Barriers to Cardiac Rehabilitation Participation Faced by Patients of Lower Socioeconomic Status

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Purpose: Individuals with lower socioeconomic status (SES) are less likely to engage in cardiac rehabilitation (CR) following a major cardiac event. Identifying barriers to attending CR is crucial for facilitating recovery for this vulnerable population.
Methods: Data are from a randomized controlled trial on improving CR attendance for individuals with lower SES (N = 192; 35% female). Of these, 103 (40% female) were randomly assigned to a case management arm and included in the present analysis. Participants were recruited at or shortly after hospitalization for a CR-qualifying cardiac event and were asked about 1) their primary post-discharge concern (Concerns Assessment) and 2) eight potential barriers to CR attendance/secondary prevention (Barriers Assessment; medical, transportation, employment, financial, housing, psychosocial, childcare, legal). Concerns were sorted into these categories, and the frequency of each was calculated and ranked.
Results: Sixty-eight participants (66%) completed the Concerns Assessment, and 96 (93%) completed the Barriers Assessment. Health-related issues were the most common primary post-hospitalization concern (57%), followed by no concerns (16%). Financial (70%), employment (48%), and transportation (47%) issues were the three most cited barriers.
Conclusions: Participants most often rated their health as their primary concern at hospitalization, but non-medical needs were more often reported as barriers. The obstacles commonly identified in the present study are often not addressed during hospital admission. Hospitalization is a critical time for emergent treatment and is where support for on-going care should begin. Addressing these barriers before discharge is an important step toward improving secondary prevention.

Key Words: barriers • cardiac rehabilitation • low socioeconomic status • secondary prevention

KEY PERSPECTIVE

What is novel?

- This study was a broad assessment of post-event concerns and barriers to recovery in cardiac patients with lower socioeconomic status.
- Concrete concerns about and barriers to recovery faced by cardiac patients with lower socioeconomic status were identified.

What are the clinical and/or research implications?

- Patients were most frequently concerned about their health prior to hospital discharge.
- Financial, employment, and transportation problems were the most common barriers to post-hospitalization recovery and cardiac rehabilitation attendance.
- Identification of these frequent concerns and barriers will inform the development of future precise, targeted interventions designed to improve recovery and attendance at cardiac rehabilitation.

Cardiac rehabilitation (CR) is a structured secondary prevention program that serves as the standard of care for cardiovascular disease. Through supervised and progressively escalating exercise, psychosocial assessment, and lifestyle management education,[1] lifestyle changes—primarily increased exercise and the reduction of cardiovascular disease risk factors—are encouraged to mitigate the risk of future major cardiac events and hospital readmissions. The myriad benefits of CR have been widely documented. Attendance in CR reduces cardiovascular mortality, all-cause mortality, and hospital readmission.[2-8] Therefore, CR is a Class 1a recommendation from the American Heart Association and American College of Cardiology.[1,4,9]

Despite these benefits, rates of referral to, enrollment in, and completion of CR remain unacceptably low.[10-19] Assessments of CR engagement have revealed demographic features that predict lower rates of attendance. Less education, higher levels of anxiety or depression, lower quality of life, greater distance to CR programs, lower socioeconomic status (SES), belonging to racial or ethnic minority groups, and lack of physician referral all have predicted lack of CR attendance.[14,20-28]

Conversely, specific obstacles that individuals face *because* of these demographic features have received considerably less attention. As these are the discrete barriers that must be surmounted to attend CR, their identification is of paramount importance. Obstacles have been identified for some demographic characteristics (ie, less access to transportation for individuals in more rural areas[21,27] or

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All authors have read and approved the manuscript and meet the 4 ICMJE criteria for authorship. Brian R. Katz and Diann E. Gaalema's present affiliation is the University of Texas Medical Branch.

Dr. Ades substantially contributed to the conception and design of this work, was involved in the analysis and interpretation of the data, and critically revised earlier drafts of the manuscript, but he unfortunately passed away before submission of the final, completed manuscript.

All authors declare no conflicts of interest.

All authors have read and approved the submission of the manuscript.

Sources of support: Work on this product was supported by NHLBI award R33HL143305 and NIGMS award P20GM103644.

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DOI: 10.1097/HCR.0000000000000967

lack of physician recommendation to CR for non-White patients[23]). However, those faced by individuals of lower SES, who are at increased risk for cardiovascular disease[29,30] and are less likely to enroll in and attend CR,[27,31,32] have not been sufficiently explored. Identification of discrete obstacles to CR among members of this high-risk population is necessary.

To devise interventions that could address and eliminate obstacles impeding CR adherence among patients with lower SES, potential barriers must be identified. The purpose of the present study was to identify the concerns and specific barriers to recovery and CR reported by individuals of lower SES.

