Examining Predictive Models for Burnout Detection in South African Medical Doctors: A Scoping Review Protocol

Name and Surname: Ethan Terblanche

Student Number: 3020408

Honours in Health Systems Science| Research Methodology FAMH4012A

Supervisor: Storm Makings BAFA (wits), BSc Honours (Wits), Current, MSc (Med) Wits

Co-Supervisor: Dr. Heleen Roos MBChB (UFS), DOMH (Pret), MMedPHM (Pret) FCPHMSA

Abstract:

Introduction:
Burnout among South African medical doctors is a significant and escalating concern, adversely impacting both clinician well-being and healthcare delivery. While artificial intelligence (AI) offers promising avenues for early detection and intervention, there is limited evidence on the specific determinants most pertinent for AI-based detection in this context. But on the other hand there is extensive research about predictive AI-based models for burnout in the healthcare system.

Objective:
To identify the main types of predictive models used for burnout detection in healthcare and explore which are best suited for early detection among South African medical doctors, considering relevant determinants and the local context.

Methodology:
This scoping review protocol follows the Joanna Briggs Institute (JBI) framework. A search will be conducted across electronic databases (PubMed, Scopus, PsycINFO), grey literature sources and manual reference checks. Inclusion and exclusion criteria are predefined. The process was carried out by a single reviewer, which could affect how thoroughly studies were selected and interpreted.

Expected Outcomes:
The review will provide an overview of psychological, physiological, and organisational determinants relevant to AI-based early burnout predictive models among South African medical doctors. Findings will inform future research predictive AI model development, to enhance early identification and intervention for burnout.

Keywords: AI-tools, Early Burnout Detection, Medical Doctors, Psychological, Physiological, Organisational Determinants.

Table of Contents

Abstract: 2

List of Tables 4

1. Introduction/Background 5

2. Literature Review 5

2.1 Prevalence and Definition of Burnout 5

2.2 Working Conditions and Organisational Contributors 5

2. 3 Artificial Intelligence (AI) and Early Detection 6

2. 4 Key Determinants for AI-Based Early Detection 6

2. 5 International Perspectives 6

2. 6 Consequences and the Imperative for Early Detection 7

2.7 Models and Artificial Intelligence (AI) in Early Burnout Detection 7

3. Rationale 8

4. Problem Statement 8

5. Research Question 8

What predictive models have been used for burnout detection in healthcare, and what evidence supports their suitability for South Africa? 8

6. Research Aim 8

7. Research Objectives 8

8. Methodology 9

8.2 Information Sources 9

8.3 Logic Grid 10

8.4 Study Selection Process 10

8.5 Data Synthesis 11

9. Ethical Considerations/Dissemination 11

10. Timeline: Gantt Chart 12

11. Strengths and Limitations 12

12. Reference List 13

13. Appendices 16

List of Tables

Table 1: Logic Grid for search strategy 10
Table 2: *Showing GANTT Chart for Health Sytems Science Honours Degree Scoping Review Protocol* 12

1. Introduction/Background

Burnout among medical doctors in South Africa is a significant concern, with prevalence rates reported between 4% and 84% before the COVID-19 pandemic, rising to as high as 78% during and after the pandemic. [1] Key psychological determinants of burnout include emotional exhaustion, anxiety, depression, and impaired concentration, which impact doctors' mental health and professional functioning.[2] Physiological manifestations often accompany these psychological symptoms, such as fatigue, insomnia, and loss of appetite.[2] Organisational determinants play a role, with excessive workload, poor job control, inadequate supervisory support, and a hierarchical work culture being significant contributors to burnout. [1,3]

The hierarchical nature of South African healthcare settings often limits doctors' autonomy and participation in decision-making, exacerbating stress and moral distress.[1] Additionally, administrative burdens and poor work-life balance further intensify burnout risk.[3] Importantly, supportive organisational environments and job satisfaction have been shown to mitigate burnout, highlighting the need for systemic interventions alongside individual resilience training.[1] Artificial intelligence (AI) offers promising opportunities for the early detection of burnout by integrating psychological, physiological, and work-related data to identify at-risk doctors before burnout becomes severe.[4] AI applications in mental health have demonstrated potential in diagnosis, prognosis, and monitoring, yet their use specifically for burnout detection in South African medical doctors remains limited.[5,6] Exploring the relevant determinants is therefore essential to guide the development of effective AI tools tailored to this context.

2. Literature Review

2.1 Prevalence and Definition of Burnout

Burnout among medical doctors in South Africa is a well-documented concern, with prevalence rates reported to vary widely. This variation is influenced by differences in study settings, populations, and measurement tools, yet the consistently high prevalence indicates a significant occupational health issue. Burnout is characterised by emotional exhaustion, depersonalisation, and a reduced sense of personal accomplishment. Psychological symptoms such as anxiety and depression are frequently reported among doctors experiencing burnout, affecting their mental well-being and professional performance.[3] Physiological symptoms, including fatigue and sleep disturbances, often accompany these psychological effects.[7] Organisational determinants such as excessive workload, limited job control, inadequate supervisory support, and hierarchical workplace cultures have been identified as important contributors to burnout in the South African context.[1,2]

2.2 Working Conditions and Organisational Contributors

The working conditions for many South African doctors, particularly junior and community service doctors, are demanding. A Study noted that doctors often work extended hours, sometimes exceeding

80 hours per week, with long shifts and limited rest periods.[7] These conditions can exacerbate stress and contribute to the development of burnout. The hierarchical nature of healthcare workplaces may also limit doctors' autonomy and participation in decision-making, which has been associated with increased burnout risk.[1] Supportive organisational environments, including effective supervisory and peer support, have been shown to mitigate burnout. Job satisfaction and opportunities for professional development are also important protective determinants.[3] However, stigma surrounding mental health issues and reluctance to seek help remain barriers to addressing burnout effectively within the medical profession.[1] The tragic case of a South African intern doctor Dr Alulutho Mazwi (25) who died after being denied time off for his diabetes management has brought renewed attention to the challenges faced by medical practitioners in the public health sector.[8] This incident highlights the potential consequences of burnout and poor working conditions, emphasising the need for early detection and intervention strategies to support doctors' health and well-being.

