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Association between perceived discrimination and pulse wave velocity: a scoping review

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ABSTRACT

Racial discrimination is a chronic stressor that may contribute to cardiovascular disease (CVD) disparities in non-Hispanic Black (NHB) adults. NHB adults experience greater perceived discrimination (PD) and CVD risk compared with non-Hispanic White adults. Although the association between PD and some subclinical CVD markers has been examined, the relationship between PD and arterial stiffness has not been established, limiting our understanding of the impact of PD on CVD.

Objective The objective of this review was to summarise the literature on the relationship between PD and arterial stiffness.

Design Systematic scoping review.

Data sources PubMed, Embase, SPORTDiscus with full text and CINALH+ with full text databases were searched from inception to 10 July 2023.

Eligibility criteria Adults (≥18 years), arterial stiffness measured as pulse wave velocity (PWV), PD assessment, and randomised control trial or observational study designs.

Data extraction and synthesis Of 453 articles identified, four studies were included. Two studies were cross-sectional (United States, Brazil), one was longitudinal (United Kingdom), and another was a randomized control trial (United States).

Results The age of the study populations ranged from 18 years to 75 years and one study evaluated a clinical population. All studies used different PWV devices and PD assessments. Associations between PD and PWV varied by geographical region, sex, clinical status and study design.

Conclusion Research evaluating the association between PD and PWV is scarce and heterogeneous in PD and PWV assessments. There is an inconclusive association between PD and PWV.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Discrimination is a chronic stressor that has been associated with cardiovascular disease risk factors.
⇒ The relationship between discrimination and pulse wave velocity (PWV) has not been established.

WHAT THIS STUDY ADDS

⇒ Four studies evaluated the link between discrimination and PWV, and each study used a different measure of discrimination and PWV.
⇒ The relationship between discrimination and PWV is inconclusive.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Future studies should use consistent methodology.

INTRODUCTION

Discrimination poses a public health risk. Perceived discrimination (PD) can be defined and measured as the behavioural manifestation of a negative attitude, judgement or unfair treatment towards members of a group.[1] It is a multidimensional construct and a chronic stressor that may contribute to advanced vascular ageing and heightened cardiovascular disease (CVD) risk.[2] This is evidenced by associations of PD with diseases like hypertension and obesity[1] and with poor health behaviours—including poor sleep and smoking.[3 4] Although research focused on PD and CVD risk has primarily focused on non-Hispanic Black (NHB) adults, recent studies evaluated the association in other racial and ethnic groups (ie, non-Hispanic White (NHW) individuals) and indicated a potential association of discrimination with CVD risk.[5]

Currently, a challenge of assessing PD includes the use of multiple instruments assessing different dimensions of PD, including domains (e.g., school, work, etc.) in which individuals are exposed and the consideration of chronic and acute exposures to discrimination. For example, the Major Experiences of Discrimination Scale (MED)[6] and the 10-item Everyday Discrimination Scale (EDS)[7] are two common PD assessments. The MED captures acute exposures to PD in public spaces, work, police stations, educational institutions, and housing. The EDS captures the impact and frequency of various

forms of day-to-day unfair treatment over the previous 12 months. A lack of consistency in the measurement of PD may lead to contrasting results and misleading conclusions and deter progress in curbing the burden of CVD risk.

Although the association between PD and CVD outcomes has been evaluated, most studies focused on incident CVD[8] and all-cause mortality,[9] with less work on subclinical CVD measures. The work on subclinical CVD measures has been limited to studies of coronary artery calcification,[10] proteins (e.g., high-sensitivity C reactive protein)[11 12] and carotid intima-media thickness.[13] However, the association between subclinical CVD risk factors and psychosocial factors has not been thoroughly elucidated. To be able to understand CVD risk over the lifespan, it is important to evaluate arterial stiffness.

