMA – 3,4-Methylenedioxymethamphetamine; LSD – Lysergic acid diethylamide; U.S – United States; SUD – Substance Use Disorder

DISCUSSION

The following section will discuss how negative media portrayals of psychedelics can bias attitudes toward PAT. Additionally, educational and regulatory actions required for the effective implementation of PAT into clinical practice will be discussed. Finally, the therapeutic promise and neuropsychiatric risks associated with psychedelic use will be highlighted.

Risk of Bias in Negative Media Reporting of Psychedelics

One of the most prominent examples of media framing to produce bias is COVID-19 coverage in the US. The use of the term "Chinese virus" by politicians and the media generated rampant misinformation and inflamed bigotry towards East Asian communities.[33] Blaming a disease on a specific ethnic population can reinforce xenophobia, stigma, and even shape public health policy in directions that are not evidence-based. This was observed at the beginning of the pandemic when misinformation regarding the origin of the virus led to a spike in anti-Asian hate crimes, racial profiling, and refusal of care by Asian-presenting healthcare providers.[34] This type of racialized framing also affected trained professionals. A national U.S. survey of healthcare workers found that Asian American medical professionals reported heightened workplace discrimination, patient mistrust, and even verbal abuse, contributing to psychological distress and professional burnout during the pandemic.[35] These findings demonstrate that biased media narratives can not only shape public sentiment but also permeate clinical environments, affecting how trained professionals are perceived and treated within the healthcare system.

Likewise, the general heritage of negative media representation of psychedelics as harmful, illegal drugs devoid of medicinal utility, has influenced professional and public opinion. The current public discourse broadcasts the use of psychedelics to the general population in a criminal, deviant, or plain socially undesirable context, minimizing or disregarding growing clinical research findings for the therapeutic promise of psychedelics.[36] This biased coverage is perhaps one factor in healthcare professionals' hesitation to view PAT as a viable treatment approach.

A response was justifiably warranted to counter the misinformation and racial bias amidst the COVID-19 pandemic with responsible reporting and public education, so the same should be warranted to clear up myths surrounding PAT. Clearly, there is a need for evidence-based education to aid healthcare professionals in critically evaluating emerging research, separating fact from stigma, and developing informed, unbiased positions regarding psychedelic therapies.

Increasing PAT Awareness, Training and Education Among Healthcare Professionals

As PAT clinical practice evolves, clinicians need to develop a sophisticated knowledge of its mechanisms, benefits, and limitations. To address this need, the American Psychedelic Practitioners Association (APPA) released 12 guidelines in 2023 to instruct practitioners in this new and evolving field.[37] The first three guidelines are directed at raising awareness, training, and education to support the safe and effective translation of PAT into clinical practice.

Increasing Awareness through Licensure and Certification

The initial guideline to raise awareness, encourages practitioners to familiarize themselves with the licensure and certification organizations overseeing PAT. Licensure, aside from being mandated by law, delineates a framework of professional duty. Certification requirements generally demand substantial education and supervised clinical practice, which are designed to supply a level of competence that is standard in nature among practitioners. By adhering to these standards, practitioners guarantee their commitment to the delivery of evidence-based and ethically appropriate care. Apart from this, increased awareness of regulatory requirements reduces possible legal risks and promotes more organized and rightful practice of PAT.

Comprehensive Training in Psychedelic Medicine

The second guideline points to the imperatives of thorough training of health professionals to equip them with the skills to navigate the complex psychological, physiological, and spiritual components of psychedelic experiences. Unlike other pharmacotherapies, PAT involves profound shifts in consciousness that demand specialty therapy intervention. Successful training programs must therefore involve a multidisciplinary curriculum in neuroscience, psychopharmacology, psychotherapy practices, harm reduction approaches, and ethics.

Other institutions have already developed education modules for these training needs. Yale University, for example, introduced an elective course, *Psychedelic Medicine: Past,*

Present, and Future, on some of the most significant topics such as indigenous healing traditions, psychedelic neurobiology, historical and contemporary research, clinical treatment models, and ethical considerations for psychedelic medicine[38]. The course has been popular, and this only goes to highlight the necessity of formal training courses in this discipline. Practitioners become competent and credible when they undergo such training, which serves to promote increased peer and patient confidence.

Dedication to Continuing Education and Professional Development

The third guideline is the need for continuing education and exposure to the latest research in PAT. As this is a rapidly evolving discipline, it is critical that practitioners remain cognizant of emerging clinical trials, evolving therapeutic paradigms, and updated regulatory guidelines. Continuing education may be obtained in many formats, including formal classes, attendance at professional conferences, participation in peer-reviewed research, and consultation with experts in the field. In addition, developing core therapeutic competencies—i.e., having a good relationship with patients, being non-judgmental and empathetic in one's presence, and being dedicated to highest ethical standards—is still at the heart of delivering effective PAT. For instance, Mastinu et al.'s review is a broad synthesis of psychedelic plant derivatives, pharmacological effects, legal frameworks, and clinical applications and is therefore an exceedingly helpful report for clinicians wishing to develop their knowledge practice in psychedelic medicine.[39]

Neurocognitive and Psychiatric Effects of Psychedelic Use

Concerns about the long-term neurocognitive and psychiatric consequences of psychedelics remain a powerful discouragement to their overall clinical embrace. A systematic review conducted by Velit-Salazar et al. discussed the neurocognitive consequences of various psychedelic drugs, including MDMA, cannabis, psilocybin, LSD, and ayahuasca, in otherwise healthy individuals.[40] The findings suggest that while the drugs hold therapeutic potential, they also pose novel risks to cognitive function and mental health.

MDMA impaired response inhibition, memory, and cognitive flexibility and induced rigid decision-making patterns.[41-46] Psychomotor performance, however, was improved when on MDMA. Cannabis, on the other hand, demonstrated widespread cognitive impairments, with detrimental effects on motor coordination, attention, memory, processing speed, and executive function.[47-49] LSD was found to be related to processing speed, memory, and executive function impairment but yielded inconclusive results for the effect on attention. Interestingly, certain studies also reported language-based skill improvement with LSD use.[40] Psilocybin was reported to exert a negative effect on executive function, processing speed, memory, and psychomotor function but is unclear regarding its effect on attention.[40] Ayahuasca, a natural plant psychedelic, was associated with executive function and memory impairment as well as reduced reaction time paradoxically[50].

Aside from cognitive effects, psychiatric effects of psychedelic use have also been reported. A case series systematic review by Yildirim et al. evaluated the prevalence of psychiatric conditions following psychedelic use.[51] The review identified seventeen schizophrenia, seventeen affective disorders (depression, mania, or both), three anxiety disorders, one depersonalization disorder, and one case of an unclassifiable psychiatric condition that occurred following the use of psychedelics.

Worryingly, 11 of 17 instances of affective disorders and schizophrenia occurred after a single psychedelic drug experience.[51] In spite of symptom resolution over time in some of the patients with drug-induced affective disorders and flashback symptoms, long-term psychiatric disturbance was noted in most of them.[51]

The risk of adverse psychiatric outcomes following psychedelic use may also be tied to individual vulnerability, particularly genetic predisposition to psychotic or affective disorders. Serotonergic hallucinogens such as LSD and psilocybin are known to exert psychomimetic effects, transiently inducing experiences that resemble psychosis, including perceptual distortions, paranoia, and ego dissolution.[1] These effects are generally short-lived in healthy individuals but may precipitate or unmask underlying psychiatric illness in susceptible populations.[41,52] Genetic predisposition to schizophrenia and bipolar disorder, for instance, has been implicated in amplifying sensitivity to serotonergic dysregulation and cortical excitation, both of which are core neurochemical effects of classical psychedelics.[3] In light of this, most modern PAT trials explicitly exclude participants with a personal or first-degree family history of psychotic disorders, acknowledging the elevated risk of decompensation in this population.[53] In the

large-scale review conducted by Yildirim et al, many of the reported cases of psychedelic-induced schizophrenia or mania likely reflected the emergence of latent psychopathology rather than de novo onset in previously unaffected individuals.[51] Thus, while concerns about long-term psychiatric sequelae are valid, they must be contextualized within the broader framework of pre-existing vulnerability and trial design.

These results highlight the need for a guarded and evidence-driven strategy for incorporating PAT into clinical practice, requiring careful patient screening, clearly established dosing regimens, and follow-up evaluations to avert adverse effects. As studies in this area evolve, further research is needed to clarify the determinants of adverse outcomes and to create detailed guidelines for optimizing therapeutic benefit while ensuring patient safety.

Comparative Provider Attitudes Toward Other Controversial Therapies

To contextualize healthcare professionals' views on PAT, it is informative to examine attitudes toward other once-stigmatized therapies such as medical cannabis and ketamine. Similar to psychedelics, early perceptions of medical cannabis were marked by skepticism due to its recreational use and legal status. However, studies have shown that as evidence accumulated for its efficacy in chronic pain, multiple sclerosis, and chemotherapy-induced nausea, provider attitudes became more favorable—especially among younger physicians and those with greater clinical exposure to cannabis therapies.[54] Ketamine, traditionally used as an anesthetic, also faced initial resistance due to its dissociative and addictive potential. Yet, growing evidence for its rapid-acting antidepressant effects in treatment-resistant depression has led to broader acceptance, particularly in psychiatric settings, though concerns about long-term cognitive risks and misuse remain.[55,56] These parallels suggest that attitudes toward emerging therapies are often shaped less by the intrinsic properties of the substance and more by regulatory legitimacy, public discourse, and the strength of clinical evidence. Thus, the evolving perceptions of cannabis and ketamine provide a roadmap for understanding the cautious optimism—and ongoing concerns—surrounding PAT.

Strengths and Limitations of the Final Articles

A key strength of the systematic reviews conducted by Barta et al. and Wells et al. was their comprehensive synthesis of attitudes, concerns, and predictive factors within a single publication.[22,29] However, the review conducted by Barta et al. was limited by the narrow participant demographic and the inclusion of only four countries.[22] The review by Wells et al. was limited by the poor quality of analyzed papers and the revision of the search criteria which could have led to missing articles.[29]

The eight cross-sectional surveys benefited from larger sample sizes but shared common methodological limitations. The use of self-reports, convenience sampling and snowball recruitment techniques could have led to sampling and selection bias thus limiting the generalizability of the findings. Other survey limitations included homogenous sample participants, low response rates and the potential for bias among participants who had personal histories with psychedelics.[23-27,30-32]

Niles et al. conducted the only content analysis among the selected studies, providing valuable insights from healthcare providers with firsthand experience using PATs in clinical practice.[28] Furthermore, the study compared attitudes toward different psychedelics offering more specific views. However, the same study was limited by convenience and snowball recruiting techniques.[28] Furthermore, Niles et al. reported that their sample skewed toward younger, less experienced clinicians with minimal racial diversity, resulting in an unrepresentative participant pool.[28]

Limitations of the Present Review

This review has several limitations that must be acknowledged. Firstly, there is a notable scarcity of literature that examines how attitudes toward different psychedelics vary by profession. Popular psychedelics benefit from increased media exposure and accessibility by garnering more research interest. However, this possibility makes it challenging to evaluate the attitudes toward less popular psychedelics. Moreover, the search criteria employed may have inadvertently excluded relevant and insightful articles, particularly those focused on less common psychedelics.
Another limitation was the disproportionate representation of psychiatrists and psychologists in the selected studies, which restricted the ability to identify meaningful differences in attitudes across a broader range of healthcare professionals. However, it is important to acknowledge that the predominance of psychiatrists and psychologists in the literature may, in part, reflect the current regulatory and professional landscape of PAT. In most jurisdictions, psy-

chotherapy is a controlled act legally restricted to certain professionals, including psychologists and psychiatrists, who are also most likely to possess the clinical authority to supervise or prescribe psychedelic treatments under investigational or compassionate-use frameworks.[57] Consequently, their overrepresentation in PAT studies may not reflect a sampling bias, but rather the reality that these professionals constitute the core group qualified to implement and evaluate such therapies. This underscores the need for future research to explore interdisciplinary collaboration in PAT delivery, while recognizing the specialized training and legal scope of practice that currently centers PAT within mental health disciplines.

Another important limitation concerns the potential for sampling bias across the included studies. Many relied on self-selected participants from professional organizations or online surveys, which may overrepresent individuals with pre-existing interest or favorable views toward PAT, thereby skewing results. Furthermore, definitional inconsistencies across studies—such as variable criteria for what constitutes "support," "concern," or even "psychedelic-assisted therapy"—complicate direct comparisons and synthesis of findings. These disparities limit the interpretability of aggregated data and may obscure subtle but meaningful differences between professional groups. The lack of longitudinal data in most included studies also hinders our ability to evaluate how attitudes evolve over time, especially in response to shifting legal frameworks or emerging clinical trial results. Finally, the use of only U.S.-based studies introduces a geographic bias that may limit the global applicability of our findings. Given that healthcare delivery models, regulatory structures, and cultural attitudes toward psychedelics vary internationally, these results may not fully reflect the perspectives of clinicians in other countries.58 Future research should prioritize more representative sampling, harmonized definitions, cross-national comparisons, and longitudinal tracking to enhance the generalizability and depth of understanding in this emerging field.

The present study was not able to examine one relevant article due to restricted access. The article was titled *Psychoanalyst attitudes towards psychedelic-assisted therapy* and was published by Kraiem et al.[59] Although, efforts were made to contact the author, the paper remained inaccessible which limited the scope our review.

In spite of these limitations, the overall effect of this review is still robust. The fact that a variety of healthcare professionals were included gives a wide-ranging view of attitudes towards PAT, counteracting the overrepresentation of psychologists and psychiatrists. Furthermore, an attempt was made to obtain a high breadth of studies by using extensive search criteria, reducing the exclusion of pertinent articles. Although a few psychedelics garnered more media attention than others, the trends found nevertheless offer useful insight in the context of general perception of PAT. Finally, the absent study was discussed openly so that its absence cannot take away from the integrity of our results.

CONCLUSION

Overall, the healthcare professionals across the different disciplines had a cautious positive perception of PAT. Though there was consistency in the recognition of its therapeutic value, the objections were discipline-specific, reflecting bias and concerns in each discipline. Some of the major recommendations emerging from this review are increased awareness, profession-specific training, and ongoing updating of healthcare professionals for facilitating informed and responsible adoption of PAT. Second, this review underscores the necessity to respect the presumed neurocognitive and psychiatric risks of psychedelic administration. Such considerations need to guide the next phase of developing proof-of-concept protocols that maximize therapeutic benefit and minimize risk. Further research would need to longitudinally evaluate the effect of targeted training and education interventions on the attitudes of healthcare professionals towards PAT. Clinical trials evaluating the effectiveness and harms of PAT would also be imperative to informing best practice and evidence-informed policy regarding the implementation of psychedelics in mainstream clinical practice.

REFERENCES

1. Nichols DE. Psychedelics. Pharmacol Rev. 2016 Apr;68(2):264–355.
2. King IV F. 02. The Mechanisms and Effects of Psychedelics [Internet]. Psychopharmacology Institute; 2024 Sep 1 [cited 2025 June 11]. Available from: https://psychopharmacologyinstitute.com/section/the-mechanisms-and-effects-of-psychedelics-2813-5748.
3. Carhart-Harris RL, Friston KJ. REBUS and the Anarchic Brain: Toward a Unified Model of the Brain Action of Psychedelics. Pharmacol Rev. 2019 Jul;71(3):316–44.
4. Passie T, Emrich HM, Karst M, Brandt SD, Halpern JH. Mitigation of post-traumatic stress symptoms by Cannabis resin: A review of the clinical and neurobiological evidence.

Drug Test Anal. 2012 Jul 26;4(7–8):649–59.
5. Mithoefer MC, Feduccia AA, Jerome L, Mithoefer A, Wagner M, Walsh Z, et al. RETRACTED ARTICLE: MDMA-assisted psychotherapy for treatment of PTSD: study design and rationale for phase 3 trials based on pooled analysis of six phase 2 randomized controlled trials. Psychopharmacology (Berl). 2019 Sep 1;236(9):2735–45.
6. Krystal JH, Abdallah CG, Sanacora G, Charney DS, Duman RS. Ketamine: A Paradigm Shift for Depression Research and Treatment. Neuron. 2019 Mar;101(5):774–8.
7. Gobbi G. The psychopharmacology of psychedelics: where the brain meets spirituality (CCNP Innovations in Neuropsychopharmacology Award). J Psychiatry Neurosci. 2024 Sep 19;49(5):E301–18.
8. Doblin RE, Christiansen M, Jerome L, Burge B. The Past and Future of Psychedelic Science: An Introduction to This Issue. J Psychoactive Drugs. 2019 Mar 15;51(2):93–7.
9. Hofmann A. LSD — My Problem Child. McGraw-Hill; 1979.
10. Grinspoon L, Bakalar JB. Psychedelic Drugs Reconsidered. 3rd ed. New York: The Lindesmith Center; 1997
11. Dyck E. LSD: a new treatment emerging from the past. CMAJ. 2015 Oct 6;187(14):1079–80.
12. Carhart-Harris RL, Goodwin GM. The Therapeutic Potential of Psychedelic Drugs: Past, Present, and Future. Neuropsychopharmacology. 2017 May 10;42(11):2105–13.
13. Cohen A, Vakharia SP, Netherland J, Frederique K. How the war on drugs impacts social determinants of health beyond the criminal legal system. Ann Med. 2022 Jul 19;54(1):2024–38.
14. Stone BM. The War on Drugs has Unduly Biased Substance Use Research. Psychol Rep. 2022 Dec 20;127(4):2087–94.
15. Vahratian A, Blumberg SJ, Terlizzi EP, Schiller JS. Symptoms of Anxiety or Depressive Disorder and Use of Mental Health Care Among Adults During the COVID-19 Pandemic — United States, August 2020–February 2021. MMWR Morb Mortal Wkly Rep. 2021 Apr 2;70(13):490–4.
16. George DR, Hanson R, Wilkinson D, Garcia-Romeu A. Ancient Roots of Today's Emerging Renaissance in Psychedelic Medicine. Cult Med Psychiatry. 2022 Sep 2;46(4):890–903.
17. Rosenbaum D, Boyle AB, Rosenblum AM, Ziai S, Chasen MR, Med) Mp. Psychedelics for psychological and existential distress in palliative and cancer care. Curr Oncol. 2019 Aug 1;26(4):225–6.
18. Luoma JB, Chwyl C, Bathje GJ, Davis AK, Lancelotta R. A Meta-Analysis of Placebo-Controlled Trials of Psychedelic-Assisted Therapy. J Psychoactive Drugs. 2020 Aug 7;52(4):289–99.
19. Bird CIV, Modlin NL, Rucker JJH. Psilocybin and MDMA for the treatment of trauma-related psychopathology. Int Rev Psychiatry. 2021 Apr 3;33(3):229–49.
20. Nutt D. Psychedelic drugs—a new era in psychiatry? Dialogues Clin Neurosci. 2019 Jun 30;21(2):139–47.
21. Kelly JR, Clarke G, Harkin A, Corr SC, Galvin S, Pradeep V, et al. Seeking the Psilocybiome: Psychedelics meet the microbiota-gut-brain axis. Int J Clin Health Psychol. 2022 Dec 14;23(2):100349.
22. Barta S, Brooker J, O'Callaghan C. Health Care Workers' Attitudes Toward and Knowledge of the Clinical Application of Classic Psychedelics for People with Serious Illness: A Systematic Review. J Palliat Med. 2024 Dec 4;0(0):1-14.
23. Davis AK, Agin-Liebes G, España M, Pilecki B, Luoma J. Attitudes and Beliefs about the Therapeutic Use of Psychedelic Drugs among Psychologists in the United States. J Psychoactive Drugs. 2021 Sep 1;54(4):309–18.
24. Kim A, Suzuki J. Addiction specialists' attitudes toward psychedelics: A National Survey. Am J Addict. 2023 Aug 7;32(6):606–9.
25. Kucsera A, Suppes T, Haug NA. Psychologists' and psychotherapists' knowledge, attitudes, and clinical practices regarding the therapeutic use of psychedelics. Clin Psychology and Psychoth. 2023 Jul 2;30(6):1369–79.
26. Hearn BG, Brubaker MD, Richardson G. Counselors' attitudes toward psychedelics and their use in therapy. J Couns Dev. 2022 Mar 19;100(4):364–73.
27. Wang E, Mathai DS, Gukasyan N, Nayak S, Garcia-Romeu A. Knowledge, attitudes, and concerns about psilocybin and MDMA as novel therapies among U.S. healthcare professionals. Sci Rep. 2024 Nov 14;14(1):28022.
28. Niles H, Fogg C, Kelmendi B, Lazenby M. Palliative care provider attitudes toward existential distress and treatment with psychedelic-assisted therapies. BMC Palliat Care. 2021 Dec 20;20(1):191.
29. Wells A, Fernandes M, Reynolds L. Perceptions and attitudes towards psychedelic-assisted psychotherapy among health professionals, patients, and the public: A systematic review. J Psychedelic Stud. 2024 Apr 10;8(1):43–62.
30. Reynolds LM, Barnett B, Weleff J, Morunga E, Wells A, Stack A, et al. The perceptions of cancer health-care practitioners in New Zealand and the USA toward psychedelic-assisted therapy with cancer patients: A cross-sectional survey. Palliat Support Care. 2022 Nov 3;22(4):664–73.
31. Szpak V, Kim A, Sager Z, Suzuki J. Survey of Massachusetts peer recovery coaches' attitudes toward the use of psychedelics to treat substance use disorders. Addict Sci Clin Pract. 2024 Nov 25;19(1):86.
32. Sims EN, Holzworth J. Social Worker Attitudes towards Psychedelics. Clin Soc Work J. 2025 Feb 6;53(1):1–11.
33. Gopal DP, Chetty U, O'Donnell P, Gajria C, Blackadder-Weinstein J. Implicit bias in healthcare: clinical practice, research and decision making. Future Healthc J. 2021 Mar 29;8(1):40–8.
34. Perng W, Dhaliwal SK. Anti-Asian Racism and COVID-19: How It Started, How It Is Going, and What We Can Do. Epidemiology. 2022 May 1;33(3):379-82.
35. Ertorer SE. Racism and Mental Health: Examining the Psychological Toll of Anti-Asian Racism during the COVID-19 Pandemic. Genealogy. 2024 Aug 2;8(3):98.
36. Feher, Orsolya. Psychedelics and the media in the Visegrad countries. J. Psychedelic Stud. 2018 Aug;2(2):1-11.
37. https://www.brainfutures.org [Internet]. Seattle: American Psychedelic Practitioners Association; c2025 [cited 2025 Feb 27]. Available from: https://www.brainfutures.org/wp-content/uploads/2023/08/Professional-Practice-Guidelines-for-Psychedelic-Assisted-Therapy-Aug-2023.pdf
38. Prueitt WL, Sloshower J. Psychedelic Medicine: Creating an Introductory Course for Mental Health Professionals and Trainees. Acad Psychiatry. 2023 Feb 26;47(1):74–7.
39. Mastinu A, Anyanwu M, Carone M, Abate G, Bonini SA, Peron G, et al. The Bright Side of Psychedelics: Latest Advances and Challenges in Neuropharmacology. Int J Mol Sci. 2023 Jan 10;24(2):1329.
40. Velit-Salazar MR, Shiroma PR, Cherian E. A Systematic Review of the Neurocognitive Effects of Psychedelics in Healthy Populations: Implications for Depressive Disorders and Post-Traumatic Stress Disorder. Brain Sci. 2024 Mar 3;14(3):248.
41. Vollenweider FX, Gamma A, Liechti M, Huber T. Psychological and Cardiovascular Effects and Short-Term Sequelae of MDMA ("Ecstasy") in MDMA-Naïve Healthy Volunteers. Neuropsychopharmacology. 1998 Oct;19(4):241–51.
42. Liechti ME, Vollenweider FX. Which neuroreceptors mediate the subjective effects of MDMA in humans? A summary of mechanistic studies. Hum Psychopharmacol. 2001 Dec 12;16(8):589–98.
43. Dumont GJH, Wezenberg E, Valkenberg MMGJ, De Jong CAJ, Buitelaar JK, Van Gerven JMA, et al. Acute neuropsychological effects of MDMA and ethanol (co-) administration in healthy volunteers. Psychopharmacology. 2008 Apr 28;197(3):465–74.
44. Van Wel JHP, Kuypers KPC, Theunissen EL, Bosker WM, Bakker K, Ramaekers JG. Effects of Acute MDMA Intoxication on Mood and Impulsivity: Role of the 5-HT2 and 5-HT1 Receptors. Mendelson JE, editor. PLoS ONE. 2012 Jul 10;7(7):e40187.
45. Farré M, De La Torre R, Ó Mathúna B, Roset PN, Peiró AM, Torrens M, et al. Repeated doses administration of MDMA in humans: pharmacological effects and pharmacokinetics. Psychopharmacology. 2004 Apr 8;173(3–4):364–75.
46. Dumont G, Van Hasselt J, De Kam M, Van Gerven J, Touw D, Buitelaar J, et al. Acute psychomotor, memory and

subjective effects of MDMA and THC co-administration over time in healthy volunteers. J Psychopharmacol. 2011 Sep 3;25(4):478–89.
47. Wallace M, Schulteis G, Atkinson JH, Wolfson T, Lazzaretto D, Bentley H, et al. Dose-dependent Effects of Smoked Cannabis on Capsaicin-induced Pain and Hyperalgesia in Healthy Volunteers. Anesthesiology. 2007 Nov 1;107(5):785–96.
48. Spindle TR, Cone EJ, Schlienz NJ, Mitchell JM, Bigelow GE, Flegel R, et al. Acute Effects of Smoked and Vaporized Cannabis in Healthy Adults Who Infrequently Use Cannabis: A Crossover Trial. JAMA Netw Open. 2018 Nov 30;1(7):e184841.
49. Crean RD, Crane NA, Mason BJ. An Evidence Based Review of Acute and Long-Term Effects of Cannabis Use on Executive Cognitive Functions. J Addict Med. 2011 Mar 1;5(1):1–8.
50. Lai MK, Tsang SW, Alder JT, Keene J, Hope T, Esiri MM, et al. Loss of serotonin 5-HT2A receptors in the postmortem temporal cortex correlates with rate of cognitive decline in Alzheimer's disease. Psychopharmacology. 2004 Nov 18;179(3):673–7.
51. Yildirim B, Sahin SS, Gee A, Jauhar S, Rucker J, Salgado-Pineda P, et al. Adverse psychiatric effects of psychedelic drugs: a systematic review of case reports. Psychol Med. 2024 Nov 20;54(15):1–13.
52. Preller KH, Vollenweider FX. Phenomenology, Structure, and Dynamic of Psychedelic States. In: Nichols DE, editor. Behavioral Neurobiology of Psychedelic Drugs. Heidelberg: Springer; 2016. p. 221–56.
53. Studerus E, Kometer M, Hasler F, Vollenweider FX. Acute, subacute and long-term subjective effects of psilocybin in healthy humans: a pooled analysis of experimental studies. Journal of Psychopharmacology. 2011 Nov 20;25(11):1434–52.
54. Gardiner KM, Singleton JA, Sheridan J, Kyle GJ, Nissen LM. Health professional beliefs, knowledge, and concerns surrounding medicinal cannabis – A systematic review. PLoS One. 2019 May 6;14(5):e0216556.
55. Wilkinson ST, Toprak M, Turner MS, Levine SP, Katz RB, Sanacora G. A Survey of the Clinical, Off-Label Use of Ketamine as a Treatment for Psychiatric Disorders. American Journal of Psychiatry. 2017 Jul 1;174(7):695–6.
56. Short B, Fong J, Galvez V, Shelker W, Loo CK. Side-effects associated with ketamine use in depression: a systematic review. Lancet Psychiatry. 2018 Jan;5(1):65–78.
57. Koffman R. Psychedelic-Assisted Therapy: Healing the "Wounds of War" [Internet]; 2024 Apr 9-11 [cited 2025 Jun 11]. Available from: https://www.socom.mil/care-coalition/SiteAssets/Conference-2024/Psychedelic%20Assisted%20Therapy%20Dr.%20Koffman.pdf?utm_source=chatgpt.com
58. Reiff CM, Richman EE, Nemeroff CB, Carpenter LL, Widge AS, Rodriguez CI, et al. Psychedelics and Psychedelic-Assisted Psychotherapy. American Journal of Psychiatry. 2020 May 1;177(5):391–410.
59. Kraiem, E., Diener, M., Guss, J., Mavrides, L., & Saban, S. Psychoanalyst attitudes towards psychedelic-assisted therapy. Drugs: Education, Prevention and Policy. 2024 June 4:1–12.