2. 3 Artificial Intelligence (AI) and Early Detection

AI applications in mental health have demonstrated potential in diagnosis, prognosis, and monitoring, through the integration of diverse data sources such as self-reported symptoms, physiological markers, and workplace variables.[4] For example, machine learning models have been developed to predict burnout risk determinants among nursing staff in South Africa, illustrating the feasibility of AI-based approaches in this context.[5] Despite these advances, challenges remain in implementing AI tools within healthcare settings. These include ensuring the reliability of AI models, addressing ethical considerations, and integrating AI systems into existing clinical workflows.[6] Systematic reviews of AI implementation in primary healthcare further highlight the need for context-specific research to optimise AI applications and ensure they meet the needs of healthcare professionals and patients.[9]

2. 4 Key Determinants for AI-Based Early Detection

A comprehensive understanding of the psychological, physiological, and organisational determinants relevant to burnout is essential for developing effective AI-based early detection systems. Psychological determinants include emotional exhaustion, anxiety, and depression, physiological determinants encompass fatigue and other stress-related symptoms, organisational determinants involve workload, job control, supervisory support, and workplace culture.[1,3,7] Integrating these determinants into AI models could facilitate timely identification of doctors at risk, enabling early interventions that may prevent burnout progression. The importance of this research is underscored by real-world consequences such as the death of the intern doctor, which might have been preventable with earlier identification and support. AI tools designed to detect burnout early could serve as valuable safeguards, alerting healthcare managers and clinicians to intervene before burnout leads to severe health deterioration or loss of life.[8] Such innovations align with broader efforts to improve working conditions and support the mental health of medical practitioners in South Africa.

2. 5 International Perspectives

Recent studies from various international contexts further elucidate the multifaceted nature of burnout among medical practitioners, reinforcing findings observed in South Africa. For instance, Karim Alenezi

et al.[10] reported a high prevalence of burnout among Saudi resident doctors, identifying workload, lack of support, and work–life balance as significant contributors. Similarly, Peltzer, Mashego, and Mabeba [11] highlighted occupational stress as a critical factor influencing burnout among South African medical practitioners, underscoring the persistent nature of this issue over time. Research from Egypt by Fadle et al.[12] during the COVID-19 pandemic also demonstrated elevated burnout rates among resident doctors, with pandemic-related stressors exacerbating psychological distress. Earlier work by Varga, Urdániz, and Canti[13] in general hospital doctors emphasised the role of organisational culture and job demands in burnout development.

2. 6 Consequences and the Imperative for Early Detection

The serious implications of burnout, including increased risk of suicide, have been documented by Moukaddam et al.[14] , stressing the urgent need for effective mental health screening and intervention strategies, as also argued by Goldman, Bernstein, and Summers.[15] Furthermore, Denning et al.[16] identified determinants of burnout during the pandemic across healthcare workers internationally, highlighting the importance of supportive work environments and mental health resources. These international perspectives corroborate and expand upon the complex interplay of psychological, physiological, and organisational determinants contributing to burnout in South African doctors, reinforcing the imperative for comprehensive, context-sensitive approaches to detection and prevention.

2.7 Models and Artificial Intelligence (AI) in Early Burnout Detection

Recent studies have highlighted the potential of artificial intelligence (AI) and predictive modelling to enhance early detection of burnout among healthcare professionals by analysing complex data from psychological, physiological, and organisational sources.[17,18] Various model types, such as machine learning algorithms and deep learning frameworks, have been used internationally to identify at-risk individuals based on determinants like electronic health records, wearable sensor data, and self-reported measures.[19] However, despite promising results in high-income settings, there remains a lack of robust evidence about which predictive models are most effective or adaptable within resource-limited healthcare systems such as South Africa's.[20] This gap underscores the need for exploring existing predictive models to evaluate their strengths, limitations, and contextual suitability for the South African medical workforce.

Burnout among South African medical doctors is influenced by a complex interplay of psychological, physiological, and organisational determinants. High prevalence rates and serious outcomes highlight the need for effective early detection and intervention strategies. AI offers a promising avenue for addressing this need by integrating multidimensional data to identify at-risk individuals. Continued research to map relevant determinants and address implementation challenges will be critical to realise the potential of AI in supporting doctors' well-being and sustaining healthcare quality in South Africa.

3. Rationale

Early identification of burnout is crucial to enable timely support and maintain healthcare standards. Recent developments in artificial intelligence (AI) have introduced promising predictive models capable of analysing these relevant determinants to detect burnout at an early stage. However, there remains a lack of comprehensive understanding regarding which types of predictive models have been applied to burnout detection and how suitable these approaches are within the South African medical context.

This scoping review protocol, guided by the JBI framework, aims to scope the existing literature on predictive models used for burnout detection in healthcare. It will explore the types of models employed, their strengths and limitations, and their potential applicability to South Africa's health system. By identifying gaps and synthesising available evidence, this review will help guide future development of AI tools tailored to support South African medical doctors, ultimately enhancing early detection strategies and promoting better healthcare outcomes.

4. Problem Statement

There is limited knowledge on the effectiveness and cultural suitability of these AI interventions within South Africa's distinct healthcare context.[3] The use of predictive models based on artificial intelligence is emerging as a promising approach for early burnout detection by analysing clinical and behavioural data, such as electronic health records and physiological signals.[18] However, there is limited evidence on which predictive model types effectively incorporate critical determinants of burnout and how suitable these models are within the South African healthcare context. [21] Addressing this gap through scoping of published models is crucial to inform tailored, context-appropriate interventions that could support South African medical doctors.[22]

5. Research Question

What predictive models have been used for burnout detection in healthcare, and what evidence supports their suitability for South Africa?

6. Research Aim

To explore the main types of predictive models used for burnout detection in healthcare, and to assess which models are most suitable for early detection of burnout among South African medical doctors, considering psychological, physiological and work related determinants and the local healthcare context.

7. Research Objectives

To identify predictive models used for burnout detection in healthcare.

To examine which predictive models are most suited for early detection of burnout among South African medical doctors, based on available determinants and local context.