METHODS

PARTICIPANTS

Data for the current analyses were collected as part of a randomized controlled trial, approved by the University of Vermont Institutional Review Board, to assess various methods (contingent financial incentives, case management, or both) of improving attendance at CR among individuals with lower SES (clinicaltrials.gov NCT03759873). The detailed methods of the trial and main outcomes are reported elsewhere.[33,34] Briefly, patients (n = 192) with a CR-qualifying event (ie, myocardial infarction, coronary revascularization, valve replacement surgery, or stable heart failure with a reduced ejection fraction) from one of the three hospitals in Vermont (University of Vermont Medical Center, Copley Hospital, or Northwestern Medical Center) were recruited. For this trial, lower SES was defined as enrollment in Medicaid, actively receiving other state benefits based on financial need, or not having finished high school. Additionally, all patients were at least 18 years old; spoke English; did not have a diagnosis of dementia, cancer, severe lung disease, or another longevity-limiting disease that would preclude participation in CR; had not previously completed six or more sessions of CR within the past year; and lived within the defined catchment areas for one of the three medical centers without plans to leave the area within the next 12 months.

Inpatient cardiology and cardiothoracic surgery records and outpatient cardiology clinic schedules were reviewed daily to identify potential participants with a CR-qualifying event. Study staff approached these patients to introduce the study and assess eligibility. Patients interested in the study signed an informed consent form and were randomly assigned to one of the four intervention conditions: usual care (n = 36), financial incentives contingent on attendance at CR (n = 53), case management (CM; n = 51), or financial incentives plus case management (n = 52). Only data from participants assigned to either case management condition (n = 103/192) are included in the present analysis.

PROCEDURE

Participants in both the CM and financial incentives plus case management groups were contacted at two distinct time points prior to enrollment in CR to complete the two assessments described below.

Concerns Assessment

The first assessment was completed in person as part of the first meeting between the participant and their assigned CM, which typically occurred in the hospital. For participants discharged prior to the arrival of the CM or consented in the outpatient setting, however, it occurred in conjunction with an outpatient visit to a cardiac clinic. After listening to an overview of the CM program, participants were asked to identify what they were most concerned about following discharge from the hospital. The major points of these verbal responses were summarized and recorded by the CM.

Barriers Assessment

The second assessment was completed by phone following discharge from the hospital but prior to enrollment in CR. With each participant, the CM specifically reviewed eight domains of potential barriers to attendance at CR and more general recovery: medical, transportation, employment, financial, housing, psychosocial, childcare, and legal (see Table 1 for examples of each barrier). The CM addressed each domain individually before progressing to the next. For each barrier, participants were asked if they could think of any obstacles they might encounter over the next few months that might interfere with attending CR or engaging in recovery more generally. If a participant identified a domain as an obstacle, they were asked to elaborate on their specific circumstances that would interfere with recovery. Participant yes/no answers for each domain were recorded and, for barriers for which the answer was "yes," the CM recorded notes summarizing and explaining the patient's circumstances. The same set of circumstances could be used to explain multiple barriers (ie, unemployment could explain both employment and financial barriers). Participants could report barriers outside these prompts, which also were summarized and categorized.

DATA ANALYSIS

Responses to the Concerns Assessment were reviewed and assigned to categories in accordance with the barriers

Table 1

Examples for Each Barrier to Cardiac Rehabilitation Attendance

Barrier	Examples
Medical	Impending surgery will interfere with taking time for secondary prevention
	Pre-existing conditions (chronic pain, poor eyesight, use of walker, etc.) make exercise challenging
Transportation	No driver's license or access to car
	Reliant on friends, family, public transit, or subsidized transportation
Employment	Currently unemployed and occupied with looking for work
	Cannot get time off work to attend CR
Financial	Reliant on disability and/or social security for income
	Requires food assistance programs (ie, 3SquaresVT, Meals on Wheels VT)
Housing	Homeless or unstable housing with no permanent residence
	Lives in Section 8 Housing
Psychosocial	History of anxiety/depression
	Social isolation with little contact with friends/family
Childcare	Needs to take care of children and cannot spare time for CR
	Picking up children from school/daycare interferes with CR
Legal	Legal disputes that interfere with taking time for secondary prevention

Abbreviation: CR, cardiac rehabilitation.

inquired about in the Barriers Assessment. Two authors (BK and BY) independently read through each response on the Concerns Assessment and sorted them into the most appropriate corresponding barrier category. Subsequently, both authors identified whether medical primary concerns were or were not directly related to the participant's study-qualifying cardiac event. Afterwards, the authors met to compare their decisions. Of the 68 completed Concerns Assessments, there was initial disagreement concerning categorization of 11 (16%) primary concerns. Additionally, there was disagreement regarding whether 10 (26%) medical concerns were related to study-qualifying cardiac events. These disagreements were discussed by the two authors with input from the principal investigator until a final consensus was reached.

Answers to the Barriers Assessment were also reviewed post hoc. The same two authors read the explanations recorded for each reported barrier and independently identified if, at the time the assessment had been conducted, help from the CM with addressing the indicated barrier had been requested. Afterwards, the authors compared their decisions. Out of the 282 reported barriers across the 96 participants who completed the Barriers Assessment, there was initial disagreement concerning 24 responses (9%) from 22 distinct participants. These disagreements were discussed by the two authors with input from the principal investigator until a final consensus was reached.