Conflicts of Interest Disclosure

There are no conflicts of interest to declare.

Evaluating the Effect of a Pre-Arrival CPR Checklist on Resuscitation Quality During a Simulated Cardiac Arrest

Doran Drew[1], Michael O'Brien[1], Warren J. Cheung[1,2,3], Lindsey McMurray[1], Ashley Krown[1], Marie-Joe Nemnom[2], Christian Vaillancourt[1,2]

[1] Department of Emergency Medicine, The Ottawa Hospital, University of Ottawa, Ottawa, Ontario, Canada

[2] The Ottawa Hospital Research Institute, Ottawa, Ontario, Canada

[3] Royal College of Physicians and Surgeons of Canada, Ottawa, Ontario, Canada

Correspondence:
Doran Drew; dodrew@toh.ca

Date Submitted: January 13, 2025
Date Accepted: March 29, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7335

Keywords: *CPR, resuscitation, simulation, checklist, cardiac arrest*

ABSTRACT

Introduction: While high-quality CPR is a cornerstone of cardiac arrest management, studies show variability in adherence to resuscitation guidelines. We sought to evaluate the effect of a CPR checklist on adherence to resuscitation guidelines during a simulated cardiac arrest scenario.

Methods: We conducted a double-blind randomized controlled trial involving Canadian emergency medicine residents. The intervention group was presented with a CPR checklist during the pre-brief and scenario, whereas the control group was not. The simulation scenario consisted of an adult patient arresting shortly after arrival to the emergency department, following which actor-provided ventilations and chest compressions deteriorated in a standardized fashion. We measured correction of deteriorating CPR quality and report the proportion of time during which high-quality CPR elements were provided.

Results: Thirty-five of 53 residents completed the study before COVID-19 closure. No difference in total arrest time with no or low-quality chest compressions was observed in the intervention group [median = 0.29 (interquartile range (IQR) 0.23-0.36)] vs. control [median = 0.42 (IQR 0.31-0.49)] p = 0.07. A significantly lower proportion of poor-quality chest compressions was observed in the intervention group [median = 0.24 (IQR 0.20-0.38)] vs. control [median = 0.42 (IQR 0.33-0.61)] p = 0.03. Furthermore, a significantly lower proportion of time with unacceptably high bag-mask ventilation rates were observed in the intervention group [median = 0.81 (IQR 0.61-1.00)] vs. control [median = 1.00 (IQR 1.00-1.00)] p = 0.02.

Conclusions: Our CPR checklist improved adherence to resuscitation guidelines amongst resident physicians in a simulated scenario.

RÉSUMÉ

Introduction : Bien qu'une RCP de haute qualité soit la pierre angulaire de la prise en charge de l'arrêt cardiaque, des études montrent que l'adhérence des directives de réanimation varie. Nous avons cherché à évaluer l'effet d'une liste de contrôle pour la RCP sur l'adhérence des directives de réanimation lors d'un scénario simulé d'arrêt cardiaque.

Méthodes : Nous avons mené un essai contrôlé randomisé en double aveugle auprès de résidents en médecine d'urgence canadiens. Le groupe d'intervention a été présenté avec une liste de contrôle pour la RCP lors de la séance d'information préalable et du scénario, contrairement au groupe témoin. Le scénario de simulation consistait en l'arrêt cardiaque d'un patient adulte peu après son arrivée aux urgences, à la suite duquel les ventilations et les compressions thoraciques effectuées par un acteur se détérioraient de manière standardisée. Nous avons mesuré la correction de la détérioration de la qualité de la RCP et rapporté la proportion de temps pendant laquelle des éléments de RCP de haute qualité ont été fournis.

Résultats : Trente-cinq des 53 résidents ont terminé l'étude avant la fermeture due à la COVID-19. Aucune différence dans la durée totale de l'arrêt cardiaque sans compressions thoraciques ou avec des compressions thoraciques de mauvaise qualité n'a été observée entre le groupe d'intervention [médiane = 0,29 (intervalle interquartile (IQR) 0,23-0,36)] et le groupe témoin [médiane = 0,42 (IQR 0,31-0,49)] (p = 0,07). Une proportion significativement plus faible de compressions thoraciques de mauvaise qualité a été observée dans le groupe d'intervention [médiane = 0,24 (IQR 0,20-0,38)] par rapport au groupe témoin [médiane = 0,42 (IQR 0,33-0,61)] p = 0,03. En outre, une proportion significativement plus faible de temps avec des taux de ventilation au masque et au ballon inacceptablement élevés a été observée dans le groupe d'intervention [médiane = 0,81 (IQR 0,61-1,00)] par rapport au groupe témoin [médiane = 1,00 (IQR 1,00-1,00)] p = 0,02.

Conclusions : Notre liste de contrôle pour la RCP a amélioré l'adhérence des directives de réanimation par les médecins résidents dans un scénario simulé.

INTRODUCTION

Cardiopulmonary resuscitation (CPR) and defibrillation represent the pillars of cardiac arrest management. Early effective CPR has been identified as the single most important intervention for patient survival following cardiac arrest (1,2). Resuscitation guidelines highlight five components of high-quality CPR, all of which are associated with improved survival to hospital discharge: 1) 100-120 compressions/minute; 2) minimal interruptions (chest compression fraction >80%); 3) compression depth > 5 cm in adults; 4) full chest recoil without leaning; and 5) ventilation rate <12 breaths/minute (1,3–8). These components of high-quality CPR have also recently been shown to increase survival to hospital discharge and neurologically intact survival when resuscitation efforts last for longer than 10 minutes (9).

The foundational knowledge and skillset involved in managing a cardiac arrest is primarily taught to physicians through basic life support (BLS) and advanced cardiac life support (ACLS) programs, with supplementation during residency training. Residents comprise a large component of the healthcare workforce and are routinely involved in cardiac arrest management during training. While BLS and ACLS programs provide trainees with a foundational basis for managing cardiac arrests, these brief courses alone cannot be expected to teach mastery of the critical ability to recognize and correct poor quality CPR. Literature has frequently reported sub-optimal quality of administered CPR and high variability in survival rates (1,9–11). A key pedagogical technique used to help residents acquire resuscitation and leadership skills is high-fidelity simulation. The literature on simulation for medical education has demonstrated improvements in trainee confidence, teamwork skills, and performance (12–18). Simulation has also been used to evaluate interventions aimed at improving CPR quality among medical trainees (12–18). Checklists have been implemented in healthcare as tools to facilitate a structured approach to critical problems, such as an operation or airway management, but have not yet been popularized as adjuncts to ensure CPR quality (19–23).

We sought to use simulation as an investigational method to evaluate the impact of a CPR checklist on resuscitation quality when used by emergency medicine (EM) residents in a cardiac arrest scenario. Our primary objective was the measurement of proportion of total arrest time without high-quality chest compressions. As secondary objectives, we measured: number of CPR cycles in which inadequate compressions were identified, proportion of time with inadequate chest compressions, total no compression time, number of pulse checks >10 seconds, and the proportion of time with a bag-mask ventilation (BMV) rate >12 breaths/min.

METHODS

Study Design

A randomized controlled trial comparing adherence to resuscitation guideline-recommended CPR performance between an intervention group using a pre-arrival CPR quality checklist and a control group without a checklist was conducted. Randomization was 1:1 and conducted in blocks of ten, stratified by year of residency training. Each study participant ran a single simulation scenario, with the rest of their team made up of trained study actors. The randomization sequence was generated using the Sealed Envelope Ltd. (2019) software (24). Participant assignment was concealed in equally weighted sealed opaque envelopes. Participants were blinded to both the intervention and study outcomes, while the data collector was blinded to group allocation.

Setting

The study was conducted between July 2019 and March 2020 at The University of Ottawa Skills and Simulation Centre (uOSSC), located in Ottawa, ON, Canada. Consent process, sharing of study forms, and initial scenario description (**Supplement 1**) occurred in a conference room. The session occurred in one of three identical high-fidelity simulation rooms.

Each simulation room was equipped with video recording technology, a high-fidelity computerized simulation mannequin (Laerdal 3G Plus), cardiac monitors, an emergency airway cart, and cardiac arrest 'crash' cart. The contents of these carts were standardized and prepared before each simulation case. Video recording technology and the display on all in-room monitors was operated by an experienced simulation technician in a control room. The simulation rooms were familiar to the residents and equipment/layout was similar to the emergency department where the residents practiced.

The cardiac arrest cart was equipped with an R-series Zoll defibrillation monitor with CPR feedback functions turned off. In addition, teaching mode was activated on the Zoll Monitor, allowing the control room technician to regulate

the rhythm displayed on both the overhead, in-room cardiac monitor, and the Zoll device.

Study Population

Participants were eligible for inclusion in the study if they were post-graduate year (PGY) 1-5 Royal College of Physician and Surgeons of Canada EM Residents, or PGY3 College of Family Physicians EM Residents enrolled at the University of Ottawa. All participants provided informed consent. We received ethics approval for this study from the Ottawa Health Science Network Research Ethics Board.

Study Intervention

The intervention consisted of a high-quality CPR checklist, outlining key parameters to high-quality CPR including reminders on minimizing interruptions, fast compressions (100-120/min), compression depth >5cm, full recoil without leaning, and ventilating <12 breaths/min (Supplement 2). The content of this checklist was based on resuscitation guidelines, and designed for simplicity based on investigator consensus (2,8).

After obtaining consent, a study staff not involved with data collection provided all participants with case scenario information (**Supplement 2**); the scenario was developed using a standardized simulation scenario development protocol (25). Participants from the intervention group were provided access to the CPR quality checklist, whereas participants from the control group were not. A standardized script was used to outline the scenario and deliver the intervention. Participants from both groups were given 2 minutes to prepare their team and delegate tasks as they felt appropriate, prior to entering the simulation room for case start. Study participants acted as case leader. Study participants had access to the handheld checklist during the resuscitation. They also had access to any tools they typically would use in their clinical practice (e.g. smart phone apps, ACLS cards etc). Case proceedings are detailed in **Supplement 3**.

This case protocol was practiced *a priori* over a 3-hour study implementation training session and implemented in a standardized fashion, with instructions being communicated to simulation team members at set time points during the case.

Following case completion, participants completed an exit survey (**Supplement 4** and **5**). The survey was developed by investigator consensus to assess quality of blinding, and reactions to the study design and intervention in accordance with Kirkpatrick's Evaluation Model (26). Residents received focused de-briefing and feedback according to the PEARLS framework for their education after study completion (27).

Methods of measurement

The following baseline characteristics were measured using a participant enrollment form (**Supplement 6**): age, sex, PGY of residency training, and previous number of years of experience as a nurse, paramedic or ACLS instructor if any.

Resuscitation quality was audited using audio/video recording and Software (LLEAP – Laerdal Learning Application v 7.2.0) which provides live, time-stamped compression rate, depth, and ventilation rate outputs applied to the simulation mannequin (SimMan 3G, Laerdal). Data was extracted by a trained investigator using a piloted data collection form. Study personnel involved in electronic data entry were blinded to participant group allocation.

Outcome measures

The primary outcome was the proportion of total time (seconds) elapsed without high-quality chest compressions, starting at the time of patient simulated cardiac arrest. High-quality chest compressions were defined as those which maintained: 1) 100-120 compressions per minute; 2) compression depth > 5cm; 3) full chest recoil without leaning. The absence of high-quality compressions was thus a composite of no compression and inadequate chest compression time.

The following were measured as secondary outcomes: 1) proportion of total time (seconds) elapsed with inadequate chest compressions (inadequate chest compressions were defined as chest compressions violating at least one of the three criteria above); 2) number of CPR cycles in which inadequate compressions were recognized (one CPR cycle was defined as the sequence of compressions-pulse/rhythm check-defibrillation-resumption of compressions); 3) total time (seconds) elapsed with no compressions when they should be provided; 4) proportion of pulse checks >10 seconds; 5) proportion of time (seconds) elapsed with BMV >12 breaths/min, following a pre-determined time point. Recognition of inadequate CPR was achieved if the study participant verbalized concerns about CPR quality or

provided instructions to correct it.

Data Analysis

Study participants were analyzed by allocated group assignment. Descriptive statistics are presented for demographics and exit survey data using frequencies with percentages or medians with interquartile ranges (IQR), as appropriate. Mann Whitney U testing was used to compare groups and calculate odds ratios (OR) with 95% Confidence Intervals (CI). All analyses were performed using Statistical Analysis System software (Version 9.4, Cari, NC, U.S.A).

Sample size

There was a total available sample size of 53 study participants undergoing EM training at our centre (approximately ten per academic year). Given our study design and the potential educational benefit offered to residents, we expected 80-90% participation and subsequent enrollment of approximately 40 participants. We intended to recruit as many of the available participants as possible.

Participants

The CONSORT flow diagram is presented in **Figure 1**. We enrolled and randomized 53 participants from July 2019-February 2020. Of the 53 participants enrolled, 1 withdrew consent prior to participation in the study, and 17 were ultimately unable to participate post randomization due to early study closure resulting from the COVID-19 pandemic. All remaining participants from the control (n=22) and intervention groups (n=13) completed the trial and study exit survey. No participant was lost to follow-up, nor was there any crossover between groups.

Table 1. Demographic Characteristics of Study Participants

	Intervention (n =13)	Control (n =22)
Male Sex, n (%)	8 (61.5)	15 (68.2)
Age, median (IQR)	28 (27 - 31)	27 (26 - 30)
Post-Graduate Year, n (%)		
PGY-1	3 (23.1)	5 (22.7)
PGY-2	4 (30.1)	5 (22.7)
PGY-3	3 (23.1)	4 (18.2)
PGY-4	1 (7.7)	4 (18.2)
PGY-5	1 (7.7)	2 (9.1)
CCFP-EM[a]	1 (7.7)	2 (9.1)
Prior Experience, n (%)		
Nursing	0 (0)	2 (9.1)
EMS	0 (0)	0 (0)
ACLS instructor	5 (38.4)	5 (22.7)
Years of Prior Experience, total		
Nursing	0	4
EMS	0	0
ACLS instructor	7	13

IQR = Interquartile range (25th-75th percentile); PGY = post-graduate year; EMS = Emergency Medical Services; ACLS = advanced cardiac life support

[a] CCFP-EM represents residents in their third year of an alternate emergency medicine stream comprised of two years of family medicine and one of focused emergency medicine

Relevant participant baseline characteristics and medical experience are detailed in **Table 1**. Allocation between arms was unequal, with a greater number of participants in the control group. Sex, age, and year of residency were similar between groups. Those with prior relevant experi-

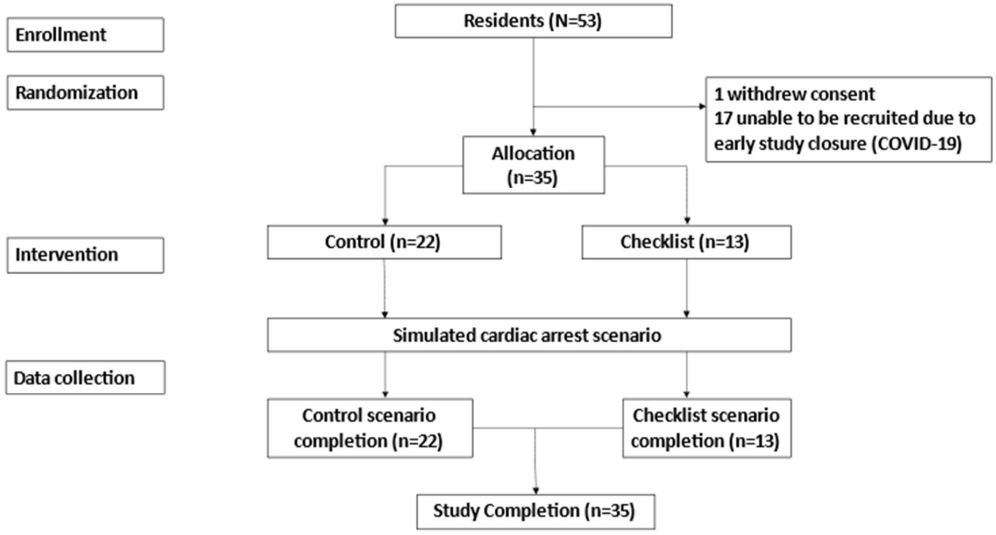


Figure 1. Consort Flow Diagram

ence were similar between arms, with slightly more nursing and ACLS instructor experience in the control group.

RESULTS

Comparison between primary and secondary outcome measures are detailed in **Table 2**. The median proportion (25th-75th IQR) of arrest time elapsed without high-quality compressions was 0.29 (0.23 – 0.36) in the checklist group compared to 0.42 (0.31 – 0.49) in the control group ($p = 0.07$). Participants in the checklist group had significantly lower proportions of time with inadequate compressions and elevated BMV rate (>12 breaths/min), with absolute differences of 18% ($p = 0.03$) and 19% ($p = 0.02$) respectively. There was a significant reduction in total no compression time in the checklist arm ($p < 0.05$). There was no difference between groups regarding number of CPR cycles in which inadequate compressions were identified ($p = 0.55$), or number of prolonged (>10s) pulse checks ($p = 0.94$).

Participants' ability to recognize and correct deficient resuscitation parameters are highlighted in **Table 3**. The proportion of individuals recognizing and correcting poor chest compressions was similar between control and checklist groups ($p = 0.41$). There was a statistically significant difference in recognition of inappropriately rapid BMV, with a greater proportion of individuals in the checklist group making this correction ($p < 0.01$).

We also investigated the impact of the checklist on the number of times participants provided instruction or commentary on target CPR parameters during the scenario. We found a statistically significant ($p < 0.001$) difference in median (IQR) number of verbalizations around these parameters between control [2.5 (2.0-3.8)] and checklist groups [6.0 (4.0-9.0)]. Most participants (10/13) who were given the checklist referenced it during the resuscitation.
Results from study participants' exit survey are presented in **Table 4**. None of the participants reported being aware of the study's objectives or intended measured outcomes, and there were no reported instances of failed participant blinding. Most individuals who received the checklist reported it was easy to understand, useful, and impacted their case management.

DISCUSSION

Interpretation of Findings

In this single-centre randomized controlled trial, we describe the impact of a CPR checklist on achieving resuscitation guideline targets during a simulated cardiac arrest scenario. We did not find a statistically significant difference between groups regarding proportion of total arrest time without high-quality compressions. Those who received the checklist had significant reductions in the proportion of time with inadequate compressions and the proportion of time with unacceptably high BMV rates. The effect sizes on

Table 2. Comparison of CPR Performance Between Control and Intervention Groups

	Control	Checklist	P-Value
Proportion of total arrest time without high-quality compressions[a]	0.42 (0.31-0.49)	0.29 (0.23-0.36)	0.07
Number of CPR cycles in which inadequate compressions were identified[b]	2 (1.25-2)	2 (2-2)	0.55
Proportion of time with inadequate compressions[b]	0.42 (0.33-0.61)	0.24 (0.20-0.38)	0.03
Total no compression time (seconds)	50 (45-56)	47 (41-49)	0.048
Number of pulse checks >10 seconds	0.5 (0-1)	1 (0-1)	0.94
Proportion of time with BMV rate >12 breaths/min	1 (1-1)	0.81 (0.61-1)	0.02

Results reported as median (IQR), p-values from Mann Whitney U Test.
BMV = bag mask ventilation
[a] time without high-quality chest compressions defined as cumulative total of no chest compression time+inadequate chest compression time.
[b] inadequate compressions defined as compressions occurring which do not meet rate and/or depth targets outlined by resuscitation guidelines

Table 3. Odds of Recognizing and Correcting Markers of Poor CPR Quality When Using Checklist

	Proportion of participants correcting in control arm	Proportion of participants correcting in checklist arm	OR (95% CI)	P-value
Chest compressions <100/min	18/22	12/13	2.67 (0.3-26.9)	0.41
BMV >12 breaths/min	1/22	7/13	24.5 (2.5-240.3)	0.006

OR = Odds Ratio; CI = confidence interval; BMV = bag mask ventilation

these outcomes were such that we felt them to be clinically significant. Overall recognition of inadequate chest compressions was similar between groups, but checklist users identified poor performance earlier. We also observed increased communication in the checklist group, suggesting these clinically important improvements in the provision of high-quality CPR were linked to improved communication.

Comparison to Previous Studies

In aviation and operating rooms, checklists have been widely implemented to minimize errors during critical tasks (19,28). As highlighted by Bleetman et al., checklists can improve task performance by: orienting team members to the intended plan, empowering team members to ask critical questions, facilitating the monitoring of vital actions, and identifying errors promptly via the aforementioned mechanisms (29). In the operating room, this has been related to patient-centered outcomes, showing reduced post-operative mortality following institution of pre-surgical checklists (20,21). Checklists have also gained popularity as an adjunct in airway management, showing improved intubation success rate and reduced incidence of complications in both prehospital and emergency department settings (22,23). As it pertains to CPR, checklists have predominately filled an evaluative role, assisting instructors in assessing the adequacy of compressions during training courses (30).

The literature currently supports checklists as beneficial tools, but their application to resuscitation optimization is relatively new. Existing studies around checklist applications to CPR have largely focused on their use as brief educational interventions on improving CPR skills (12,31,32). Our study highlights that most participants in these stressful situations liked having this tool available, and found it changed their management with resultant improvement in clinically relevant outcomes. These findings were in agreement with the work of Arriaga et al. studying checklist application to managing simulated operating room crises (33).

Strengths and Limitations

The COVID-19 pandemic has been a globally disruptive phenomenon. Due to lockdowns of our centre's educational spaces, our study was unfortunately disrupted near the end of completion. This early study closure was unanimously agreed upon by the investigators, as resident safety was of chief concern. Due to the combination of early study closure and randomization occurring at study commencement, group allocation was unequal by chance. This unequal group allocation manifested in greater cumulative prior nursing and ACLS instructor experience in our control group. This, however, would bias our findings towards the null hypothesis and could not invalidate our study findings. Unequal allocation also led to fewer senior residents participating in the study, potentially limiting generalizability of our findings. While our sample size was too small to allow for subgroup analysis, there were no obvious patterns suggesting the benefit seen in the checklist group was driven by junior residents. Finally, as with all simulation studies, despite ensuring a reproducible, high-fidelity environment, caution is required in extrapolating findings to patient care. Despite these limitations, our study was of rigorous methodology and provides preliminary quantitative and qualitative data to support future research of CPR checklists and highlights that simulation is a tool amenable to this investigation.

