

Investigating Racial Bias in Medical Diagnostic Techniques and Algorithms: A Systematic Review

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Background

Health inequities for people of colour pervade our society despite significant medical advances. In response to high-profile racial injustices, civil society has challenged global societal norms elucidating evidence of systemic modern racism across health structures and institutions. Previous research has shown racial disparities in physician implicit bias, COVID-19 outcomes, and healthcare algorithms. With the exponential growth of technology-driven personalised medicine, there are concerns regarding the potential for diagnostic techniques and algorithms to compound healthcare inequities.

Research objectives

Do medical diagnostic techniques and algorithms encode bias based on racial grouping?

- To what extent, if any, does this occur?
- Should bias exist, what clinical fields are affected by this?
- For which racial groups are diagnostic techniques and algorithms biased?

Introduction

In response to high-profile racial injustices, civil society has challenged global societal norms elucidating evidence of systemic modern racism across health structures and institutions. This takes many forms at societal, institutional, and individual levels (Banaji et al., 2021). Structural racism has been cited as a 'public health crisis' with inequalities across service provision, pay scales and health outcomes identified in both public and private health systems (Andrews, 2021; Frogner & Schwartz, 2021; Kumar, 2021). It further extends into research, medical education and has been evidenced within global health institutions (Martin et al., 2016). Growing societal awareness is bringing light to modern racism. Civil society alongside social justice movements are demanding accountability for, and an end to, systemic racism.

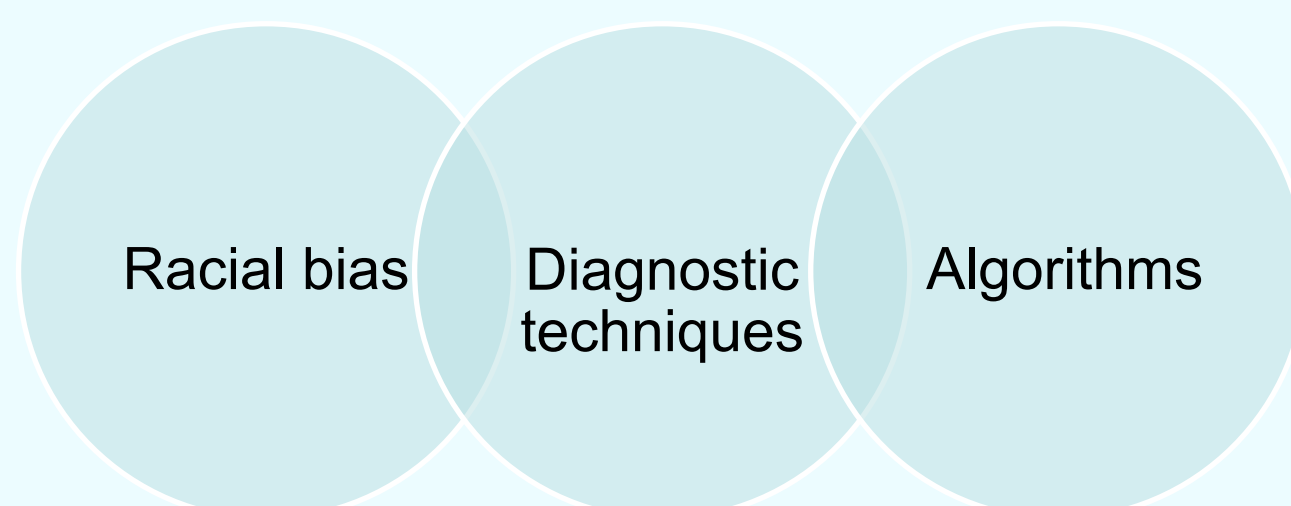
While race is today recognised as lacking in biological basis, it can be a useful means through which we can analyse the socio-political context of scientific research, particularly when considering the health deficit experienced by people of colour (Flanagin et al., 2021). Medicine is not free from these biases and in fact, from technology to clinical practice, some argue it is structurally permeated by racial bias (Cerdeña et al., 2020). A striking example of modern health inequity is seen in the disproportionate burden of COVID-19 on non-white patients and the extent to which socioeconomic factors influence this (Agyemang et al., 2021; Magesh, John et al., 2021; Mude et al., 2021).