Central arterial stiffness is a marker of vascular ageing and CVD risk,[14–17] and indicates whether vascular ageing is accelerated (e.g., due to risk factors) or attenuated (e.g., due to lifestyle). It also independently predicts CVD in clinical and population-based studies.[18] Arterial stiffness offers prognostic value over and above traditional blood pressure measurements,[18–21] making it an ideal measure to evaluate CVD risk, especially in younger individuals. The most widely used and clinically relevant non-invasive measure of arterial stiffness is pulse wave velocity (PWV), otherwise known as the velocity of pressure waves as they propagate along an arterial segment. Carotid to femoral PWV (cfPWV) is considered the referent non-invasive measure of PWV because it encompasses the large, elastic aorta susceptible to both structural and functional stiffening.[22]

To understand the effect of discrimination on CVD risk, this scoping review evaluated the existing literature to understand the relationship between PD and arterial stiffness (measured as PWV).

OBJECTIVE

The primary aim of this scoping review was to consolidate and synthesise the literature pertaining to the relationship between PD and PWV in adults. We initially planned to focus on only NHB individuals, but due to the scarcity of studies focusing on NHB individuals, we expanded to all adults.

METHODS

This scoping review is reported in accordance with PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Review) guidelines; however, it was not preregistered.[23] The research question and search strategy were refined using PEO: Population, Exposure of interest, and Outcomes.[24] Neither patients nor the public were involved in the design, completion, reporting, or dissemination plans for this review.

Data sources and searches

Electronic databases (PubMed, Embase, SPORTDiscus with full text, Cumulative Index to Nursing and Allied Health Literature Plus [CINALH+] with full text) were searched by one author (PPL). The keywords used for the search were derived from these initial keywords: ((((((discrimination) OR (perceived discrimination)) OR (perceived stress)) OR (stress) OR (psychosocial stress) OR (psychological stress)) AND ((arterial stiffness)) OR (cfPWV)) OR (PWV)) with the assistance of an experienced librarian. These keywords were expanded and adapted for each of the search engines used. A comprehensive list of the search terms is available in the online supplemental file 1. We excluded narrative reviews, letters and unpublished data. We evaluated the reference lists of all identified studies, relevant reviews and editorials to ensure a comprehensive identification of relevant studies. The search was limited to English language studies published between inception and 10 July 2023. All identified studies were imported into an online systematic review software (Covidence systematic review software, Veritas Health Innovation, Melbourne, Australia).

Article selection

For this scoping review, the term ‘article’ is used synonymously with ‘study’, and ‘cohort’ will refer to the study population evaluated within an article included in this scoping review. Each article was considered the basic unit of analysis. If multiple publications included the same cohort, each was evaluated separately, and the most relevant was retained for analysis. Initially, article titles and abstracts were screened for relevance by two reviewers (PPL and CP) independently using the online systematic review software. The systematic review software tracked the progress of each reviewer and blinded the reviewer to their peer’s progress and their decision for each abstract. If there were any conflicts during the article review process, including eligibility, quality or data extraction, the software would flag the articles. Reviewers (PPL and CP) would meet, discuss and reach a consensus. The full text of potentially eligible articles was reviewed for inclusion. The following criteria were used to select studies for inclusion in the review: (1) measurement of PWV, (2) measurement of PD, (3) randomised controlled trials or observational studies (ie, cross-sectional and cohort). Exclusion criteria consisted of (1) inclusion of individuals under 18 years of age and (2) previous cancer or cancer-related illness in the sample. We focused on adults as CVD risk and CVD become evident during this period. Additionally, we excluded cancer or cancer-related illnesses as these can lead to CVD and confound the association between PD and PWV.