RESULTS

Demographic characteristics of the 103 participants are shown in Table 2. Participants were on average 57.9 ± 11.8 years old, 40% female, and 89% non-Hispanic White. Most participants qualified for the study because they were enrolled in Medicaid, but slightly less than 5% qualified because they had not finished high school.

CONCERNS ASSESSMENT

Sixty-eight participants (66%) completed the Concerns Assessment. Not all Concerns Assessments could be completed due to various reasons—generally that the patient was discharged prior to arrival by the CM, restrictions due to coronavirus disease-2019, or that the consent occurred in an outpatient setting. Results from the assessment are shown in Figure 1. Health-related issues were the most frequent primary concern cited in hospital (39 participants; 57%). Of these 39 participants, 33 (85%) expressed concerns directly related to their CR-qualifying cardiac event. Eleven participants (16%) reported no concerns at all, the second-most common response to the Concerns Assessment. Selection of the remaining options as a primary post-hospitalization concern was minimal; each was endorsed by 5 or fewer participants. No systematic sex-related differences in primary concerns were observed.

BARRIERS ASSESSMENT

The Barriers Assessment was completed by 96 (93%) participants. Eighty-seven participants (91% of those who completed the assessment) reported at least one barrier to secondary prevention/CR participation, and a total of 282 distinct barriers were reported. Results from the assessment are shown in Figure 2. Financial obstacles were the most common barrier and impacted over two thirds of participants (N = 67; 70%). Barriers related to employment, transportation, and health were cited by slightly less than half of the participants who completed the assessment (N = 46, 45, and 43 participants; 48%, 47%, and 45%, respectively). Approximately one third of participants were impacted by psychosocial barriers (N = 34; 35%), and slightly less than one quarter encountered housing barriers (N = 22; 23%). Childcare (N = 13; 14%) and legal (N = 12; 13%) were the least common barriers reported. No systematic sex-related differences in reported barriers were observed.

Table 2

Demographic Features of Patients with Lower Socioeconomic Status Reporting Barriers to Cardiac Rehabilitation Participation (N = 103)[a]

Age, yr	57.9 ± 11.8
Female sex	41 (40%)
Race/ethnicity	
Non-Hispanic White	95 (89%)
Black or African American	5 (5%)
American Indian	2 (2%)
Other or >1 race	4 (4%)
Education	
Less than high school	19 (19%)
High school or G.E.D.	42 (41%)
Some college	16 (16%)
2-yr associate's degree	6 (6%)
4-yr degree or advanced degree	20 (19%)
Lower-SES qualification	
Medicaid	98 (95%)
Other	5 (5%)
Qualifying event	
Myocardial infarction	47 (46%)
PCI/stent	58 (56%)
Coronary artery bypass graft	13 (13%)
Valve repair/replacement	13 (13%)
Chronic heart failure	20 (19%)
Coronary artery disease	33 (32%)
Stable angina	2 (2%)
Smoking prior to hospitalization	44 (43%)
Number of cigarettes smoked/day	16.2 ± 11.9

Abbreviations: G.E.D., General Education Development; PCI, percutaneous coronary intervention; SES, socioeconomic status.
[a]Data are presented as mean ± SD or n (%).

Initial requests for CM assistance with a given barrier are shown in Figure 3. Requests for assistance upon completion of the Barriers Assessment were low. Slightly over half of the participants who reported a barrier to CR participation made requests for assistance (N = 49; 56%). Overall, across the entire sample, assistance was requested for less than one fourth of the total number of barriers reported (N = 66; 23%). Participants were most likely to request assistance from their CM in addressing transportation barriers. Of the 45 who reported transportation-related obstacles, 18 (40%) requested aid from their CM immediately during the completion of the Barriers Assessment. Legal and financial barriers were the next most common, with roughly one third of participants who endorsed these barriers requesting assistance. Requests for assistance with housing (27%), employment (17%), childcare (15%), psychosocial (12%), and medical (5%) barriers were less frequent.

DISCUSSION

During an initial interview conducted prior to hospital discharge, most participants with lower SES indicated that they

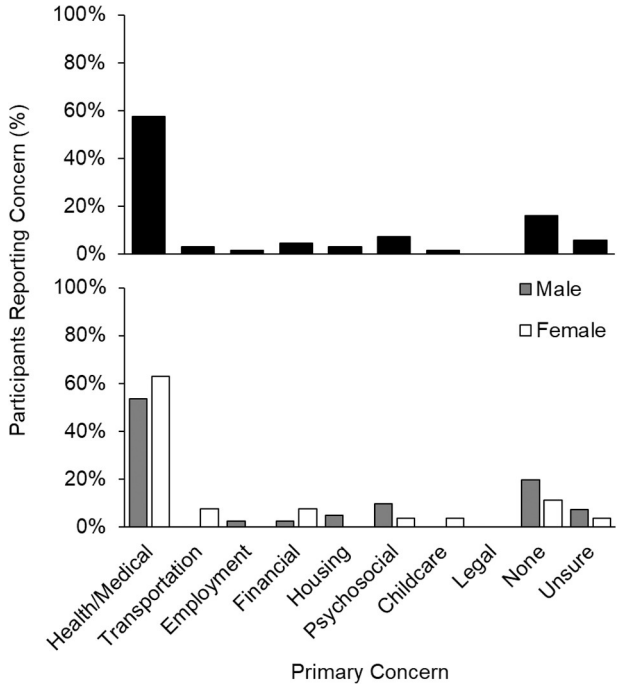

Figure 1. Percentage of participants with lower socioeconomic status reporting surveyed concerns about cardiac rehabilitation attendance. Data in the upper panel reflect the overall percentage of participants who indicated each barrier as their primary concern. Data in the lower panel reflect the percentage of men and women who indicated each barrier as their primary concern.