8. Methodology

8.1 Eligibility Criteria (Inclusion and Exclusion)

a. Inclusion Criteria

The inclusion criteria for this review consists of doctors as the population of interest. The concept centres on studies examining AI-based predictive models designed for the early detection of mental health burnout or related psychological, physiological, and organisational outcomes among medical doctors, with an emphasis on applicability within the South African healthcare context and predictive AI-based models. Eligible study types include quantitative, qualitative, mixed-methods studies, and reviews addressing AI-driven early detection of burnout among South African medical doctors and clinical practitioners. The timeframe for included studies spans from 2018 to the present in order to capture recent developments. All healthcare settings within South Africa and global literature involving medical doctors are considered, including public and private sectors, hospitals, clinics, and other clinical environments where AI-based early burnout detection tools or related assessments may be applied.

b. Exclusion Criteria

Studies unrelated to healthcare settings, including those conducted exclusively in non-healthcare fields such as education, social sciences, or other unrelated disciplines, will also be excluded. Editorials, opinion pieces, conference abstracts without full data, and sources lacking supporting evidence will be excluded. Additionally, opinion articles authored by individuals without relevant expertise or experience in the field will be excluded to ensure the inclusion of credible and methodologically sound evidence. Studies published in languages other than English will be excluded due to resource limitations for translation and to maintain consistency in data interpretation.

8.2 Information Sources

Electronic Databases: Key bibliographic databases relevant to healthcare, psychology, and technology will be searched, including PubMed, Scopus, and PsycINFO. These databases provide extensive coverage of peer-reviewed literature on AI applications, mental health, and occupational health. **Grey Literature:** To capture unpublished or non-traditional sources of evidence, grey literature will be searched through ProQuest Dissertations & Theses, OpenGrey, as well as reports from the World Health Organization (WHO), South African government departments, and relevant non-governmental organisations (NGOs). This approach aligns with JBI guidance to include diverse evidence sources beyond published studies. **Manual Searching:** Reference lists of all included studies and relevant systematic and scoping reviews will be hand-searched to identify additional pertinent studies.

8.3 Logic Grid

Table 1: Logic Grid for search strategy

PCC Element	Keywords / Concepts	Notes	Search Logic Example
Population	Medical doctors, clinical practitioners, physicians	Focus on medical doctors and closely related clinical roles relevant to the review population.	(medical doctor* OR clinical practitioner* OR physician*)
Concept	Artificial intelligence, AI, machine learning, chatbot, digital intervention, wearable device, automated documentation, digital scribe, burnout detection, mental health monitoring, predictive models	Include AI technologies and digital tools relevant to early detection of burnout or mental health.	(artificial intelligence OR AI OR machine learning OR chatbot* OR digital intervention* OR wearable device* OR automated documentation OR digital scribe* OR burnout detection OR mental health monitoring OR predictive models)
Context	Healthcare settings, hospitals, clinics, public health facilities, primary care centres. South Africa	Capture healthcare environments and geographic focus relevant to the study context.	(healthcare setting* OR hospital* OR clinic* OR public health facility* OR primary care centre* OR resource-limited OR LMIC* OR “South Africa”)

8.4 Study Selection Process

Two reviewers will independently screen all titles and abstracts using Rayyan software to efficiently manage and blind the screening process.[23] Studies deemed potentially eligible will undergo full-text review to confirm inclusion based on predefined criteria.[23] Any disagreements arising at either screening stage will be resolved through discussion and consensus between the reviewers; if consensus cannot be reached, a third reviewer will adjudicate.[24] The entire study selection process will

be transparently documented and reported using a PRISMA-ScR flow diagram, aligning with JBI and PRISMA-ScR guidance for methodological transparency.[24]

8.5 Data Synthesis

Data will be synthesised using a descriptive and thematic approach, consistent with established methodologies for scoping reviews in healthcare and digital health research.[25] The descriptive analysis will provide an overview of study determinants, including the types of AI-driven predictive models and interventions employed for early burnout detection, the target population of South African medical doctors and clinical practitioners, and the healthcare settings involved.[25] This will facilitate clear visual and tabular presentation of the current evidence landscape, enabling identification of patterns and distribution of research.

The thematic analysis will explore key themes related to the implementation and applicability of AI-based predictive models for burnout detection, including facilitators and barriers reported across studies.[25] It will also examine how burnout and AI concepts are defined and operationalised within the literature. This approach will support the identification of knowledge gaps and research priorities, thereby guiding future investigations and development of contextually relevant AI interventions.[25]

9. Ethical Considerations/Dissemination

Since this scoping review is based solely on the analysis of existing published literature and does not involve the collection of new or identifiable data from human participants, formal ethics approval is not typically required. However, a submission for an ethical waiver will be made to the University of the Witwatersrand Human Research Ethics Committee (HREC) to confirm this status and ensure compliance with institutional requirements. The review will uphold principles of integrity, transparency, and respect for original authorship throughout the process. The findings of this review will be disseminated through publication in a peer-reviewed journal to support knowledge-sharing and inform future research and practice.

