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## A Review of Disparities in Cardiac Rehabilitation: Evidence, Drivers and Solutions

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### Abstract

**Purpose:** Cardiac rehabilitation (CR) has been shown to improve functional status, quality of life, and recurrent cardiovascular disease (CVD) events. Despite its demonstrated compelling benefits and guideline recommendation, CR is underutilized, and there are significant disparities in CR utilization particularly by race, ethnicity, sex, and socioeconomic status. The purpose of this review is to summarize the evidence and drivers of these disparities and recommend potential solutions.

**Methods:** In this review, key studies documenting disparities in CR referrals, enrollment, and completion are discussed. Additionally, potential mechanisms for these disparities are summarized and strategies are reviewed for addressing them.

**Summary:** There is a wealth of literature demonstrating disparities among racial and ethnic minorities, women, those with lower income and education attainment, and those living in rural and dense urban areas. However, there was minimal focus on how the social determinants of health contribute to the observed disparities in CR utilization in many of the studies reviewed. Interventions such as automatic referrals, inpatient liaisons, mitigation of economic barriers, novel delivery mechanisms, community partnerships, and health equity metrics to incentivize healthcare organizations to reduce care disparities are potential solutions.

This review confirms disparities in CR among patients who might benefit the most from CR by reduction in recurrent CVD events and improved survival which are driven by negative social determinants of health. Innovative strategies to overcome barriers to CR participation in special populations are necessary for successfully closing these healthcare gaps.

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## Condensed Abstract:

This review describes disparities in utilization of cardiac rehabilitation (CR) by race and ethnicity, sex, and geography. Further, the intersection of social determinants of health on observed disparities based on individual characteristics are described. Despite the proven benefits of CR, significant disparities in patient referrals, enrollment, and completion remain. Relevant literature documenting these disparities, their potential mechanisms, and means for disparity reduction are discussed.

## Keywords

health disparities; race; sex; socioeconomic status; region; cardiac rehabilitation

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Cardiovascular disease (CVD) is the greatest cause of morbidity and mortality in the United States (US) and worldwide.<sup>1</sup> Individuals with incident CVD events are at high risk of recurrent events, rehospitalization, and death.<sup>2</sup> Secondary prevention strategies including pharmacotherapies, aggressive risk-factor control, and lifestyle modification have all been shown to reduce the risk of subsequent adverse CVD outcomes.<sup>1</sup>

Cardiac rehabilitation (CR), an effective secondary prevention strategy for patients who have experienced a CVD event, is highly underutilized.<sup>3-7</sup> Research has shown that CR reduces mortality and recurrent CVD events by up to 26%, and 47%, respectively<sup>3</sup> and is also associated with improved functional status and quality of life. American College of Cardiology/American Heart Association clinical guidelines recommend CR for patients after acute myocardial infarction (MI), coronary artery bypass graft surgery (CABG), percutaneous coronary intervention (PCI), heart valve surgery, chronic stable angina, chronic heart failure with reduced ejection fraction, and heart/lung transplantation. Medicare and most commercial health insurers reimburse CR services for patients with a qualifying indication. Out of nearly 2.1 million patients with CVD events eligible for CR annually, national estimates of CR participation range from 20–30%.<sup>8-10</sup> More recently, low utilization has been exacerbated by lack of access and reduced capacity for center-based CR due to the coronavirus disease 2019 (COVID-19) pandemic.<sup>11</sup> Previous work has documented specific disparities in CR utilization based on individual characteristics of race, ethnicity, sex, and socioeconomic status (SES).<sup>12</sup> A review in 2011 by Valencia et al. described widespread disparities to CR participation by race, ethnicity, SES, and rurality.<sup>12</sup> The purpose of this review is to update the literature since 2011 with select key literature, and to provide insights of the significant role that the social determinants of health (SDOH) contribute to observed disparities in CR utilization based on individual characteristics and region. Lastly, we provide relevant recommendations to address these pervasive disparities.