were primarily concerned about their health, and most often about aspects of heart health specifically. After hospital discharge, reported barriers were diverse, with all eight domains endorsed by at least some participants. However, health-related barriers to recovery were only the fourth most common obstacle. Financial, employment, and transportation barriers were all more commonly indicated as obstacles. Of the barriers surveyed, participants were most likely to request CM aid for transportation, legal, and financial barriers.

The present study is one of few that isolates discrete types of barriers faced by individuals with lower SES, one of the vulnerable populations most at risk for cardiovascular disease and poor CR attendance.[27,29,30,32] Unsurprisingly, given the population studied, financial barriers were reported most often. Although not as commonly reported, employment and transportation-related concerns—both of which are highly tied to finances—were also frequently endorsed. These findings echo those previously reported in an assessment of discrete barriers faced by patients from rural areas and with lower SES, specifically.[27] However, one notable difference between present and past results is that Shanmugasegaram et al.[27] used the Cardiac Rehabilitation Barriers Scale they had previously psychometrically validated,[35] which also included questions regarding participant attitudes and feelings about CR or exercise that could discourage them for attending (ie, "many people with heart problems don't go to CR and they are fine" or "I prefer to take care of my health alone"). As many participants in that study indicated that these sorts of feelings and impressions had discouraged them from attending CR, future assessments of barriers to secondary prevention should survey them alongside more concrete obstacles.

The frequency with which patients in the present study identified health-related issues as their primary post-hospitalization concern is not surprising. As noted in the results, most participants who reported health-related primary concerns went on to describe issues directly related to the cardiac event for which they had been hospitalized. Given the acute, sudden, and often novel nature of this condition, it stands to reason that it would serve as a salient source of anxiety. This is further supported by the extensive set of lifestyle changes—including new medications, dietary changes, increased exercise, and smoking cessation—that may be recommended following a major cardiac event. The need to make many of these demanding lifestyle changes simultaneously may be overwhelming and increase the odds of reporting health-related issues as a primary concern.

Although health-related issues were the most common post-discharge concern reported in hospital, they were only the fourth most common barrier to recovery reported following discharge. The rise in importance of non-health-related obstacles following discharge suggests that patients may only fully come to appreciate the extent to which they are influenced by certain barriers to secondary prevention when they have been released from the hospital and can see firsthand how their cardiac event is now impacting their daily lives.

The three most common barriers—financial, employment, and transportation—reflect the needs of the population recruited for the present study. Given that exclusively individuals with lower SES were recruited, it stands to reason that concerns regarding money itself—or over earning or spending it (ie, employment or transportation, respectively)—would serve as pronounced barriers to attending CR. Interventions designed to address these barriers, consequently, are a priority. Financial incentives contingent on CR attendance have been shown to increase completion of the program,[34,36] and the elimination of cost sharing and copays has been encouraged to improve attendance.[37,38] Additionally, telehealth CR has been proposed as a more flexible alternative program that is no less effective than traditional facility-based CR[39-41] and has been shown to reduce the risk of non-completion even among individuals of lower SES.[42] As sessions are completed remotely, traditional constraints and barriers associated with facility-based CR are not a concern, and participants are afforded markedly more flexibility with respect to their schedules. Transportation to and from the clinic does not need to be organized, and associated costs (ie, gas, additional vehicular wear and tear, or cab fares) do not need to be paid. Furthermore, the absence of transportation time to and from the clinic means that CR sessions may be easier to fit into the day, and less time may need to be taken off work.

The assistance of a CM for patients is another potential strategy for improving secondary prevention. Prior assessments have shown that access to a CM can lead to improved health outcomes and reductions in mortality following hospital discharge.[43-45] A CM may also be able to assist patients by addressing potential barriers and could begin this process even before discharge to help bridge the gap from a hospital to a treadmill. For example, a CM could organize subsidized transportation at no cost to the participant (transportation and financial barriers), put participants in contact with social service providers for other issues they are dealing with (ie, legal disputes, unemployment, childcare needs, or lack of stable housing) that might interfere with regular CR attendance (employment, financial barriers, childcare, legal, and housing barriers), collaborate with the health care team (medical and psychosocial barriers), and review patient symptoms and answer questions about their health (medical barriers). Despite these many potential benefits, initial CM usage in the present study was low. Only 49 participants,