CONCLUSION

In our simulation-based study, a CPR checklist did not change total time without high-quality compressions. There were clinically and statistically significant reductions in the proportion of time with inadequate chest compressions and duration of inappropriate BMV associated with checklist use. These findings suggest that high-quality CPR checklists may improve resuscitation guideline adherence. The low-cost and low-tech nature of checklists make them easily adoptable and amenable to future investigation. Given this new evidence of potential benefit, further studies are warranted.

Table 4. Insight from Study Exit Surveys

Survey Question	Proportion of participants answering in the affirmative
Were you aware of study outcomes?	0% (0/35)
Was blinding broken?	0% (0/35)
Did you find the checklist useful?	76.9% (10/13)
Did you find the checklist easy to understand?	84.6% (11/13)
Did the checklist change any of your management decisions?	76.9% (10/13)

REFERENCES

1. Meaney PA, Bobrow BJ, Mancini ME, Christenson J, de Caen AR, Bhanji F, et al. Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital. Circulation [Internet]. 2013 Jul 23 [cited 2018 Dec 11];128(4):417–35. Available from: https://www.ahajournals.org/doi/10.1161/CIR.0b013e31829d8654
2. Perkins GD, Handley AJ, Koster RW, Castrén M, Smyth MA, Olasveengen T, et al. European Resuscitation Council Guidelines for Resuscitation 2015. Section 2. Adult basic life support and automated external defibrillation. Resuscitation. 2015 Oct 1;95:81–99.
3. Cheskes S, Schmicker RH, Verbeek PR, Salcido DD, Brown SP, Brooks S, et al. The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial. Resuscitation [Internet]. 2014 Mar [cited 2018 Nov 5];85(3):336–42. Available from: http://www.ncbi.nlm.nih.gov/pubmed/24513129
4. Idris AH, Guffey D, Aufderheide TP, Brown S, Morrison LJ, Nichols P, et al. Relationship Between Chest Compression Rates and Outcomes From Cardiac Arrest. Circulation [Internet]. 2012 Jun 19 [cited 2018 Dec 11];125(24):3004–12. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22623717
5. Idris AH, Guffey D, Pepe PE, Brown SP, Brooks SC, Callaway CW, et al. Chest Compression Rates and Survival Following Out-of-Hospital Cardiac Arrest*. Crit Care Med [Internet]. 2015 Apr [cited 2018 Dec 11];43(4):840–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25565457
6. Stiell IG, Brown SP, Christenson J, Cheskes S, Nichol G, Powell J, et al. What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation?*. Crit Care Med [Internet]. 2012 Apr [cited 2018 Dec 11];40(4):1192–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22202708
7. Christenson J, Andrusiek D, Everson-Stewart S, Kudenchuk P, Hostler D, Powell J, et al. Chest Compression Fraction Determines Survival in Patients With Out-of-Hospital Ventricular Fibrillation. Circulation [Internet]. 2009 Sep 29 [cited 2018 Dec 11];120(13):1241–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19752324
8. Kleinman ME, Brennan EE, Goldberger ZD, Swor RA, Terry M, Bobrow BJ, et al. Part 5: Adult Basic Life Support and Cardiopulmonary Resuscitation Quality. Circulation [Internet]. 2015 Nov 3 [cited 2018 Dec 12];132(18 suppl 2):S414–35. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26472993
9. Cheskes S, Schmicker RH, Rea T, Morrison LJ, Grunau B, Drennan IR, et al. The association between AHA CPR quality guideline compliance and clinical outcomes from out-of-hospital cardiac arrest. Resuscitation [Internet]. 2017 Jul [cited 2018 Dec 11];116:39–45. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28476474
10. Høyer CB, Christensen EF, Eika B. Junior physician skill and behaviour in resuscitation: A simulation study. Resuscitation [Internet]. 2009 Feb [cited 2018 Dec 11];80(2):244–8. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19084318
11. Brennan EE, McGraw RC, Brooks SC. Accuracy of instructor assessment of chest compression quality during simulated resuscitation. CJEM [Internet]. 2016 Jul 18 [cited 2018 Dec 11];18(04):276–82. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26775890
12. Haffner L, Mahling M, Muench A, Castan C, Schubert P, Naumann A, et al. Improved recognition of ineffective chest compressions after a brief Crew Resource Management (CRM) training: a prospective, randomised simulation study. BMC Emerg Med [Internet]. 2017 [cited 2018 Dec 11];17(1):7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28253848
13. Fernandez Castelao E, Boos M, Ringer C, Eich C, Russo SG. Effect of CRM team leader training on team performance and leadership behavior in simulated cardiac arrest scenarios: a prospective, randomized, controlled study. BMC Med Educ [Internet]. 2015 Dec 24 [cited 2018 Aug 13];15(1):116. Available from: http://bmcmededuc.biomedcentral.com/articles/10.1186/s12909-015-0389-z
14. Langdorf MI, Strom SL, Yang L, Canales C, Anderson CL, Amin A, et al. High-Fidelity Simulation Enhances ACLS Training. Teach Learn Med [Internet]. 2014 Jul 3 [cited 2018 Aug 13];26(3):266–73. Available from: http://www.tandfonline.com/doi/abs/10.1080/10401334.2014.910466
15. Sullivan NJ, Duval-Arnould J, Twilley M, Smith SP, Aksamit D, Boone-Guercio P, et al. Simulation exercise to improve retention of cardiopulmonary resuscitation priorities for in-hospital cardiac arrests: A randomized controlled trial. Resuscitation [Internet]. 2015 Jan [cited 2018 Aug 13];86:6–13. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0300957214008053
16. Espey E, Baty G, Rask J, Chungtuyco M, Pereda B, Leeman L. Emergency in the clinic: a simulation curriculum to improve outpatient safety. Am J Obstet Gynecol [Internet]. 2017 Dec [cited 2018 Dec 11];217(6):699.e1-699.e13. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28919404
17. Surcouf JW, Chauvin SW, Ferry J, Yang T, Barkemeyer B. Enhancing residents' neonatal resuscitation competency through unannounced simulation-based training. Med Educ Online [Internet]. 2013 Mar 21 [cited 2018 Aug 13];18:1–7. Available from: http://www.ncbi.nlm.nih.gov/pubmed/23522399
18. Hall AK, Damon Dagnone J, Moore S, Woolfrey KGH, Ross JA, McNeil G, et al. Comparison of Simulation-based Resuscitation Performance Assessments With In-training Evaluation Reports in Emergency Medicine Residents: A Canadian Multicenter Study. Santen S, editor. AEM Educ Train [Internet]. 2017 Oct [cited 2018 Dec 11];1(4):293–300. Available from: http://doi.wiley.com/10.1002/aet2.10055
19. Powell-Dunford N, Brennan PA, Peerally MF, Kapur N, Hynes JM, Hodkinson PD. Mindful Application of Aviation Practices in Healthcare. Aerosp Med Hum Perform [Internet]. 2017 Dec 1 [cited 2018 Nov 5];88(12):1107–16. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29157340
20. van Klei WA, Hoff RG, van Aarnhem EEHL, Simmermacher RKJ, Regli LPE, Kappen TH, et al. Effects of the Introduction of the WHO "Surgical Safety Checklist" on In-Hospital Mortality. Ann Surg [Internet]. 2012 Jan [cited 2019 Jan 15];255(1):44–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22123159
21. Haynes AB, Weiser TG, Berry WR, Lipsitz SR, Breizat A-HS, Dellinger EP, et al. A Surgical Safety Checklist to Reduce Morbidity and Mortality in a Global Population. N Engl J Med [Internet]. 2009 Jan 29 [cited 2019 Jan 15];360(5):491–9. Available from: http://www.nejm.org/doi/abs/10.1056/NEJMsa0810119
22. Chen C, Kan T, Li S, Qiu C, Gui L. Use and implementation of standard operating procedures and checklists in prehospital emergency medicine: a literature review. Am J Emerg Med [Internet]. 2016 Dec [cited 2019 Jan 15];34(12):2432–9. Available from: http://www.ncbi.nlm.nih.gov/pubmed/27742522
23. Kerrey BT, Mittiga MR, Rinderknecht AS, Varadarajan KR, Dyas JR, Geis GL, et al. Reducing the incidence of oxyhaemoglobin desaturation during rapid sequence intubation in a paediatric emergency department. BMJ Qual Saf [Internet]. 2015 Nov [cited 2019 Jan 15];24(11):709–17. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26183713
24. Sealed Envelope Ltd. Create a blocked randomisation list. [Internet]. [cited 2019 Aug 7]. Available from: https://www.sealedenvelope.com/simple-randomiser/v1/lists
25. Baylis J, Heyd C, Thoma B, Hall AK, Chaplin T, Petrosoniak A, et al. Development of a national, standardized simulation case template. Can J Emerg Med. 2020 Nov 1;22(6):822–4.
26. Kirkpatrick DL. Evaluation in Training. In: Training and Development Handbook. New York, NY: McGraw Hill; 1967. p. 87–112.
27. Eppich W, Cheng A. Promoting Excellence and Reflective Learning in Simulation (PEARLS). Simul Healthc J Soc Simul Healthc [Internet]. 2015 Apr [cited 2019 Jan 15];10(2):106–15. Available from: https://insights.ovid.com/

crossref?an=01266021-201504000-00007
28. Clay-Williams R, Colligan L. Back to basics: checklists in aviation and healthcare. BMJ Qual Saf [Internet]. 2015 Jul [cited 2018 Nov 5];24(7):428–31. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25969512
29. Bleetman A, Sanusi S, Dale T, Brace S. Human factors and error prevention in emergency medicine. Emerg Med J [Internet]. 2012 May [cited 2019 Jan 15];29(5):389–93. Available from: http://www.ncbi.nlm.nih.gov/pubmed/21565880
30. van Dawen J, Vogt L, Schröder H, Rossaint R, Henze L, Beckers SK, et al. The role of a checklist for assessing the quality of basic life support performance: An observational cohort study. Scand J Trauma Resusc Emerg Med. 2018 Nov 16;26(1).
31. Beskind DL, Stolz U, Thiede R, Hoyer R, Robertson W, Brown J, et al. Viewing an ultra-brief chest compression only video improves some measures of bystander CPR performance and responsiveness at a mass gathering event. Resuscitation [Internet]. 2017 Sep [cited 2018 Aug 13];118:96–100. Available from: http://linkinghub.elsevier.com/retrieve/pii/S0300957217302927
32. Beskind DL, Stolz U, Thiede R, Hoyer R, Burns W, Brown J, et al. Viewing a brief chest-compression-only CPR video improves bystander CPR performance and responsiveness in high school students: A cluster randomized trial. Resuscitation. 2016 Jul 1;104:28–33.
33. Arriaga AF, Bader AM, Wong JM, Lipsitz SR, Berry WR, Ziewacz JE, et al. Simulation-Based Trial of Surgical-Crisis Checklists. N Engl J Med. 2013 Jan 17;368(3):246–53.

Acknowledgements
We thank Dr. Simon Wells, Dr. Abdullah Al Thunayan and all staff members from the uOSSC for their support in conducting the study. We also thank Angela Marcantonio for her administrative support.

Conflicts of Interest Disclosure
There are no conflicts of interest to declare.

Additional Information
Supplementary information is available at https://doi.org/10.18192/UOJM.V15i2.7335

Medical Student Wellbeing:

Breaking the Cycle of Stress in Medical School

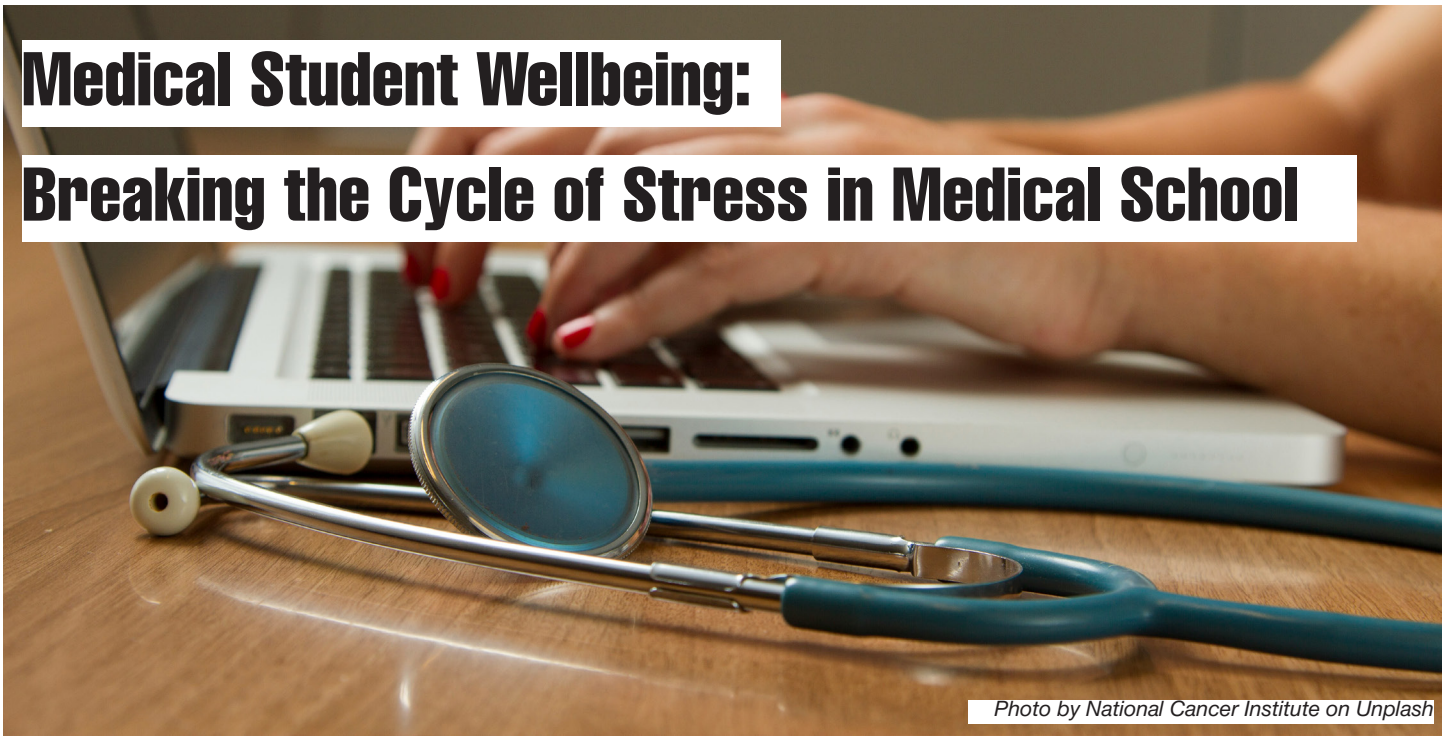


Photo by National Cancer Institute on Unplash

Nabeel Abu-Mahfouz[1]

[1] University of Guelph, Guelph, ON, Canada

Correspondence: Nabeel Abu Mahfouz; nabeelabumahfouz@gmail.com

Date Submitted: February 10, 2025
Date Accepted: April 30, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7377

Keywords: *medical education, burnout, coping strategies, medical school stress cycle*

ABSTRACT

Medical students encounter a high level of academic rigor with an expectation to learn a vast amount of information in short periods of time. The constant high pressure can often produce increased stress, burnout, anxiety, and depression. The proposed Medical Student Stress Cycle describes a behavioral pattern that begins with having an overwhelming course load, setting unattainable study goals, falling behind, leading to last-minute cramming, followed by only brief relief after exams. This cycle can lead to long-term mental and physical repercussions. This article outlines each stage of the stress cycle and suggests interventions, like active learning strategies and organized scheduling, to mitigate them, fostering a supportive plan for student success.

RÉSUMÉ

Les étudiants en médecine rencontrent un niveau élevé de rigueur académique avec une attente d'apprendre une grande quantité d'information en peu de temps. La pression constante peut souvent entraîner une augmentation du stress, un épuisement professionnel, de l'anxiété et une dépression. Le cycle de stress des étudiants en médecine proposé décrit un comportement qui commence avec une charge de cours écrasante, des objectifs d'études irréalisables, des retards dans le travail, conduisant à des bachotages de dernière minute, suivis seulement d'un bref soulagement après les examens. Ce cycle peut avoir des répercussions mentales et physiques à long terme. Cet article décrit chaque étape du cycle de stress et suggère des interventions, telles que des stratégies d'apprentissage actif et une planification organisée, afin de les atténuer et de favoriser un plan de soutien à la réussite des étudiants.

INTRODUCTION

Medical students face a rigorous academic environment with a vast degree of information to learn in a short duration of time. The constant high pressure can often produce increased stress, burnout, anxiety, and depression. In a systemic review, approximately 37% of medical students were found to be experiencing burnout, a condition that is defined by exhaustion, depersonalization, and reduced feelings of personal accomplishment.[1] When managing this magnitude of stress, students adopt ambitious objectives, then inadvertently foster anxiety and perfectionism tendencies. Students develop feelings of guilt and imposter syndrome as a result of lagging behind their study schedules.[3,11] Despite their efforts, students develop feelings of guilt and imposter syndrome as a result of falling behind schedule.[2] To make up for lost time, students often resort to cramming—studying a subject intensively within a short period of time for an imminent exam—sacrificing essential self-care such as sleep and socialising. A routine like this not only hinders studying efficiency but can also negatively impact a student's overall well-being.[15] This commentary proposes a cyclical pattern of behaviour in medical school while introducing several strategies to mitigate and break this cycle.

PROPOSED MEDICAL STUDENT STRESS CYCLE

Medical students often encounter a recurring pattern of stressors that adversely affect their academic performance and overall well-being, including mental and physical health.[20] This article introduces the Medical Student Stress Cycle as a conceptual model proposed by the author, synthesizing common patterns described in the literature into a single framework. This section will delve into the various stages of this proposed stress cycle and offer practical solutions to mitigate its impact on academic performance and overall well-being (**Figure 1**).

1. OVERWHELMED BY VOLUME OF INFORMATION

Medical school exposes students to a rich and complex curriculum that requires the assimilation of vast amounts of information within a limited timeframe, which can become quite overwhelming. In most cases, high cognitive loads lead to heightened stress, imposter syndrome, and self-doubt, causing students to question their abilities even after performing well in exams and assessments.[3]

To manage such a challenge, students can apply active learning strategies, such as spaced repetition, which fortifies recall through review at optimal times.[4] Additionally, another technique known as concept mapping, a visual method that illustrates connections between key ideas to deepen comprehension.[5] These approaches help students move beyond rote memorization toward meaningful understanding and clinical application. A well-structured study routine that prioritizes high-yield topics and the most relevant information maximizes efficiency. By integrating these strategies, students can establish a sustainable study plan that enhances recall while reducing overall stress.

2. SETTING UNREALISTIC STUDY TARGETS

In response to feeling overwhelmed, many medical students set study targets that are overly ambitious, expecting to master vast amounts of material in an unrealistically short timeframe.[6] Overexerting oneself can generate anxiety, perfectionism, and criticism, especially when students cannot meet such high standards.[7] Overstudying, at the cost of sleep and proper care, can induce a state of tension and decrease productivity.[7] Student distress, lowered motivation, and burnout have been shown to occur in part due to unrealistically high academic goals.[8]

A more efficient model is one in which SMART (Specific, Measurable, Achievable, Relevant, and Time-bound) goals are set, which provide clarity and structure to study plans.9 By breaking down big tasks into bite-sized actions, students make progress easier to track and accomplish toward their study goals. Incorporating balanced study habits, such as utilizing the use of the Pomodoro Technique,[10] which involves working in short, timed intervals (typically 25 minutes) followed by brief breaks, students prevent mental overload and maximize recall. Recognizing that complete mastery of all material is unrealistic, and that learning occurs incrementally, helps students manage expectations and reduce unnecessary stress. By adopting a cumulative learning approach—gradually building knowledge over time through consistent review—students can replace unrealistic study targets with more achievable goals. This shift reduces unnecessary stress while enhancing their confidence in the long-term retention and application of medical knowledge.

3. FALLING BEHIND

Even with meticulous planning and diligent study routines, unexpected setbacks—such as interpersonal issues,

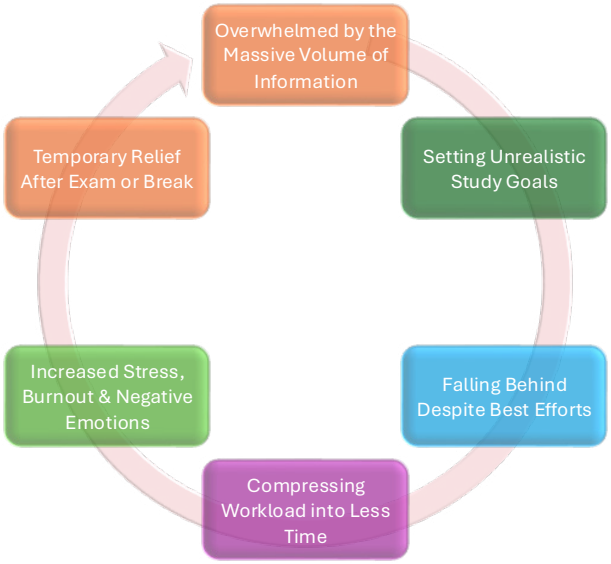


Figure 1. Medical Student Stress Cycle Model

unplanned academic difficulties, or an increased workload—can cause medical students to fall behind their own schedule. This can lead to feelings of guilt, frustration, and imposter syndrome, where students may perceive that they are not capable, not qualified, and are constantly behind.[11] Overwhelming anxiety about not keeping up with classmates, not mastering critical information, can lead to heighten tension.[11] Medical students often feel perpetually behind, struggling to catch up, rather than achieving the sense of control and preparedness they believe they should ideally have.[12]

One of the most effective strategies for overcoming this challenge is fostering adaptability in study routines, enabling students to adjust their plans when faced with unexpected obstacles. Recognizing setbacks as an inherent part of the learning process helps reduce stress and maintain motivation.[15] Seeking early intervention with classmates, mentors, or instructors can reveal new insights, break down challenging information. Finally, reframing setbacks as a chance for improvement and not a reflection of one's ability helps build resilience and encourages continuous improvement.[15] By having a growth mindset, which is the belief that abilities can be developed through effort and learning, and maintaining a focus on continuous improvement over perfection, students can navigate academic obstacles with confidence and determination.

4. COMPRESSING WORK

In an attempt to compensate for lost study time, many medical students resort to cramming, sacrificing important self-care activities such as sleep, exercise, and socializing. Such a practice proves effective in a short-term capacity, it pays decreased dividend, with sleep loss and mental exhaustion impairing cognitive function, recall, and overall efficiency in studying.[13] Studying while stressed can even amplify anxiety, and students become less concentrated and less effective in recalling information.[14] Neglecting one's self-care not only exacerbates stress but even impacts academic performance, producing burnout and overwork syndrome.[15]

A more effective approach involves prioritizing evidence-based studying techniques with high retention and less cramming. As described earlier, active recall where students test themselves rather than passively reviewing notes, has been proven to have a significant impact in long-term memory. Similarly, the tactic of interleaving,[16] in which students switch between subjects in one study session, promotes problem-solving and adaptability. Besides studying techniques, proper sleep, nutrition, and exercise contribute to peak mental function.[17] Incorporating planned breaks and prioritizing self-care optimizes retention, mental clarity, and overall performance, underscoring the importance of a balanced and sustainable study routine for students.[18] By appreciating the benefits of such routines, students can preserve their mental and physical well-being.

5. INCREASED STRESS, BURNOUT, AND EMOTIONAL EXHAUSTION

The relentless cycle of overexertion, high academic pressure, and inadequate self-care often culminates in emo-

tional exhaustion and burnout among medical students. Burnout is a state of persistent exhaustion, depersonalization, and a reduced sense of accomplishment undermines both academic performance and clinical practice.[19] Left unaddressed, burnout may lower empathy, increase dropout rates, and contribute to long-term mental health disorders in students.[20]

To combat such an issue, engaging in regular physical activity has been shown to regulate stress responses and support both mood and cognitive function.[21] Mindfulness practices, such as meditation and breathing exercises, can help medical students develop emotional resilience and maintain focus under pressure. It is also crucial for medical students to enjoy their hobbies and interests outside of medicine.

Another pivotal aspect of burnout prevention is creating peer support systems. Having a supportive group of classmates and mentors can become a key platform for information exchange, normalizing struggles, and exchanging practical coping strategies. Social support generates a sense of community and reduces feelings of loneliness, both of which are common precursors to emotional distress.[22] Lastly, access to mental health interventions, including therapy and counseling programs, can allow students to gain expert guidance in managing stress, anxiety, and emotional concerns.[22,23] By combining these strategies, medical students can protect their well-being, sustain motivation, and build resilience for the demands of their future careers.