## REVIEW OF RELEVANT LITERATURE

Participation in CR reflects *referral*, defined as a physician order, a discussion with the patient, and the receipt of the referral by a CR program.<sup>10</sup> An abundance of data show that disparities in CR participation stem, in part, from low referral rates by healthcare providers. Participation in 1 CR session is defined as *enrollment*, while attending the

standard program of either 32 – 36 sessions over a 3 mo period is considered *completion* in the majority of CR programs.<sup>10,13</sup> This review provides insight on the importance of considering the SDOH in enhancing CR participation, particularly for under-resourced racial and ethnic minority groups. The SDOH are defined by the U.S. Department of Health and Human Services as “conditions in the environments in which people are born, live, learn, work, play, and worship” that affect health outcomes.<sup>14</sup> Negative SDOH include limited access to educational opportunities, employment, and health care as well as food and housing insecurity.<sup>15</sup>

## DISPARITIES IN CARDIAC REHABILITATION BY RACE AND ETHNICITY

Physician referral is one of the most important predictors of subsequent CR enrollment.<sup>16</sup> Studies examining differences in referral rates mainly come from nationwide quality improvement registries or single center studies thus limiting their generalizability to real world clinical practice. However, findings from these studies have illuminated disparities in referral rates by race and ethnicity.

In a retrospective analysis of 50,000 patients, from 551 hospitals across the US with MI between 2003 and 2009 from hospitals enrolled in the *Get With The Guidelines Registry*, referral rates at hospital discharge were significantly lower for racial and ethnic minorities.<sup>17</sup> African Americans, Hispanics, Asians, and other minorities were 20, 36, 50, and 22% less likely to be referred to CR, respectively, than White patients.<sup>17</sup> The major strength of this study was its provision of population-based, national-level data with rigorous ascertainment of CR referral order pattern. The study limitations included a lack of more recent data, low proportion of racial and ethnic minorities (82% White), and residual confounding (patient-centered factors such as lack of access to CR). In addition, the voluntary and quality improvement nature of the patient registry may not be reflective of routine clinical practice and diverse CVD patients. Lastly, while the investigators adjusted for demographics, clinical characteristics, hospital characteristics and patients’ insurance status, there was limited information on other SDOH to account for the demonstrated racial/ethnicity gaps in CR referrals.

Similarly, the *Get with the Guidelines Registry* from the *National Cardiovascular Data Registry (NCDR) Acute Coronary Treatment and Intervention Outcomes Network – ACTION Registry* from 2007 and 2012, showed that overall CR referrals improved from 72.9% in 2007 to 80.7% by 2012, but that African Americans and Hispanics had significantly lower odds of referral to CR (OR=0.75: 95% CI, 0.65–0.87; OR=0.64: 95% CI, 0.52–0.79, respectively).<sup>18</sup> Nonetheless, there were several limitations of this study including that it encompassed data from a voluntary quality improvement registry of hospitals providing CR referral data, thus it may not be representative of low-resourced hospitals. As such, the investigators acknowledged that their findings may overestimate CR referral rates. Also, the analyses did not specifically account for patient-level SDOH that could have influenced the observed racial disparities.

These findings were consistent with another large study of 1.5 million consecutive patients who underwent PCI between 2009 and 2012, across 1,310 US hospitals enrolled in the *NCDR Cath-PCI Registry*. Referral rates were 59% after PCI and no significant differences

by race were found. However, when restricting the analyses to patients on Medicare, African Americans were significantly less likely to be referred to CR compared to their White counterparts (OR=0.94: 95% CI, 0.896–0.995).<sup>19</sup> Similar to the previous registry studies, there was limited focus on the SDOH.

While all of these studies have consistently shown disparities in rates of referrals by race, when viewed as a conglomerate, they all have similar limitations. Although published within the last 10 yr, the data analyzed within the studies are in general > 10 yr old and may not be reflective of current clinical practice in the digital age of electronic health records, and increased use of automated electronic CR referrals. In addition, the study's participants were relatively homogenous (>80% White) and lack patient diversity with relatively low proportions of racial and ethnic minority groups. Additionally, the majority of the data analyses in these studies compare non-Hispanic White to non-White racial and ethnic minority groups, which may reflect a broader issue of structural racism.<sup>20</sup> As outlined by a recent American Heart Association Scientific Statement, proper use of US Census-delineated race and ethnicity classifications is preferred as a best practice for publishing disparities research. The exclusion of diverse racial and ethnic populations may not be intentional, but may be a result of lack of diversity in cardiovascular clinical trials and medical research.<sup>21,22</sup> More studies are needed on referral practices specifically for Native Americans, Hispanics, and Asians. Lastly data on the SDOH (e.g., income, education attainment, neighborhood characteristics) were not adjusted for in these studies, thus the role and magnitude of influence that individual characteristics or the SDOH play as drivers of these observed disparities in referrals remains unknown.