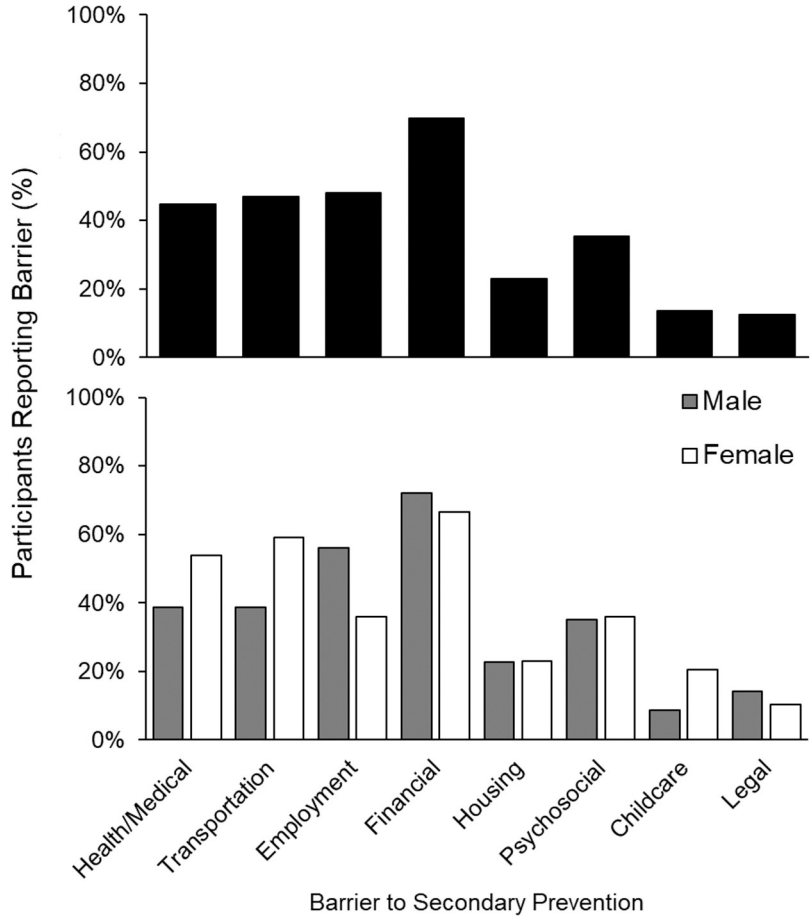

Figure 2. Percentage of participants with lower socioeconomic status reporting surveyed barriers to cardiac rehabilitation attendance. Data in the upper panel reflect the overall percentage of participants who reported each barrier to CR attendance. Data in the lower panel reflect the percentage of men and women who indicated each barrier.

slightly over half of the 87 who reported at least one barrier, requested at least some form of assistance during the needs assessment. This may be because CM use was measured early on—before patients were able to fully gauge the extent to which their lives had been impacted by their cardiac event and the amount of assistance they required. Additionally, an

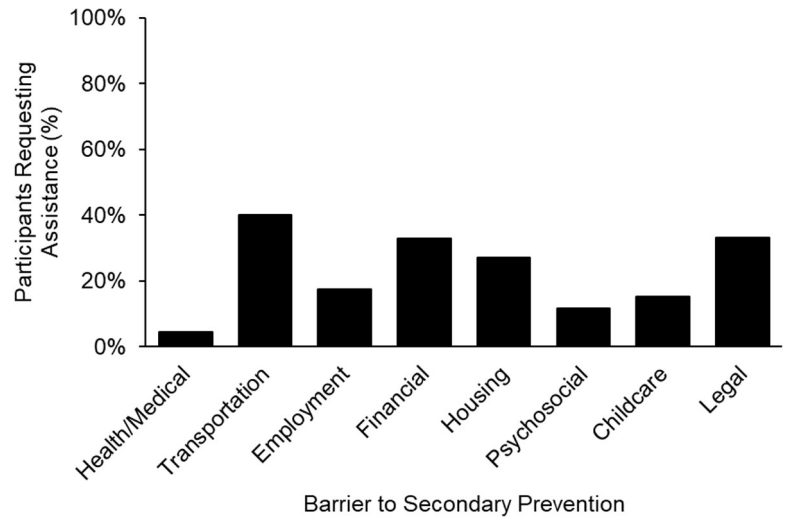

Figure 3. Percentage of participants with lower socioeconomic status requesting assistance with reported barriers to cardiac rehabilitation attendance. Bars represent the percentage of participants who requested assistance with a barrier (calculated by dividing by the number of participants who reported a given barrier, not the total number of participants).

ongoing CM-patient relationship might be necessary before the patient is comfortable requesting assistance.

The present study has several strengths. One is the wide range of potential barriers and obstacles to CR attendance that were surveyed. Although these barriers are not unique to individuals with lower SES, they may act as larger obstacles given these patients' financial situations. A second strength is the explicit focus on barriers to attendance faced by individuals with lower SES. Third, results from the Barriers Assessment were immediately integrated into patient care as part of the parent trial. Many prior explorations of barriers to CR attendance have assessed obstacles either by interviewing CR staff about trends observed in their patient populations[46-48] or by administering surveys to patients after they finished the program.[27,35,46,49,50] In the present study, conversely, the Barriers Assessment was completed earlier—prior to enrollment in CR. This allowed for the assessment to serve as not only a diagnostic tool for identifying impediments to CR attendance but as an opportunity for the patient and CM to begin devising ways to overcome these obstacles before they occurred. This in turn allowed for preventative measures (ie, organizing subsidized transportation, providing contact information for social service providers, or answering questions about health concerns) to be taken as early as immediately after the completion of the Barriers Assessment.