Data extraction and quality assessment

Data extracted for each eligible study included bibliographic information (author, publication year), baseline participant characteristics, study design details and

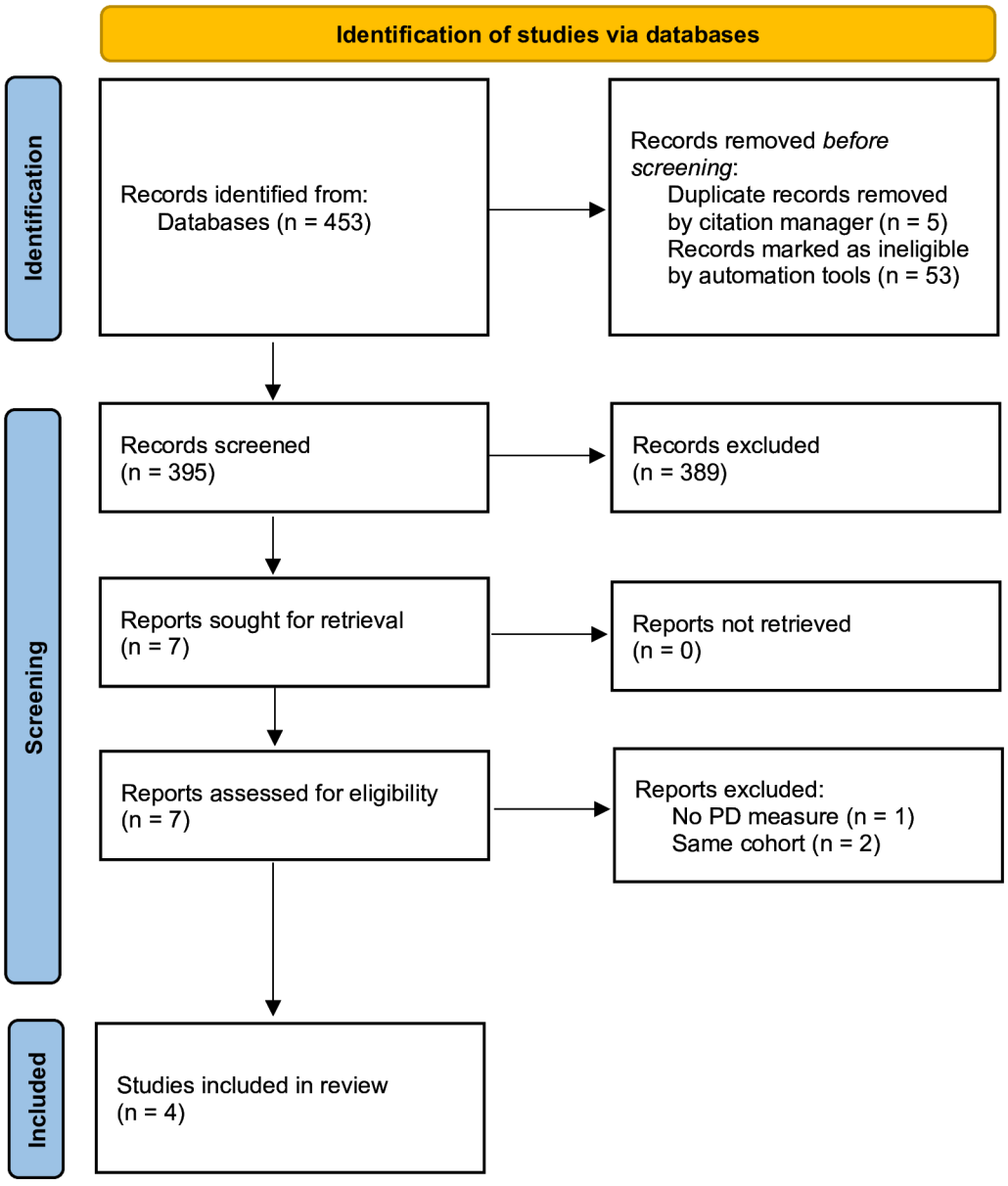

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram for study selection. PD, perceived discrimination.

results of reported outcomes. Study quality was assessed using the National Heart, Lung, Blood Institute's Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (score: good, fair, poor), which includes items related to randomization, blinding and description of dropout/withdrawals.[25] Data extraction, quality assessment and scrutiny of the available literature were completed by two reviewers (PPL and CP) independently.