Disparities also manifest in lower enrollment and completion rates among racial and ethnic minorities. A cross-sectional examination of 260,000 Medicare beneficiaries with acute MI or CABG showed that White patients were 33% more likely to participate in 1 CR session compared to racial and ethnic minority patients.<sup>8</sup> Two decades later not much progress had been made in CR participation as demonstrated by a follow-up study by Ritchey et al. which showed similar findings.<sup>9</sup> Among nearly 360,000 Medicare beneficiaries hospitalized for a CVD event with a CR indication, African American, Hispanic, and Asian patients were 30, 37, and 20% less likely to enroll in CR compared to Whites. Both of these studies, and others,<sup>23,24</sup> confirmed low participation rates among largely racial and ethnic minority Medicare beneficiaries.

Single center studies have demonstrated consistent findings. Among > 800 patients cared for at an academic medical center in New York serving a predominantly Hispanic patient population, Whites were more likely to enroll in CR compared to racial and ethnic minority groups (OR=1.78: 95% CI, 1.13–2.80).<sup>25</sup> Similarly, Whites were 60% more likely to complete CR.<sup>25</sup> While data is limited for Native Americans, it has been reported that CR programs in US Native American communities are virtually non-existent.<sup>26</sup>

## **DISPARITIES IN CARDIAC REHABILITATION BY SEX AND GENDER**

Significant disparities by sex and gender also exist in CR referrals, as shown in numerous studies. Women with ischemic heart disease eligible for CR are less likely to have a written referral and receive instructions on CR compared to men. A recent meta-analysis of 19

observation studies examining differences in referral rates by sex among over 240,000 participants found that women were 32% less likely to be referred to CR compared to men despite similar eligibility.<sup>27</sup> Registry data have shown consistent findings. In the *Get With The Guidelines Registry*, women were less likely to be referred to CR (adjusted OR=0.88: 95% CI, 0.85 – 0.92) despite adjustment for age, demographic and other clinical characteristics.<sup>17</sup> Similarly, in a claims registry in Michigan, women discharged after hospitalization for PCI for symptomatic CHD were less likely to be referred to CR after adjustment for age and other demographics (adjusted OR=0.94: 95% CI, 0.92 – 0.96).<sup>28</sup>

One of the largest known cohorts examining sex and gender disparities in CR is within the APPROACH (Alberta Provincial Project for Outcomes Assessment in Coronary Heart Disease) database of 36,264 consecutive patients (24.6% women) undergoing coronary angiography for symptomatic CAD.<sup>29</sup> The study found that women had 25% lower odds of being referred to CR. The women in the cohort were older, with more CVD risk factors and comorbid conditions, but these associations persisted despite adjustment for age and clinical characteristics. In terms of outcomes, women who were referred and attended CR had a survival benefit compared to those who were not referred. While Canada has a universal healthcare system which limits generalizability to other health systems, this study provides substantial evidence pointing to the existence of sex and gender-related referral bias.

After referral, the majority of studies show that women, particularly racial and ethnic minority women, enroll and complete CR at lower rates than men. Data from two recent meta-analyses confirm these findings. Sun et al. included 21 studies (n = 349,058) examining factors associated with CR participation and found that women were 41% less likely to enroll in CR.<sup>30</sup> A meta-analysis by Samayoa et al. of 26 studies (n = 297,719), found that women were 36% less likely to enroll in CR compared to men.<sup>31</sup> In the APPROACH database, compared to men who were referred, women who were referred were less likely to attend or complete CR.<sup>29</sup> Additionally, US population-based estimates of sex disparities in CR participation among Medicare beneficiaries have remained relatively unchanged for the past 20 yr.<sup>8,9</sup> Older data suggests that racial and ethnic minority women in particular have lower adherence and completion rates in CR despite the known mortality benefits and are more likely to withdraw from CR due to work conflicts.<sup>29,32</sup> On the other hand, other studies show similar enrollment rates among men and women once referred.<sup>33</sup> Despite such compelling data, limitations of these studies are the lack of exploration of sociodemographic characteristics such as insurance type, education attainment, and employment status that could potentially explain the observed disparities by sex and gender.