Reviewing research investigating racial bias in medical diagnostic techniques and procedures, while acknowledging there would be no biological explanation to account for this, provides a critical opportunity for identification of embedded racism before further dissemination of their use.

Methods

- A search strategy of three main concepts; 'racial bias', 'diagnostic techniques' and 'algorithms' was used to search PUBMED, Embase and Scopus up to 29/05/2022.
- Included studies involved adult patients with somatic conditions undergoing diagnosis using medical techniques or algorithms. Only studies investigating effect of 'race' on diagnostic accuracy were included.
- Outcome of interest: presence or absence of racial bias
- All studies using empirical data were included; randomised controlled trials, observational studies, cohort studies, case-control studies, validation studies and single case studies.
- Data extracted included; author(s), sample size, study setting, publication year, study design, key findings, racial/ethnic groupings used, presence of bias, direction of bias, algorithm or diagnostic technique of interest, study methodology and condition for which diagnostics are being undertaken.
- Methodological quality of included studies was appraised using the QUADAS-2 Risk of Bias Evaluation Tool.
- Characteristics of the 24 included studies and extracted data were presented in a summary table.
- Research measures (including sensitivity, specificity and receiver operating characteristic) varied depending on study aims.

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References:

Agyemang, C., Richters, A., Jolani, S., Hendriks, S., Zalpuri, S., Yu, E., Pijls, B., Prins, M., Stronks, K., & Zeegers, M. P. (2021). Ethnic minority status as social determinant for COVID-19 infection, hospitalisation, severity, ICU admission and deaths in the early phase of the pandemic: a meta-analysis. *BMJ Global Health*, 6(11), e007433. <https://doi.org/10.1136/bmjgh-2021-007433>. Andrews, K. (2021). Racism is the public health crisis. *The Lancet*, 397(10282), 1342-1343. [https://doi.org/10.1016/S0140-6736\(21\)00775-3](https://doi.org/10.1016/S0140-6736(21)00775-3). Banaji, M. R., Fiske, S. T., & Massey, D. S. (n.d.-a). *Systemic racism: individuals and interactions, institutions and society*. <https://doi.org/10.1186/s41235-021-00349-3>. Cerdeña, J. P., Plaisime, M. v., Tsai, J., Floyd, G., Taylor, B., Arbery, A., & Mcdade, T. (2020a). From race-based to race-conscious medicine: how anti-racist uprisings call us to act. *The Lancet*, 396(10257), 1125-1128. [https://doi.org/10.1016/S0140-6736\(20\)32076-6](https://doi.org/10.1016/S0140-6736(20)32076-6). Flanagin, A., Frey, T., Christiansen, S. L., & Bauehner, H. (2021). The Reporting of Race and Ethnicity in Medical and Science Journals: Comments Invited. *JAMA*, 325(11), 1049-1052. <https://doi.org/10.1001/JAMA.2021.2104>. Ford, C. L., & Airhihenbuwa, C. O. (2010). Critical race theory, race equity, and public health: Toward antiracism praxis. *American Journal of Public Health*, 100(SUPPL. 1). <https://doi.org/10.2105/AJPH.2009.171058>. Frogner, B. K., & Schwartz, M. (2021). 100782 *Examining Wage Disparities by Race and Ethnicity of Health Care Workers*. www.lww-medicalcare.com. Kumar, S. (2021). Ethnic and racial inequity and inequality in health and science: a call for action. *EclinicalMedicine*, 32. <https://doi.org/10.1016/j.eclinm.2021.100161>. Magesh, S., Daniel, J., Wei, J., Li, T., Li, Y., Mattingly-App, A., Jain, S., Chang, E. Y., & Ongkeko, W. M. (2021). Original Investigation | Infectious Diseases Disparities in COVID-19 Outcomes by Race, Ethnicity, and Socioeconomic Status A Systematic Review and Meta-analysis Key Points Question Are race and ethnicity-based + Supplemental content. *JAMA Network Open*, 4(11), 2134147. <https://doi.org/10.1001/jamanetworkopen.2021.34147>. Martin, G., Kirgis, J., Sid, E., Medicine, J. S.-A., & 2016, undefined. (n.d.). Equitable imagery in the preclinical medical school curriculum: findings from one medical school. *Ingentaconnect.Com*. Retrieved May 17, 2022, from <https://www.ingentaconnect.com/content/wk/acm/2016/00000091/00000007/art00031>. Mude, W., Oguoma, V. M., Nyanhanda, T., Mwanri, L., & Njue, C. (2021). Racial disparities in COVID-19 pandemic cases, hospitalisations, and deaths: A systematic review and meta-analysis. *Journal of Global Health*, 11, 1-15. <https://doi.org/10.7189/jogh.11.05015>.