10. Timeline: Gantt Chart

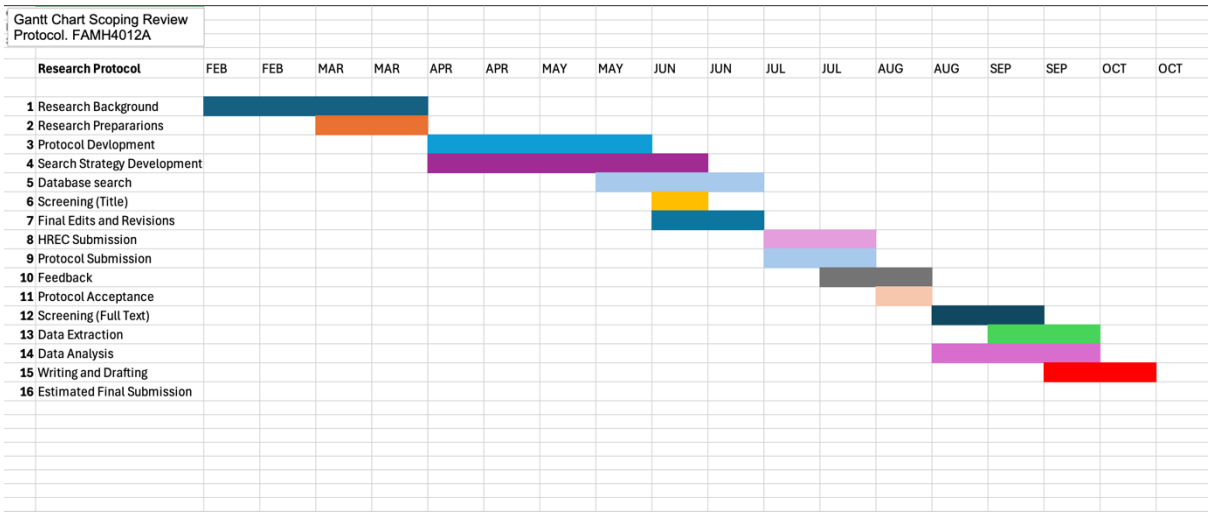

Table 2: *Showing GANTT Chart for Health Sytems Science Honours Degree Scoping Review Protocol*

11. Strengths and Limitations

11.1 Strengths

By exploring AI-based predictive models with particular attention to their adaptability and scalability across diverse healthcare settings within South Africa, the review lays a foundation for the development of personalised mental health support systems tailored to the needs of medical professionals. The review aims to support the development of AI-based predictive model approaches for early detection of burnout and to contribute to the broader understanding of determinants affecting medical professionals within digital healthcare environments.

11.2 Limitations

This review is limited in that it only focuses on three specific determinants linked to predictive AI-based burnout models in South African medical doctors, which means other determinants of burnout may not be captured. The review mostly draws on South African research, so findings may not always reflect insights from international studies. In addition, the process was carried out by a single reviewer, which could affect how thoroughly studies were selected and interpreted.

12. Reference List

1. Khan S, Ntatamala I, Adams S. A review of burnout among doctors in South Africa: Pre-, during and post-COVID-19 pandemic. South Afr Fam Pract. 2024 Oct 28;66(1):10.

2. Kgatle M, George J, Dominic F, De Jager P. Prevalence and factors associated with burnout among junior medical doctors at a South African tertiary public sector hospital. Pan Afr Med J. 2024;47:208.

3. Naidoo T, Tomita A, Paruk S. Burnout, anxiety and depression risk in medical doctors working in KwaZulu-Natal Province, South Africa: Evidence from a multi-site study of resource-constrained government hospitals in a generalised HIV epidemic setting. PloS One. 2020;15(10):e0239753.

4. Graham S, Depp C, Lee EE, Nebeker C, Tu X, Kim HC, et al. Artificial Intelligence for Mental Health and Mental Illnesses: an Overview. Curr Psychiatry Rep. 2019 Nov 7;21(11):116.

5. Van Zyl-Cillié MM, Bührmann JH, Blignaut AJ, Demirtas D, Coetzee SK. A machine learning model to predict the risk factors causing feelings of burnout and emotional exhaustion amongst nursing staff in South Africa. BMC Health Serv Res. 2024 Dec 31;24(1):1665.

6. Aung YYM, Wong DCS, Ting DSW. The promise of artificial intelligence: a review of the opportunities and challenges of artificial intelligence in healthcare. Br Med Bull. 2021 Sep 10;139(1):4–15.

7. Purbrick GM, Morar T, Kooverjee J. Burnout among community service doctors in South Africa. Afr J Prim Health Care Fam Med. 2024 May 15;16(1):9.

8. Yoganathan V. Intern doctor's death sparks outcry over public health working conditions [Internet]. Juta MedicalBrief. 2025 [cited 2025 Jul 8]. Available from: https://www.medicalbrief.co.za/intern-doctors-death-sparks-outcry-over-public-health-working-conditions/

9. Yousefi F, Dehnavieh R, Laberge M, Gagnon MP, Ghaemi MM, Nadali M, et al. Opportunities, challenges, and requirements for Artificial Intelligence (AI) implementation in Primary Health Care (PHC): a systematic review. BMC Prim Care. 2025 Jun 9;26(1):196.

10. Karim Alenezi N, Hamad Alyami A, Omar Alrehaili B, Adnan Arruhaily A, Kareem Alenazi N, Abdo Radman Al-Dubai S. Prevalence and associated factors of burnout among saudi resident doctors: A multicenter cross-sectional study. Alpha Psychiatry. 2022 Jan 1;23(4):173–83.

11. Peltzer K, Mashego TA, Mabeba M. Occupational stress and burnout among South African medical practitioners. Stress Health J Int Soc Investig Stress. 2003 Dec 1;19(5):275–80.

12. Fadle AA, Khalifa AA, Mahran DG, Khidr SS, Said HG, Farouk O. Burnout syndrome (BOS) among resident doctors in an Egyptian tertiary care university hospital: Prevalence and determinants during the COVID-19 pandemic. Int J Soc Psychiatry. 2023 Mar 1;69(2):396–405.

13. Varga ED, Urdániz AP, Canti GF. Burnout syndrome in general hospital doctors. Eur J Psychiatry. 1996 Oct 1;10(4):207–13.

14. Moukaddam N, Parks K, Le H, Khawaja L, Shah AA. Burnout and suicide among physicians during times of stress. Psychiatr Ann. 2020 Dec 1;50(12):536–41.

15. Goldman ML, Bernstein CA, Summers RF. Potential Risks and Benefits of Mental Health Screening of Physicians. JAMA. 2018 Dec 25;320(24):2527–8.

16. Denning M, Goh ET, Tan B, Kanneganti A, Almonte M, Scott A, et al. Determinants of burnout and other aspects of psychological well-being in healthcare workers during the COVID-19 pandemic: A multinational cross-sectional study. PLoS ONE [Internet]. 2021 Apr 16 [cited 2025 Jul 8];16(4). Available from: https://research.ebsco.com/linkprocessor/plink?id=ba304eca-aaf6-3263-a5f5-c2bfa2a4d034

17. Gupta MD, Bansal A, Sarkar PG, Girish MP, Jha M, Yusuf J, et al. Design and rationale of an intelligent algorithm to detect BuRnoUt in HeaLthcare workers in COVID era using ECG and artificiaL intelligence: The BRUCEE-LI study. Indian Heart J. 2021;73(1):109–13.