6. TEMPORARY RELIEF AFTER AN EXAM OR BREAK

While stress levels may temporarily decrease following major exams or during short breaks, medical students often find themselves quickly returning to the same stress-inducing patterns once the next academic challenge arises. The post-exam transient comfort brings a state of seeming restoration, but without long-term strategies to manage workload and emotional well-being, students fall into a recurring cycle of over-stressing and cramming that ultimately leads to burnout. This cycle results in chronic exhaustion and declining motivation, which over time undermine academic achievement as well as long-term career fulfillment. To break such a cycle, students will have to make an effort towards creating long-term habits for dealing with stress that extend beyond examination periods. Effectively utilizing one's time, such as scheduling study sessions in a realistic format and prioritizing work in terms of urgency, keeps long-term wellness and productivity in check. Approaching medical school as a marathon and not a sprint allows students to pace themselves, rather than procrastinate and prevent the burnout that comes from chronic overexertion.

An essential component of balancing medical training is developing techniques for resilience, such as flexible coping strategies. By acknowledging and working through each stage of the medical student continuum of stress, students can implement real, evidence-based techniques for both enhancing well-being and academic success, enabling them to flourish in medical school.

CURRICULUM REFORM TO END THE CYCLE OF MEDICAL STUDENT STRESS

While medical schools play a critical role in addressing stress—through wellness programs, academic counseling, and peer-support initiatives—proactive curriculum modifications can help prevent the cycle before it begins. One of the most critical strategies is reducing content overload by consolidating clinically relevant content and incorporating competency-based learning rather than rigid memorization-based curricula. Merging coursework to focus on foundational principles rather than exhaustive detail allows students to focus on long-term knowledge retention rather than short-term cramming.

Furthermore, providing flexible due dates for exams and assignments can reduce unnecessary stress. Providing staggered due dates for significant tests and projects guarantees that students are not disproportionately loaded with excessive work within short time frames. Schools can also integrate low-stakes formative assessments, like pass/fail exams or interactive case studies, to promote learning without inducing excessive stress.

Curriculum redesign to include inherent wellness programs—such as mandatory self-care training, breaks, and formal reflection periods—foster a healthier educational environment. Encouraging medical students to develop sustainable study habits through the provision of faculty-led workshops on stress management and time management can allow them to maintain balance throughout their training. Ensuring that mental care is accessible encourages students to seek care when in need, and reduces mental care-related stigma. Medical schools can make such care accessible in terms of therapy, counseling sessions, and

groups targeted for medical students' specific issues.

Another possible reform is personalized learning pathways that enable students to learn at their own pace, supporting various learning styles and eliminating the pressure of keeping up with inflexible schedules. Institutions that implement such reforms foster an academic environment that is concerned about student well-being and long-term success in the future and therefore more resilient and capable future physicians.

CONCLUSION AND CALL TO ACTION

The medical student stress cycle can be broken through greater awareness, deliberate planning, and strong institutional support. Recognizing how it progresses— from initial overwhelm and unrealistic goals to cramming and eventual burnout— provides a framework for effective solutions. Schools must provide wellness programs, mentorship, and mental health resources, while students adopt balanced study habits and self-care.[25] Prioritizing well-being ensures future physicians are not only skilled but also compassionate, benefiting both their careers and patient care.

REFERENCES

1. Almutairi H, Alsubaiei A, Abduljawad S, Alshatti A, Fekih-Romdhane F, Husni M, Jahrami H. Prevalence of burnout in medical students: A systematic review and meta-analysis. Int J Soc Psychiatry. 2022 Sep;68(6):1157–1170. PMID: 35775726
2. Feenstra S, Begeny CT, Ryan MK, Rink FA, Stoker JI, Jordan J. Contextualizing the Impostor "Syndrome." Front Psychol. 2020 Nov 13;11:575024. PMCID: PMC7703426
3. Bravata DM, Watts SA, Keefer AL, Madhusudhan DK, Taylor KT, Clark DM, Nelson RS, Cokley KO, Hagg HK. Prevalence, Predictors, and Treatment of Impostor Syndrome: a Systematic Review. J Gen Intern Med. 2020 Apr;35(4):1252–1275. PMCID: PMC7174434
4. Niroula S, Niroula A. Effective Way of Studying and Learning in Medical School. JNMA J Nepal Med Assoc. 2020 Nov;58(231):954–956. PMCID: PMC7775017
5. Torre D, German D, Daley B, Taylor D. Concept mapping: An aid to teaching and learning: AMEE Guide No. 157. Med Teach. 2023 May;45(5):455–463. PMID: 36862077
6. Densen P. Challenges and Opportunities Facing Medical Education. Trans Am Clin Climatol Assoc. 2011;122:48–58. PMCID: PMC3116346
7. Fernández-García O, Gil-Llario MD, Castro-Calvo J, Morell-Mengual V, Ballester-Arnal R, Estruch-García V. Academic Perfectionism, Psychological Well-Being, and Suicidal Ideation in College Students. Int J Environ Res Public Health. 2022 Dec 21;20(1):85. PMCID: PMC9819691
8. Burnout in early year medical students: experiences, drivers and the perceived value of a reflection-based intervention - PMC [Internet]. [cited 2025 Feb 7]. Available from: https://pmc.ncbi.nlm.nih.gov/articles/PMC10765935/
9. Bjerke MB, Renger R. Being smart about writing SMART objectives. Eval Program Plann. 2017 Apr;61:125–127. PMID: 28056403
10. Biwer F, Wiradhany W, Oude Egbrink MGA, de Bruin ABH. Understanding effort regulation: Comparing "Pomodoro" breaks and self-regulated breaks. Br J Educ Psychol. 2023 Aug;93 Suppl 2:353–367. PMID: 36859717
11. Wrench A, Padilla M, O'Malley C, Levy A. Impostor phenomenon: Prevalence among 1st year medical students and strategies for mitigation. Heliyon. 2024 Apr 9;10(8):e29478. PMCID: PMC11019193
12. Ogunyemi D, Lee T, Ma M, Osuma A, Eghbali M, Bouri N. Improving wellness: Defeating Impostor syndrome in medical education using an interactive reflective workshop. PLoS One. 2022;17(8):e0272496. PMCID: PMC9352101
13. Khan MA, Al-Jahdali H. The consequences of sleep deprivation on cognitive performance. Neurosciences (Riyadh). 2023 Apr;28(2):91–99. PMCID: PMC10155483
14. Córdova A, Caballero-García A, Drobnic F, Roche E, Noriega DC. Influence of Stress and Emotions in the Learning Process: The Example of COVID-19 on University Students: A Narrative Review. Healthcare (Basel). 2023 Jun 17;11(12):1787. PMCID: PMC10298416
15. Michael K, Schujovitzky D, Karnieli-Miller O. The associations between resilience, self-care, and burnout among medical students. PLoS One. 2024;19(9):e0309994. PMCID: PMC11412677
16. Van Hoof TJ, Sumeracki MA, Madan CR. Science of Learning Strategy Series: Article 3, Interleaving. J Contin Educ Health Prof. 2022 Oct 1;42(4):265–268. PMID: 35170479
17. Puri S, Shaheen M, Grover B. Nutrition and cognitive health: A life course approach. Front Public Health. 2023 Mar 27;11:1023907. PMCID: PMC10083484
18. Study shows how taking short breaks may help our brains learn new skills [Internet]. National Institutes of Health (NIH). 2021 [cited 2025 Feb 7]. Available from: https://www.nih.gov/news-events/news-releases/study-shows-how-taking-short-breaks-may-help-our-brains-learn-new-skills
19. Li CJ, Shah YB, Harness ED, Goldberg ZN, Nash DB. Physician Burnout and Medical Errors: Exploring the Relationship, Cost, and Solutions. Am J Med Qual. 2023 Aug 1;38(4):196–202. PMID: 37382306
20. Yang Q, Liu Y, Yang WF, Peng P, Chen S, Wang Y, Wang X, Li M, Wang Y, Hao Y, He L, Wang Q, Zhang J, Ma Y, He H, Zhou Y, Long J, Qi C, Tang YY, Liao Y, Tang J, Wu Q, Liu T. Mental health conditions and academic burnout among medical and non-medical undergraduates during the mitigation of COVID-19 pandemic in China. Environ Sci Pollut Res Int. 2022;29(38):57851–57859. PMCID: PMC8969817
21. Mahindru A, Patil P, Agrawal V. Role of Physical Activity on Mental Health and Well-Being: A Review. Cureus. 15(1):e33475. PMCID: PMC9902068
22. Reflecting peer-support groups in the prevention of stress and burnout: randomized controlled trial - PubMed [Internet]. [cited 2025 Feb 7]. Available from: https://pubmed.ncbi.nlm.nih.gov/18727753/
23. Vidal EI de O, Ribeiro LFA, de Carvalho-Filho MA, Fukushima FB. Mindfulness training in medical education as a means to improve resilience, empathy, and mental health in the medical profession. World J Psychiatry. 2024 Apr 19;14(4):489–493. PMCID: PMC11036457
24. Ehsan F, Iqbal S, Younis MA, Khalid M. An educational intervention to enhance self-care practices among 1st year dental students- a mixed method study design. BMC Med Educ. 2024 Nov 14;24:1304. PMCID: PMC11562083
25. Farkas AH, Allenbaugh J, Bonifacino E, Turner R, Corbelli JA. Mentorship of US Medical Students: a Systematic Review. J Gen Intern Med. 2019 Nov;34(11):2602–2609. PMCID: PMC6848625

Conflicts of Interest Disclosure
There are no conflicts of interest to declare

Should We Still Be Concerned About Screen Time Use for Canada's Young Children? Understanding the Research Landscape of Screen Time After the COVID-19 Pandemic

Photo by Kelly Sikkema on Unsplash

Constance de Schaetzen[1,2], Nicole Sheridan[2], Katherine Matheson[3,4]

[1] Faculty of Medicine, University of Ottawa, Ottawa, Ontario, Canada
[2] Mental Health Research, CHEO Research Institute, Ottawa, Ontario, Canada
[3] Department of Psychiatry, CHEO, Ottawa, Ontario, Canada
[4] Department of Psychiatry, University of Ottawa, Ottawa, Ontario, Canada

Correspondence: Constance de Schaetzen; constance.deschaetzen@uottawa.ca

Date Submitted: February 27, 2025
Date Accepted: June 12, 2025
Date Published: December 9, 2025

DOI: https//doi.org/10.18192/UOJM.v15i2.7424

Keywords: *screen time, COVID-19, mental health, early childhood, development*

ABSTRACT

During the COVID-19 pandemic, screen time rates greatly surpassed the recommended guidelines for Canada's young children despite the evidence for prolonged screen time having a negative effect on a child's health being well established. It is unknown if these rates have decreased in our post-pandemic world, underscoring the urgent need for understanding screen time patterns to inform future guidelines and policy for young children. This commentary aims to address the need for further research regarding screen time usage in the post-COVID era following a documented surge in screen usage during the pandemic.

RÉSUMÉ

Pendant la pandémie de la COVID-19, le temps passé par les jeunes enfants devant les écrans a largement dépassé les recommandations au Canada, malgré les preuves bien établies qu'un temps d'écran prolongé a un effet négatif sur leur santé. On ne sait pas si le niveau d'exposition a diminué après la pandémie, ce qui souligne l'urgence de comprendre les habitudes d'utilisation des jeunes enfants des écrans afin d'informer les futures lignes directrices et politiques les concernant. Ce commentaire vise à répondre à la nécessité de recherches supplémentaires sur l'utilisation des écrans par les jeunes enfants dans l'ère post-COVID, après une augmentation documentée de l'utilisation des écrans pendant la pandémie.

INTRODUCTION

The impact of screen time on children has gained significant attention in Canada in recent years, mirroring a global reliance on electronic devices.[1] The term "screen time" refers to the duration one dedicates to electronic devices (e.g., smartphones, tablets, television, etc.).[1-2] Activities can range from actively engaging in video calls, online learning or passively watching television. Surprisingly, even the youngest of children are not exempt from these activities and studies have reported that 50% of infants aged six to 11 months engage with touchscreens daily.[2-3] Based on expert consensus, the Canadian Paediatric Society (CPS) recommends limiting screen time for young children as excessive screen use has been linked to challenges in language development, attention, and social skills.[2-3] Recommendations include avoiding screen time altogether for children under the age of two, one hour of screen time per day for children aged two to five, and no more than two hours for those five and older.[2-3] During the COVID-19 pandemic, rates of screen time rose significantly among children of all ages.[4-12] However, it remains unclear whether—and to what extent—these patterns have changed in recent years as we transition into the post-pandemic era. This commentary aims to address the need for further research on screen time usage following the documented surge during the pandemic.

SCREEN TIME EFFECTS IN EARLY CHILDHOOD

Early childhood is a critical time for brain development, during which emotional, cognitive and physical health are especially sensitive to environmental influences.[13-17] High-quality interactions with caregivers, including reciprocal communication, joint play, eye contact, comforting during distress, and emotional coregulation, are key to supporting healthy development.[18] These interactions help build brain networks that are essential for language, emotional regulation, executive function, and social skills.

As digital media becomes increasingly integrated into the environments of young children, concerns have emerged regarding the potential impact of screen exposure during this sensitive developmental window.[2-3] Although screen time may not always be inherently harmful, its benefits in infancy and toddlerhood appear limited. In certain contexts, screens may complement development by encouraging movement (e.g., singing, dancing) or reinforcing cognitive skills like language and memory through repetition and interactive features.[19-21] However, such benefits are highly context-dependent and cannot replace the richness of real-world, social experiences. Concerns around early screen exposure largely center on the nature of the content and the extent to which it displaces essential developmental activities such as imaginative play, physical activity, as well as meaningful caregiver-child interactions that support secure attachment—such as reciprocal communication.[2] Understanding these dynamics lays the groundwork for examining the broader implications of excessive screen time on children's emotional, mental, physical, cognitive, and social health.

Emotional and Mental Health

Screen time has been linked to several aspects of children's emotional well-being and mental health. A potential dose-response relationship (i.e., increasing exposure leads to progressively greater effects) has been observed, with increased screen time associated with more negative psychological impacts.[6,22] Emerging evidence connects excessive screen use with both internalizing (e.g. anxiety and depression) and externalizing (e.g. aggression and impulsivity) behaviours.[22] A systematic review and meta-analysis found that higher screen time in young children was associated with more frequent symptoms of aggression, irritability, frustration, and emotional dysregulation.[5] Specific types of passive screen use, such as television and leisure-based media, were significantly correlated with increased symptoms of anxiety and depression.[5] Additionally, a Canadian study showed that each extra hour of screen time at age 3 and a half predicted increased anger and frustration by age 4 and a half.[23] These findings suggest that excessive screen use may interfere with emotional development, potentially by displacing key opportunities for self-regulation, stress management, and caregiver interaction. As nurturing relationships are central to buffering children against stress and promoting mental well-being, disruptions caused by screen overuse may have long-term emotional consequences.[18]

Physical Health

Screen exposure is linked to a range of adverse physical health outcomes in young children, particularly affecting sleep and weight regulation. Numerous studies have shown that increased screen time is associated with delayed time to fall asleep, shorter sleep duration, and poorer sleep quality.[5,24-25] A comprehensive review found a dose-dependent relationship between screen use and

poor sleep, along with a heightened risk of unhealthy weight gain when recommended limits were exceeded.[4] Additionally, higher screen use in 2-year-olds has been associated with less outdoor play, suggesting that screen time may displace physical activity.[26] Children aged 2 to 5 years also appear especially vulnerable to screen-induced eye strain, however, this effect was not observed in younger age groups.[4] The timing of screen use matters as well, with evening exposure potentially disrupting sleep hormone (e.g., melatonin) production and sleep and wake cycles (e.g., circadian rhythms).[25]

Cognitive and Social Health

Cognitive and social development in early childhood is highly dependent on language-rich environments, imaginative play, and real-world exploration.[13] Elevated screen use during this period has been linked to structural and activation changes in brain regions associated with language processing and executive functioning.[27-28] An Australian study found that toddlers with higher screen exposure experienced less back and forth interaction with caregivers, produced fewer vocalizations, and heard less adult speech, all of which are key components of language development and cognitive stimulation.[29] Similarly, a 2023 Japanese cohort study reported that children exposed to more than one hour of screen time daily at age 2 had lower communication scores by age 4.[26]

Previous research has also raised concerns for the social implications around screen time. Excessive screen use may displace opportunities for shared play and face-to-face interactions, impeding the development of secure attachment relationships that are crucial for emotional regulation, resilience, and social competence.[16] Reduced caregiver-child interaction due to excessive screen time has been linked to delays in developmental milestones, language acquisition, and creative play, all of which affect social skill development.[16-18,30,31] While certain digital tools can support learning when used interactively and intentionally, they should not replace real-world experiences that drive cognitive and social development in early childhood.

The extensive list of the negative effects of screen time on young children's social, cognitive, and behavioural development underscores the importance of promoting established guidelines and recommendations regarding screen time to mitigate these effects on this population.

SCREEN TIME AND THE COVID-19 PANDEMIC

Prior to the COVID-19 pandemic, adherence to pediatric screen time guidelines was already a global concern. A 2021 survey revealed that Canadian pediatricians strongly understood and adhered to the recommendations, and 94.3% of respondents believed that they played a crucial role in implementing these guidelines with their patients and families.[1] Despite this, studies in Canada reported that 76-82% of Canadian preschooler aged children exceeded the 1-hour recommended daily screen limit.[32-34] Similarly, a recent meta-analysis involving over 89,000 children revealed that, globally, only 24.7% of children under two years, and 35.6% of children aged two to five met these guidelines.[35] These concerns also extended beyond the home, including educational settings (e.g., schools, early childcare, etc.).

The COVID-19 pandemic added new complexity to the screen time debate, as widespread lockdowns, school and childcare closures, restrictions on gatherings, and the shift to remote learning reshaped daily routines.[7,11,36-37] As a result, many families—particularly those with young children—increasingly relied on electronic devices for both education and entertainment.[4,8-9,38-39] In many cases, screen time functioned as an "electronic babysitter," giving parents temporary relief or time to focus on remote work and household responsibilities.[40] Unsurprisingly, this led to a significant rise in screen time among young children during the initial lockdowns worldwide, including in Canada.[5-6,12,41] One study examining a large cohort (n = 2,209) of children aged 8 to 36 months across 12 countries—including France, Turkey, and Canada—found that caregivers reported increased screen time during lockdown. Increased rates were even found among toddlers without online educational requirements and were more pronounced in countries that experienced longer lockdown durations.[41] Two systematic reviews and meta-analyses confirmed this trend, reporting that young children spent an additional 36 to 53 minutes per day on screens during the pandemic, compared to their average daily screen time before the pandemic.[5-6] These findings are consistent with other reports showing that 64% of preschoolers exceeded the recommended one hour of screen time per day during this period.[23] Adherence to public health restrictions has contributed to this increase for a multitude of reasons, including families spending more time indoors and facing limited access to outdoor and structured activities. This was supported by a study of Ontario children under age five where researchers

observed a strong association between strict adherence to lockdown guidelines and reduced outdoor activity, accompanied by increased screen exposure.[7]

Compounding the issue, daycare and school closures left many parents struggling to balance childcare responsibilities with remote work and educational demands. Across North America, studies have documented a correlation between increased screen time and heightened family stress—particularly among families with fewer resources—highlighting how the pandemic disproportionately impacted vulnerable households.[8-11] These patterns suggest that the interplay between family stress and screen time may strain family attachment and hinder healthy child development.

GAP IN INFORMATION ON SCREEN TIME POST COVID-19 PANDEMIC

The pandemic ushered in an unprecedented reliance on screens, prompting widespread discussions among parents, educators, and healthcare professionals about the potential long-term ramifications of such extensive digital exposure.[4-6] A survey of 53 Canadian pediatricians found that over 80% reported an increase in their patients' screen time during the pandemic, and nearly all (98%) expressed concern about its impact on children's health and wellbeing.[1] In the United States, *Common Sense Media (2025)* released an updated report with some of the first post-pandemic insights.[42] They found that while screen time among children under 8 has plateaued since the peak in the pandemic, the nature of content consumed has shifted markedly—short-form videos (e.g., YouTube Shorts, TikTok-style content) have become increasingly dominant, while educational content has declined.[42] The report also highlights socioeconomic disparities, with children from lower-income families engaging in significantly more screen time on average than higher-income households.[42] To our knowledge, aside from this report, no peer-reviewed studies have examined post-pandemic changes in screen use among children under six. While this commentary synthesizes current literature, it relies solely on secondary sources without original data collection. Given the recency of the pandemic, peer-reviewed evidence remains limited. Moreover, many pre-pandemic studies have notable methodological limitations. For example, studies by Glassman and Cardy rely on parent-reported screen time, which may be subject to recall errors and social desirability bias.[9-12] Furthermore, various systematic reviews have emphasized how definitions of "screen time" often vary across studies, especially in distinguishing recreational from educational use, making it difficult to draw direct comparisons.[5-6]

As we continue to navigate the post-pandemic world, there remains a significant knowledge gap regarding the prevailing patterns of screen time consumption both at home and at school among children under age 6. Although there is a breadth of literature outlining the pre-pandemic concerns for screen time among young children, and extensive evidence documenting its sharp increase during the pandemic, comprehensive research examining the current state of screen time, especially in young children, remains strikingly absent.[3-6,21,27] This gap leaves many important questions unanswered. *Common Sense Media (2025)* also notes that children's digital media use remains "poorly understood in terms of content, context, and consequences," and that "virtually no longitudinal research" has explored how these behaviors have evolved post-pandemic.[42] Has screen time decreased post-pandemic? Now that in-person schooling has resumed post-pandemic, how has educational screen time changed in this age group, and how does it compare to recreational screen time? Could this shift help us better understand evolving screen use patterns and their potential impacts on young children? Are the effects of increased screen time permanent? Addressing these concerns is important to understand how screen time has impacted young children and how related patterns of use and associated effects have evolved over time, especially given evidence that screen time has short- and long-term implications on children's emotional, mental, physical, cognitive, and social health.

RECOMMENDATIONS

What do we need to do next?

Given the evolving digital era and young children being the fastest-growing group of digital media users, there is an urgent need for comprehensive research on screen time.[39,42] It is imperative to unite all those who work with children and their families, including pediatric and mental health professionals, policymakers, educators, and caregivers to critically evaluate existing screen time guidelines and adapt them to today's realities. In their recent screen time update, the CPS voiced a pressing need for revised guidance that reflects the dramatic shifts in digital habits following the COVID-19 pandemic.[43] In alignment with these concerns, a Canadian organization comprising clinicians, caregivers,

and educators has developed a pledge to educate families about the risks of smartphone use in early childhood and to encourage limiting its use before the age of 14.[44] Additionally, in June 2025, the CPS launched the *Centre for Healthy Screen Use*, an online resource designed to support health professionals, policymakers, and families in making informed decisions about screen time.[45] Although Canada has taken steps in this direction, several countries have also actively implemented measures to address this issue. **Table 1** outlines key policy actions from various countries, including school device bans, official guidelines, and public health campaigns. Interestingly, some countries like Germany, prioritize family education over formal legislation to guide children's screen use.[46] The *Schau Hin!* campaign, for example, offers parents evidence-based tips to delay screen exposure and promote screen-free family routines.[46] Meanwhile, the World Health Organization emphasizes the broader importance of limiting screen time in early childhood.[47]

To support evidence-informed policymaking, the collective expertise of interdisciplinary professionals should be harnessed to establish a national research consortium for post-pandemic screen time levels. Such a body could lead and guide the development of a balanced and developmentally appropriate digital environment for Canada's youngest children. For example, a multidisciplinary collaboration among clinicians, researchers, educators and parents could help review and strengthen current screen time guidelines by integrating diverse expertise, emerging evidence, and clinical realities. To complement this, studies should not only track changes in screen time use at home and in schools since the onset of the COVID-19 pandemic but also examine the long-term outcomes of this increased exposure. Ideally, such research would explore how factors like family socioeconomic background and children's cognitive and emotional states during screen use may mediate or moderate its effects, helping to explain why screen time impacts some children more than others. A dual approach, measuring both usage patterns and associated short- and long-term outcomes, can help update and establish evidence-based policies and recommendations that better address the complex realities of screen time in early childhood in this post-pandemic era. **Table 2** outlines key recommendations for future research and policy direction, consolidating these priorities and summarizing our proposed next steps.

In addition to revising guidelines, Canadians can learn from other countries by ensuring revised policies include specific and actionable strategies. For example, Singapore holds some of the strictest global screen time rules reported, limiting preschoolers to one hour per day of educational content and banning passive "background screen time" entirely.[48] In North America, the American Academy of Pediatrics developed the *Family Media Plan*, an interactive online tool that helps families set screen time priorities, develop media use rules, and foster healthy digital habits based on individual family needs and values.[49] Although the CPS lays a strong foundation for national guidance, further efforts are needed to strengthen implementation and respond to evolving needs.[43] See **Table 2** for examples of proposed strategic directions.

Finally, prioritizing positive early childhood experiences and connections can help mitigate the challenges posed by increased digital media use in early childhood. Fostering and sustaining a strong parent-child relationship has been reported to counteract the negative mental health effects associated with screen time and should be a central focus in both prevention and treatment efforts.[22] As we navigate the realities of a tech-driven world, promoting healthy relational dynamics will be essential to supporting young children's physical and emotional well-being. Ultimately, supporting healthy child development in a rapidly evolving digital world requires a clearer understanding of how pandemic-era increases in early-childhood screen use have changed—or persisted. Conducting longitudinal research studies, developing more robust, evidence-based guidelines for professionals and families, and coordinating efforts across disciplines should be prioritized.

