How might repeated experiences of racial discrimination lead to the biological outcome of cardiovascular disease?

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Abstract

The current review proposes one pathway through which repeated experiences of racial discrimination may lead to the biological outcome of cardiovascular disease. Racial discrimination will be considered as a chronic stressor, which is the first component of the model of cardiovascular disease proposed by Tawakol and colleagues (2017). This model proposes that steps from psychosocial stress to cardiovascular disease are the following: stress leads to increased amygdala activity, which leads to increased bone marrow activity and arterial inflammation, which, in turn, lead to cardiovascular disease. Literature about racial discrimination suggests its connection to each step in the Tawakol model; repeated experiences with racism have been linked to chronic stress, heightened amygdala activity, inflammation, and cardiovascular disease. The reviewed research provides support for the Tawakol model as a potential pathway through which the chronic stressor of racial discrimination ultimately leads to cardiovascular disease.

Keywords: racial discrimination, cardiovascular disease, chronic stress, amygdala

Introduction

Research has demonstrated that frequent activation of the stress response is one factor that can increase the risk of cardiovascular and inflammatory diseases (Dimsdale, 2008; Wellen & Hotamisligil, 2005), and that Black Americans are at higher risk of developing cardiovascular disease relative to White Americans (Van Dyke et al., 2018). Therefore, it stands to reason that a chronic stressor in the lives of Black Americans may be contributing to these health disparities. As racism is pervasive throughout the United States (Kessler et al., 1999; Lee et al., 2019), it is likely that racial discrimination is one of the chronic stressors that leads to detrimental health outcomes for Black Americans. Therefore, this review paper seeks to propose one pathway through which repeated experiences of racial discrimination may lead specifically to the biological outcome of cardiovascular disease.

In order to outline such a pathway, this review will consider racial discrimination as a chronic stressor, which is the first component in a psychosocial stress and cardiovascular disease model proposed by Tawakol and colleagues (2017). These researchers proposed that psychosocial stress leads to cardiovascular disease through the following pathway: stress leads to increased amygdala activity, which leads to increased bone marrow activity and arterial inflammation, which, in turn, lead to cardiovascular disease. Their findings supported the idea that chronic stress, manifested through amygdala activity and inflammation, could predict later development of cardiovascular disease. They also found that perceived stress was correlated with amygdala activity and arterial inflammation. Besides its clear role as a chronic stressor (Ahmed et al., 2007), racial discrimination has been linked to increased amygdala activity (Clark et al., 2018), chronic inflammation (Cuevas et al., 2020), and cardiovascular disease (Lewis et al., 2014). This suggests that the pathway from racial discrimination to cardiovascular disease

follows a similar model to that proposed by Tawakol and colleagues (2017). Therefore, this paper will provide support for each step of the Tawakol model, examining racial discrimination as the first step of psychosocial stress eventually leading to cardiovascular disease.

Method

This literature review was conducted using the Google Scholar database to locate articles on racial discrimination in relation to the steps of the Tawakol model. For the following search terms, both "racism" and "racial discrimination" were used, but only "racism" will be listed for simplicity. In the order of the Tawakol model, the following terms were searched for in the database: 1) "racism AND chronic stress"/ "racism AND perceived stress"; 2) racism AND amygdala/ "racism AND amygdala activity"; 3) "racism AND arterial inflammation"/ "racism AND bone marrow activity"; 4) "racism AND cardiovascular disease." To define cardiovascular disease, this review will use the same terms outlined by the Tawakol et al. (2017) paper: "coronary death, myocardial infarction, coronary insufficiency, angina, cerebrovascular accidents, revascularization, peripheral artery disease, and heart failure." After the search terms yielded results, literature was selected according to its pertinence to the current review's research question. In addition, both articles that cited, and were cited by, the resulting studies on Google Scholar were considered for inclusion in the review.

Chronic Perceived Psychosocial Stress

The first step in the Tawakol model of cardiovascular disease is the presence of chronic psychosocial stress. Racial discrimination experienced on a daily basis is a clear chronic stressor with long-term health effects (Ahmed et al., 2007; Ong et al., 2009). Both stress-related biological markers and perceived social stress have been linked with self-reported experiences of racial discrimination (Cuevas et al., 2019; Han et al., 2020; Ong et al., 2017; Spence et al., 2016;

Yang & Chen, 2018). Everyday repeated experiences of racial discrimination precede and contribute to a chronic stress state, as indicated by research demonstrating higher levels of PTSD and increased, disproportionate risk of disease in those exposed to racism (Bale & Jovanovic, 2021; Harnett, 2020).