18. Liu H, Lou SS, Warner BC, Harford DR, Kannampallil T, Lu C. HiPAL: A Deep Framework for Physician Burnout Prediction Using Activity Logs in Electronic Health Records. In 2022 [cited 2025 Jul 22]. p. 3377–87. Available from: http://arxiv.org/abs/2205.11680

19. Alam S, Alam MAU. EMBRACE: Explainable Multitask Burnout Prediction for Resident Physicians using Adaptive Deep Learning [Internet]. medRxiv; 2023 [cited 2025 Jul 22]. p. 2023.06.24.23291864. Available from: https://www.medrxiv.org/content/10.1101/2023.06.24.23291864v1

20. Yoganathan V. The challenges of rapidly evolving AI in healthcare [Internet]. Juta MedicalBrief. 2025 [cited 2025 Jul 22]. Available from: https://www.medicalbrief.co.za/challenges-of-rapidly-evolving-ai-in-healthcare/

21. Alam S, Alam MAU. EMBRACE: Explainable Multitask Burnout Prediction for Resident Physicians using Adaptive Deep Learning [Internet]. medRxiv; 2023 [cited 2025 Jul 22]. p. 2023.06.24.23291864. Available from: https://www.medrxiv.org/content/10.1101/2023.06.24.23291864v1

22. Daryanani AE, Ehrenfeld JM. AI in medicine: Hype, hope, and the path forward. S Afr Med J. 2025 May 30;e3668–e3668.

23. Peters MDJ, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, et al. Updated methodological guidance for the conduct of scoping reviews. JBI Evid Synth. 2020 Oct;18(10):2119–26.

24. Peters MDJ, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, et al. Updated methodological guidance for the conduct of scoping reviews. JBI Evid Synth. 2020 Oct;18(10):2119–26.

25. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol. 2005 Feb;8(1):19–32.

13. Appendices

13.1 Appendix A: Database Search Strings, Filters, and Article Retrieval Counts

Electronic Database	Filters	Number of Articles Retrieved	Search Logic/Key Words Used
PubMed	Publication Date: From 2019 to 2025 Text Availability: Abstract Language: English	116 Results	(burnout OR "burnout syndrome") AND ("medical doctors" OR physicians OR "healthcare workers") AND ("South Africa" OR Africa)
	Publication Date: From 2019 to 2025 Text Availability: Abstract Language: English	66 Results	(("artificial intelligence"[Title/Abstract] OR AI[Title/Abstract] OR "machine learning"[Title/Abstract] OR "predictive model"[Title/Abstract]) AND (burnout[Title/Abstract] OR "burnout syndrome"[Title/Abstract]) AND (doctor[Title/Abstract] OR physician[Title/Abstract] OR "medical doctor"[Title/Abstract]))
	Publication Date: From 2019 to 2025 Text Availability: Abstract Language: English	29 Results	(burnout OR "burnout syndrome") AND ("medical doctors" OR physicians) AND "South Africa"
	Publication Date: From 2019 to 2025 Text Availability: Abstract Language: English	218 Results	(("artificial intelligence"[Title/Abstract] OR AI[Title/Abstract] OR "machine learning"[Title/Abstract]) AND (burnout[Title/Abstract] OR "mental health"[Title/Abstract])) AND (healthcare[Title/Abstract] OR medical[Title/Abstract] OR doctor[Title/Abstract] OR physician[Title/Abstract]) AND (detection[Title/Abstract] OR screening[Title/Abstract] OR intervention[Title/Abstract])

Electronic Database	Filters	Number of Articles Retrieved	Search Logic/Key Words Used

PsycINFO	Publication Date: From 2019 to 2025 Academic Journals Linked Full Text Language: English	18 Results	(burnout OR "burnout syndrome") AND ("medical doctors" OR physicians OR "healthcare workers") AND ("South Africa" OR Africa)
	Publication Date: From 2019 to 2025 Academic Journals Linked Full Text Language: English	3 Results	("artificial intelligence" OR AI OR "machine learning" OR "predictive model") AND (burnout OR "burnout syndrome") AND ("natural language processing" OR NLP OR "text analysis" OR "psychological assessment" OR "early detection")
	Publication Date: From 2019 to 2025 Academic Journals Linked Full Text Language: English	4 Results	(burnout OR "burnout syndrome") AND ("medical doctors" OR physicians) AND "South Africa"
	Publication Date: From 2019 to 2025 Academic Journals Linked Full Text Language: English	507 Results	("artificial intelligence" OR AI OR "machine learning") AND (burnout OR "mental health") AND (healthcare OR medical OR doctor OR physician) AND (detection OR screening OR intervention)

Electronic Database	**Filters**	**Number of Articles Retrieved**	**Search Logic/Key Words Used**
SCOPUS	Publication Date: 2019-Present Language: English Search Article Title, Abstract, Keywords	80 Results	TITLE-ABS-KEY(burnout OR "burnout syndrome") AND TITLE-ABS-KEY(doctor OR physician OR healthcare) AND TITLE-ABS-KEY(South Africa)
	Publication Date: 2019-Present Language: English Search Article Title, Abstract, Keywords	36 Results	TITLE-ABS-KEY(("artificial intelligence" OR AI OR "machine learning" OR "predictive model") AND (burnout OR "burnout syndrome") AND (doctor OR physician OR "medical doctor")

			AND (detection OR screening OR intervention))
	Publication Date: 2019-Present Language: English Search Article Title, Abstract, Keywords	**30 Results**	TITLE-ABS-KEY((burnout OR "burnout syndrome") AND (doctor OR physician) AND ("South Africa"))
	Publication Date: 2019-Present Language: English Search Article Title, Abstract, Keywords	346 Results	TITLE-ABS-KEY(("artificial intelligence" OR AI OR "machine learning") AND (burnout OR "mental health") AND (doctor OR physician OR "healthcare worker" OR clinician) AND (detection OR screening OR intervention))