## **DISPARITIES IN CARDIAC REHABILITATION BY SOCIOECONOMIC STATUS**

Socioeconomic status as measured by several individual (e.g., income, education attainment, occupation, medical assistance such as Medicaid) and environmental indicators (e.g., area deprivation index or median income based on zip code data) has been shown to have a significant impact on CVD development and outcomes.<sup>34</sup> Individuals with low SES and CVD face a disproportionately higher risk of recurrent events and mortality compared to those with high SES.<sup>35</sup>

However, data shows that patients with low SES are less likely to be referred to CR. Among the 1.5 million patients in the NCDR *Cath-PCI Registry*, those on Medicaid had a significantly lower likelihood of being referred to CR compared to those with private insurance (OR=0.979; 95% CI, 0.960 – 0.998).<sup>19</sup> Among nearly 1,800 patients with symptomatic CHD with an indication for CR discharged from 11 hospitals in Ontario, Canada, patients with low SES were significantly less likely to be referred to or enrolled in CR.<sup>36</sup>

Enrollment in CR and completion rates are also low among patients with low SES.<sup>37</sup> In 1997, < 6% of dual eligible Medicare and Medicaid beneficiaries (as a surrogate to classify low SES patients) enrolled in CR, compared to > 20% who were on Medicare only.<sup>8</sup> Significant differences remained in a 2016 examination of Medicare claims; dual eligible Medicare/Medicaid beneficiaries still enrolled in CR at lower rates compared to those on Medicare only (OR=0.65; 95% CI, 0.59 – 0.71).<sup>9</sup> In their analysis of CR use among Medicare beneficiaries, Suaya et al. made notable efforts to include a variety of socioeconomic variables such as zip code characteristics of patient's residence including degree of urbanization, income, proportion of the population at or below the poverty level, and proportion with college education.<sup>8</sup> They found that patients residing in zip codes with the highest levels of urbanization and poverty were 36 and 17% less likely to use CR than those living in the most rural or least impoverished areas, respectively ( $P<.001$ ). Ritchey and colleagues also acknowledged the importance of financial barriers on CR participation rates citing transportation, employment and issues with supplemental issues—all high-risk factors also of consideration in racial and ethnic minority groups.<sup>9</sup>

Income is also correlated with CR enrollment and completion in multiple studies.<sup>38</sup> In the *Southern Community Cohort Study*, among > 4,000 participants with symptomatic CHD as an indication for CR, individuals with a higher household income (>\$25,000) were 68% more likely to initiate CR than individuals making < \$15,000.<sup>39</sup> Education level has also consistently been a strong predictor of CR enrollment; those with less than high school education are less likely to enroll and complete CR compared to those with college education or greater.<sup>30,38</sup> The effect of education persists despite controlling for income.<sup>38</sup> In one study, state-by-state variation in CR enrollment was correlated with state-by-state variation in high school graduation rates.<sup>38</sup> Area-level factors also influenced enrollment and completion; those living in the most deprived neighborhoods were less likely to enroll in CR compared to those in the least deprived neighborhoods.<sup>8,39</sup>

## **GEOGRAPHIC DISPARITIES IN ACCESS TO CARDIAC REHABILITATION**

There is a dearth of more recent research examining disparities in CR utilization by geography. However, older studies still provide important insight into existing disparities by region.

Distance to the CR center, particularly in rural areas, is a significant barrier to referral, enrollment, and completion.<sup>40</sup> For example, Curnier et al. compared population density based on the 2000 census and active, certified CR programs in the US.<sup>41</sup> They found significant variations in CR availability by geography; northeastern states had 1 program/428 square mi compared to < 1 program/2,689 square mi in the northwestern states.