Many Black Americans experience anticipatory stress, or racism-related vigilance, in their day to day lives; in preparing to deal with potential experiences of racial discrimination before any of these events actually occur, Black Americans are even more likely to experience chronic stress (Hicken et al., 2013). In a study by Vines and colleagues (2006) using the Telephone-Administered Perceived Racism Scale, over 400 Black women reported that experiences of racism are extremely common in their everyday lives. Over two-thirds of the women had personally experienced racism in everyday experiences, like being followed when shopping, and over 90% agreed that Black people in general experienced this chronic stressor frequently (Vines et al., 2006).

Furthermore, one researcher studied the relationship between perceived racism and chronic stress emotions, finding that racism was a stressor frequently experienced by African Americans and was associated with chronic stress (Peters, 2006). In addition, in their review paper, Berger and Sarnyai (2015) reported that the effects of racial discrimination on health are mediated by elevated cortisol levels and dysregulation of the HPA axis involved in the stress response. They discussed the similarities between racial discrimination and chronic social stress, as both stressors activate the anterior cingulate cortex and can impair prefrontal cortex functioning (Berger & Sarnyai, 2015). As such, racial discrimination should be studied as a cause of chronic perceived psychosocial stress, which leads to detrimental biological outcomes like cardiovascular disease.

Amygdala Reactivity

According to the Tawakol et al. (2017) model, heightened amygdala reactivity results from repeated activation of the stress response. This elevated activity of the amygdala is also key in the next steps of the pathway, preceding arterial inflammation, bone marrow activity, and cardiovascular events. Tawakol and colleagues (2017) found that participants with higher resting amygdala activity were more likely to develop cardiovascular disease sooner than those with lower resting amygdala activity. Therefore, if the literature shows that racial discrimination is also associated with higher resting amygdala activity and generally greater reactivity, this continues to support its function as a stressor in the steps in the Tawakol pathway.

Clark, Miller, and Hegde (2018) studied this exact question of the effect of racial discrimination on amygdala activity. They found that participants with greater exposure to racial discrimination showed greater levels of spontaneous, resting amygdala activity. The researchers found this activity specifically in the left amygdala, which is, in part, responsible for processing negative stimuli (Beraha et al., 2012; Wager et al., 2003). In addition, their results showed an association between spontaneous amygdala activity and discrimination that was independent of other symptoms of stress, depression, and anxiety. This finding underscores the idea that discrimination affects the amygdala independently of other stressors. Though discrimination is often accompanied by other symptoms, like stress and depression, it still affects amygdala activity in a different, distinguishable way.

Though Clark and colleagues (2018) are the only researchers who have studied the specific relationship between experiences of racial discrimination and resting amygdala activity, many other researchers have studied changes in the amygdala due to social stressors. Some studies have demonstrated that individuals with high levels of stress, especially in stress

disorders, have higher levels of spontaneous amygdala activity (Yan et al., 2013). As discrimination is known to cause chronic stress and high perceived stress levels, (Ahmed et al., 2007; Vines et al., 2006), this provides an explanation for the finding of Clark and colleagues (2018). Furthermore, research has found that social exclusion functions as a clear psychological stressor, and that people who have experienced acts of social exclusion often exhibit greater amygdala reactivity (Carter, 2007; Eisenberger et al., 2003, 2007; Krill & Platek, 2009). In addition, subtle acts of discrimination, as opposed to overt ones, often elicit greater or equal physiological responses; researchers have posed the explanation that ambiguity of more subtle acts of discrimination contributes to greater stress and therefore physiological responses (Carter, 2007; Jones et al., 2016). Consistent with this, research has shown that the amygdala processes ambiguity, which may lead to its greater reactivity in those who experience continued subtle acts of discrimination, like microaggressions (de Gelder et al., 2014).

Additionally, a 2020 study found that children belonging to racial and ethnic minorities (in this case, Black and Latino families) had smaller amygdala volumes than their non-marginalized counterparts (Assari, 2020). The study found that socioeconomic status (SES) mediates this effect of race and ethnicity on amygdala volume, and proposed that one mechanism explaining these results is the everyday discrimination faced by Black and Latino families (Assari, 2020). Another study also found an association between the adverse social stressor of poverty and changes in the functional connectivity of the amygdala (Barch et al., 2016). Though it is beyond the scope of this paper to examine poverty and SES in detail, as related to discrimination, it does appear that these two factors may contribute to the chronic stress and resulting changes in the amygdala associated with racial discrimination.