13.2 Appendix B: Data Extraction Template

Author(s)	Year	Country	Study Design	Population	Psychological, Physiological, Organisational determinants	Predictive AI-based Models	Applicable for South African Healthcare Systems

13.3 Appendix C: PRISMA-ScR Checklist

Section	Item	Description	Included
Title	1	To identify the report as a scoping review protocol	YES
Objectives	2	Clearly states the review questions and objectives	YES
Eligibility Criteria	3	Includes a inclusion/exclusion criteria	YES
Information Sources	4	Lists databases and sources	YES
Search	5	Draft of full search strategy	YES
Selection Process	6	State how studies will be selected	YES
Data Charting	7	Describe data extraction process	YES
Synthesis of Results	8	Explain how data will be analysed and summarised	YES
Strengths and Limitations	9	Describes potential strengths and limitations	YES
Ethics and Dissemination	10	Indicate plans to share results	YES

Adapted from: Tricco et al., 2018. PRISMA Extension for Scoping Reviews (PRISMA-ScR).

13.4 Appendix D: Storm Makings TREE Ethics Certificate

TRREE

Zertifikat
Certificat
Certificado
Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Clinical Trials Centre
The University of Hong Kong

Storm Makings

a complété avec succès - has successfully completed

Module 1 (2023) - Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2024/02/13

CID : gsG6WwQZWF

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

APPROVED BY SIWF FMH ISFM
Programmes de formation continue (2 crédits)
Continuing Education Programs (2 credits)

Foederatio Pharmaceutica Helvetiae
FPH
Programmes de formation postgraduée et continue
Programmes de formation continue
Continuing Education Programs

Ce programme est soutenu par - This program is supported by :
European and Developing Countries Clinical Trials Partnership (EDCTP) (www.edctp.org) - Swiss National Science Foundation (www.snf.ch) - Canadian Institutes of Health Research (http://www.cihr-irsc.gc.ca/e/2891.html) - Swiss Academy of Medical Science (SAMS/ASSM/SAMW) (www.samw.ch) - Commission for Research Partnerships with Developing Countries (www.kfpe.ch)

[REV : 20220217]

13.5 Appendix E: Dr Heleen Roos TREE Ethics Certificate

TRREE

Zertifikat
Certificat
Certificado
Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Clinical Trials Centre
The University of Hong Kong

Heleen Roos

a complété avec succès - has successfully completed

Module 1 (2023) - Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2024/02/13
CID : eRXcO0mXfb

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

APPROVED BY
SIWF FMH ISFM
Programmes de formation continue (2 crédits)
Continuing Education Programs (2 credits)

Foederatio Pharmaceutica Helvetiae
FPH
Programmes de formation postgraduée et continue
Programmes de formation continue
Continuing Education Programs

Ce programme est soutenu par - This program is supported by :
European and Developing Countries Clinical Trials Partnership (EDCTP) (www.edctp.org) - Swiss National Science Foundation (www.snf.ch) - Canadian Institutes of Health Research (http://www.cihr-irsc.gc.ca/e/2891.html) - Swiss Academy of Medical Science (SAMS/ASSM/SAMW) (www.samw.ch) - Commission for Research Partnerships with Developing Countries (www.kfpe.ch)

[REV : 20220217]

13.6 Appendix F: Ethan Terblanche TREE Ethics Certificate

TRREE

Zertifikat
Certificat
Certificado
Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Ethan Terblanche

a complété avec succès - has successfully completed

Module 1 (2023) - Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2025/03/02

CID : ajwvVZpaJ9

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

APPROVED BY SIWF FMH ISFM

Programmes de formation continue (2 crédits)
Continuing Education Programs (2 credits)

HKU Med LKS Faculty of Medicine Clinical Trials Centre

Ce programme est soutenu par - This program is supported by :

European and Developing Countries Clinical Trials Partnership (EDCTP) (www.edctp.org) - Swiss National Science Foundation (www.snf.ch) - Canadian Institutes of Health Research (http://www.cihr-irsc.gc.ca/e/2891.html) - Swiss Academy of Medical Sciences (SAMS/ASSM/SAMW) (www.samw.ch) - Commission for Research Partnerships with Developing Countries (www.kfpe.ch)

[REV : 20250110]

13.7 Appendix G: Supervisors Agreement

Statement of principles for postgraduate supervision

In a context of academic freedom and within a framework of individual autonomy and the pursuit of knowledge, this statement is written in the belief that there is a reciprocal relationship and mutual accountability between supervisor and student

THE SUPERVISOR AND THE STUDENT:

1. Will establish agreed roles and clear processes to be maintained by both parties. In the case of joint supervision, the roles and responsibilities of each supervisor and the student need to be clarified.
2. Will meet regularly and as frequently as is reasonable to ensure steady progress towards the completion of the proposal, research report, dissertation or thesis. This time varies but the normal minimum requirement for face-to-face contact spread across each year of registration is: 10 contact hours for an Honours project, 15 contact hours for a Masters by coursework and research report and 24 contact hours for a Masters by dissertation and a PhD.
3. Will keep appointments, be punctual and respond timeously to messages.
4. Will keep one another informed of any planned vacations or absences as well as changes in his or her personal circumstances that might impact on the work schedule. Unplanned absences or delays should be discussed as soon as possible and arrangements should be made, to catch up lost time.
5. Will ensure that research on animal or human subjects is conducted with prior approval and according to the procedures and the requirements of the relevant Ethics committee.
6. Will both complete Progress Reports on the research project as required/requested by the relevant Faculty Graduate Studies Committee.