Table 1. Summary of Global Strategies to Address Excessive Childhood Screen Time By Country

Country	Key Measures	Details
Australia	National screen time guidelines Social Media Ban	The Department of Health promotes ≤2 hours/day of recreational screen time for ages 5–17 and discourages any screen use under age 2[50]. These recommendations are supported by public campaigns aimed at promoting active play and healthy routines[50]. In November 2024, Australia passed legislation to ban social media access for individuals under age 16, with the law set to take effect in December 2025. This legislation is intended to protect youth from online harms and places the burden of compliance on social media platforms[51].
Canada	Classroom phone bans Updated pediatric guidelines Educational online platform	Several Canadian provinces have taken action to regulate student phone use in schools: Ontario has banned mobile phones in classrooms, Alberta has implemented a province-wide ban, and British Columbia requires school districts to restrict personal device use during instructional hours[43,52-54]. Nationally, the CPS recently revised its recommendations to emphasize reduced passive use and increased interactive play in 2019[43]. More recently, in June 2025, the CPS launched the *Centre for Healthy Screen Use*, an online platform offering resources for clinicians, policymakers, and families to support informed screen use decisions[45].
China	Strict screen regulations School phone ban	China enforces strict regulations limiting online gaming for minors to 3 hours/week and has mandated "youth mode" settings on apps[55]. Phone use is also restricted during school hours, reflecting concern over gaming addiction and mental health impacts[56].
France	School phone ban Public health messaging	A 2018 national law bans mobile phone use in schools up to age 15[57]. National campaigns such as "Pas d'écran avant 3 ans" aim to educate parents on the developmental risks of early screen exposure[58].
Germany	Family education and voluntary limits	Germany relies on family education rather than legislation[46]. The *Schau Hin!* campaign offers evidence-based guidance to help parents manage media use in the home, promoting delayed exposure and screen-free family routines[46].
New Zealand	National screen-time guidelines	The Ministry of Health advises no screen use for children under 2, ≤1 hour/day for preschoolers, and ≤2 hours/day for school-age children[59]. These guidelines are part of a broader public health approach encouraging balanced movement, screen, and sleep behaviours.
Norway	Increased age of consent	The Norwegian government is raising the age of consent for social media use from ages 13 to 15[60]. While parents may still provide consent for children under 15, the government is also implementing measures to protect youth from the potential harms of social media, particularly the influence of algorithms that target young users[60].
Singapore	Strict limits for preschoolers Content-based rules	Singapore enforces some of the most stringent screen time guidelines globally, limiting preschoolers to one hour per day of educational content while explicitly banning passive background screen time[48]. These rules are part of a broader public health strategy to prevent childhood myopia and promote healthy development.
Taiwan	Legally enforceable screen-time limits	Since 2015, Taiwan has empowered authorities to fine parents who allow children to engage in excessive screen use under the Child and Youth Welfare Act, treating overexposure as a developmental risk[61].
United Kingdom	Non-statutory guidance to ban school phone use National screen-use advice	The UK government issued non-statutory guidance encouraging schools in England to prohibit mobile phone use during school hours[62]. Public Health agencies advise families to prioritize screen-free meals, limit use before bed, and monitor content rather than applying rigid time limits[58].
United States of America	National screen time guidelines Educational interactive tools for families Kids Online Safety Act to regulate digital platforms	The American Academy of Pediatrics (AAP) recommends avoiding screen time for children under 18 months (except video chatting), limiting preschoolers to one hour per day of high-quality content, and encourages co-viewing and screen-free routines to support healthy development[49].The AAP also developed the *Family Media Plan*, an interactive tool that helps families set screen time priorities, establish media use rules, and promote healthy digital habits tailored to individual family needs and values[49]. In 2024, the U.S. Senate passed the Kids Online Safety Act (KOSA), which mandates that platforms disable addictive features, enable privacy-by-default settings for minors, and allow users to opt out of algorithmic content[63].

Table 2. Recommendations for Future Research Directions and Policy

Focus Area	Key Action/Recommendation
Screen Time Guidelines	• Update national guidelines to reflect post-pandemic use and current evidence[43,47]
Global Comparison & Leadership	• Learn from countries like Singapore with stricter policies (e.g., limits, background screen bans[48] • Assess applicability of international approaches in a national context
Interdisciplinary Collaboration	• Form a national research consortium to guide child-focused digital policy • Initiate longitudinal research on the developmental effects of screen exposure
Examining Variance in Individual-Level Impacts	• Study cognitive and emotional factors that influence how screen time affects children[42] • Recognize variability in individual responses to screen use • Keep an eye out for worrisome screen habits and consult a doctor if concerns arise[64]. Emotional and behavioural signs include [64] - Upset feelings after screen use - Feeling sad or stressed without screens - Struggling with screen time limits - Screen use disrupting daily tasks like school, family time, sleep, or hanging out with friends
Practical Strategies	• Promote and expand the reach of national public health initiatives like the CPS's *Centre for Healthy Screen Use* to support families and professionals[45] • Integrate screen time discussions into routine pediatric visits • Implement school-based media literacy programs • Promote local screen-free community initiatives • Provide accessible family guidance and personalized strategies for healthy digital habits such as Germany's The *Schau Hin!* Campaign[46] and tools like the American Academy of Pediatric's *Family Media Plan*[49] • Implement CPS' Four M's approach: minimize, mitigate, use mindfully, and model healthy screen habits[2]
Parent-Child Connection	• Promote strong parent-child relationships to buffer negative mental health effects of screen time[22] • Designate tech-free zones during family meals and gatherings to foster bonding and promote face-to-face interactions[4] • Co-view content with children to exemplify and nurture digital media literacy • Maintain open, judgment-free communication with children about online safety, encouraging them to seek support if they encounter harassment or inappropriate content

REFERENCES

1. Amos KA, Ogilvie JD, Ponti M, Miller MR, Yang F, Ens AR. Paediatricians' awareness of Canadian screen time guidelines, perception of screen time use, and counselling during the COVID-19 pandemic. Paediatr Child Health. 2023 Sep 22;28(6):357–61.
2. Ponti M. Screen time and preschool children: Promoting health and development in a digital world. Paediatr Child Health. 2023 Jun 1;28(3):184–92.
3. Ponti M, Bélanger S, Grimes R, Heard J, Johnson M, Moreau E, Norris M, et al. Screen time and young children: Promoting health and development in a digital world. Paediatr Child Health. 2017 Nov;22(8):461–8.
4. Toombs E, Mushquash CJ, Mah L, Short K, Young NL, Cheng C, et al. Increased Screen Time for Children and Youth During the COVID-19 Pandemic [Internet]. Science Briefs of the Ontario COVID-19 Science Advisory Table; 2022 Apr [cited 2024 Mar 5]. Available from: https://covid19-sciencetable.ca/sciencebrief/increased-screen-time-for-children-and-youth-during-the-covid-19-pandemic
5. Trott M, Driscoll R, Irlado E, Pardhan S. Changes and correlates of screen time in adults and children during the COVID-19 pandemic: A systematic review and meta-analysis. EClinicalMedicine. 2022 Jun;48:101452.
6. Choi EJ, King GKC, Duerden EG. Screen time in children and youth during the pandemic: A systematic review and meta-analysis. Glob Pediatr. 2023 Dec 1;6:100080.
7. Li X, Vanderloo LM, Maguire JL, Keown-Stoneman CDG, Aglipay M, Anderson LN, et al. Public health preventive measures and child health behaviours during COVID-19: a cohort study. Can J Public Health. 2021 Oct 1;112(5):831–42.
8. Carroll N, Sadowski A, Laila A, Hruska V, Nixon M, Ma D, et al. The Impact of COVID-19 on Health Behavior, Stress, Financial and Food Security among Middle to High Income Canadian Families with Young Children. Nutrients. 2020 Aug 7;12(8):2352.
9. Glassman J, Humphreys KL, Jauregui A, Milstein A, Sanders L. Evidence for Changes in Screen Use in the United States During Early Childhood Related to COVID-19 Pandemic Parent Stressors: Repeated Cross-Sectional Study. JMIR Pediatr Parent. 2024 May 22;7:e43315.
10. Hartshorne JK, Huang YT, Lucio Paredes PM, Oppenheimer K, Robbins PT, Velasco MD. Screen time as an index of family distress. Curr Res Behav Sci. 2021 Nov 1;2:100023.
11. Seguin D, Kuenzel E, Morton JB, Duerden EG. School's out: Parenting stress and screen time use in school-age children during the COVID-19 pandemic. J Affect Disord Rep. 2021 Dec 1;6:100217.
12. Cardy RE, Dupuis A, Anagnostou E, Ziolkowski J, Biddiss EA, Monga S, et al. Characterizing Changes in Screen Time During the COVID-19 Pandemic School Closures in Canada and Its Perceived Impact on Children With Autism Spectrum Disorder. Front Psychiatry. 2021 Aug 18;12:702774.
13. Fox SE, Levitt P, Nelson Iii CA. How the Timing and Quality of Early Experiences Influence the Development of Brain Architecture. Child Dev. 2010 Jan;81(1):28–40.
14. Gilmore JH, Knickmeyer RC, Gao W. Imaging structural and functional brain development in early childhood. Nat Rev Neurosci. 2018 Mar;19(3):123–37.
15. Teicher MH, Samson JA, Anderson CM, Ohashi K. The effects of childhood maltreatment on brain structure, function and connectivity. Nat Rev Neurosci. 2016 Oct 1;17(10):652–67.
16. Williams RC, Biscaro A, Clinton J. Relationships matter: How clinicians can support positive parenting in the early years. Paediatr Child Health. 2019 Jul 25;24(5):340–7.
17. Burns SB, Szyszkowicz JK, Luheshi GN, Lutz PE, Turecki G. Plasticity of the epigenome during early-life stress. Semin Cell Dev Biol. 2018 May;77:115–32.
18. Shonkoff JP. Capitalizing on Advances in Science to Reduce the Health Consequences of Early Childhood Adversity. JAMA Pediatr. 2016 Oct 1;170(10):1003.
19. Marsh J, Plowman L, Yamada-Rice D, Bishop JC, Scott F, Davenport A, et al. Exploring play and creativity in pre-schoolers' use of apps: a report for early years practitioners [Internet]. Sheffield (UK): University of Sheffield; 2015 [cited 2025 Apr 16]. Available from: https://www.pure.ed.ac.uk/ws/portalfiles/portal/21871467/2015._Exploring_play_and_creativity.pdf
20. Marsh J, Lahmar J, Plowman L, Yamada-Rice D, Bishop J, Scott F. Under threes' play with tablets. J Early Child Res. 2021 Sep;19(3):283–97.
21. Huber B, Yeates M, Meyer D, Fleckhammer L, Kaufman J. The effects of screen media content on young children's executive functioning. J Exp Child Psychol. 2018 Jun;170:72–85.
22. Mougharbel F, Goldfield GS. Psychological Correlates of Sedentary Screen Time Behaviour Among Children and Adolescents: a Narrative Review. Curr Obes Rep. 2020 Dec;9(4):493–511.
23. Fitzpatrick C, Cristini E, Bernard JY, Garon-Carrier G. Meeting preschool screen time recommendations: which parental strategies matter? Front Psychol. 2023 Nov 6;14:1287396.
24. Foreman J, Salim AT, Praveen A, Fonseka D, Ting DSW, Guang He M, et al. Association between digital smart device use and myopia: a systematic review and meta-analysis. Lancet Digit Health. 2021 Dec;3(12):e806–18.
25. Zhu R, Fang H, Chen M, Hu X, Cao Y, Yang F, et al. Screen time and sleep disorder in preschool children: identifying the safe threshold in a digital world. Public Health. 2020 Sep;186:204–10.
26. Sugiyama M, Tsuchiya KJ, Okubo Y, Rahman MS, Uchiyama S, Harada T, et al. Outdoor Play as a Mitigating Factor in the Association Between Screen Time for Young Children and Neurodevelopmental Outcomes. JAMA Pediatr. 2023 Mar 1;177(3):303.
27. Hutton JS, Dudley J, Horowitz-Kraus T, DeWitt T, Holland SK. Associations Between Screen-Based Media Use and Brain White Matter Integrity in Preschool-Aged Children. JAMA Pediatr. 2020 Jan 6;174(1):e193869.
28. Hutton JS, Dudley J, DeWitt T, Horowitz-Kraus T. Associations between digital media use and brain surface structural measures in preschool-aged children. Sci Rep. 2022 Nov 9;12(1):19095.
29. Brushe ME, Haag DG, Melhuish EC, Reilly S, Gregory T. Screen Time and Parent-Child Talk When Children Are Aged 12 to 36 Months. JAMA Pediatr. 2024 Apr 1;178(4):369.
30. Barroso NE, Mendez L, Graziano PA, Bagner DM. Parenting Stress through the Lens of Different Clinical Groups: a Systematic Review & Meta-Analysis. J Abnorm Child Psychol. 2018 Apr 1;46(3):449–61.
31. Zhao J, Zhang Y, Jiang F, Ip P, Ho FKW, Zhang Y, et al. Excessive Screen Time and Psychosocial Well-Being: The Mediating Role of Body Mass Index, Sleep Duration, and Parent-Child Interaction. J Pediatr. 2018 Nov 1;202:157-162.e1.
32. Tremblay MS, LeBlanc AG, Carson V, Choquette L, Connor Gorber S, Dillman C, et al. Canadian Sedentary Behaviour Guidelines for the Early Years (aged 0–4 years). Appl Physiol Nutr Metab. 2012 Apr;37(2):370–80.
33. Chaput JP, Colley RC, Aubert S, Carson V, Janssen I, Roberts KC, et al. Proportion of preschool-aged children meeting the Canadian 24-Hour Movement Guidelines and associations with adiposity: results from the Canadian Health Measures Survey. BMC Public Health. 2017 Nov;17(S5):829.
34. Colley RC, Garriguet D, Adamo KB, Carson V, Janssen I, Timmons BW, et al. Physical activity and sedentary behavior during the early years in Canada: a cross-sectional study. Int J Behav Nutr Phys Act. 2013;10(1):54.
35. McArthur BA, Volkova V, Tomopoulos S, Madigan S. Global Prevalence of Meeting Screen Time Guidelines Among Children 5 Years and Younger: A Systematic Review and Meta-analysis. JAMA Pediatr. 2022 Apr 1;176(4):373–83.
36. Government of Canada. Coronavirus disease (COVID-19): Canada's response [Internet]. Ottawa (ON): Government of Canada; 2020 [cited 2025 Apr 8]. Available from: https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/canadas-reponse.html

37. Guan H, Okely AD, Aguilar-Farias N, Del Pozo Cruz B, Draper CE, El Hamdouchi A, et al. Promoting healthy movement behaviours among children during the COVID-19 pandemic. Lancet Child Adolesc Health. 2020 Jun;4(6):416–8.
38. Plamondon A, McArthur BA, Eirich R, Racine N, McDonald S, Tough S, et al. Changes in Children's Recreational Screen Time During the COVID-19 Pandemic. JAMA Pediatr. 2023 Jun 1;177(6):635.
39. Rideout, V, Robb, MB. The Common Sense Census: Media Use by Kids Age Zero to Eight, 2020. [Internet]. San Francisco, CA: Common Sense Media; 2020. Available from: https://www.commonsensemedia.org/sites/default/files/research/report/2020_zero_to_eight_census_final_web.pdf
40. Radesky JS, Silverstein M, Zuckerman B, Christakis DA. Infant Self-Regulation and Early Childhood Media Exposure. Pediatrics. 2014 May 1;133(5):e1172–8.
41. Bergmann C, Dimitrova N, Alaslani K, Almohammadi A, Alroqi H, Aussems S, et al. Young children's screen time during the first COVID-19 lockdown in 12 countries. Sci Rep. 2022 Feb 7;12(1):2015.
42. Mann S, Calvin A, Lenhart A, Robb, MB. The Common Sense Census: Media Use by Kids Age Zero to Eight [Internet]. San Francisco, CA; 2025 [cited 2025 Apr 16]. Available from: https://www.commonsensemedia.org/sites/default/files/research/report/2025-common-sense-census-web-2.pdf
43. Ponti M Canadian Paediatric Society, Digital Health Task Force, Ottawa, Ontario. Digital media: Promoting healthy screen use in school-aged children and adolescents. Paediatr Child Health. 2019 Sep 5;24(6):402–8.
44. Unplugged Canada. Unplugged Canada [Internet]. Vancouver (BC): Unplugged Canada; 2025 [cited 2025 Jun 8]. Available from: https://unpluggedcanada.com/
45. Canadian Paediatric Society. Centre for Healthy Screen Use [Internet]. Ottawa (ON): Canadian Paediatric Society; [cited 2025 Jun 6]. Available from: https://healthyscreenuse.cps.ca/
46. Bundesministerium für Familie, Senioren, Frauen und Jugend (BMFSFJ). SCHAU HIN! Screen time: Social networks, surfing, gaming, or watching TV shows – digital media holds a great fascination for children and young people. But when is too much too much? [Internet]. Berlin (DE): BMFSFJ; 2023 [cited 2025 Apr 16]. Available from: https://www.schau-hin.info/bildschirmzeiten
47. World Health Organization. Guidelines on physical activity, sedentary behaviour and sleep for children under 5 years of age [Internet]. Geneva (CH): World Health Organization; 2019 [cited 2025 Apr 16]. Available from: https://www.who.int/publications/i/item/9789241550536
48. Ministry of Health, Singapore. Guidance on screen use in children [Internet]. Singapore: Ministry of Health; 2025 [cited 2025 Apr 9]. Available from: https://go.gov.sg/moh-screenadvisory
49. American Academy of Pediatrics. Family media plan [Internet]. Itasca (IL): American Academy of Pediatrics; 2024 [cited 2025 Apr 15]. Available from: https://www.healthychildren.org/English/fmp/Pages/MediaPlan.aspx
50. Australian Department of Health. Australian 24-hour movement guidelines for children and young people (5–17 years): an integration of physical activity, sedentary behaviour, and sleep [Internet]. Canberra (AU): Department of Health; 2019 [cited 2025 Apr 16]. Available from: https://www.health.gov.au/resources/publications/24-hour-movement-guidelines-children-and-young-people-5-to-17-years-brochure
51. eSafety Commissioner (Australia). Social media age restrictions [Internet]. Sydney (AU): eSafety Commissioner; [cited 2025 Apr 16]. Available from: https://www.esafety.gov.au/
52. French J. Alberta government pondering whether schools need rules about smartphones, other devices [Internet]. Toronto (ON): CBC News; 2024 May 27 [cited 2025 Apr 16]. Available from: https://www.cbc.ca/news/canada/edmonton/alberta-government-pondering-whether-schools-need-rules-about-smartphones-other-devices-1.7213296
53. Government of British Columbia. Personal digital device (cell phone) restrictions in schools [Internet]. Victoria (BC): Government of British Columbia; 2024 [cited 2025 Apr 16]. Available from: https://www2.gov.bc.ca/gov/content/education-training/k-12/administration/legislation-policy/public-schools/personal-digital-device-restrictions-in-schools
54. Jones A. Ontario to ban cellphones in classrooms next school year [Internet]. Toronto (ON): The Canadian Press; 2019 Mar 19 [cited 2025 Apr 16]. Available from: https://www.cbc.ca/news/canada/toronto/ontario-school-classroom-cellphone-ban-1.5052564
55. Goh B. Three hours a week: play time's over for China's young video gamers [Internet]. London: Reuters; 2021 Aug 31 [cited 2025 Apr 16]. Available from: https://www.reuters.com/world/china/china-rolls-out-new-rules-minors-online-gaming-xinhua-2021-08-30/
56. Wakefield J. China bans children from using mobile phones at school [Internet]. London: BBC News; 2021 Feb 2 [cited 2025 Apr 16]. Available from: https://www.bbc.com/news/technology-55902778
57. Ettedgui S. France: government adopts law banning cell phone use at school [Internet]. Washington (DC): Library of Congress; 2018 [cited 2025 Apr 16]. Available from: https://www.loc.gov/item/global-legal-monitor/2018-10-30/france-government-adopts-law-banning-cell-phone-use-at-school/
58. Willsher K. French schools start new year with phone ban in class [Internet]. London: The Guardian; 2018 Sep 3 [cited 2025 Apr 16]. Available from: https://www.theguardian.com/world/2018/sep/03/french-schools-start-new-term-with-mobile-phone-ban.
59. Ministry of Health. Sit less, move more, sleep well: active play guidelines for under-fives resources [Internet]. Wellington (NZ): Ministry of Health; 2018 May [cited 2025 Apr 16]. Available from: https://www.health.govt.nz/publications/sit-less-move-more-sleep-well-active-play-guidelines-for-under-fives-resources
60. Henley J. Norway to increase minimum age limit on social media to 15 to protect children [Internet]. London: The Guardian; 2024 Oct 23 [cited 2025 Jun 9]. Available from: https://www.theguardian.com/world/2024/oct/23/norway-to-increase-minimum-age-limit-on-social-media-to-15-to-protect-children
61. Locker M. This country just made it illegal to give kids too much screen time [Internet]. New York (NY): TIME; 2015 Jan 26 [cited 2025 Apr 16]. Available from: https://time.com/3682621/this-country-just-made-it-illegal-to-give-kids-too-much-screen-time/
62. Department for Education (UK). Government launches crackdown on mobile phones in schools [Internet]. London: UK Government; 2024 Feb [cited 2025 Apr 16]. Available from: https://www.gov.uk/government/news/government-launches-crackdown-on-mobile-phones-in-schools
63. United States Congress. S.2073 – Kids Online Safety and Privacy Act of 2023 [Internet]. Washington (DC): Congress.gov; 2023 [cited 2025 Jun 9]. Available from: https://www.congress.gov/bill/118th-congress/senate-bill/2073
64. Saunders TJ, Rollo S, Kuzik N, Demchenko I, Bélanger S, Brisson-Boivin K, et al. International school-related sedentary behaviour recommendations for children and youth. Int J Behav Nutr Phys Act. 2022 Dec;19(1):39.

Conflicts of Interest Disclosure

There are no conflicts of interest to declare.

Digital Learning Tools: Findings from a National Survey of Canadian Medical Learners

Claire Sethuram[1,2], Tess McCutcheon[1], Hui (Harriet) Yan[2], Sathya Karunananthan[1,3], Alex Hajjar[4], Oussama Outbih[2], Kim Rozon[2], Ed Seale[2], Lyn K. Sonnenberg[5,6], Clare Liddy[1,2,7]

[1] C.T. Lamont Primary Health Care Research Centre, Bruyère Research Institute, Ottawa, Ontario, Canada

[2] Department of Family Medicine, University of Ottawa, Ottawa, Ontario, Canada

[3] Interdisciplinary School of Health Sciences, University of Ottawa, Ottawa, Ontario, Canada

[4] Department of Surgery, University of Alberta, Edmonton, Alberta, Canada

[5] Office of Education, University of Alberta, Edmonton, Alberta, Canada

[6] Glenrose Rehabilitation Hospital, Edmonton, Alberta, Canada

[7] Ontario eConsult Centre of Excellence, The Ottawa Hospital, Ottawa, Ontario, Canada

Correspondence:
Clare Liddy; cliddy@uottawa.ca

Date Submitted: April 8, 2025
Date Accepted: June 7, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7448

Keywords: *primary care, digital learning, medical education, equity*

ABSTRACT

Objectives: The need for enhanced adoption of digital learning tools into medical education was highlighted by the COVID-19 pandemic. To inform development and implementation of such tools during training, we designed a survey exploring the current scope of digital learning tool use by medical students and family medicine residents in Canada.

Methods: We conducted a national survey of medical students and family medicine residents at 14 of 17 medical schools across Canada. We used frequency tables and descriptive statistics to summarize the multiple-choice responses and performed a content analysis of the free-text responses to identify recurrent themes.

Results: Survey responses indicated that learners value information quality, user experience, and accessibility. Barriers to accessing digital learning tools included cost and usability.

Conclusions: Medical educators looking to improve the delivery of medical education should focus on learner experience, removing the aforementioned barriers, and using iterative evaluation by learners to maintain relevance, usefulness, and effectiveness.

RÉSUMÉ

Objectifs : La nécessité d'adopter davantage les outils d'apprentissage numériques dans l'enseignement médical a été mis en évidence par la pandémie de COVID-19. Afin d'informer le développement et la mise en œuvre de tels outils pendant la formation, nous avons conçu une enquête pour explorer l'étendue actuelle de l'utilisation des outils d'apprentissage numériques par les étudiants en médecine et les résidents en médecine familiale au Canada.

Méthodes : Nous avons mené une enquête nationale auprès d'étudiants en médecine et de résidents en médecine familiale dans 14 des 17 facultés de médecine en Canada. Nous avons utilisé des tableaux de fréquence et des statistiques descriptives pour résumer les réponses à choix multiples et avons effectué une analyse du contenu des réponses libres afin d'identifier les thèmes récurrents.

Résultats : Les réponses de l'enquête ont indiqué que les apprenants apprécient la qualité de l'information, l'expérience utilisateur et l'accessibilité. Les obstacles à l'accès aux outils d'apprentissage numériques comprenaient le coût et la facilité d'utilisation.