Compared to patients with MI or CABG living < 1.5 mi of a CR center, those living 3, 15, and > 15 mi from a CR center were 7, 42, and 71% less likely to enroll in CR, respectively.<sup>8</sup> Furthermore, southern states had participation rates of 6 – 13%, while north-central states had participation rates as high as 24 – 42%.<sup>38</sup> Among 1.5 million patients with PCI in the NCDR database, those living in midwestern states had 7.3 higher odds of referral to CR compared to those in southern states.<sup>19</sup>

Even if rural patients are referred and enroll, they are less likely to complete CR. One study examined 1,800 patients with an indication for CR discharged from 11 hospitals in Ontario, Canada between 2006 and 2008.<sup>36</sup> Patients from rural areas who reported driving > 30 min to a CR center had similar proportions of referrals, enrollment, and participation compared to urban patients; however, they were less likely to complete CR.<sup>36</sup> Among 254 rural patients with symptomatic CHD who were referred to CR, 28% participated in >1 session, but only 17% of those completed a full CR course, with distance from the center reported as the greatest barrier to completion.<sup>42</sup> Richet et al. found interesting geographic variation in CR use in the US, with the Southeast and Appalachia US regions having the lowest participation but highest completion and the Midwest having the highest participation but lowest completion.<sup>9</sup>

Regions with high population density also have impediments to CR.<sup>41</sup> For example, in cities like New York, there is only 1 program/728,000 residents.<sup>41</sup> This is in contrast to Nebraska, which has 1 program/23,000 residents. Urban hospitals serving racial and ethnic minority patients may not always have a CR center affiliated with them, and physicians are less likely to refer to other facilities for fear of losing their patient base.<sup>37</sup> The *Get with the Guidelines Registry* confirmed these regional differences due to population density; compared to those in the northeast, midwestern states had a higher likelihood of referral to CR (adjusted OR=2.51; 95% CI, 1.38 – 4.58).<sup>17</sup>

## DISCUSSION

This review provides a contemporary summary of peer-reviewed literature documenting the existing, and persistent disparities in utilization of CR by race/ethnicity, sex, SES, and geography. Although limited in quantity, the studies included in this review provide support for the necessity of more intentional efforts to reduce these disparities. This will require a more nuanced understanding of the underlying mechanisms by which these disparities occur, including the overarching influence of the SDOH on their propagation. In this discussion, we will examine research describing potential sources of these disparities including implicit bias, discrimination, and structural barriers at the institutional and health system levels.

**Mechanisms for racial and ethnic disparities in CR**—Several mechanisms are hypothesized to exacerbate disparities in CR utilization among racial and ethnic minority groups. The intersectionality of individual and community level SES and race/ethnicity may play a role in observed disparities as these groups are more likely to carry a high burden of negative SDOH leading to their low engagement with CR. Scarcity of CR centers in rural areas and in urban hospital systems that serve predominantly minority patients also significantly influence racial and ethnic disparities in referral and enrollment.<sup>37</sup> This is

supported by an investigation by Aragam et al. showing that disparities in CR referrals were pronounced in hospitals that cared for predominantly minority patients.<sup>28</sup>

Healthcare provider factors may also drive these disparities. One mechanism is through differences in referrals for CVD-related procedures such as PCI or CABG. Data shows that compared to Whites with symptomatic CHD, African Americans are less likely to be referred for PCI or CABG.<sup>43,44</sup> Compared to patients who have medically managed CHD, those who undergo procedures (e.g., CABG or PCI) are more likely to be referred to CR thus exacerbating racial disparities in CR.<sup>9</sup> Patients' insurance status may also pose a challenge for CR referrals and enrollment. Racial and ethnic minorities in the US are more likely to have Medicaid or be uninsured compared to Whites, which may contribute to lower referrals and enrollment.<sup>45,46</sup> Patients on Medicaid or medical assistance are less likely to be referred to CR compared to patients on commercial insurance plans.<sup>19</sup> Additionally, while patients on Medicaid have no associated CR copays, lower-tier insurance plans may have inadequate coverage for CR or prohibitive copays, resulting in lower enrollment rates.<sup>37,45</sup> Lack of healthcare provider awareness of CR, skepticism about its benefits, lack of access to CR facilities, and misconceptions on eligibility and reimbursements may play a role in lower referrals, particularly from safety net hospitals that serve predominantly minority patients.<sup>37</sup>

Additionally, implicit bias has been suggested as a reason why racial and ethnic minorities may be less likely to be referred to CR.<sup>47</sup> Physicians caring for racial and ethnic minorities are less likely to encourage them to participate in CR or actually refer to them CR.<sup>37</sup> In one study examining provider perspectives towards CR, clinicians held the belief that African Americans and other minorities had negative attitudes toward exercise that would result in their lower participation and adherence to CR.<sup>37</sup>