THE SUPERVISOR:

1. Undertakes to provide guidance for the student's research project in relation to the design and scope of the project, the relevant literature and information sources, research methods and techniques and methods of data analysis.
2. Will provide guidance at the commensurate NQF level requirements for autonomy and accountability that the student is expected to demonstrate.
3. Has a responsibility to be reasonably accessible to the students.
4. Will be prepared for meetings with the student. This includes being up-to-date on the latest work in his/her area of expertise.
5. Will expect written work as jointly agreed, and will return that work with constructive criticism within a timeframe (a suggestion of 2-4 weeks) jointly agreed at the outset of the research.
6. Will provide advice that can help the student to improve his/her writing. This may include referrals for language training and academic writing. The supervisor will provide guidance on technical aspects of writing such as referencing as well as on discipline specific requirements. Detailed correction of drafts and instruction in aspects of language and style are **not** the responsibility of the supervisor.
7. Will guide the student in the production of a research report, dissertation or thesis. Provision should be allowed for adequate, mutually respectful, discussion around recommendations made.
8. Will assist with the construction of a written time schedule, which outlines the expected completion dates of successive stages of the work.
9. Will encourage the student to present work at postgraduate/ staff seminars/national/international conferences as appropriate.
10. Will assist with the publication of research articles as appropriate.

THE STUDENT:

1. Takes full responsibility for the research and its successful completion; including managing the process under the guidance of supervisor (s).
2. Will attend such courses and lectures that are compulsory for the degree, and undertakes to catch up fully on any work, lectures and/or assignments, that are missed.
3. Undertakes to work independently under the guidance of the supervisor(s). This includes reading widely and critically to ensure that the seminal **and** current literature pertinent to his/her chosen topic has been identified, consulted and critiqued.
4. Undertakes to work in accordance with the academic standards expected by the University for the commensurate NQF level of qualification.
5. Is obliged to make appointments to consult the supervisor(s) and arrange meeting times convenient to both parties well in advance.
6. Should submit written work for discussion with the supervisor(s) well in advance of a scheduled meeting. The kind and frequency of written work should be agreed with the supervisor(s) at the outset of the research.
7. Written work that is submitted to the supervisor, including final submissions to examiners, should be relatively free from basic spelling mistakes, incorrect punctuation and grammatical errors. Responsibility for the accuracy of language, the overall structure and coherence of the final research report, dissertation or thesis rests with the student.
8. Cannot expect the supervisor to be proof-reader and editor of his/her work or to approve work with any of the weaknesses spelt out in **7** above.
9. Undertakes to heed the advice given by the supervisor(s) and to engage in discussion around suggestions made. Ultimately the student has to take responsibility for the quality, integrity and presentation of the work.

We confirm that we have read and understood this statement and agree to be guided by its principles for as long as we continue to work together.

Name of student: Ethan Cowan Terblanche

Student Number: 3020408

Student's signature: EthanTerblanche

Name of Supervisor: Storm Makings

Supervisor's signature:

Name of Co-Supervisor: Dr Heleen Roos

Co-Supervisor's signature:

The broad area of study is:_ Examining Predictive Models for Burnout Detection in South African Medical Doctors: A Scoping Review Protocol

11. Will discuss the ownership of research conducted by the student in accordance with the University rules on intellectual property, copyright, **guidelines on authorship/co-authorship**, and **policy on research integrity.** 12. Will ensure that the student is aware of the University's Plagiarism Policy, knows what plagiarism is, and what the consequences are for academic dishonesty and violation of research integrity and intellectual property. 13. Will ensure that the student is made aware in writing of the inadequacy of progress and/or of any work where the standard is below par. Acceptability will be according to criteria previously supplied to the student. 14. Has a duty to refuse to allow the submission of sub-standard work for examination, regardless of the circumstances. If the student chooses to submit without the consent of the supervisor, then this should be clearly recorded and the appropriate procedures followed.	10. Should strive to maintain a focus on his/her research area and to work diligently within the agreed time schedule. 11. Agrees to honour agreements about ownership of the research and in accordance with the University's guidelines and rules in relation to co-authorship, copyright and intellectual property. 12. Will ensure that the work contains no instances of plagiarism, violation of intellectual property and research integrity standards, that all citations are properly referenced, and that the list of references is accurate, complete and consistent. 13. Agrees to work in accordance with the criteria of acceptability as supplied by the supervisor(s). 14. Undertakes not to place the supervisor(s) under undue pressure to submit work for examination until the supervisor is satisfied that it has reached an acceptable, **examinable*** level of quality.	Provisional submission date is: 15 July 2025 Degree: Health Systems Science Honours School: Family Medicine and Primary Care Faculty: Health Science Date: 14 July 2025 **Specific agreements pertaining to:** ownership, joint publication, funding, confidentiality and disclosures pertinent to the Certificate of Clearance and ETD Form which the student and/or supervisor are required to sign, must be attached to this agreement as and when appropriate and kept in the Faculty Office. In the event of disagreements between the supervisor(s) and student, the parties should act in accordance with the University Grievance Policy. ***Note: Consent by supervisor**(s) to submit work for examination does NOT guarantee that the work will pass. The appointed examiners assess and determine whether the work is of a passable standard. **(2019/09/30)**

13.8 Appendix H: HREC Medical Ethics Waiver Form

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL) – WAIVER APPLICATION FORM 2025

FOR DEGREE AND OTHER INVESTIGATOR INITIATED RESEARCH

When is an ethics waiver appropriate? It is appropriate for studies in which no active human participants are involved and no human materials (tissue, blood, hair, sputum, etc.) are to be used. Some typical examples are listed in the Appendix to this form. Waiver applications satisfying this criterion may be submitted by e-mail (HREC-Medical.ResearchOffice@wits.ac.za), to the Medical Ethics Office at any time, *i.e.* they are not subject to the published monthly closing dates for full HREC (Medical) applications.

IMPORTANT INSTRUCTIONS:

- Read the Appendix before completing this application form. Answer all questions (Y/N), incomplete application will not be accepted. State N/A rather than leaving question blank.
- **Please check the appropriate checkbox using an 'X'**. This application form **must be typed**, and handwritten form will not be accepted.