Results: overview

Inadequacies of guidelines, inaccuracies of eGFR equations, higher misclassification rates or unsuitable metabolic parameters for minority racial groups found: 12 studies (48%)

No presence of racial bias found: 13 (52%) studies

Risk of bias varied greatly between studies.

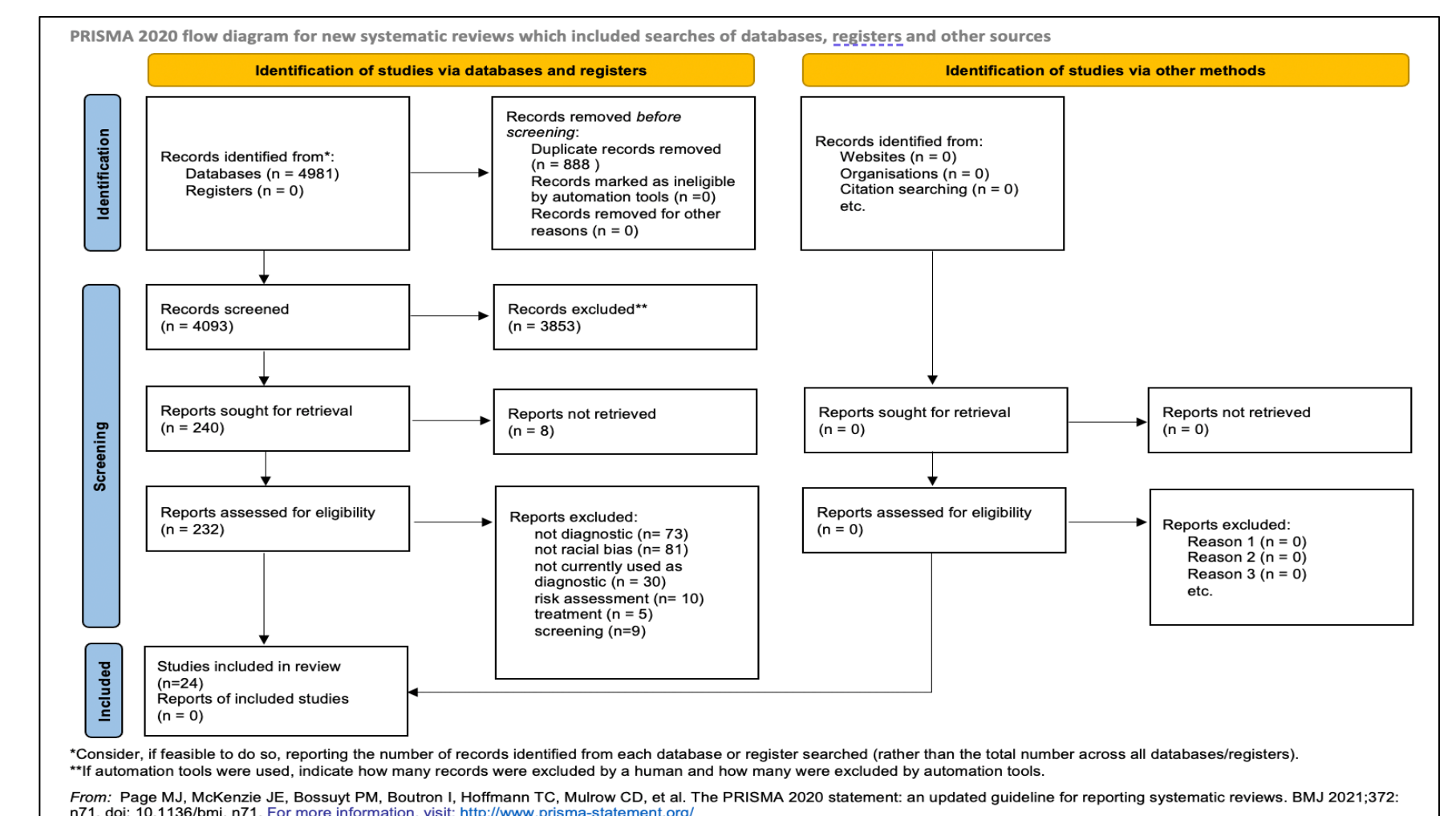


Figure 1: PRISMA Flow Chart showing screening process for systematic review of three included databases.

Results: where was bias found?

Of the included studies, diagnostics were related to (% of included studies):

- eGFR equations in context of chronic kidney disease (40%) : Most studies found discrepancies in eGFR accuracy, and subsequent CKD classification, when using racial coefficients in non-White populations. No included studies approved the use of any current eGFR racial adjustment factors. Some included validation studies alternatively recommended use of population-specific factors.
- Cardiovascular pathologies (32%) : Higher rates of diagnostic misclassification in non-white groups were found for cardiac magnetic resonance imaging. Current threshold of 200ms (PR interval length) as a diagnostic criterion for atrial fibrillation is more suited to non-Hispanic Whites compared to other populations. Current diagnostic guidelines may be unsuitable for black athletes with potential for false positive diagnoses. A diagnostic protocol for acute chest pain showed to be more likely to yield a low risk assessment in non-white patients (however, arguing this did not underestimate risk in this subgroup, rather it reflected the actual difference in risk between subgroups). Four studies found no bias in their respective diagnostics.
- Eye pathologies (12%): No bias found in any of three included studies.
- Prostate cancer (8%): No bias found in either study.
- Liver pathologies (4%) : Current metabolic parameters for non-invasive liver tests found to be less suitable for South Asian populations compared to a Caucasian population.
- Skin-related diagnostics (4%): Bias found with stereophotogrammetry less accurate in darker skin.

Theoretical Framework

This systematic review integrated race-consciousness by contextualising findings according to Critical Race Theory (CRT). CRT was used in the form of the Public Health Critical Race Praxis, shown in Figure 2 (Ford & Airhihenbuwa, 2010).

- When socially-constructed racial categories experience 'different' outcomes from 'objective' medical diagnostics, despite lack of true biological difference, this suggests an inherent inadequacy.
- While bias may have been unintentional during diagnostic development, given the well-documented awareness of white male domination within both historic and current medical research, continued ignorance is not a justification for any residual diagnostic biases.
- Responsibility to eliminate biases should be accepted by those developing and utilising medical diagnostics.