There are limitations of the present study that must also be mentioned. First, only two measures were used to assess SES, and members of other vulnerable populations with low rates of CR attendance were not explicitly recruited. Second, the sample was predominantly non-Hispanic White patients due to the racial and ethnic makeup of Vermont. Third, direct quotes from participants regarding concerns and barriers were not transcribed. Finally, the administered Barriers Assessment was not comprehensive and likely did not fully probe all potential obstacles to CR attendance. Future explorations of barriers to CR attendance should assess patient thoughts and attitudes regarding CR, concrete external barriers, and include an open-ended question for participants to express any other thoughts, concerns, or barriers.

CONCLUSIONS

Given that CR adherence is exceptionally poor among individuals with lower SES, identification of barriers impeding attendance is imperative to improve access to treatment. Participants in the present study reported a wide range of obstacles to CR attendance, many of which could be handled with the assistance of a dedicated CM. As evidenced by the present study, this process can begin as early as in the hospital. Hospitalization is a critical time for treatment and can be where lifestyle and behavioral change to support secondary prevention begin. Identifying and addressing potential barriers before discharge is an important step toward improving CR attendance and recovery more generally.

REFERENCES

1. Ades PA. Cardiac rehabilitation and secondary prevention of coronary heart disease. *N Engl J Med*. 2001;345(12):892-902. doi:10.1056/nejmra001529.
2. Ades PA, Keteyian SJ, Balady GJ, et al. Cardiac rehabilitation exercise and self care for chronic heart failure. *JACC Heart Fail*. 2013;1(60):540-547. doi:10.1016/j.jchf.2013.09.002.
3. Heran BS, Chen JMH, Ebrahim S., et al. Exercise-based cardiac rehabilitation for coronary heart disease. *Cochrane Database Syst Rev*. 2011;7:CD001800. doi:10.1002/14651858.cd001800.pub2.
4. Lawler PR, Filion KB, Eisenberg MJ. Efficacy of exercise-based cardiac rehabilitation post-myocardial infarction: a systematic review and meta-analysis of randomized controlled trials. *Am Heart J*. 2011;162(4):571-584e2. doi:10.1016/j.ahj.2011.07.017.
5. Martin BJ, Arena R, Haykowsky M, et al. Cardiovascular fitness and mortality after contemporary cardiac rehabilitation. *Mayo Clin Proc*. 2013;88(5):455-463. doi:10.1016/j.mayocp.2013.02.013.
6. Suaya JA, Stason WB, Ades PA, Normand S-LT, Shepard DS. Cardiac rehabilitation and survival in older coronary patients. *J Am Coll Cardiol*. 2009;54(1):25-33. doi:10.1016/j.jacc.2009.01.078.
7. Taylor RS, Brown A, Ebrahim S, et al. Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomized controlled trials. *Am J Med*. 2004;116(10):682-692. doi:10.1016/j.amjmed.2004.01.009.
8. Thygesen LC, Zinckernagel L, Dalal H, et al. Cardiac rehabilitation for patients with heart failure: association with readmission and mortality risk. *Eur Heart J Qual Care Clin Outcomes*. 2022;8(8):830-839. doi:10.1093/ehjqcco/qcab086.
9. Thomas RJ, Balady G, Banka G, et al. 2018 ACC/AHA clinical performance and quality measures for cardiac rehabilitation: a report of the American college of cardiology/American heart association task force on performance measures. *Circ Cardiovasc Qual Outcomes*. 2018;11(4):e000037. doi:10.1161/hcq.0000000000000037.
10. Beatty AL, Truong M, Schopfer DW, Shen H, Bachmann JM, Whooley MA. Geographic variation in cardiac rehabilitation participation in medicare and veterans affairs populations: opportunity for improvement. *Circulation*. 2018;137(18):1899-1908. doi:10.1161/circulationaha.117.029471.
11. Fang J, Ayala C, Luncheon C, Ritchey M, Loustalot F. Use of outpatient cardiac rehabilitation among heart attack survivors – 20 states and the district of columbia, 2013 and four states, 2015. *MMWR Morb Mortal Wkly Rep*. 2017;66(33):869-873. doi:10.15585/mmwr.mm6633a1.
12. Martin BJ, Hauer T, Arena R, et al. Cardiac rehabilitation attendance and outcomes in coronary artery disease patients. *Circulation*. 2012;126(6):677-687. doi:10.1161/circulationaha.111.066738.
13. Marzolini S, Brooks D, Oh PI. Sex differences in completion of a 12-month cardiac rehabilitation programme: an analysis of 5922 women and men. *Eur J Cardiovasc Prev Rehabil*. 2008;15(6):698-703. doi:10.1097/hjr.0b013e32830c1ce3.
14. McGrady A, McGinnis R, Badenhop D, Bentle M, Muhammad R. Effects of depression and anxiety on adherence to cardiac rehabilitation. *J Cardiopulm Rehabil Prev*. 2009;29(6):358-364. doi:10.1097/hcr.0b013e3181be7a8f.
15. Oberg EB, Fitzpatrick AL, Lafferty WE, LoGerfo JP. Secondary prevention of myocardial infarction with nonpharmacologic strategies in a medicaid cohort. *Prev Chronic Dis*. 2009;6(2):A52. https://pmc.ncbi.nlm.nih.gov/articles/PMC2687858/.
16. Ritchey MD, Maresh S, McNeely J, et al. Tracking cardiac rehabilitation participation and completion among medicare beneficiaries to inform the efforts of a national initiative. *Circ Cardiovasc Qual Outcomes*. 2020;13(1):e005902. doi:10.1161/circoutcomes.119.005902.
17. Samayoa L, Grace SL, Gravely S, Scott LB, Marzolini S, Colella TJF. Sex differences in cardiac rehabilitation enrollment: a meta-analysis. *Can J Cardiol*. 2014;30(7):793-800. doi:10.1016/j.cjca.2013.11.007.
18. Suaya JA, Shepard DS, Normand S-LT, Ades PA, Prottas J, Stason WB. Use of cardiac rehabilitation by medicare beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation*. 2007;116(15):1653-1662. doi:10.1161/circulationaha.107.701466.
19. Thomas RJ, Miller NH, Lamendola C, et al. National survey on gender differences in cardiac rehabilitation programs: patient characteristics and enrollment patterns. *J Cardiopulm Rehabil*. 1996;16(6):402-412. doi:10.1097/00008483-199611000-00010.
20. Ades PA, Khadanga S, Savage PD, Gaalema DE. Enhancing participation in cardiac rehabilitation: focus on underserved populations. *Prog Cardiovasc Dis*. 2022;70:102-110. doi:10.1016/j.pcad.2022.01.003.
21. De Angelis C, Bunker S, School A. Exploring the barriers and enablers to attendance at rural cardiac rehabilitation programs. *Aust J Rural Health*. 2008;16(3):137-142. doi:10.1111/j.1440-1584.2008.00963.x.
22. Fernandez RS, Salamonson Y, Griffiths R, Juergens C, Davidson P. Sociodemographic predictors and reasons for participation in an outpatient cardiac rehabilitation programme following percutaneous