RESULTS

Literature search and trial selection

The specifics of this literature search are summarised in figure 1. A total of 453 potentially eligible articles were identified. Of these 453, 5 were marked as duplicates by the citation manager and 58 studies were identified as duplicates by automation tools (Covidence). Following the screening of abstracts and titles, 395 were excluded for not meeting the selection criteria. Of these, seven studies were identified for a full-text review (figure 1). One study was excluded because it did not measure PD.[26] Three studies evaluated the same cohort,[27–29] and two were excluded because results focused on a different outcome and did not explicitly report the relationship between PD and PWV. Of the two excluded studies, the main outcome of one study was lung function,[27] and the other study focused on arterial wave augmentation.[28] A total of four studies were included in our analysis.[7 29–31]

Description of the included studies

Trial setting and participants

Included trial characteristics are summarised in table 1. The trials were carried out in the USA (n=2), the UK (n=1) and Brazil (n=1). The dates the studies were published ranged from 2016 to 2023 and the studies were conducted from 2002 to 2014 for the Determinants of Adolescent Social Wellbeing and Health (DASH) Study, 2008–2010 for the Brazilian Longitudinal Study of Adult Health (ELSA-Brazil), prior to 2020 for the Myocardial Infarction and Mental Stress 2 Study, and prior to 2023 for the Grosicki *et al*[31] sample. The number of participants in each trial ranged from 38[31] to 13 284.[30] All studies included male and female participants and multiple racial or ethnic groups. One study evaluated Black or White individuals;[31] another Black and White/other race/ethnicity;[7] another 'Black', 'Brown', 'White', 'Asian descent' and 'Brazilian indigenous';[30] and another evaluated White British, Indian, Pakistani or Bangladeshi, Black African (mainly Nigerian and Ghanaian), Black Caribbean, and other ethnicities.[29] The mean age of the participants ranged from 21.3 years to 51.6 years (SD: 8.9). Only one study evaluated a clinical population.[7] All studies used self-reported PD assessments (EDS;[7] MED;[30] standardised questions on unfair treatment on the grounds of race, skin colour, country of birth, or religion;[29] and the Perceived Ethnic Discrimination Questionnaire (PEDQ[31]). One study used single-point oscillometry (Arteriograph 24-hours device, TensioMed, Budapest, Hungary),[29] another piezoelectric mechanotransducers (Complior, Artech Medicale, Patin, France),[30] another used radial applanation tonometry (SphygmoCor, AtCor Medical, Sydney, Australia),[7] and another used a combination of applanation tonometry and oscillometry (SphygmoCor Xcel, AtCor Medical, Sydney, Australia)[31] to assess PWV.

Methodological quality assessment

The methodological quality assessment of included trials is summarised in table 1. Three studies were rated as good quality,[29–31] and the remaining study was rated as fair quality.[7] Two studies were cross-sectional, one longitudinal, and one was a randomised, placebo-controlled, blinded, cross-over design. Exposure measures were clearly defined for all studies. Outcome measures were clearly defined in all but one study.[7] All studies clearly outlined how they identified their population of interest. Three of the studies evaluated the exposure continuously,[7 30 31] whereas the other study dichotomised the exposure for the analysis.[29] Three studies adjusted for potential confounding variables on the relationship between PD and PWV, one study did not.[31] Two studies evaluated different exposure levels as related to the outcome and specified participation rates of eligible persons.[29 30]