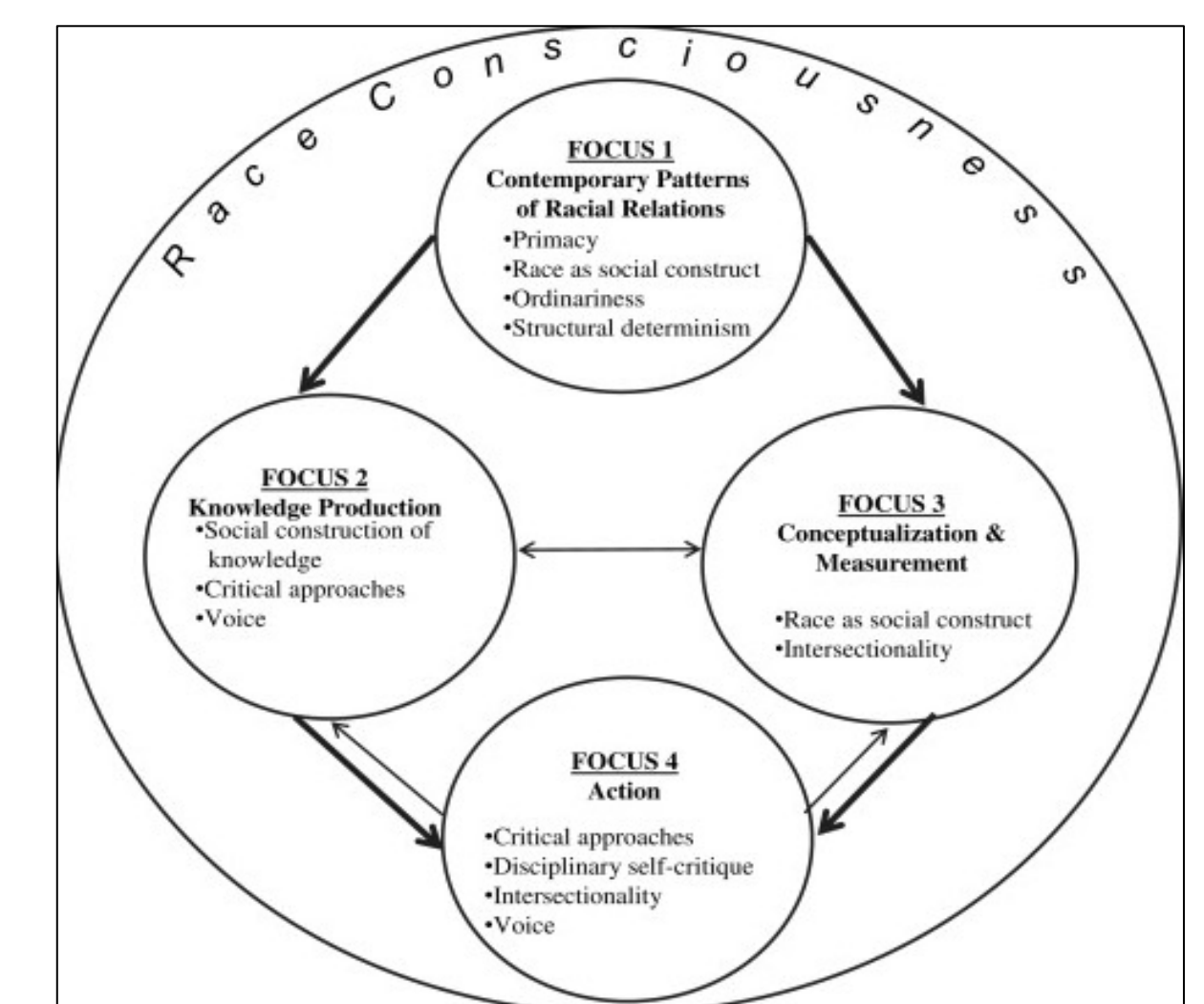


Figure 2: Public Health Critical Race Praxis. (Ford & Airhihenbuwa, 2010).

Conclusions

- In general, presence of bias in medical diagnostics based on racial group varied between studies and diagnostic technique. Where difference between racial groups was found, this outcome always disadvantaged the racial minority population.
- There is need for higher quality research, at lower risk of bias, in this area.
- There is need for clarification of algorithmic fairness legislation, development of more diverse datasets, and more inclusive research to investigate racial biases across current diagnostics to address health inequities.
- Identifying with a racial group can be a signpost of cultural background, potential environmental exposures, and previous experience of healthcare. This should be a key consideration in future race-conscious research.
- Race-conscious medicine provides a platform for education, research, and meaningful discussion from which structural barriers for people of colour can be addressed.