coronary intervention. *Int J Nurs Pract*. 2008;14(3):237-242. doi:10.1111/j.1440-172x.2008.00685.x.
23. Mochari H, Lee JR, Kligfield P, Mosca L. Ethnic differences in barriers and referral to cardiac rehabilitation among women hospitalized with coronary heart disease. *Prev Cardiol*. 2006;9(1):8-13. doi:10.1111/j.1520-037x.2005.3703.x.
24. Nielsen KM, Faergeman O, Foldspang A, Larsen ML. Cardiac rehabilitation: health characteristics and socio-economic status among those who do not attend. *Eur J Public Health*. 2008;18(5):469-483. doi:10.1093/eurpub/ckn060.
25. Rose M, Timmons SM, Amerson R, Reimels E, Pruitt RH. Facilitators and barriers in cardiac rehabilitation participation: an integrative review. *JNP-J Nurse Pract*. 2011;7(5):399-408. doi:10.1016/j.nurpra.2011.02.003.
26. Sanderson BK, Shewchuk RM, Bittner V. Cardiac rehabilitation and women: what keeps them away? *J Cardiopulm Prev*. 2010;30(1):12-21. doi:10.1097/hcr.0b013e3181c85859.
27. Shanmugasegaram S, Oh P, Reid RD, McCumber T, Grace SL. Cardiac rehabilitation barriers by rurality and socioeconomic status: a Cross-sectional study. *Int J Equity Health*. 2013;12(1):72. doi:10.1186/1475-9276-12-72.
28. Yohannes AM, Yalfani A, Doherty P, Bundy C. Predictors of drop-out from an outpatient cardiac rehabilitation programme. *Clin Rehabil*. 2007;21(3):222-229. doi:10.1177/0269215506070771.
29. Alter DA, Chong A, Austin PC, et al. Socioeconomic status and mortality after acute myocardial infarction. *Ann Intern Med*. 2006;144(2):82-93. doi:10.7326/0003-4819-144-2-200601170-00005.
30. de Mestral C, Stringhini S. Socioeconomic status and cardiovascular disease: an update. *Curr Cardiol Rep*. 2017;19(11):115. doi:10.1007/s11886-017-0917-z.
31. Gaalema DE, Elliott RJ, Morford ZH, Higgins ST, Ades PA. Effect of socioeconomic status on propensity to change risk behaviors following myocardial infarction: implications for healthy lifestyle medicine. *Prog Cardiovasc Dis*. 2017;60(1):159-168. doi:10.1016/j.pcad.2017.01.001.
32. Svendsen ML, Gadager BB, Stapelfeldt CM, Ravn MB, Palner SM, Maribo T. To what extent is socioeconomic status associated with not taking up and dropout from cardiac rehabilitation: a population-based follow-up study. *BMJ Open*. 2022;12(6):e060924. doi:10.1136/bmjopen-2022-060924.
33. Yant B, Kromer L, Savage PD, Khadanga S, Ades PA, Gaalema DE. Financial incentives and case management to improve cardiac rehabilitation participation among patients with lower socio-economic status: rationale and protocol for a randomized controlled trial. *Contemp Clin Trials*. 2023;129:107174. doi:10.1016/j.cct.2023.107174.
34. Gaalema DE, Khadanga S, Savage PD, et al. Improving cardiac rehabilitation adherence in patients with lower socioeconomic status: a randomized clinical trial. *JAMA Intern Med*. 2024;184(9):1095-1104. doi:10.1001/jamainternmed.2024.3338.
35. Shanmugasegaram S, Gagliese L, Oh P, et al. Psychometric validation of the cardiac rehabilitation barriers scale. *Clin Rehabil*. 2012;26(2):152-164. doi:10.1177/0269215511410579.
36. Gaalema DE, Savage PD, Rengo JL, Cutler AY, Higgins ST, Ades PA. Financial incentives to promote cardiac rehabilitation participation and adherence among medicaid patients. *Prev Med*. 2016;92:47-50. doi:10.1016/j.ypmed.2015.11.032.