Synthesis of results

In the Camelo *et al*[30] and Cruickshank *et al*[29] studies, PD was associated with greater (worse) PWV. In the Bromfield *et al*[7] study, a similar association was evident only in NHB women, but not for NHB men or NHW men or women. More recently, Grosicki *et al*[31] did not identify a significant association between PD and PWV. For the Camelo *et al*[30] study, they evaluated the racial PD and the joint impact of skin colour and race on PWV. Comparisons between ethnic groups used White individuals as the reference group. The findings indicated that compared with White individuals, Black and Brown individuals with and without experiences of PD had greater PWV for the crude associations (Brown without PD: β=0.075, 95% CI 0.003, 0.146 m/s; Brown with PD: β=0.455, 95% CI 0.222, 0.687 m/s; Black without PD: β=0.418, 95% CI 0.318, 0.518 m/s; Black with PD: β=0.297, 95% CI 0.157, 0.436 m/s), and when adjusted for age, sex, research centre, mean arterial pressure, heart rate (Brown without PD: β=0.085, 95% CI 0.026, 0.144 m/s; Brown with PD: β=0.401, 95% CI 0.218, 0.583 m/s; Black without PD: β=0. 183, 95% CI 0.101, 0.264 m/s; Black with PD: β=0.251, 95% CI 0.141, 0.361 m/s). When additionally adjusted for education, the association between PD and PWV in Brown individuals without PD was no longer statistically significant, but remained statistically significant for Brown individuals with PD: β=0.365 95% CI 0.181, 0.548, Black individuals without PD: β=0.124, 95% CI 0.039, 0.209; and Black individuals with PD: β=0.223, 95% CI 0.112, 0.333 m/s (table 1). These findings were consistent when evaluating the odds of having PWV>10 m/s for the crude association, and for the model adjusted for age, sex, research centre, mean arterial pressure and heart rate. However, for the model additionally adjusted for education, the odds of having PWV>10 m/s was significant for Brown individuals with or without PD (Brown without PD: OR=1.14, 95% CI 1.01, 1.29 and Brown with PD: OR=2.01, 95% CI 1.43, 2.81), and for Black individuals with or without PD (Black without PD: OR=1.24, 95% CI 1.05, 1.45 and Black with PD: OR=1.39, 95% CI 1.12, 1.72). Overall, Brown individuals with PD compared with White individuals had the highest βs and ORs of having PWV>10 m/s (table 1).

For the Cruickshank *et al*[29] study, after adjusting for age, brachial blood pressure at 21–23 years of age, sex, ethnicity, waist-to-height ratio, and socioeconomic circumstances at 21–23 years of age, PD was associated with a 0.25 m/s increase in PWV. Further, when they included adjustment for adolescent family affluence and circumstance, PD was associated with a 0.30 m/s increase in PWV (table 1).

For the Bromfield *et al*[7] study, the crude association between everyday PD and PWV was statistically significant. However, the association was attenuated when adjusted for age, race and gender. They observed a similar attenuation of the results when adjusting for other demographic characteristics (e.g., poverty status, education and marital status) and behavioural and disease risk factors (eg, diabetes, coronary heart disease, depression and perceived stress). Further, when they evaluated the relationship by race and gender, there was a significant association between everyday PD and PWV in NHB women

Table 1 Study characteristics

Authors (country)	Study design	Sample size	Age (years)	Female (%)	Clinical population	Race/ethnicity	PD assessments and PWV method	Summary of main outcomes
Bromfield *et al* (USA)[7]	Cross-sectional	313	≤60	49.2	Yes (post-MI)	White Black	**PD:** 10-item EDS (self-reported) **PWV method:** applanation tonometry	*PD was associated with worse PWV only in Black women, but not for any other race-gender group.
Camelo *et al* (Brazil)[30]	Cross-sectional	13284	34–75	54.7	No	White (ref) Black Brown	**PD:** MED (self-reported) **PWV method:** piezoelectric mechano-transducers	†Compared with White individuals, Black and Brown individuals with and without PD had worse PWV. Black and Brown with and without PD had higher odds of worse PWV (>10 m/s).
Cruickshank *et al* (UK)[29]	Longitudinal	665	21–23	~equal	No	White (ref) British Indian Pakistani/ Bangladeshi Black African Black Caribbean Other	**PD:** Standardised questions on unfair treatment on the grounds of race, skin colour, country of birth or religion in various locations (self-reported) **PWV method:** single-point oscillometry	‡PD was associated with a 0.3 m/s increase in PWV.
Grosicki *et al* (USA)[31]	Randomised, placebo-controlled, blinded, cross-over	38	18–39	47.4	No	White Black	**PD:** PEDQ (self-reported) **PWV method:** applanation tonometry and oscillometry	There was a non-significant moderate correlation between PD and PWV.