Arterial Inflammation and Bone Marrow Activity

According to the Tawakol model, the next step in the pathway after amygdala hyperreactivity is arterial inflammation and bone marrow activity. Interestingly, increased bone marrow activity and arterial inflammation are both mediators of the association between amygdala activity and cardiovascular disease (Tawakol et al., 2017). In addition, bone marrow activity is a mediator in the relationship between amygdala activity and arterial inflammation, and the pathway from amygdala activity to inflammation, without increased bone marrow activity, was still significant in analyses conducted by Tawakol and colleagues (2017). Therefore, any research demonstrating at least a link between racial discrimination and arterial inflammation, if not increased bone marrow activity as well, would support the Tawakol model.

There is only one study that has examined both arterial inflammation and bone marrow activity in relation to racial discrimination (Powell-Wiley et al., 2021). This research recruited participants from a community-based cohort in Washington D.C., working with mostly underserved urban neighborhoods with African-American populations. Researchers measured neural (amygdala) and physiological (arterial inflammation, hematopoietic tissue) activity in these individuals, who had likely experienced chronic stress due to lack of resources and adverse social conditions. Results showed that amygdala activity and arterial inflammation were significantly greater in the cohort than in controls, and that bone marrow activity did mediate the relationship between amygdala activity and arterial inflammation (Powell-Wiley et al., 2021). These results are directly in line with what the Tawakol model proposes.

Furthermore, two recent studies reported significant relationships between chronic racial discrimination and chronic inflammation in African American women. In order to elucidate the mechanisms that link discrimination and inflammation, one study examined the coping

mechanisms and cognitive stress appraisals regularly used by African American women in anticipation of, and in response to, racial discrimination (Nuru-Jeter et al., 2018). This research found that, in a group of women who regularly experienced the stress of anticipatory racism threat, results showed a correlation between discrimination and high levels of pro-inflammatory biomarkers. Another study, also focusing on Black American women, found moderate relationships between repeated experiences of discrimination and the presence of arterial plaque; in addition, the researchers found significant relationships between repeated racial discrimination and coronary artery calcification (Black et al., 2015; Lewis et al., 2006).

Lastly, many studies have demonstrated various ways in which racial discrimination leads to inflammation. Research has suggested that that self-reported experiences of racial discrimination are correlated with inflammation, as measured by C-reactive protein (CRP), which is an indicator of low-grade inflammation (Cunningham et al., 2012). In addition, perceived discrimination is associated with increased inflammatory responses to acute stressors (Saban et al., 2018). Certain physiological systems are activated by negative appraisal of situations, leading to inflammatory responses, such as capillary dilation and increased blood flow (Cuevas et al., 2020). Though these responses are healthy when they occur occasionally in response to stressors, there can be lasting harm to the body when inflammation becomes chronic. In situations like repeated exposure to discrimination, negative appraisal occurs frequently, starting a cycle of physiological and inflammatory responses that lead to negative physical and mental health outcomes (Cuevas et al., 2020).

The implications of greater risk of inflammation are far-reaching, as this health concern has made conditions like COVID-19 far more dangerous for minority populations, especially Black Americans (Ajilore & Thames, 2020). In addition, research has shown that educational

attainment has less protective effects on inflammation levels in African Americans than in White Americans (Fuller-Rowell et al., 2015). This is especially significant because a common claim in society that a good socioeconomic standing can result from a better educational background, and that a better lifestyle, including good health, can result from higher SES. However, the negative health effects, like inflammation, caused by racial discrimination are still largely a problem even when protective factors are present.

Overall, this research provides abundant support for the link between chronic discrimination and inflammation. Though only one study has examined the role of bone marrow activity in the health consequences of discrimination, the results of that research did support Tawakol's proposed function of bone marrow as a mediator of amygdala activity and arterial inflammation. The study of racial discrimination within the Tawakol model is supported by the demonstrated link between heightened amygdala activity and both inflammation and bone marrow activity, as well as the link between discrimination and chronic inflammation.

Cardiovascular Disease

The last step in the Tawakol model is the final biological outcome of cardiovascular disease (CVD). There is a wealth of research documenting the connections between racial discrimination and cardiovascular disease, though many studies have not suggested the explicit pathway through which this link occurs. Support for the other previous steps of the Tawakol model, taken in conjunction with evidence linking discrimination and CVD, provides one potential pathway through which this association may occur.