The most significant barriers to CR enrollment described by African American patients were lack of insurance, constraints by insurance coverage on participation, and prohibitive out-of-pocket costs such as copays, and transportation difficulties.<sup>37</sup> Self-perceived discrimination, dissatisfaction with the doctor-patient relationship, and trustworthiness of the health system have also been proposed as factors that lower participation rates.<sup>12</sup> Among non-English speaking minorities, language barriers play a role in lower referrals and enrollment. In one study in Canada, prior to interpreter services being universally offered, patients who required interpreter services were less likely to be referred to CR compared to their counterparts.<sup>48</sup> Language barriers adversely impact all phases CR utilization including referral, enrollment, and completion.<sup>49</sup>

Structural racism is increasingly recognized as an underlying cause of health-related disparities in the US. While there is data on disparities in CVD risk factors, control, and outcomes, the impact of structural racism on CVD and CR access in particular are not well understood and are worthy of in-depth, future investigation.<sup>50</sup>

**Mechanisms for sex and gender disparities in CR**—Literature suggests that multiple factors related to sex and gender impact CR participation. Barriers to participation may occur at the healthcare provider level manifesting as lower referral rates.<sup>29</sup> Data suggests that physicians discuss and endorse CR with men more often than women. There



are a few hypothesized reasons for the lower referral rates. One, in general women may be older with more comorbidities at the time of their CVD event, and physicians may adjust referral patterns based on patient comorbidity burden (i.e. less likely to refer their older and sicker patients).<sup>29,51</sup> However, many studies show differences persist despite adjustment for age. Another reason is implicit bias among healthcare providers that women may benefit less from CR or be less likely to attend than men.<sup>52</sup> Also, psychosocial factors such as social support and anxiety may play a larger role in enrollment among women compared to men.<sup>51</sup> Gender-related factors including those in which women may face more competing responsibilities related to work or home, or feel guilty about enrolling in CR due to their responsibilities can lead to low CR participation.<sup>52</sup> Further, women may face more financial barriers related to enrollment or attendance in CR.<sup>52</sup>

**Mechanisms for socioeconomic disparities in CR**—Existing literature has documented multiple barriers to accessing health services such as CR for patients with low SES in urban areas.<sup>53</sup> These barriers in access are predominantly related to adverse SDOH such as cost,<sup>36</sup> transportation,<sup>36</sup> inadequate facilities,<sup>37</sup> interpersonal barriers such as mistrust,<sup>37</sup> time constraints,<sup>54,55</sup> lack of awareness or social supports to seek care,<sup>37</sup> and systemic barriers such as physician perceptions (lower health literacy, lower likelihood of complying with medical advice) and fewer referrals.<sup>37,56</sup> The COVID-19 pandemic has drastically reduced in-person health services utilization thus has significantly impacted use of center-based CR. Many CR programs substituted telemedicine-based services such as home-based, virtual CR. However, significant disparities by SES have been documented in the use of telehealth during the pandemic.<sup>57–58</sup> In addition, the pandemic has had a devastating impact on patients of lower SES, particularly racial and ethnic minorities, further widening healthcare inequities.<sup>59–61</sup>

## APPLICATION TO PRACTICE: POTENTIAL SOLUTIONS

There is an abundance of literature on practical strategies to address known barriers, improve CR referral and enrollment, thus addressing disparities in CR participation (Figure 1).<sup>10</sup>

**Referral strategies**—Referrals, which include both the order and a discussion with the patient, are a significant factor in CR utilization. One evidence-based strategy to improve physician referrals is to create automatic referrals to CR via electronic health records at the time of hospital discharge.<sup>10</sup> These can be issued for specific qualifying diagnoses and thus capture the majority of patients with an indication. Grace and colleagues found that automatic referrals of eligible patients to CR in Canada through electronic health records led to a three-fold increase in CR referrals and doubled enrollment rates compared to usual care.<sup>62</sup> In addition, systematic referrals were also shown to increase equitable access and enrollment rates among socioeconomically disadvantaged patients with CVD including those with obesity and functional status limitations from Ontario hospitals.<sup>63</sup> While the US healthcare system differs from its Canadian counterpart, due to lack of single payer insurance, there is evidence to suggest that automatic referrals could increase CR enrollment by systematizing referrals and reducing biases.<sup>10,64</sup>