*Adjusted for age, income, education, marital status, depressive symptoms and perceived stress.
†All β and ORs are compared with **White adults**, adjusted for age, sex, research centre, mean arterial pressure, heart rate and education.
‡Adjusted for age, brachial blood pressure at 21–23 years, sex, ethnicity, waist-to-height ratio, socioeconomic circumstances at 21–23 years, adolescent family affluence and circumstance.
EDS, Everyday Discrimination Scale; MED, Major Experiences of Discrimination Scale; MI, myocardial infarction; NHW, non-Hispanic White; PD, perceived discrimination; PEDQ, Perceived Ethnic Discrimination Questionnaire; PWV, pulse wave velocity; ref, referent race/ethnic group.

for models adjusting for sociodemographic, behavioural, and disease risk factors and unadjusted models. Finally, for the Grosicki *et al*[31] study, there was a non-significant moderate positive correlation (r=0.287) for the association between PD and PWV.

DISCUSSION

For this scoping review, we identified four studies assessing the relationship between PD and arterial stiffness across the world published between 2016 and 2023. According to our findings, there is a paucity of research specifically on the association between PD and PWV, an indicator of CVD risk. Overall, there is an inconclusive association between higher PD and higher (worse) PWV with results varying by geographical region, biological sex, clinical status and study design. We also noticed most studies controlled for important covariates, often including age, sex, racial and ethnic group, blood pressure, and socioeconomic status or position. Additionally, there was heterogeneity in the methods used to assess PD and PWV, which aligns with the established limitations of both PD and PWV research. Lastly, the use of four different PD measurement scales may impact the association between PD and PWV. Each PD scale addresses different aspects of discrimination. The MED, which captures unfair treatment in public spaces, work, police stations, educational institutions, and housing assesses PD acutely.[6] Whereas, the EDS assesses the impact and frequency of various forms of day-to-day unfair treatment over the previous 12 months.[7] Both address aspects of discrimination, yet the EDS focuses on frequency events on a day-to-day basis. The scale used for the Cruickshank *et al*[29] study assesses unfair treatment as a result of gender and race discrimination or other types of gender or race-biased treatment, and does not specify a time period.[32 33] Finally, the PEDQ focuses on discrimination due to ethnic background within a 3-month period.[34] The use of multiple scales of PD, and the fact each scale addresses some, but not all, of the different aspects of PD may be contributing to the heterogeneity of the results identified. The current paucity in the literature and the identified studies support the need for further research in this area to fully characterise the relationship between PD and arterial stiffness.

Limitations

As this was a scoping review, it is important we acknowledge the limitations. First, there is notable scarcity of literature on the association between PD and PWV. Second, not all studies evaluated differences by sex. Only one study evaluated the association within a clinical population. Although the findings come from several world regions, the findings may not be generalisable to all populations. Evaluating and consistently reporting results by sex and clinical status could contribute to the generalisability of the results. Further, the identified inconsistent association between PD and PWV could be due to unmeasured factors. Future studies should explore the effect of coping mechanisms (good and bad) and how these impact the association between PD and PWV, as intersectionality of factors could modify the association between PD and PWV.

CONCLUSIONS

The goal of this scoping review was to consolidate and synthesise the literature on the relationship between PD and PWV in adults. There is a lack of research evaluating PD and PWV. This advocates for more high-quality research focused on assessing the association between PD and PWV, as experiences of PD could contribute to CVD risk, especially in minority populations. As noted previously, heterogeneity in the use of different scales of PD is a current limitation, so considering the use of multiple scales to assess PD simultaneously could improve generalisability. Additionally, the use of consistent devices to assess PWV could improve generalisability and CVD risk assessment in the general population.

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