SECTION 1 – STUDY DETAILS: *

1.1 Purpose of the Research:

Postgraduate Degree/Diploma: **Yes** ☐ **No** ☐ (state which): Honours Degree

Undergraduate Degree/Diploma: **Yes** ☐ **No** ☐ (state which):

Not for Degree Purposes: **Yes** ☐ **No** ☐

1.2 Is this a New Submission? **Yes** ☐ **No** ☐

1.3 Is this a Resubmission? **Yes** ☐ **No** ☐

(**If yes**, please give the initial HREC number):

SECTION 2 – STUDY TITLE IN FULL (No abbreviations): *

Examining Predictive Models for Burnout Detection in South African Medical Doctors: A Scoping Review Protocol

SECTION 3 – INVESTIGATOR(S)/ SUPERVISOR(S)/APPLICANT INFORMATION: *

3.1 PRINCIPAL INVESTIGATOR(S): *

TITLE (Prof/Dr/Mr/Mrs/Miss/Ms/Other):	Mr
FIRST NAME	Ethan
SURNAME	Terblanche
TELEPHONE/CELL NO	083 440 0419
E-MAIL	Terblanche2003@gmail.com
WITS STAFF/STUDENT NUMBER	3020408

PROFESSIONAL STATUS, OR STUDENT YEAR OF STUDY AND DEGREE	Student, 4th year, Honours degree in Health Systems Science
DEPARTMENT/DIVISION/RESEARCH ENTITY:	DFMPC
SITES(S) WHERE THE RESEARCH WILL BE CARRIED OUT (Please furnish hospital/institution and department**)**	N/A
NAME AND DATE OF ETHICS TRAINING (Please include/attach certificate)	TREE Ethics certificate 2025/03/02

3.2 SUPERVISOR(S) DETAILS: *

TITLE (Prof/Dr/Mr/Mrs/Miss/Ms/Other):	Miss	Dr
FIRST NAME	Storm	Heleen
SURNAME	Makings	Roos
TELEPHONE/CELL NO	060-456-1361	0727477880
E-MAIL	0415605e@students.wits.ac.za	heleen.roos@wits.ac.za
DEPARTMENT/DIVISION/RESEARCH ENTITY:	DFMPC	DFMPC
NAME AND DATE OF ETHICS TRAINING (Please include/attach certificate)	TREE Ethics certificate 2024-02-13	TRREE Ethics Certificate 2024/02/13

3.3 APPLICANT DETAILS (if applicable – applying on behalf of PI/Investigators): *

TITLE (Prof/Dr/Mr/Mrs/Miss/Ms/Other):	
FIRST NAME	
SURNAME	
TELEPHONE/CELL NO	
E-MAIL	
DEPARTMENT/DIVISION/RESEARCH ENTITY:	
NAME AND DATE OF ETHICS TRAINING (Please include/attach certificate)	

SECTION 4: Description of Research and Motivation for Waiver*

4.1 List the objectives of the research: (Do not say "see attached") *

Primary (if applicable): To identify determinants linked to burnout in South African medical doctors.

Secondary (if applicable): To explore how these determinants could support AI-based early detection of burnout.

Other: n/a

4.2 Motivation for waiver: (Do not say "see attached") *

Select the appropriate box and include motivation below.

1. ☐ **A review of information in the public domain**. Provide the title of the data source, a motivation regarding the review and confirm there are no active human participants. Data should normally be anonymised and aggregated. There should be no gatekeeper, membership requirement, fee payable, or the like; access must be freely available to any member of the public, at no cost. A literature review would normally fall into this category.

2. ☐ **For an *in vitro* or microbiology laboratory study**. If using cell lines, bacterial/viral/fungal cultures, materials, or whatever, confirm that no humans, human data or human bodily materials will be used. Provide a motivation in section 4.2 and the research protocol.

3. ☐ **For An environmental surveillance study.** Typically, this might involve topics as diverse as measurements of air quality or noise in the workplace, or in public places, the functional condition of hospital or other equipment and hospital waste disposal. A common feature is that there can be no human participation.

4. ☐ **An observational study.** This is where the movement of people in a public place might be observed. Individuals would not actively participate, or be visually identifiable, but they might be counted, or broadly categorized, *e.g.* by race or gender.

   Motivation:

This scoping review protocol will use only publicly available data from sources such as published journal articles and openly accessible grey literature. No new data will be collected, and there will be no involvement of living human participants. All information is already anonymised and aggregated, with no access restrictions, fees, or memberships required. As such, there are no privacy or ethical risks, and an ethics waiver is requested in line with standard practice for literature reviews relying solely on public domain sources.

4.3 Study protocol *

***PLEASE REMEMBER TO ATTACH A FULL STUDY PROTOCOL**

SECTION 5: INFORMATION, DECLARATION AND SIGNATURES (To be kept on separate page) *

Investigator(s) Name and Surname: *
In appending my signature below, I confirm that I am aware of and agree to abide by the University's policy on plagiarism, as referenced in the Appendix to this Application Form.

I have read and understood the terms and conditions in the Appendix of the HREC (Medical) Application Form. I acknowledge that it is my responsibility to ensure that I have received final HREC (Medical) clearance before commencing any research.
I declare that I have not and will not collect data or do secondary data analysis, or any other form of research involving human participants, prior to obtaining a Clearance Certificate from HREC (Medical).

Repeat Study Title here: Examining Predictive Models for Burnout Detection in South African Medical Doctors: A Scoping Review Protocol

PRINCIPAL INVESTIGATOR(S): *

Name: ***Please Print Title, Name and Surname***	Ethan Cowan Terblanche
Department:	*DFMPC*
Email:	Terblanche2003@gmail.com
Date:	17/07/2025
Signature:	EthanCowanTerblanche

APPLICANT (where applicable - applying on behalf of PI/Investigators**):** *

Name: ***Please Print Title, Name and Surname***	*Ethan Cowan Terblanche*
Department:	*DFMPC*
Email:	Terblanche2003@gmail.com

Date	17/07/2025
Signature:	**EthanCowanTerblanche**

SUPERVISOR(S) (where applicable): *

Name: ***Please Print Title, Name and Surname***	*Storm Makings*	*Dr Heleen Roos*
Department:	*DFMPC*	*DFMPC*
Email:	**0415605e@students.wits.ac.za**	**heleen.roos@wits.ac.za**
Date	**22-07-2025**	**22/07/2025**
Signature:		

HEAD OF DEPARTMENT / UNIT OF INSTITUTION / RESEARCH ENTITY IN WHICH STUDY WILL BE CONDUCTED:

Name: *Please Print Title, Name and Surname*	
Head of Dept / Unit of Institution / Research Entity where study will be conducted:	
Date:	
Signature:	