Conclusions : Les éducateurs en médecine qui cherchent à améliorer la livraison de l'enseignement médical devraient se concentrer sur l'expérience des apprenants, supprimer les obstacles susmentionnés et utiliser une évaluation itérative par les apprenants pour maintenir la pertinence, l'utilité et l'efficacité.

INTRODUCTION

Over the past few decades, digital learning has gained prevalence in education, although widespread adoption within medical education has been limited.[1,2] The onset of the COVID-19 pandemic has accelerated the need for medical educators to shift focus to integrating meaningful and interactive digital tools that complement traditional learning. The value of digital learning tools (DLTs) has been well documented in the literature for professional development, enhancing learning outcomes, material retention, study motivation, and accessible learning.[3–10] DLTs are defined as "any online or offline computer-based resource, mobile application, electronic game, or resource that supports, enhances, or contributes to medical education". This definition was collaboratively developed by an interdisciplinary team of faculty members, program administrators, students, and researchers, with expertise in medicine, software development, education, and research methods.

The early phases of an ongoing scoping review regarding DLTs in medical teaching has revealed immense heterogeneity in this field.[11] As medical education programs like ours at the University of Ottawa's Department of Family Medicine strive to improve online curriculum accessibility, it is essential to understand current user experiences.[12,13] As such, our team conducted a national survey to explore the scope of DLT use by medical students and family medicine (FM) residents in Canada. We targeted these groups because they are both considered FM learners, as medical students rotate through FM as part of their training, and therefore both groups will be affected by changes to the FM online curriculum. Our findings may inform the development and implementation of DLTs for medical learners across training programs in Canada and beyond as medical education evolves in response to the digital shift with the COVID-19 pandemic.

METHODS

Survey Design

We designed a 12-question survey which included multiple-choice questions with the option for free-text comments (**Appendix A**). Four additional questions regarding access and Equity, Diversity, and Inclusion (EDI) (**Appendix B**) were added to the surveys sent to two medical schools (University of Ottawa and Université de Montreal), as these questions were developed after the initial ethics approval processes took place at other schools. Recruitment emails and surveys were provided in both English and French to ensure that it was equally accessible to anglophone and francophone populations.

Population and Ethics

Participants were eligible if they were enrolled as an undergraduate medical student or FM resident at a Canadian medical school in January 2022. The survey was open for eight weeks from February to April 2022.

Ethics approval was obtained from the Ottawa Health Science Network and the Bruyère Continuing Care Research Ethics Boards. Ethics approval was also obtained from 16/17 postgraduate FM programs and 10/17 undergraduate programs at their local institutions for inclusion in the study. Only participants from schools with ethics approval in place were contacted.

Recruitment

To reach undergraduate medical students, we contacted program administrators and/or student representatives. FM program directors were asked to distribute the survey to reach FM residents. Reminder emails were sent two weeks after the initial invitation to participating programs.

Quantitative Analysis

Responses to survey questions were exported into Microsoft Excel for analysis. We used frequency tables and descriptive statistics to summarize multiple-choice responses.

Qualitative Analysis

We conducted a content analysis of the free-text responses about terms used to refer to DLTs and comments to developers of DLTs using a latent pattern content analysis strategy to identify recurrent themes.[14] Two members of the research team (CS and TM) independently reviewed all responses and broadly coded the data without preconceived themes. Survey responses were anonymized. The two researchers (CS and TM) met to test codes and develop a codebook, which was used to develop themes that capture the qualitative data.

RESULTS

A total of 150 learners, including medical students (n=62) and FM residents (n=88), completed the survey, with national representation from 14/17 schools across the country. Demographic data was collected from all survey respondents (**Table 1**). Access and EDI data was provided by 27 respondents. Among them, 96% of respondents reported no disability and 48% of respondents reported their racial or ethnic group as White – North American (e.g., Canadian, American).

Table 1. Characteristics of Survey Respondents

Characteristic	Number of respondents (%)
Language (n=150)	
English	128 (85)
French	22 (15)
Age (n=150)	
18-24	19 (13)
25-35	118 (79)
36-50	13 (9)
Gender (n=150)	
Female	95 (63)
Male	49 (33)
Other	6 (4)

Digital Learning Tool Utilization

The majority of survey respondents (98%; n=147) agreed with the aforementioned definition of DLTs. Most respondents considered studying subscription services (97%), clinical aids (97%), online learning modules (96%), and mobile applications (96%) to be DLTs. During medical school and/or residency training, learners had used clinical aids (97%), online learning modules (89%), and mobile applications (77%) to support their learning. Some respondents indicated that DLTs were endorsed by their program, including online learning modules (78%), clinical aids (75%), and mobile applications (27%). Additional information regarding DLT use can be found in **Table 2**. No meaningful differences were observed between different years of medical school and FM residency training.

Of the individuals who responded to the access and EDI questions, the majority (78%; n=21) expressed that they experience barriers to accessing DLTs. The percentage of respondents experiencing each of the specific barriers to access can be found in **Table 3**. Cost was the most commonly reported barrier, with both highest responses relating to the cost of the DLT (70%) and cost of equipment (26%), respectively.

Qualitative Analysis

Three overarching themes emerged from the analysis of over 150 free-text comments: quality, user experience, and accessibility.

Respondents' discussions of the quality of DLTs involved factors such as information quality, simplicity, and usefulness. Several respondents also highlighted that user expe-

Table 2. Digital Learning Tool Use (n=150)

Digital learning tool	Number of respondents that considered it a digital learning tool (%)	Number of respondents that used this tool during their training (%)	Number of respondents that indicated the digital learning tool was endorsed by their program (%)
Online learning module	144 (96)	133 (89)	117 (78)
Studying subscription service	146 (97)	107 (71)	18 (12)
Quizzing software	134 (89)	88 (59)	25 (17)
Social media educational post	50 (33)	37 (25)	5 (3)
Virtual reality simulation	129 (86)	31 (21)	12 (8)
Educational video game	92 (61)	7 (5)	1 (1)
Online escape room	20 (13)	2 (1)	1 (1)
Online card game	20 (13)	2 (1)	0 (0)
Online board game	19 (13)	2 (1)	1 (1)
Clinical aid	145 (97)	146 (97)	113 (75)
Mobile application	144 96)	116 (77)	40 (27)
Online game miscellaneous	2 (1)	3 (2)	1 (1)
Other	12 (8)	19 (13)	31 (21)

rience should be a key consideration in DLT development. The user experience includes the structure of content and the audience (level of learning) for the DLTs, as well as their usability/user-friendliness. Finally, several comments related to the accessibility of DLTs, not only in terms of ease of access, but also cost (i.e., low or no cost), time (i.e., short time to use the tool), portability, and multi-device operability. For example, one survey respondent wrote, "make it accessible (easy to find, easy to use) and affordable."

DISCUSSION

The results of this national survey reveal valuable insights into DLT use among Canadian medical learners. Clinical aids, online learning modules, and mobile applications were the most common types of DLTs used by survey respondents and endorsed by their programs. In the development and implementation of novel tools, this survey revealed that Canadian medical learners value quality, user experience, and accessibility. When incorporating novel tools into medical curricula, educators should consider the quality of information presented to ensure it reflects learning objectives without introducing redundancy. DLT developers should also prioritize user-centered design processes with regular feedback from learners to ensure tools are easy to navigate (i.e., user-friendly). Finally, to enhance traditional learning, DLTs must be low-cost and multi-device compatible to enhance accessibility.

Interestingly, this survey revealed that a large proportion of Canadian medical learners face barriers related to the use of DLTs. This is consistent with studies from other jurisdictions that cite barriers related to poor internet coverage, limited interaction and engagement, user-friendliness, variation across platforms, and lack of suitable devices.[1,12,15,16] However, in our survey, the most common barriers reported were costs associated with equipment and individual tools or subscription services. As digital tools become more commonplace in medical education, it is critical for developers and educators to recognize cost as a significant barrier to access. Undergraduate and postgraduate medical faculties and departments should make efforts to ensure that DLTs are accessible, affordable, and available to learners. This survey revealed that affordability extends beyond the cost of a tool itself. For example, mobile applications that are available only on newer devices may limit their use as the cost of equipment represents a barrier. Further, DLTs that require a high-speed internet connection in the home may also be difficult for some learners to access, which is consistent with perspectives from learners in other countries.[12,15,16]

To our knowledge, our study is the first to conduct a survey of undergraduate medical students and FM residents on DLT at a national scope. Another novel aspect is the qualitative analysis from over 150 free-text responses. We provided our survey in both English and French to increase accessibility and minimize the common sampling bias favouring participants who speak fluent English. This is important because some medical practitioners serve French-speaking communities and benefit from the availability of DLT in multiple languages. Indeed, one respondent identified "Unavailable in preferred language" as a barrier. One significant study limitation is low response rate. Additionally, participation rates differed between medical students and FM residents, as well as between institutions. Those individuals using digital tools may be more likely to respond; perhaps those who have not used them did not answer the survey. As such, the results produced by this survey could be biased and may not be completely representative of all Canadian medical and FM learners. Strategies such as a longer data collection period, additional email reminders, increased promotion on social media, and monetary compensation may have increased survey participation.[17–22]

Table 3. Barriers to access experienced by respondents (n=27)

Barriers to Access	Number of respondents that experienced barriers (%)
Cost of Equipment (laptop, tablet, mobile phone)	7 (26)
Lack of available equipment through university (laptop, tablet, mobile phone)	4 (15)
Usability (functionality, universal design)	7 (26)
Cost of the digital learning tool (licence, subscription)	19 (70)
Reliable high-speed internet at home	1 (4)
Reliable high-speed internet on campus	0 (0)
Unavailable in preferred language	1 (4)
No need / no interest / not useful	1 (4)

CONCLUSION

In conclusion, clinical aids, online learning modules, and mobile applications were the most common types of DLTs reported by survey respondents. When incorporating these tools into medical education, barriers to access, particularly related to cost, should be actively addressed to ensure equity among learners. The free-text responses of this survey highlighted themes of quality, user experience, and accessibility, which should be considered by educators and developers during the design, development, and implementation of DLTs. Moreover, ongoing evaluation is essential to ensure these tools remain relevant, useful, effective, and aligned with learners' needs.

REFERENCES

1. O'Doherty D, Dromey M, Lougheed J, Hannigan A, Last J, McGrath D. Barriers and solutions to online learning in medical education - an integrative review. BMC Med Educ. 2018;18(1):130. doi:10.1186/s12909-018-1240-0
2. Shachar M, Neumann Y. Differences Between Traditional and Distance Education Academic Performances: A Meta-Analytic Approach. The International Review of Research in Open and Distributed Learning. 2003;4(2). doi:10.19173/irrodl.v4i2.153
3. Hopkins L, Hampton BS, Abbott JF, et al. To the point: medical education, technology, and the millennial learner. Am J Obstet Gynecol. 2018;218(2):188-192. doi:10.1016/j.ajog.2017.06.001
4. Edmonson, SR. Technology in Primary and Secondary Medical Education. In: Handbook of Research on Instructional Systems and Technology. IGI Global; 2008.
5. Nevin CR, Westfall AO, Rodriguez JM, et al. Gamification as a tool for enhancing graduate medical education. Postgrad Med J. 2014;90(1070):685-693. doi:10.1136/postgradmedj-2013-132486
6. Dankbaar M. Serious games and blended learning; effects on performance and motivation in medical education. Perspect Med Educ. 2017;6(1):58-60. doi:10.1007/s40037-016-0320-2
7. Pettit RK, McCoy L, Kinney M. What millennial medical students say about flipped learning. Adv Med Educ Pract. 2017;8:487-497. doi:10.2147/AMEP.S139569
8. Mangold K. Educating a new generation: teaching baby boomer faculty about millennial students. Nurse Educ. 2007;32(1):21-23. doi:10.1097/00006223-200701000-00007
9. Twenge JM. Generational changes and their impact in the classroom: teaching Generation Me. Med Educ. 2009;43(5):398-405. doi:10.1111/j.1365-2923.2009.03310.x
10. Wong, Roger. Medical education during COVID-19: Lessons from a pandemic. BCMJ. 2020;62(5):170-171.
11. Yan H, Rahgozar A, Sethuram C, et al. Natural Language Processing to Identify Digital Learning Tools in Postgraduate Family Medicine: Protocol for a Scoping Review. JMIR Res Protoc. 2022;11(5):e34575. doi:10.2196/34575
12. Roslan NS, Halim AS. Enablers and Barriers to Online Learning among Medical Students during COVID-19 Pandemic: An Explanatory Mixed-Method Study. Sustainability. 2021;13(11):6086. doi:10.3390/su13116086
13. Santoso HB, Schrepp M. The impact of culture and product on the subjective importance of user experience aspects. Heliyon. 2019;5(9):e02434. doi:10.1016/j.heliyon.2019.e02434
14. Kleinheksel AJ, Rockich-Winston N, Tawfik H, Wyatt TR. Demystifying Content Analysis. Am J Pharm Educ. 2020;84(1):7113. doi:10.5688/ajpe7113
15. Al-Balas M, Al-Balas HI, Jaber HM, et al. Distance learning in clinical medical education amid COVID-19 pandemic in Jordan: current situation, challenges, and perspectives. BMC Med Educ. 2020;20(1):341. doi:10.1186/s12909-020-02257-4
16. Bastos RA, Carvalho DR dos S, Brandão CFS, Bergamasco EC, Sandars J, Cecilio-Fernandes D. Solutions, enablers and barriers to online learning in clinical medical education during the first year of the COVID-19 pandemic: A rapid review. Medical Teacher. 2022;44(2):187-195. doi:10.1080/0142159X.2021.1973979
17. Peng S, Micks T, Braganza D, et al. Canadian national survey of family medicine residents on point-of-care ultrasound training. Can Fam Physician. 2019;65(12):e523-e530.
18. Falconer J, Couture F, Demir KK, Lang M, Shefman Z, Woo M. Perceptions and intentions toward medical assistance in dying among Canadian medical students. BMC Med Ethics. 2019;20(1):1-7. doi:10.1186/s12910-019-0356-z
19. Nagji A, Leslie K, Wong E, Myhre D, Young M, Chan MK. Something's missing from my education: Using a cross sectional survey to examine the needs and interest of Canadian medical students relating to their roles as teachers and educators. Can Med Educ J. 2017;8(3):e21-e29.
20. Katz NJ, Lovrics O, Zevin B. A Canadian survey of medical students and undergraduate deans on the management of patients living with obesity. BMC Med Educ. 2022;22(1):1-10. doi:10.1186/s12909-022-03636-9
21. Khan R, Apramian T, Kang JH, Gustafson J, Sibbald S. Demographic and socioeconomic characteristics of Canadian medical students: a cross-sectional study. BMC Med Educ. 2020;20(1):1-8. doi:10.1186/s12909-020-02056-x
22. Robert P, Bégin F, Ménard-Castonguay S, et al. Attitude and knowledge of medical students about organ donation – training needs identified from a Canadian survey. BMC Med Educ. 2021;21(1):1-7. doi:10.1186/s12909-021-02736-2

Conflicts of Interest Disclosure
There are no conflicts of interest to declare.

APPENDICES

Appendix A: Survey

1. In this survey, we are using “digital learning tools” to refer to any online or offline computer-based resource, mobile application, electronic game or resource that supports, enhances, or contributes to medical education.

   Does this definition capture your understanding of digital learning tools? Please select one response.

   - ☐ Yes
   - ☐ No
   - ☐ Uncertain
   - ☐ Don't know

2. Are there other terms you would use to refer to what we have defined here as “digital learning tools”?
   Free text

3. Which of the following do you consider a digital learning tools? Please check all that apply.

   - ☐ Online learning module
   - ☐ Studying Subscription Service (ex: Osmosis, MedSkool, SketchyMedic)
   - ☐ Quizzing software (ex: Quizlet, TopHat, Kahoot)
   - ☐ Social media educational post (ex: Snapchat stories from surgeons)
   - ☐ Virtual reality simulation (ex: Simulated patient encounters)
   - ☐ Educational video game (ex: Septris)
   - ☐ Online Escape Room
   - ☐ Online card game
   - ☐ Online board game
   - ☐ Clinical aid (ex: UpToDate, Lexicomp)
   - ☐ Mobile app (ex: Complete Anatomy, Touch Surgery)
   - ☐ Online game miscellaneous
   - ☐ Other (please specify)

4. What digital learning tools have you used in your medical and/or residency training? Please check the box that most accurately describes the modality, and write its name in text.

   - ☐ Online learning module
   - ☐ Studying Subscription Service (ex: Osmosis, MedSkool, SketchyMedic)
   - ☐ Quizzing software (ex: Quizlet, TopHat, Kahoot)
   - ☐ Social media educational post (ex: Snapchat stories from surgeons)
   - ☐ Virtual reality simulation (ex: Simulated patient encounters)
   - ☐ Educational video game (ex: Septris)
   - ☐ Online Escape Room
   - ☐ Online card game
   - ☐ Online board game
   - ☐ Clinical aid (ex: UpToDate, Lexicomp)
   - ☐ Mobile app (ex: Complete Anatomy, Touch Surgery)
   - ☐ Online game miscellaneous
   - ☐ Other (please specify)

5. Please indicate the name of the corresponding program/application you have used in the text box.

6. What digital learning tools have been endorsed by your program to support your medical education and/or residency training? Please select all options that accurately describe the digital learning tools.

   - ☐ Online learning module
   - ☐ Studying Subscription Service (ex: Osmosis, MedSkool, SketchyMedic)
   - ☐ Quizzing software (ex: Quizlet, TopHat, Kahoot)
   - ☐ Social media educational post (ex: Snapchat stories from surgeons)

- ☐ Virtual reality simulation (ex: Simulated patient encounters)
- ☐ Educational video game (ex: Septris)
- ☐ Online Escape Room
- ☐ Online card game
- ☐ Online board game
- ☐ Clinical aid (ex: UpToDate, Lexicomp)
- ☐ Mobile app (ex: Complete Anatomy, Touch Surgery)
- ☐ Online game miscellaneous
- ☐ Other (please specify)

7. Please indicate the name of the corresponding program/application you have used in the text box.

8. In thinking about the current way medical students and family medicine residents are being taught, what is the one thing you would like the people creating digital learning tools to understand. **Free Text**

Demographic Question

9. Indicate which age category you belong to: (please select one)

- ☐ 18-24
- ☐ 25-35
- ☐ 36-50
- ☐ 51-64
- ☐ 65+

10. With which gender do you identify? (please select one)

- ☐ Male
- ☐ Female
- ☐ Other
- ☐ Prefer not to say

11. What university do you currently attend? (Check off the appropriate institution)

- ☐ University of British Columbia
- ☐ University of Alberta
- ☐ University of Calgary
- ☐ University of Saskatchewan
- ☐ University of Manitoba
- ☐ Northern Ontario School of Medicine
- ☐ Western University
- ☐ McMaster University
- ☐ University of Toronto
- ☐ Queen's University
- ☐ University of Ottawa
- ☐ McGill University
- ☐ Université Laval
- ☐ Université de Montréal
- ☐ Université de Sherbrooke
- ☐ Dalhousie University
- ☐ Memorial University of Newfoundland
- ☐ Centre de formation médicale du Nouveau-Brunswick
- ☐ Other

12. What year of training are you currently in? (check off year)

- ☐ Undergraduate medicine year 1

- ☐ Undergraduate medicine year 2
- ☐ Clerkship Year 3 & 4
- ☐ PGY1
- ☐ PGY2
- ☐ PGY3+

OPTIONAL: If you are interested in being contacted by our team for future surveys or interviews related to digital learning tools in medical education, please provide your name and email address below.

Name
School
Email Address

Appendix B: Additional Questions – Access and EDI

9. Do you experience barriers that prevent you from using digital learning tools? **Yes/No**

10. If yes, what are the barriers that prevent you from using digital learning tools (select all that apply):

- ☐ Cost of equipment (laptop, tablet, mobile phone)
- ☐ Lack of available equipment through university (laptop, tablet, mobile phone)
- ☐ Usability (functionality, universal design)
- ☐ Cost of the digital learning tool (license, subscription)
- ☐ Reliable high-speed internet at home
- ☐ Reliable high-speed internet on campus
- ☐ Unavailable in preferred language
- ☐ No need/no interest/not useful
- ☐ Other:

13. Which of the following BEST describes your racial or ethnic group? Check ONE only.

- ☐ Asian - East (e.g., Chinese, Japanese, Korean)
- ☐ Asian - South (e.g., Indian, Pakistani, Sri Lankan)
- ☐ Asian - South East (e.g., Malaysian, Filipino, Vietnamese)
- ☐ Black - African (e.g., Ghanaian, Kenyan, Somali)
- ☐ Black - Caribbean (e.g., Barbadian, Jamaican)
- ☐ Black - North American (e.g., Canadian, American)
- ☐ Black - European (e.g., English, Italian, Portuguese, Russian)
- ☐ Indian - Caribbean (e.g., Guyanese with origins in India)
- ☐ Latin American (e.g., Argentinean, Chilean, Salvadorian)
- ☐ First Nations
- ☐ Inuit
- ☐ Métis
- ☐ Middle Eastern (e.g., Egyptian, Iranian, Lebanese)
- ☐ White - European (e.g., English, Italian, Portuguese, Russian)
- ☐ White - North American (e.g., Canadian, American)
- ☐ Indigenous/Aboriginal not included elsewhere
- ☐ Mixed heritage (e.g., Black - African and White - North American) (Please specify) _____
- ☐ Other(s) (Please specify) _____
- ☐ Prefer not to answer
- ☐ Do not know

14. Do you identify as a person with a disability?

- ☐ Yes
- ☐ No
- ☐ Prefer not to answer

Xenotransplantation Unveiled: Breakthroughs, Challenges, and Public Perceptions

Photo by Günter Valda on Unplash

James Vowles[1]

[1] Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada

Correspondence: James Vowles; vowlesjames@yahoo.ca

Date Submitted: April 9, 2025
Date Accepted: August 12, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7450

Keywords: *organ donation, xenotransplantation, organ shortage, public perception, CRISPR/CAS9*

ABSTRACT

Xenotransplantation has recently made headlines in media reports showcasing the advancement and potential of this process. However, with this recognition comes questions, doubts, and disbelief. This commentary reviews recent scientific breakthroughs, including CRISPR–enabled genetic modifications and human–pig chimeric organ development, while also addressing immunological barriers, ethical concerns, and public perception. Although major challenges remain–such as immune rejection and societal acceptance–xenotransplantation offers a promising strategy to address the critical organ shortage and transform future healthcare.

RÉSUMÉ

La xénotransplantation a récemment fait la une des médias, qui ont mis en avant les progrès et le potentiel de ce procédé. Cependant, cette reconnaissance s'accompagne de questions, de doutes et d'incrédulité. Ce commentaire passe en revue les récentes avancées scientifiques, notamment les modifications génétiques rendues possibles par la technologie CRISPR et le développement d'organes chimériques humains-porcins, tout en abordant les obstacles immunologiques, les préoccupations éthiques et la perception du public. Bien que des défis majeurs subsistent, tels que le rejet immunitaire et l'acceptation sociale, la xénotransplantation offre une stratégie prometteuse pour remédier à la pénurie critique d'organes et transformer les soins de santé à l'avenir.

INTRODUCTION

Organ donation can be a sensitive topic for many people. Furthermore, the question "would you like to be an organ donor?" is asked at a time of life when most people are just learning to drive, and the thought of death is incomprehensibly too far in the future. Unfortunately, there is still a lack of organ donors throughout Canada. Fewer than a quarter of Canadians are currently registered as organ donors.[1] Ultimately, this shortage is influenced by various factors, including social norms, reluctance to discuss death, a lack of awareness, and delayed decision-making.[2] Due to the ongoing shortage, two options are currently being explored. One, is legislative changes, specifically, most Canadian provinces still use an opt-in model for organ donation, though some are exploring or adopting opt-out systems, with Nova Scotia leading the way.[3]

Second, is a procedure called xenotransplantation. While commonly associated with the transplantation of animal organs or tissues into humans, xenotransplantation broadly refers to the transplant of living cells, tissues, or organs from one species to a different species.[4] This technique is also vital in biomedical research, where human cells or tissues are transplanted into animal models to study diseases or develop therapies. In this commentary, we will primarily focus on the transplantation of animal organs, tissues, or cells into humans.

Another rapidly advancing field aimed at tackling the organ shortage is the *in vitro* creation or "organ in a dish" phenomenon, where scientists aim to grow human organs or complex tissues from stem cells in the laboratory. While highly promising for personalized medicine and reducing immune rejection, this approach currently faces significant hurdles. These include the challenge of scaling up miniature organoids to full, transplantable organ sizes, achieving functional maturity, and developing a comprehensive, integrated vascular system crucial for organ survival.

Given these formidable challenges in growing whole, functional human organs *in vitro*, xenotransplantation emerges as a potentially more immediate solution for addressing the critical organ shortage. As such, the importance of xenotransplantation and its impact on potentially solving the organ shortage crisis has fueled a resurgence of research. Specifically, a pivotal study published in September 2023 by Wang et al., titled 'Generation of a humanized mesonephros in pigs from induced pluripotent stem cells via embryo complementation', showed promising results for functional, laboratory-grown human kidneys in animals, bringing xenotransplantation one step closer to reality. However, there is still a gap in knowledge concerning public awareness of xenotransplantation and its implications, which this paper will address. This commentary will discuss important background information, further details on the breakthrough study, the benefits, and challenges of xenotransplantation as well as the public perception and acceptance.