Firstly, it is known that repeated activation of the human stress response, including the sympathetic nervous system and HPA axis, leads to increased risk of cardiovascular disease (Dimsdale, 2008), and that Black Americans are at an increased risk of developing and dying

from this condition relative to other Americans (Cooper, 2001; Ferdinand & Nasser, 2017; Van Dyke et al., 2018). This is likely due in part to the fact that self-reported experiences of discrimination and perceived discrimination have both been correlated with higher risk of cardiovascular disease (Lewis et al., 2014). Indeed, a systematic review of the literature from 1984 to 2017 on discrimination and cardiovascular disease found that 86% of the included studies demonstrated a significant relationship between stigma or discrimination and risk/health indicators of CVD (Panza et al., 2019).

This greater risk of cardiovascular disease has been studied in part by measuring cardiovascular reactivity, usually measured by diastolic blood pressure, in response to racial discrimination. One study found that exposure to racist stimuli increases cardiovascular reactivity in both Black and White Americans (Fang & Myers, 2001). However, most research studying this measure has shown significant differences in cardiovascular activity between Black and White Americans. Two studies both found that African American women, as compared to White/European American women, exhibited higher cardiovascular reactivity in response to racial stressors (Guyll et al., 2001; Lepore et al., 2006). In one of the studies, women spoke about the scenario of an accusation of shoplifting, a racial stressor, and Black women showed significantly higher cardiovascular reactivity; this is a risk factor for cardiovascular disease, linking the stress of perceived racism to later potential development of CVD (Lepore et al., 2006). The other study found that African American women had higher cardiovascular reactivity in response to subtle mistreatment than European American women, especially when that mistreatment was perceived as linked to racial discrimination (Guyll et al., 2001). Another study on cardiovascular reactivity also found higher blood pressure scores in Black men in response to more ambiguous events (Merritt et al., 2006). This heightened cardiovascular response being

linked to subtle acts of discrimination is reminiscent of the research concerning the amygdala's greater reactivity to subtle, more ambiguous discrimination as well.

In addition to the studies on cardiovascular reactivity, research discusses other ways that racial discrimination might be linked to cardiovascular disease. Some researchers have proposed that internalizing negative racist beliefs about Black people can be very harmful on health of Black individuals. One research team found that both reported experiences of racial discrimination and internalized negative racial attitudes were positively associated with cardiovascular disease history (Chae et al., 2010). In addition, another study proposed three levels at which racism can affect cardiovascular health risk: institutional racism, perceived racism, and internalized racism (Calvin et al., 2003). The first, institutional racism, deals more with barriers to healthcare, but the latter two have been especially linked to physical, cardiovascular health consequences of racism (Calvin et al., 2003; Chae et al., 2010). Furthermore, some research proposed using the CVD indicators of depression, anxiety, and body mass index (BMI), and found that higher levels of racial discrimination experienced by college students of color were associated with greater CVD health risk factors (Serpas et al., 2020). It has also been demonstrated that the association between racial discrimination and cardiovascular disease is, in part, moderated by a history of a mood disorder, like depression (Chae et al., 2012).

Regardless of the ways the literature has studied the relationship between racial discrimination and cardiovascular disease, it has repeatedly found a positive association between the two. There is a clear relationship between the first and the last step in the Tawakol model: a psychosocial stressor, racial discrimination, eventually leads to cardiovascular disease. There may be more than one way in which this relationship ultimately occurs, but the steps of the

Tawakol model are certainly a feasible way to study the biological outcome of cardiovascular disease resulting from racial discrimination.

Conclusions

In summary, the use of the Tawakol model of cardiovascular disease in studying racism is supported by literature on the biological effects of racial discrimination as a psychosocial stressor. This review paper found evidence for each step of the Tawakol pathway, demonstrating that racial discrimination is a clear psychosocial stressor that affects amygdala reactivity, impacts arterial inflammation and bone marrow activity, and ultimately leads to cardiovascular disease. The Tawakol model itself is supported by other literature, which has further studied and discussed the pathway from amygdala to inflammation and bone marrow activity to CVD (Dar et al., 2019; Goyal Aditya et al., 2020). Ultimately, this model is an effective way to study how repeated experiences of racial discrimination lead to cardiovascular disease.

As racism has always been, and still is, pervasive in the United States, it is imperative to study its damaging effects. Especially in light of recent incidents of violence and discrimination against people of color (POC), it is absolutely necessary that research elucidates how these experiences affect and cause health problems. We know that numerous health issues disproportionately affect POC, and this fact is inextricably linked to the racism that these individuals experience on a daily basis. The model of racial discrimination and cardiovascular disease proposed in this paper is only one of numerous possibilities, and future research should seek to further study biological outcomes of racism and their origins. More research on these outcomes resulting from racial discrimination can lead to better opportunities for intervention and treatment that target the root of health disparities.

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