Staff liaisons who can meet with patients prior to discharge to discuss CR and help them navigate the referral process has also been shown to boost referrals.<sup>62</sup> Grace et al. showed that the combination of automatic referrals and patient liaisons significantly increased CR referrals and enrollment compared to usual care (OR=4.45; 95% CI, 1.98 – 10.00).<sup>62</sup> Culturally sensitive liaisons who share some characteristics with the patients such as belonging to a peer group<sup>65</sup> or community health workers may be a way to reduce disparities by assisting with healthcare navigation after hospital discharge.<sup>66</sup> These liaisons can also provide encouragement toward CR participation and help to identify and target barriers to enrollment which is particularly important for under-represented patient groups with a high burden of adverse SDOH.

Many patients face significant barriers from copays, out-of-pocket, and transportation costs. Elimination of these costs, or assistance with navigation of these barriers,<sup>67</sup> and financial incentives,<sup>68</sup> could help improve CR enrollment.<sup>10</sup>

**Improving access through alternative CR delivery models**—One significant cause of disparities is difficulty accessing CR due to logistical difficulties and this has been more pronounced during the COVID-19 public health crisis.<sup>11,37</sup> Alternatives to center-based CR through digital platforms have been shown to achieve similar improvements in CVD outcomes.<sup>69</sup> These primarily home-based modalities have the potential to expand CR to more eligible patients who may have limitations to participating in center-based CR.<sup>70–73</sup> In addition, the use of text messaging and mobile applications to engage with patients and track participation has been shown to improve outcomes in CR and may complement home-based CR.<sup>74</sup>

Home-based CR programs can be an alternative to making it accessible to patients.<sup>69</sup> Historically, one of the challenges of home-based CR is lack of reimbursement. However, the COVID-19 pandemic has resulted in CR center closures and reductions in CR capacity, which has resulted in CMS approving reimbursement for home-based CR during the public health emergency and a rapid expansion of mobile platforms to support home based CR.<sup>75</sup> However, for racial and ethnic minorities, patients with lower SES and patients in rural areas, access to the Internet, devices and tele-health services may be more challenging.<sup>57,76</sup> Efforts at equitable access to technology and innovative home-based CR models that include all the key CR components are needed.<sup>58,77–79</sup>

**Community partnerships**—Partnerships with trusted community organizations such as churches or community recreation centers (e.g., YMCA) have the potential to increase enrollment by enhancing trust, cultural sensitivity, and access.<sup>80,81</sup> In addition, developing program content with community member input that is culturally and linguistically tailored to patients' needs could potentially increase adherence to CR among socially and economically disadvantaged populations.<sup>10</sup> Community-based participatory research strategies to design culturally relevant, lifestyle interventions through academic-community partnerships have demonstrated positive outcomes on cardiovascular health outcomes in African Americans.<sup>82</sup> These approaches could be translated to the development of more patient-centric CR programs within the context of SDOH to combat racial and ethnic disparities in CR.

**Healthcare Delivery**—Promoting diversity in CR staff could be another potential way of improving health equity in CR. Research has shown that racial and ethnic concordance between patients and providers results in higher rates of health-service utilization, patient satisfaction, and adherence to treatment.<sup>83</sup> The American Association of Cardiac and Pulmonary Rehabilitation (AACVPR) surveyed its members in 2010 and found that among nearly 1,000 respondents, only 1% were African American.<sup>84</sup> Improving patient-provider relationships by increasing diversity among CR health professionals, may lead more trust, patient satisfaction, and to higher participation in CR.<sup>12</sup> Cultural competence in health care also contributes to better patient-provider relationships, increased patient satisfaction and higher quality of care.<sup>85</sup> Therefore, integration of health equity, cultural competence and implicit bias training among CR professionals, may result in higher enrollment and completion rates, particularly among racial and ethnic minorities.<sup>12,85–86</sup>