BACKGROUND

Interestingly, the idea of xenotransplantation is not new and has been around for centuries. Xenotransplantation has historical roots dating back to the 17th century, beginning with Jean Baptiste Denis' sheep-to-human blood transfusion in 1667.[5] Then, almost 200 years later, by 1838, physicians were already experimenting with xenotransplantation, including a pig-to-human corneal transplant.[6] Since then, several more historical clinical xenotransplantations took place using a variety of animals such as rabbits, pigs, goats, monkeys, sheep, and chimpanzees.[7] Unfortunately, the outcomes were not promising as most patients died within several weeks.[7] Nowadays scientists commonly rely on pigs as the main contributors. Pigs are especially suitable for xenotransplantation due to their early reproductive maturity, short pregnancy durations, large litters, and organ sizes that closely match human anatomy which offer considerable advantages over other animals.[8] Yet, despite finding the most suitable animal to implement xenotransplantation, one of the strongest obstacles remains, the immune system's tendency to reject the transplanted organ.[9] The most powerful and rapid rejection is called a hyperacute rejection (HAR), which occurs when the recipient's existing antibodies immediately recognize and attack the foreign antigens in the xenograft.[10] These antibodies quickly attack the new organ, causing damage to its cells and blood vessels within just a few minutes or hours. Therefore, to address the immunogenicity problem, scientists have turned to precision gene editing via the clustered regularly interspaced short palindromic repeats/CRISPR-associated protein 9 system (CRISPR/CAS9). CRISPR/CAS9 has permitted scientists to remove (*knock out*) or add (*knock-in*) genes to ensure immunological compatibility. For example, in 2022, David Bennett Sr was the first person in the world to receive a genetically modified pig's heart. The pig was genetically modified by having three genes deleted, *GGTA1, CMAH* and *B4GALNT2* in addition to the knockout of the growth hormone receptor (GHR).11 Additionally, to

improve compatibility, scientists inserted six human genes —*CD55, CD47, h-TBM, CD-46, H0-1*, and *h-EPCR*—into the donor pig.[11] Unfortunately, David died just two months after the surgery. However, his survival for that length of time marked a remarkable breakthrough, demonstrating that a genetically modified pig heart could sustain human life beyond the immediate post-operative period. This case underscored both the promise of xenotransplantation and the urgent need for continued research that could one day save the lives of thousands of individuals currently in need of organ transplants.

XENOTRANSPLANTATION: A BREAKTHROUGH

On September 7th, 2023, Wang et al., published a pivotal study demonstrating the feasibility of generating early-stage humanized kidneys within pig embryos. Their method involved several key steps. First, they engineered induced pluripotent stem cells (iPSCs) derived from a cultured human cell line with enhanced survival traits by expressing *MYCN + BCL2*, resulting in a competitive stem cell line known as 4CL/N/B iPSCs. These cells were cultured in a specialized medium (4CL) to further support their pluripotency.[12] Next, they created pig embryos which were genetically modified to lack kidney-forming potential by knocking out the *SIX1* and *SALL1* genes, which are essential for mesonephric tubule development.[12] By injecting the human iPSCs into these nephric-null embryos, they aimed to create a developmental "niche" that human cells could occupy. These embryos were transferred into surrogate sows (female pigs) and allowed to develop for 25 or 28 days before analysis.[12]

The results showed that the successful integration of human cells into developing kidney structures was possible. However, despite the promise, several critical challenges remained. Notably, the efficiency of human cell contribution was limited—typically less than 5%—raising questions about the functional viability of the resulting organs.[12] In addition, the study reported high gestational loss rates, with a large proportion of the chimeric embryos failing to develop properly or degenerating early in gestation.[12] These findings suggest that the host environment may not fully support cross-species organogenesis at this stage of research.

Moreover, several translational hurdles persist. One major concern is vascular chimerism, where blood vessels within the developing organ may remain of porcine origin.[12] This is problematic because recipient immune systems are more likely to reject non-human vasculature, potentially triggering acute or chronic rejection even if the parenchymal (functional) tissue is human-derived. Another challenge is ensuring long-term functional maturation of these organs.[12] At just 25-28 days gestation, the chimeric kidneys were at a rudimentary stage, and there is currently no evidence that these organs can grow, mature, and function long-term *in vivo*.

Perhaps most controversially, a small number of human cells were found to contribute to neural cell lineages within the developing pig embryo, raising ethical concerns about off-target integration.[12] This also ties into the critical issue of germline exclusion – ensuring that human cells do not integrate into reproductive tissues and pass on human genetic material to animal offspring. Without strict germline control, the clinical translation of this technology will likely face insurmountable regulatory and ethical barriers.

In summary, while the Wang et al. Study marks a significant step forward in xenotransplantation, the technical and translational challenges – low efficiency, gestational instability, vascular incompatibility, incomplete maturation, and ethical safeguards – are far from incidental. They remain core barriers that must be overcome before human-animal chimeras can become a reliable source of transplantable organs.

ADDITIONAL CLINICAL PROGRESS IN ORGAN XENOTRANSPLANTATION

In 2022, Griffith et al. Reported the first successful porcine to human heart xenotransplantation in a 57-year-old patient with terminal heart disease. The genetically modified donor heart functioned for 49 days post-transplant, demonstrating partial immune compatibility and no signs of hyperacute rejection at autopsy, though the patient ultimately passed away due to cardiac dysfunction unrelated to clear graft failure.[13]

Meanwhile, kidney xenotransplantation continues to advance in both preclinical and human decedent models. Allison (2022) outlines promising developments using gene-edited pig kidneys in brain-dead human recipients. These kidneys produced urine and showed no signs of hyperacute or acute rejection during the short observation period.[14] This model provides an ethically viable platform for testing functional outcomes and refining immunosuppressive protocols before transitioning to living patients.

Because brain-dead individuals are legally deceased but maintained on life support with prior consent from families or guardians, this approach avoids exposing living patients to undue risk while still allowing clinically relevant data to be collected.

BENEFITS AND CHALLENGES

As research advances in the field of xenotransplantation, we must continue to consider both the benefits and challenges. First and foremost, a notable benefit would be the alleviation of organ shortages. Xenotransplantation could greatly expand the organ supply that will be available promptly for use. Secondly, if the field reaches clinical maturity, xenogenetic donor organs could be produced under standardized, pathogen-free conditions and procured electively, potentially improving the consistency and predictability of organ quality compared with variable deceased-donor organs. Ordinarily, assessing the quality of donor organs remains a significant challenge, as it can vary widely and is often unpredictable, thus, patients may receive organs which differ in quality.[15] Thirdly, xenotransplantation could help reduce issues of coercion within families and lessen the financial burdens often faced by living donors. Unfortunately, in cases when a family member becomes ill and needs an organ transplant, family members may coerce other members to give their organs. Additionally, nearly one in four kidney donors reported experiencing financial difficulties as a result of their donation.[16] Finally, it could provide societal economic savings. The kidney is one of the most donated organs, and for those awaiting a kidney transplant, the typical long-term treatment often involves dialysis. In Canada, this treatment costs the healthcare system an estimated "$56,000–$107,000 per patient per year".[17,18] A successful xenotransplantation could reduce the need for such ongoing treatments, leading to potentially astronomical savings that could be redirected to other areas of the healthcare system that are underfunded or struggling to meet demand.

However, despite all these benefits, there remain pertinent challenges (**Table 1**). Firstly, as mentioned above, the main concern associated with xenotransplantation is immunological rejection. If this barrier cannot be addressed, xenotransplantation is unlikely to transition from experimental research to practical medical application. While hyperacute rejection (HAR) occurs within minutes due to pre-formed antibodies targeting a-Gal, other forms of rejection, such as delayed xenograft rejection, involve natural killer (NK)

Table 1. Key challenges in xenotransplantation and current mitigation strategies

Domain	Challenge	Mitigation Strategy	Status (2025)
Immunological	Hyperacute rejection (a-Gal antibodies)	*GGTA1* knockout; expression of human *CD46/C55*	Demonstrated in pig-to-human trials
	Delayed rejection (non-Gal antigens, NK/macrophages)	*CMAH, B4GALNT2* knockouts; anti-*CD40* therapy	Preclinical primate models
	Chronic rejection	Long-term immunosuppression; anti-inflammatory gene edits	Under investigation
Microbiological	Risk of porcine endogenous retroviruses (PERVs)	PERV-inactivated donor pigs via CRISPR; designated pathogen-free herds	Early-stage implementation
Ethical	Neural/germline chimerism in organoid models	Targeted organ niches; germline exclusion protocols	ISSCR oversight required
	Animal welfare concerns	Use of high-welfare donor herds; justification under saving-human-lives model	Ongoing debate
Regulatory	Long-term recipient surveillance	Lifetime monitoring; 50-year tissue archiving (FDA draft guidance 2024)	Regulatory drafts in progress

cells, macrophages, and antibodies against non-Gal antigens like *Neu5Gc* and *SDa*. Recent studies such as Bryne et al., 2018 have highlighted *B4GALNT2*, the enzyme responsible for *SDa* antigen synthesis, as a key barrier, with its deletion significantly reducing human antibody binding.[19] Although genetic modifications have improved early outcomes in preclinical models, chronic rejection and long-term graft acceptance remain major hurdles. Secondly, there is a concern regarding microbiological risks, such as transmitting infectious agents from animal to human. Pigs carry endogenous retroviruses in their DNA, and some of these viruses have the potential to infect human cells, raising concerns about cross-species disease transmission.[20] This poses a threat to the safety of not only the patient but their family, friends, and society as a whole if transmission becomes uncontrolled. Thirdly, there is concern about the potential rise of xenotourism, where patients travel abroad to undergo xenotransplantation procedures not available in their home countries.[21] When people become desperate, which often results from terminal diseases, travelling thousands of miles to different countries becomes the only solution. However, xenotourism can bring extreme challenges for the Centers for Disease Control and Prevention (CDC) about containing outbreaks of viruses. Finally, the ethical concern about raising animals solely for the use of harvesting their organs for human use. Realistically, the idea is not so different than what we do now, raising animals for the sole purpose of eating. But, in this context, we raise animals to save a life. Certainly, the health and well-being of the animals must be considered, therefore, we should evaluate the most ethical practices that minimize harm for both parties.

ETHICAL AND REGULATORY CONSIDERATIONS

While ethical concerns such as animal welfare and neural chimerism have been noted, formal guidance is now shaping the boundaries of both research and clinical xenotransplantation. The International Society for Stem Cell Research (ISSCR) 2021 guidelines classify full gestation human-animal chimeras as a Category 2 activity, meaning they are permissible only under specialized oversight and ethics review, and they prohibit the breeding of chimeric animals with potential human germline integration.[22] These distinctions are crucial when considering research using embryonic chimeras versus clinical applications involving organ transplantation. On the regulatory front, the FDA's 2024 draft guidance on xenotransplantation emphasizes lifetime patient monitoring, 50-year biological specimen storage, and rigorous genomic screening of donor animals.[23] These evolving frameworks reflect the growing translational momentum in the field, while ensuring that ethical and biosafety risks are managed proactively and transparently.

PUBLIC PERCEPTION AND ACCEPTANCE

As xenotransplantation becomes more popular, opinions surrounding it will become more pronounced. These views vary depending on who you ask—healthcare professionals, patients, or the general public—and are shaped by multiple factors. For example, in a hospital-based survey, 67% of healthcare professionals expressed support for xenotransplantation, 7% opposed it, and 26% remained undecided, whereas the public responded even more favorably at 74%.[24] Another study looked at the general public and patients (who were awaiting organ transplants) and found that both groups showed greater willingness to accept xenogeneic cells and tissues than entire organs.[25] This gradient in acceptance may reflect concerns about identity, infection risk, or the perceived invasiveness of the procedure. Religious beliefs and cultural values can also shape responses, particularly when mixing human and animal cells is involved. Media coverage, especially in high-profile cases like the 2022 pig-heart transplant, can further influence perceptions by framing xenotransplantation as either a miracle or a moral dilemma. Therefore, much like other controversial therapies, public attitudes will depend not only on who you ask, but also on how the therapy is presented, perceived, and ethically framed. As research progresses, clear communication and transparency will be key to building long-term public trust.

CONCLUSION

Xenotransplantation is a unique topic that is drawing attraction to the scientific community at a rapid speed. With this, questions and apprehension are surely to follow. Therefore, the aim of this paper was to unravel what xenotransplantation is and to enhance public understanding of its potential and challenges. Through the discussion of recent breakthroughs, benefits versus challenges, and public perception, the idea of xenotransplantation is beginning to evolve from a thought of science fiction to reality. The challenges of immunological and societal rejection could one day be overcome and showcase the true life-saving benefits. Xenotransplantation exemplifies the essence of scientific progress: investigation, innovation, and information.

REFERENCES

1. Government of Canada [Internet]. / Gouvernement du Canada; 2023 [cited 2023 Sept 14]. Available from: https://www.canada.ca/en/health-canada/services/healthy-living/blood-organ-tissue-donation/organ-tissue.html
2. Cotrau P, Hodosan V, Vladu A, Daina C, Daina LG, Pantis C. Ethical, Socio-Cultural and Religious Issues in Organ Donation. Maedica (Bucur). 2019 Mar;14(1):12-14. Greek, Modern. doi: 10.26574/maedica.2019.14.1.12. PMID: 31123506; PMCID: PMC6511665.
3. Tennankore KK, Klarenbach S, Goldberg A. Perspectives on Opt-Out Versus Opt-In Legislation for Deceased Organ Donation: An Opinion Piece. Can J Kidney Health Dis. 2021 Jun 16;8:20543581211022151. doi: 10.1177/20543581211022151. PMID: 34188947; PMCID: PMC8212358.
4. Center for Biologics Evaluation and Research. Xenotransplantation [Internet]. FDA; [cited 2023 Sept 14]. Available from: https://www.fda.gov/vaccines-blood-biologics/xenotransplantation
5. Yoon CH, Choi HJ, Kim MK. Corneal xenotransplantation: Where are we standing? Prog Retin Eye Res. 2021 Jan;80:100876. doi: 10.1016/j.preteyeres.2020.100876. Epub 2020 Aug 2. PMID: 32755676; PMCID: PMC7396149.
6. Cooper DK. A brief history of cross-species organ transplantation. Proc (Bayl Univ Med Cent). 2012 Jan;25(1):49-57. doi: 10.1080/08998280.2012.11928783. PMID: 22275786; PMCID: PMC3246856.
7. Rodger D, Cooper DK. Kidney Xenotransplantation: Future clinical reality or science fiction? Nursing & Health Sciences. 2022;25(1):161–70. doi:10.1111/nhs.12994
8. Villiers CB de. Xenotransplantation: Gene editing animals for organ transplants to humans [Internet]. 2022 [cited 2023 Sept 14]. Available from: https://www.phgfoundation.org/briefing/xenotransplantation#:~:text=Pigs have become the most, offer advantages over other animals.
9. Carvalho-Oliveira M, Valdivia E, Blasczyk R, Figueiredo C. Immunogenetics of xenotransplantation. Int J Immunogenet. 2021 Apr;48(2):120-134. doi: 10.1111/iji.12526. Epub 2021 Jan 7. PMID: 33410582.
10. Vadori M, Cozzi E. Immunological challenges and therapies in xenotransplantation. Cold Spring Harb Perspect Med. 2014 Apr 1;4(4):a015578. doi: 10.1101/cshperspect.a015578. PMID: 24616201; PMCID: PMC3968789.
11. Bender M, Längin M, Reichart B, Mokelke M, Radan J, Neumann E, et al. Clinical cardiac xenotransplantation first in the clinical arena. Xenotransplantation. 2022 Jan;29(1):e12734. doi: 10.1111/xen.12734. Epub 2022 Feb 15. PMID: 35165939.
12. Wang J, Xie W, Li N, Li W, Zhang Z, Fan N, et al. Generation of a humanized mesonephros in pigs from induced pluripotent stem cells via embryo complementation. Cell Stem Cell. 2023 Sep 7;30(9):1235-1245.e6. doi: 10.1016/j.stem.2023.08.003. PMID: 37683604.
13. Griffith, B. P., Goerlich, C. E., Singh, A. K., Rothblatt, M., Lau, C. L., Shah, A., Lorber, M., Grazioli, A., Saharia, K. K., Hong, S. N., Joseph, S. M., Ayares, D., & Mohiuddin, M. M. (2022). Genetically modified porcine-to-human cardiac xenotransplantation. New England Journal of Medicine, 387(1), 35–44. https://doi.org/10.1056/nejmoa2201422
14. Allison, S. J. (2022). A model of pig-to-human kidney transplantation. Nature Reviews Nephrology, 18(4), 199–199. https://doi.org/10.1038/s41581-022-00550-7
15. Von Moos S, Akalin E, Mas V, Mueller TF. Assessment of Organ Quality in Kidney Transplantation by Molecular Analysis and Why It May Not Have Been Achieved, Yet. Front Immunol. 2020 May 12; 11:833. doi: 10.3389/fimmu.2020.00833. PMID: 32477343; PMCID: PMC7236771.
16. Schover, L. R., Streem, S. B., Boparai, N., Duriak, K., & Novick, A. C. (1997). The psychosocial impact of donating a kidney. The Journal of Urology, 1596–1600. https://doi.org/10.1097/00005392-199705000-00014
17. Organ transplant [Internet]. [cited 2023 Sept 14]. Available from:https://www.healthlinkbc.ca/health-topics/organ-transplant#:~:text=Organs most often transplanted include, failure, and other heart problems.
18. [Internet]. [cited 2023 Sept 14]. Available from: https://secure.cihi.ca/free_products/report-corr-high-risk-high-cost-en-web.pdf
19. Byrne, G., Ahmad-Villiers, S., Du, Z., & McGregor, C. (2018). B4galnt2 and Xenotransplantation: A newly appreciated xenogeneic antigen. Xenotransplantation, 25(5). https://doi.org/10.1111/xen.12394
20. Denner J. Porcine Endogenous Retroviruses and Xenotransplantation, 2021. Viruses. 2021 Oct 26;13(11):2156. doi: 10.3390/v13112156. PMID: 34834962; PMCID: PMC8625113.
21. Kwon I (Bok-K, Mo H. Xenotransplantation. Encyclopedia of Global Bioethics. 2015;1–14. doi:10.1007/978-3-319-05544-2_449-1
22. ISSCR (2021). Guidelines for Stem Cell Research and Clinical Translation. https://www.isscr.org/guidelines
23. FDA (2024). Source Animal, Product, Preclinical, and Clinical Issues Concerning the Use of Xenotransplantation Products. Draft Guidance
24. Ríos A, Conesa C, Ramírez P, Galindo PJ, Rodríguez MM, Martínez L, et al. Hospital personnel faced with organ xenotransplantation: an attitudinal survey in a hospital with a pre-clinical liver xenotransplantation program. Xenotransplantation. 2006 Sep;13(5):447- 54. doi: 10.1111/j.1399-3089.2006.00334.x. PMID: 16925669.
25. Persson MO, Persson NH, Ranstam J, Hermerén G. Xenotransplantation public perceptions: rather cells than organs. Xenotransplantation. 2003 Jan;10(1):72-9. doi: 10.1034/j.1399- 3089.2003.01132. x. PMID: 12535228.

Conflicts of Interest Disclosure
There are no conflicts of interest to declare

A Pilot Randomized Controlled Trial of Anatomy Coloring Books for First-Year Medical Students: Impact on Anxiety and Anatomical Knowledge Retention

Salomon Fotsing[1,3,4], Lisa Xuan[1], Michel Khoury[1], Hsin Yun Yang[1], Nicole Parent[2], Manon Denis-LeBlanc[1,3,4], Sarvesh Jaunky[1], Alireza Jalali[1,5]

[1] Francophone Affairs, Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada

[2] Médecins francophones du Canada, Montréal, QC, Canada

[3] Institut du Savoir Montfort, Ottawa, ON, Canada

[4] Department of Family Medicine, University of Ottawa, Ottawa, ON, Canada

[5] Division of Clinical and Functional Anatomy, Faculty of Medicine, University of Ottawa, Ottawa, ON, Canada

Correspondence:
Alireza Jalali; ajalali@uottawa.ca

Date Submitted: February 26, 2025
Date Accepted: June 5, 2025
Date Published: December 9, 2025

DOI: https://doi.org/10.18192/UOJM.V15i2.7422

Keywords: anatomy education, teaching-learning strategy, undergraduate medical education, coloring book

ABSTRACT

Objective: Recent pedagogical shifts and limited resources have led many medical schools to adopt alternatives to cadaveric dissection and didactic anatomy lectures. Although some studies have focused on art/drawing as an alternative learning modality, no previous studies have explored coloring books as an accessible way of consolidating anatomy knowledge. We aimed to investigate whether anatomy coloring books could enhance knowledge retention and reduce anxiety in medical students compared to traditional methods.

Methods: First-year medical students (n = 17) at the University of Ottawa were randomly assigned to either an intervention group or a control group. The intervention group received an anatomy coloring page, and the control group received an annotated anatomy diagram with corresponding structures to learn from. Both groups completed questionnaires prior to and after their learning activity to gauge anxiety, and they took serial knowledge tests one week apart to evaluate retention.

Results: Although there were no statistically significant differences in retention test scores between the two groups, the coloring group reported significantly lower levels of anxiety after their learning activity, whereas the control group experienced a significant increase. In addition, the majority of the intervention group (78%) agreed or strongly agreed that coloring helped them consolidate knowledge. Further, students reported that the anatomy coloring book was a good supportive learning tool (67%) and they would recommend it to their friends (78%).

Conclusion; Anatomy coloring books appear beneficial in anatomy education, offering stress reduction and improved knowledge consolidation. However, results should be interpreted cautiously due to the limited sample size.

RÉSUMÉ

Objectif : Des changements pédagogiques récents et des ressources limitées ont conduit de nombreuses écoles de médecine à adopter des alternatives à la dissection cadavérique et aux cours d'anatomie didactiques. Bien que certaines études se soient concentrées sur l'art/le dessin en tant que modalité d'apprentissage alternative, aucune étude antérieure n'a exploré les livres de coloriage en tant que moyen accessible de consolider les connaissances en anatomie. Nous avons cherché à savoir si les livres de coloriage d'anatomie pouvaient améliorer la rétention des connaissances et réduire l'anxiété chez les étudiants en médecine par rapport aux méthodes traditionnelles.

Méthodes : Des étudiants en première année de médecine (n = 17) de l'Université d'Ottawa ont été assignés au hasard à un groupe d'intervention ou à un groupe de contrôle. Le groupe d'intervention a reçu une page de coloriage d'anatomie, et le groupe de contrôle a reçu un diagramme d'anatomie annoté avec les structures correspondantes à apprendre. Les deux groupes ont rempli des questionnaires avant et après l'activité d'apprentissage pour évaluer l'anxiété, et ils ont passé des tests de connaissances en série à une semaine d'intervalle pour évaluer la rétention.

Résultats : Bien qu'il n'y ait pas eu de différences statistiquement significatives dans les résultats des tests de rétention entre les deux groupes, le groupe de coloriage a rapporté des niveaux d'anxiété significativement plus bas après leur activité d'apprentissage, alors que le groupe de contrôle a connu une augmentation significative. En outre, la majorité des membres du groupe d'intervention (78 %) étaient d'accord ou tout à fait d'accord pour dire que le coloriage les avait aidés à consolider leurs connaissances et que le livre de coloriage sur l'anatomie était un bon outil d'apprentissage (67 %) qu'ils recommanderaient à leurs amis (78 %).

Conclusion : Les livres de coloriage d'anatomie semblent bénéfiques pour l'enseignement de l'anatomie, car ils permettent de réduire le stress et d'améliorer la consolidation des connaissances. Toutefois, les résultats doivent être interprétés avec prudence en raison de la petite taille de l'échantillon.