37. Farah M, Abdallah M, Szalai H. Association between patient cost sharing and cardiac rehabilitation adherence. *Mayo Clin Proc*. 2019;94(12):2390-2398. doi:10.1016/j.mayocp.2019.07.018.
38. Zhang L, Sobolev M, Piña IL, Prince DZ, Taub C. Predictors of cardiac rehabilitation initiation and adherence in a multiracial urban population. *J Cardiopulm Rehabil Prev*. 2017;37(1):30-38. doi:10.1097/hcr.0000000000000226.
39. Huang K, Liu W, Dingxiu H, et al. Telehealth interventions versus center-based cardiac rehabilitation of coronary artery disease: a systematic review and meta-analysis. *Eur J Prev Cardiol*. 2015;22(8):959-971. doi:10.1177/2047487314561168.
40. Rawstorn JC, Gant N, Direito A, Bechmann C, Maddison R. Telehealth exercise-based cardiac rehabilitation: a systematic review and meta-analysis. *Heart*. 2016;102(15):1183-1192. doi:10.1136/heartjnl-2015-308966.
41. Shi W, Green H, Sikhosana Q, Fernandez R. Effectiveness of telehealth cardiac rehabilitation programs on health outcomes of patients with coronary heart disease: an umbrella review. *J Cardiopulm Rehabil Prev*. 2024;44(1):15-25. doi:10.1097/hcr.0000000000000807.
42. Beleigoli A, Dafny HA, Pinero de Plaza MA, et al. Clinical effectiveness of cardiac rehabilitation and barriers to completion in patients of low socioeconomic status in rural areas: a mixed-methods study. *Clin Rehabil*. 2024;38(6):837-854. doi:10.1177/02692155241236998.
43. Berra K. Does nurse case management improve implementation of guidelines for cardiovascular disease risk reduction? *J Cardiovasc Nurs*. 2011;26(2):145-167. doi:10.1097/jcn.0b013e3181ec1337.
44. Ma J, Berra K, Haskell WL, et al. Case management to reduce risk of cardiovascular disease in a county health care system. *Arc Intern Med*. 2009;169(21):1988-1995. doi:10.1001/archinternmed.2009.381.
45. Rollman BL, Belnap BH, LeMenager MS, et al. Telephone-delivered collaborative care for treating post-CABG depression: a randomized controlled trial. *JAMA*. 2009;302(19):2095-2103. doi:10.1001/jama.2009.1670.
46. Sérvio TC, Britto RR, de Melo Ghisi GL, et al. Barriers to cardiac rehabilitation delivery in a low-resource setting from the perspective of healthcare administrators, rehabilitation providers, and cardiac patients. *BMC Health Serv Res*. 2019;19(1):615. doi:10.1186/s12913-019-4463-9.
47. Evenson KR, Fleury J. Barriers to outpatient cardiac rehabilitation participation and adherence. *J Cardiopulm Rehabil*. 2000;20(4):241-246. doi:10.1097/00008483-200007000-00005.
48. Tod AM, Lacey EA, McNeill F. 'I'm still waiting…': barriers to accessing cardiac rehabilitation services. *J Adv Nurs*. 2002;40(4):421-431. doi:10.1046/j.1365-2648.2002.02390.x.
49. Bakhshayeh S, Sarbaz M, Kimiafar K, Vakilian F, Eslami S. Barriers to participation in center-based cardiac rehabilitation programs and patients' attitude toward home-based cardiac rehabilitation programs. *Physiother Theory Pract*. 2021;37(1):158-168. doi:10.1080/09593985.2019.1620388.
50. Grace SL, Shanmugasegaram S, Gravely-Witte S, Brual J, Suskin N, Stewart DE. Barriers to cardiac rehabilitation: does age make a difference? *J Cardiopulm Rehabil Prev*. 2009;29(3):183-187. doi:10.1097/hcr.0b013e3181a3333c.