Efforts are underway to measure the impact that hospitals and health systems have on community health by serving their surrounding disadvantaged communities using health equity metrics.<sup>87</sup> Potentially including high-quality CR as a health equity metric to ensure that hospitals are accountable for offering evidence-based preventive services such as CR to their communities in both urban and rural areas, may be another step in achieving equity in CR.<sup>87</sup> As aforementioned integration of electronic health records for systematic referrals and longitudinal surveillance of CR demographics (i.e., proportion of women, racial and ethnic minority groups, etc.) should also be included within CR health equity metrics. In addition, the required and enhanced ascertainment and documentation of the SDOH in electronic health records, could assist in addressing barriers to CR participation, care coordination lapses, patient-clinician shared decision making, and resource allocation to underserved patients—all key in achieving equity in CR.<sup>88</sup>

## SUMMARY

Each year, nearly 2.1 million individuals have a cardiac event making them eligible for CR, however, < 30% of them participate.<sup>10</sup> This translates to an enormous volume of missed opportunities in health benefits, especially among special patient population groups.<sup>9</sup> Cardiac rehabilitation is underutilized by racial and ethnic minorities, women, and individuals with low SES. Additionally, disparities in CR exist in both rural and dense urban areas. Rigorous, population-based data on longitudinal utilization patterns among all eligible patients, with more precise information on race, ethnicity, and SES are lacking. Furthermore, while many factors contribute to these observed disparities, the SDOH undergird and exacerbate inequities in CR access and participation. More up-to-date data are needed in this regard, especially in the devastating aftermath of COVID-19 on vulnerable populations and with the increased adoption of telemedicine.<sup>11</sup> Future research and efforts should focus on understanding the etiology of CR disparities, development of authentic community partnerships and increasing workforce diversity. Finally, standardization and longitudinal surveillance of quality metrics of health equity for CR access, referrals and enrollment to track progress in eliminating disparities in CR are essential.<sup>87</sup>

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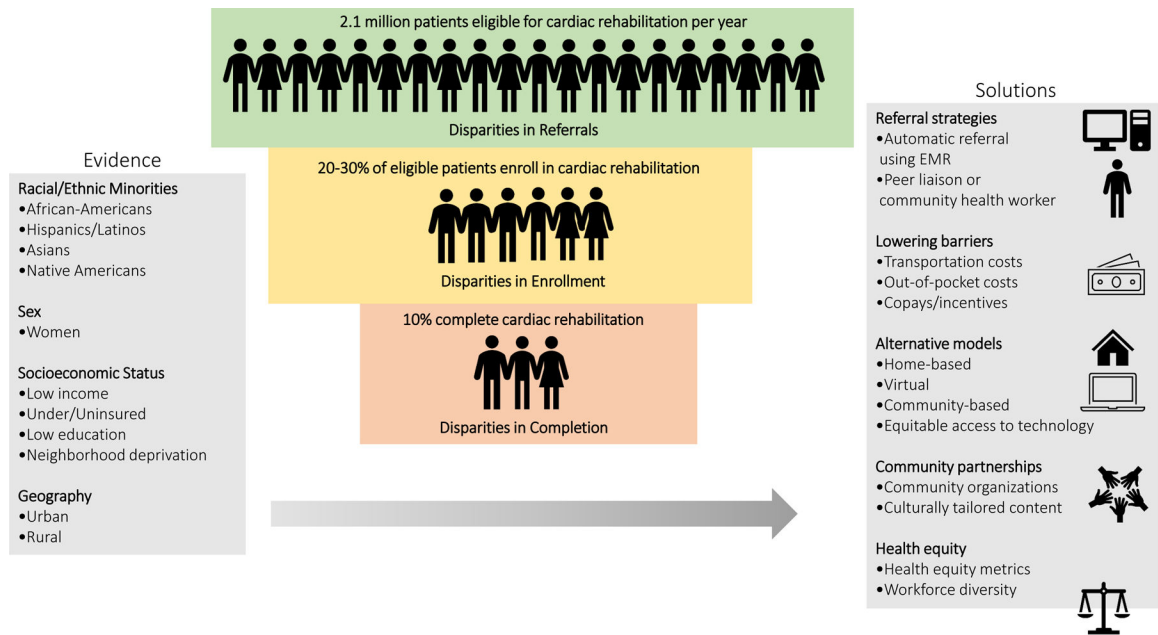
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**Figure 1.**  
Disparities in Cardiac Rehabilitation.