INTRODUCTION

Basic knowledge of human anatomy is fundamental in the field of medicine and essential for clinical practice.[1] Comprehensive anatomy teaching is incorporated into the early curriculum of medical schools worldwide, as it provides students with a solid foundation of knowledge that they can build upon throughout their careers. However, recent shifts in pedagogy have resulted in a reduction of traditional methods of teaching anatomy, such as cadaveric dissections and didactic lectures, and an increase in problem-based and self-directed learning,[2-4] which may not provide the same level of hands-on experience and in-depth understanding of anatomy. Constraints in faculty resources, the scarcity of cadavers, and changes in the demands of the medical profession have prompted many schools to adopt alternatives in anatomy teaching, including prosections and computer-assisted learning.[2,3,5] Although human cadaveric dissection is the preferred teaching method for achieving the expected learning outcomes in a model anatomy curriculum, it has certain drawbacks. One limitation is its inherent lack of responsiveness to interactive investigations such as palpation and percussion.[6] Furthermore, the information acquired from dissection does not readily align with the cross-sectional perspectives commonly presented through imaging methods.[7] Hence, finding alternatives to teaching anatomy has become an even more pressing matter. These teaching methods generally limit students' exposure to anatomy compared to traditional methods .[2,5,8] This is a concern for future patient safety, as well as medical students interested in surgery who need to develop competency in anatomy before entering clerkship .[5,8]

Throughout history, drawing and art have been employed as a method of studying human anatomy to aid students in comprehending relationships between structures.[2,8,9] Many studies have shown that students' confidence and understanding of anatomical structures increase when art is incorporated into anatomy education.[2,8,10] In addition, students reported better retention of anatomical knowledge[11] and greater satisfaction with their learning.[4,8,12] Art modalities are especially effective for students with multimodal or visual learning preferences, comprising approximately 68% of medical students.[13] It has even been found that coloring may stimulate neural connections and foster muscle memory, resulting in increased content retention.[14] Indeed, even by simply selecting a color, the reader is compelled to engage more deeply with the subject matter compared to reading a conventional text.[15] Students transcend the role of a passive reader and become something akin to cocreators, contributing their own perspective and interpretation to the book. The chosen colors for anatomical structures can be influenced by logic, emotion, or wordplay. For example, the radial nerve could be represented by a cool mint blue to symbolize its peripheral location, whereas the muscles it innervates, originating from the lateral epicondyle, could also be depicted in a chilly blue hue; unconventional reasons for color choices can be memorable.[15] As an adjunct to traditional teaching methods, art modalities can be a cost-effective and nonlabor-intensive way to help medical students consolidate anatomical knowledge.[11]

Further, color functions as a powerful information channel to the human cognitive system and has been found to enhance memory performance significantly.[16] In this context, coloring emerges as a valuable tool for the cognitive development of medical students, establishing itself as an essential method for learning anatomy. In fact, artistic methods like body painting have been shown to enhance the understanding of anatomy by involving students through kinesthetic and visual learning. Research has indicated that the hands-on nature and active participation, combined with the striking visual representations of underlying anatomy, significantly contribute to the effectiveness of body painting as a teaching tool. Art modalities utilized in anatomy education include drawing, pipe cleaner models, and three-dimensional (3D) printing. To our knowledge, no one has explored coloring as a method of learning anatomy. Moreover, coloring has been shown to lower depressive symptoms and anxiety in a study involving university students.[17] This added benefit could prove helpful for medical students who are vulnerable to increased stressors such as academic load, financial strain, lack of work–life balance, uncertainty about the future, and decreased sense of personal accomplishment.[2,4,8,10,12,18,19] Furthermore, medical students report higher levels of depression, distress, and burnout compared to their same-aged peers in other fields[18,19,20], making them a particularly appropriate target for the intervention.

Our study aimed to test the hypothesis that anatomy coloring books can decrease anxiety and increase anatomy knowledge retention in first-year medical students compared to conventional learning methods.

MATERIALS AND METHODS

Study Design and Sampling

This study was reported in concordance with the CONSORT guidelines for writing and reading a randomized controlled trial.[21] The complete table is presented in the Supplementary Digital (**Appendix 1**). To assess knowledge retention and anxiety levels, this project was conducted with 17 participants, all of whom provided their verbal consent to participate.

Settings and Participants

The participants were first-year medical students enrolled in the University of Ottawa, Faculty of Medicine, and data collection took place from November 15 to December 13, 2018. To ensure that the results were not influenced by prior exposure to formal cadaveric anatomical pedagogy, participants with such prior experience were excluded from the study, and the study was conducted before these students received the course on mediastinal anatomy. This exclusion criterion helped to ensure that all participants had a similar baseline level of anatomical knowledge 11 and were not advantaged or disadvantaged based on prior educational exposure.

Recruitment and Randomization

Seventeen first-year medical students were recruited through an email. No financial compensation or academic credits were awarded for their participation in the study. The students were randomly assigned to either the conventional studying group (control group, n = 8) or the coloring group (intervention group, n = 9). It is important to note that participants were randomly assigned to groups in order to minimize bias. The research assistant assigned students to either the control or intervention group using an online randomizer tool.

Blinding

In this project, single-blind randomization was used. Thus, to minimize participant bias, participants did not know whether they belonged to the "control" or "intervention" groups, so they could not influence the results.

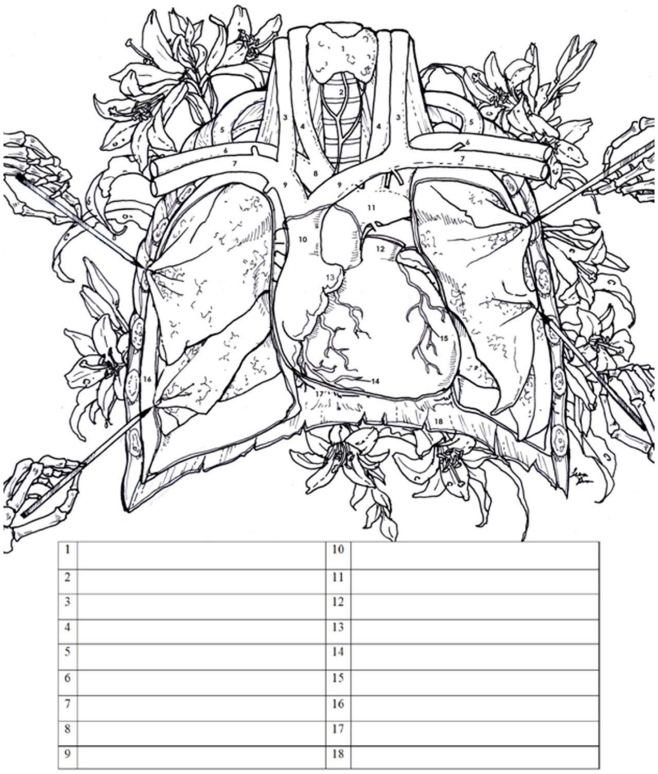
Data Collection and Outcome Measures

The data collection was carried out at the Anatomy Division, Faculty of Medicine, University of Ottawa. The study's primary objective was to evaluate knowledge retention, comparing the conventional studying group and the coloring group. Additionally, the study aimed to measure anxiety levels in both groups before and after the learning activities. Pre- and post-tests were administered to assess knowledge retention, whereas the Trait Anxiety Inventory (TAI)[22] questionnaires were used to measure anxiety levels. By utilizing a randomized controlled trial design and applying specific inclusion and exclusion criteria, the study aimed to provide valuable insights into the effects of conventional studying and coloring studying on knowledge retention and anxiety levels among first-year medical students.

Intervention

The control group received a conventional study aid—that is, an annotated diagram of the mediastinum from the eighth edition of the *Atlas of Human Anatomy* (**Appendix 2**).[23] The intervention group was provided with a coloring page depicting the relevant anatomy, taken directly from physical coloring books designed at the University of Ottawa's Faculty of Medicine (**Figure 1**). Both modalities incorporated the same 18 mediastinal anatomical parts.

Stage 1: The control and intervention groups completed the Trait Anxiety Inventory (TAI)[22] as a pretest. This validat-



1		10	
2		11	
3		12	
4		13	
5		14	
6		15	
7		16	
8		17	
9		18	

Figure 1. Anatomy coloring page depicting mediastinal structures, provided for the intervention

ed 20-item tool is widely used in research to measure students' state of anxiety and anxiety traits.[24] In other words, the student who fills in this questionnaire shares 1) how they feels at a particular moment and 2) how they feels generally.

Stage 2: Both groups studied mediastinal anatomy over a 20-minute period in a self-directed activity. We relied on the similar time required for medical students to study comparable content. The control group members did not have to write or draw on their annotated diagram, which was taken from a human anatomy atlas. The intervention group was instructed to color and label a coloring page depicting mediastinal anatomical structures and to complete the coloring activity on physical paper (**Appendix 3**).

Stage 3: After participants finished their respective learning activities, they completed the TAI for a second time.

Stage 4: Following Stage 3, students proceeded to the anatomy lab to examine cadaveric prosecutions of the mediastinum. Two-dimensional (2D) to 3D knowledge translation was assessed by giving students 10 minutes to identify 10 labeled structures (**Appendix 4**). This tool was designed by a multidisciplinary research team including anatomy professors involved in exam question design and student evaluation at the University of Ottawa's Faculty of Medicine. To perform the knowledge test, students were instructed to identify 10 parts of the mediastinum previously labeled on a cadaver in the anatomy laboratory. To do so, they completed a grid numbered from 1 to 10. This tool has not yet been validated. However, discussions were held within the team in order to reach agreement on the ideas of the team members, particularly with regard to the parts to be identified an anatomy teacher member of the research group graded the results.

Stage 5: After leaving the anatomy lab, students in the intervention group completed an online qualitative questionnaire about their learning habits and their perception of the anatomy coloring activity. The research team, which includes students, anatomy professors, research professionals, and medical education experts, created and revised the questionnaire. After its initial preparation by the research assistant, it was first distributed to team members for suggestions and comments, after which they met to reestablish concordance. The points of discussion at the meeting concerned the content of the items, the scoring of the items, and the chronological order of the items. In the event of disagreement, the discussion remained open until a consensus was reached.

Stage 6: Long-term knowledge retention[17] was assessed with a cadaveric mediastinal anatomy test 3 weeks after the initial intervention, with students been informed in advance of the test. Students were prompted to identify another 10 labeled structures (**Appendix 4**) in 10 minutes.

Data Analysis

Anxiety

Anxiety was evaluated in Stages 1 and 3 with the TAI, which was adapted from Spielberger's State-Trait Anxiety Inventory.[22,24] Students self-rated their level of anxiety using a four-point Likert scale (*not at all, somewhat, moderately*, and *very much*) for 14 items. One example of an item from the questionnaire is "I feel tense, stressed." An analysis of variance (ANOVA) was conducted to determine whether a statistically significant difference in anxiety could be observed between the conventional studying group and the coloring group before and after their respective interventions.

Cadaveric Posttest and Knowledge Retention

Students in both groups completed serial posttest in Stages 4 and 6. Repeated measures of analysis of variance (ANOVA) on two factors (time and group) were conducted to determine if a difference in scores could be observed between the coloring group and the conventional studying group. Tests were two-tailed, and a p-value of 0.05 or less was considered statistically significant.

Perception

Student perceptions were assessed in Stage 5 using a Likert questionnaire (options included *strongly disagree, disagree, neutral, agree*, and *strongly agree*). The questions assessed students' appreciation for coloring as a learning modality and its efficacy in translating 2D to 3D knowledge. The intervention group was exclusively surveyed, as the control group was not exposed to anatomical coloring.

RESULTS

A total of 17 first-year medical students agreed to take part

in this project. They were randomly assigned to one of two groups: the intervention group (n = 9) and the control group (n = 8).

Anxiety

The comparison between pre- and posttest shows a significant interaction between time (pre- vs. posttest) and group (coloring vs. conventional studying) with an F(1,14) value of 11.613 and a p-value of 0.004. The effect size, as measured by the partial eta squared (ηp^2), was 0.453, indicating a medium effect size and that the coloring group showed a decrease in state anxiety after their intervention, whereas the conventional studying group showed an increase in state anxiety after their intervention.

Cadaveric Posttest and Knowledge Retention

In terms of improving knowledge and retention, there were no significant differences over time (p = .755) or by group (p = .933), as well as no significant interactions between group and time (p = .246).

Perception

67% of participants considered the anatomy coloring book a valuable supportive learning tool, while 78% expressed their willingness to recommend it to their friends (**Table 1**). Approximately half of the intervention group reported that the anatomy coloring book enhanced their confidence in translating 2D knowledge to a 3D understanding. Participants also highlighted that the coloring book aided in developing spatial orientation skills for the tested 3D structures. These outcomes suggest that the use of coloring as a learning technique positively impacted participants' perception of their anatomical knowledge acquisition.

DISCUSSION

In this study, the effectiveness of coloring as a method to consolidate anatomical knowledge retention, as well as develop 2D to 3D knowledge translation and its effect on stress reduction during the learning process, was explored for the first time. The study findings revealed no statistically significant differences in the scores between the two groups on the immediate posttest or long-term knowledge retention posttest 3 weeks later. However, it is possible that the effect was present but small, and so the power of the study was not sufficient to detect such an effect.

Our results also report a significant interaction between the time and group (F(1,14) = 11.613, p = 0.004, ηp^2 = 0.453, medium effect size), indicating that the coloring group's state anxiety decreased after their intervention, whereas the state anxiety for the conventional studying group increased after their intervention. This suggests that the new learning strategy of coloring can improve student satisfaction and reduce stress while maintaining similar knowledge retention in the same amount of time compared to conventional studying by reading. This is consistent with the findings of Eaton and Tieber, who showed that engaging in traditional coloring, without specific instructions, for a short period can decrease anxiety and potentially enhance perseverance on challenging tasks. Providing coloring opportunities to individuals with anxiety could not only alleviate their anxiety but also promote proactive behavior.[25]

Moreover, most of the intervention group indicated that coloring helped to consolidate their anatomical knowledge (78%) and that coloring was a good learning tool (67%), which they would recommend to their friends (78%). The findings from the perception questionnaire indicate a positive response from most participants in the intervention group regarding the effectiveness of coloring as a tool for consolidating anatomical knowledge. The majority (78%) of the intervention group agreed or strongly agreed that coloring helped them in this regard. Various colors can have stylistic effects in anatomical representations, emphasizing organs or structures and enabling the highlighting of ele-

Table 1. Perceptions of students in the intervention group (anatomy coloring)

Perception	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Q1: Coloring helped me learn anatomy	0	0	2 (22.22%)	4 (44.44%)	3 (33.33%)
Q2: I will use coloring/drawing to learn anatomy in the future	1 (11.11%)	0	4 (44.44%)	3 (33.33%)	1 (11.11%)
Q3: Anatomy coloring book is a good support	0	1 (11.11%)	2 (22.22%)	5 (55.55%)	1 (11.11%)
Q4: Anatomy coloring book increased my confidence to apply 2D to 3D	0	2 (22.22%)	3 (33.33%)	4 (44.44%)	0
Q5: Coloring helped with spatial orientation for 3D structure	0	0	5 (55.55%)	3 (33.33%)	1 (11.11%)
Q6: I would recommend the coloring book to a friend	0	0	2 (22.22%)	6 (66.66%)	1 (11.11%)

ments to create a 3D organization within a 2D representation.[26] For instance, using color to distinguish between complex organs can aid in differentiating branches of blood vessels, especially in cases like cerebral blood vessels that exhibit intricate 3D paths.[27] Approximately half of the intervention group would continue to use coloring or drawing to learn anatomy as it assisted with developing their confidence in knowledge translation and the spatial orientation of 3D anatomical structures. Overall, the findings of this study suggest that coloring can be a promising adjunctive method for learning anatomy, as it not only supports knowledge retention but also has a positive impact on students' mental well-being.

Limitations

We acknowledge that the sample size in this study was relatively small (n = 17), and the sample size power analysis was not performed for this study, so the results should be interpreted with caution. This limitation may be attributed to the few numbers of eligible students at the Faculty of Medicine at the University of Ottawa, which led to a lower participant count. Even if the project was in the category of improving teaching quality, participation was voluntary. Self-selection bias, as well as the self-reported nature of the survey, is another limitation, which can lead to subjectivity bias, particularly in non-validated surveys completed by the intervention group. While the TAI is a validated tool, it still lacks of physiological measures (e.g., heart rate, cortisol), which could provide more objective data. This study focused on anatomical structures in the mediastinum for knowledge retention, but it would be interesting to explore any significant differences in knowledge retention and stress reduction in more complex anatomical systems. Nonetheless, these findings provide preliminary evidence to support the use of coloring interventions as a potential tool to reduce state anxiety among medical students. Our study model could be used as a pilot for future studies with larger samples to increase statistical power. Furthermore, baseline anxiety may have been over- or under-skewed by outliers. A solution for this limitation may involve starting an induction of anxiety exercises, which could potentially homogenize baseline scores.

CONCLUSION

Anatomy education is a vital component of the medical curriculum for students. In the modern age, anatomy pedagogies have evolved, with a decrease in traditional cadaveric dissection and an increase in self-directed learning. Overall, less time is devoted to anatomy education, which means new effective learning modalities should be explored. In addition, medical students have higher rates of burnout and distress compared to their peers. Our study explored anatomy coloring books as a learning modality and a way to decrease students' anxiety. Although the coloring group did not significantly differ in anatomical knowledge acquisition and retention compared to the traditional self-studying group, a significant decrease in anxiety was observed after the intervention, as well as strong support for using coloring as a recommended learning tool to consolidate anatomical knowledge. We hope to use this pilot study to explore further how coloring may positively influence knowledge retention and anxiety for medical students in the future. Because of the limitations in this study, the results should be interpreted with caution and further research with a larger sample size, a greater variety of anatomical systems as tested topics, and additional long-term time points to test how anatomical knowledge consolidation can better determine the effectiveness of coloring and support the consideration of integrating this learning strategy into the anatomy curriculum.

REFERENCES

1. Singh R, Yadav N, Pandey M, Jones DG. Is inadequate anatomical knowledge on the part of physicians hazardous for successful clinical practice? Surg Radiol Anat SRA. 2022 Jan;44(1):83–92.
2. Borrelli M, Leung B, Morgan M, Saxena S, Hunter A. Should drawing be incorporated into the teaching of anatomy? J Contemp Med Educ. 2018;6(2):34-48
3. Singh V, Kharb P. A paradigm shift from teaching to learning gross anatomy: meta-analysis of implications for instructional methods. J Anat Soc India. 2013 Jun;62(1):84-9
4. Noorafshan A, Hoseini L, Amini M, Dehghani MR, Kojuri J, Bazrafkan L. Simultaneous anatomical sketching as learning by doing method of teaching human anatomy. J Educ Health Promot. 2014 May 5;3:50.
5. Estai M, Bunt S. Best teaching practices in anatomy education: A critical review. Ann Anat-Anat Anz. 2016 Nov;208:151–7.
6. McLachlan JC, Bligh J, Bradley P, Searle J. Teaching anatomy without cadavers. Med Educ. 2004 Apr;38(4):418–24.
7. Kerby J, Shukur ZN, Shalhoub J. The relationships between learning outcomes and methods of teaching anatomy as perceived by medical students. Clin Anat. 2011 May;24(4):489-97.
8. Joewono M, Karmaya INM, Wirata G, Widianti IGA, Wardana ING. Drawing method can improve musculoskeletal anatomy comprehension in medical faculty student. Anat Cell Biol. 2018 Mar;51(1):14–8.
9. O'Byrne PJ, Patry A, Carnegie JA. The development of interactive online learning tools for the study of Anatomy. Med Teach. 2008 Jan;30(8):260–71.
10. Alhamdani FY, Hatem HA. Drawings as learning aid for the human anatomy students' based evaluation. J Oral Health Craniofacial Sci. 2017 Oct;2(4):090–5.
11. Alsaid B, Bertrand M. Students' memorization of anatomy,

influence of drawing. Morphologie. 2016 Mar;100(328):2-6.
12. Lefroy H, Burdon-Bailey V, Bhangu A, Abrahams P. A novel technique for teaching the brachial plexus. Clin Teach. 2011 Sep;8(3):196-9.
13. Kharb P, Samanta PP, Jindal M, Singh V. The learning styles and the preferred teaching-learning strategies of first year medical students. J Clin Diagn Res. 2013 Jun;7(6):1089-92.
14. Dempsey BC, Betz BJ. Biological drawing: A scientific tool for learning. Am Biol Teach. 2001 Apr;63(4):271-9.
15. McConnell J. The anatomy coloring book. British Medical Journal Publishing Group; 2012 Nov .
16. Dzulkifli MA, Mustafar MF. The influence of colour on memory performance: a review. Malays J Med Sci. 2013 Mar;20(2):3-9.
17. Beers GW, Bowden S. The effect of teaching method on long-term knowledge retention. J Nurs Educ. 2005 Nov;44(11):511-4.
18. McMenamin PG. Body painting as a tool in clinical anatomy teaching. Anat Sci Educ. 2008 Jul-Aug;1(4):139-44.
19. Dyrbye LN, West CP, Satele D, Boone S, Tan L, Sloan J, Shanafelt TD. Burnout among U.S. medical students, residents, and early career physicians relative to the general U.S. population. Acad Med. 2014 Mar;89(3):443-51.
20. Hill MR, Goicochea S, Merlo LJ. In their own words: stressors facing medical students in the millennial generation. Med Educ Online. 2018 Dec;23(1):1530558.
21. Schulz KF, Altman DG, Moher D; CONSORT Group. CONSORT 2010 statement: updated guidelines for reporting parallel group randomised trials. BMJ. 2010 Mar 23;340:c332.
22. Spielberger CD. State-trait anxiety inventory for adults. Palo Alto, CA: Mind Garden; 1983.
23. Netter FH. Netter Atlas of Human Anatomy: Classic Regional Anatomy Approach. In: ClinicalKey. 8th ed. Elsevier; 2022.
24. Ramanaiah NV, Franzen M, Schill T. A psychometric study of the State-Trait Anxiety Inventory. J Pers Assess. 1983 Oct;47(5):531-5.
25. Eaton J, Tieber C. The Effects of Coloring on Anxiety, Mood, and Perseverance. Art Ther. 2017 Jan;34(1):42-6.
26. Clavert P, Bouchaïb J, Duparc F, Kahn JL. A plea for the use of drawing in human anatomy teaching. Surg Radiol Anat. 2012 Oct;34(8):787-9.
27. Segawa H, Araki N, Miki A, et al. Creation of Stereo-paired Color Vascular Anatomical Charts Using 3-dimentional Images. Nihon Hoshasen Gijutsu Gakkai Zasshi. 2022 Jan ;78(1):62-71.

Conflicts of Interest Disclosure
There are no conflicts of interest to declare.

Additional Information
Supplementary information is available at https://doi.org/10.18192/UOJM.V15i2.7422

Faire de l'Outaouais son chez-soi

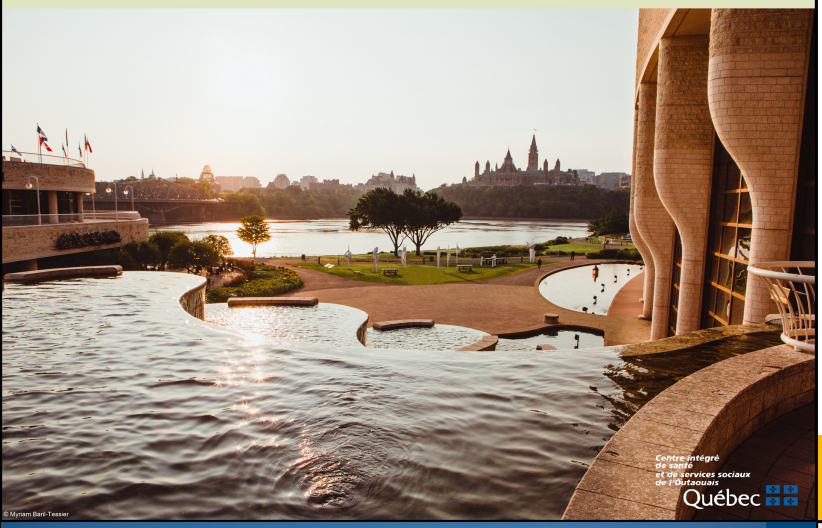
Lieux de pratique diversifiés et dynamiques

- 33 000 KM^2 de nature à explorer tout en n'étant jamais loin des grands centres

Envoyez votre CV :

recrutement.md.outaouais@ssss.gouv.qc.ca

Pour plus d'information outaouais.gouv.qc.ca /recrutement/recrutement-des-medecins



Centre de santé communautaire de l'Estrie

Médecins de famille recherchés à Cornwall et Embrun (Ontario) à temps plein et temps partiel

Au cœur de l'Est ontarien, entre Ottawa et Montréal, le CSCE est bien plus qu'un centre de santé : c'est un milieu de vie où les communautés trouvent des soins accessibles, humains et de qualité. Notre équipe interdisciplinaire, passionnée et engagée, offre des soins de santé primaires intégrés, enrichis par une vaste gamme de programmes et de services complémentaires, tous conçus pour soutenir la santé et le bien-être de notre population.

Exigences

- Spécialisation en médecine familiale.
- Permis de pratique du Collège des médecins de l'Ontario ou intéressé à l'obtenir.
- Communication écrite et verbale dans les deux langues officielles.

Avantages et bénéfices

- Horaire de travail fixe sans quart de travail sur appel
- Couverture assurée par collègues lors des vacances
- Assurances collectives et fonds de pension HOOPP
- Budget de formation individuel et formations mensuelles en groupe de médecins

Pour découvrir la description complète du poste et la liste des tâches, visitez notre site web au www.cscestrie.on.ca/emplois/

JOIN OUR TEAM

ICARE

613-938-4240 ext:3524
joy.cella@cornwallhospital.ca

Explore the outstanding training opportunities Bruyère Health offers

Affiliated with the University of Ottawa

- Rehabilitation programs that help patients stay or return home
- Complex care, adding life to years and years to life
- Multidisciplinary dynamic environment with exposure to primary care and subspecialty clinics
- Memory Clinic providing diagnosis and treatment for individuals with memory loss

Bruyère Health is Eastern Ontario's leading health organization specializing in aging, rehabilitation, and care for those with multiple complex medical conditions. We bring together compassionate, person-centred care with world-class research to maximize quality of life for those we care for and their loved ones.

Bruyère Health has a proven history of addressing gaps in our health system with compassion, innovation, and courage. Today, as an academic health sciences centre, we are training the next generation of health professionals to see—and take action on—creating a better health system for all.

medicalaffairs@bruyere.org | bruyere.org


UNIVERSITY OF OTTAWA JOURNAL OF MEDICINE
JOURNAL MÉDICAL DE L'UNIVERSITÉ D'OTTAWA