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ORIGINAL ARTICLE

Cardiac Rehabilitation Trends Among Commercially Insured Adults in the United States, 2017–2023

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BACKGROUND: Cardiac rehabilitation (CR) reduces morbidity and mortality among individuals with heart disease. Although the COVID-19 pandemic disrupted health services, its impact on CR participation remains poorly understood—especially among commercially insured populations, for whom CR utilization trends are poorly documented.

METHODS: This cross-sectional time series study of enrollees aged 18 to 64 years with ≥1 CR-qualifying event (acute myocardial infarction, coronary artery bypass graft, heart valve repair/replacement, percutaneous coronary intervention, or heart/heart-lung transplant) during 2017 to 2022, with follow-up through 2023, used MarketScan commercial claims data. Adjusted analyses used Poisson log-linear models with robust standard errors to examine trends in enrollment and completion (≥36 sessions), and generalized linear models with negative binomial distribution and log-link function to examine trends in days to enrollment and number of sessions.

RESULTS: The sample included 143 870 unique individuals aged 18 to 64 years with a CR-qualifying event. Of the sample, the mean age was 53.9 (SD, 8.1), and 70% were men. On average, from 2017 to 2023, enrollment was 24.2%, days to enrollment were 46.3 (SD, 51.4 days), the number of sessions was 13.9 (SD, 12.8), and completion was 9.6%. Compared with year 2017, 2020 was associated with a 12% lower prevalence of enrollment (adjusted prevalence ratio, 0.88 [95% CI, 0.85–0.90]), 6-day longer time to enrollment on average (adjusted difference, 6.04 [95% CI, 4.36–7.72]), 1.2 fewer sessions on average (adjusted difference, −1.24 [95% CI, −1.72 to −0.75]), and 13% lower prevalence of completion (prevalence ratio, 0.87 [95% CI, 0.78–0.97]). All metrics rebounded to prepandemic levels, except days to enrollment (4 days longer in 2022 versus 2017; adjusted difference, 3.78 [95% CI, 2.22–5.34]).

CONCLUSIONS: Among commercially insured adults <65 years, only one-quarter of eligible individuals participated in CR. CR metrics worsened during the COVID-19 pandemic in 2020, but most rebounded to prepandemic levels. These findings highlight an opportunity for health systems and public health initiatives to support broader CR uptake.

Key Words: cardiac rehabilitation ■ cardiovascular disease ■ heart valve ■ myocardial infarction ■ prevalence

See Editorial by Holtzman and Beatty

Cardiac rehabilitation (CR) is a comprehensive secondary prevention program designed to improve cardiovascular health among individuals with a qualifying cardiac event/procedure.[1,2] The program consists of physician-directed exercise, education on cardiovascular disease (CVD) risk reduction, and nutritional and other lifestyle modification support.[1]

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WHAT IS KNOWN

- Cardiac rehabilitation (CR) is a physician-supervised comprehensive cardiovascular risk reduction program endorsed by consensus guidelines for the secondary prevention of cardiac events among patients with cardiovascular disease.
- Although CR among Medicare beneficiaries is underused and participation declined further during the COVID-19 pandemic, there is little information about CR metrics and pandemic-related trends among commercially insured adults.

WHAT THE STUDY ADDS

- Due to a lack of information about CR utilization in younger, working-age, commercially insured individuals, we conducted the first large-scale analysis to assess CR metrics among individuals <65 years with a CR-qualifying event between 2017 and 2022.
- We found that one-quarter of eligible individuals <65 years enrolled in CR, substantially below participation goals set by consensus guidelines.
- All metrics worsened during the COVID-19 pandemic in 2020, but 3 of the 4 metrics (enrollment, number of sessions, completion) rebounded in subsequent years, and 1 (days to enrollment) partially rebounded.

Nonstandard Abbreviations and Acronyms

AD	absolute difference
AMI	acute myocardial infarction
CR	cardiac rehabilitation
CVD	cardiovascular disease
PR	prevalence ratio

CR has been shown to reduce cardiovascular mortality[3] and all-cause mortality,[4,5] and improve exercise capacity and quality of life.[3] Despite these health benefits, participation remains low, ranging from ≈19% to 35% in national analyses.[6–8] There is limited data on how the COVID-19 pandemic impacted key CR metrics in the United States, including enrollment, days to enrollment, number of sessions, and completion. A prior study, restricted to Medicare beneficiaries, found that CR participation declined after the onset of the COVID-19 pandemic, with partial recovery to levels that remained below prepandemic rates.[9] The use of elective and preventive health services among commercially insured populations declined during the COVID-19 pandemic.[10] However, there is little information on CR services during and after the COVID-19 pandemic among the commercially insured population. Additionally, although CR participation has been reported for Medicare beneficiaries,[6,8] little is known about younger, working-age, commercially insured individuals,[11] an age group for which we see a rise in CVD mortality.[12] Participation among younger people may differ due to considerations, such as insurance coverage[13] or work-related responsibilities.[14] Younger individuals may have competing responsibilities—such as work or caregiving—affecting their ability to participate.[15–18]

A national goal of 70% CR participation among eligible patients has been established by Million Hearts, a national initiative colead by the Centers for Medicare and Medicaid Services and the Centers for Disease Control and Prevention, working with public and private partners. To understand the scope of CR participation among commercially insured individuals, we examined CR metrics using private claims data, among individuals aged 18 to 64 years with a CR-qualifying event between 2017 and 2022, focusing on pre- and post-COVID-19 pandemic trends.

METHODS

Data

This cross-sectional time series study used Merative MarketScan Commercial Claims and Encounters private health insurance data from January 1, 2017, to December 31, 2023.[19] The Merative MarketScan Commercial Database is a nationwide convenience sample of privately insured patients. The database is derived from administrative medical claims of a large subsample of enrollees in employer-sponsored health insurance plans provided by > 300 employers across the United States. The databases include longitudinally linked records using encrypted patient identifiers on patient-level data. We accessed the data through Merative MarketScan Treatment Pathways, an online analytic platform for identifying cohorts of patients based on diagnoses and procedure codes, and the place and date of service. The data that support the findings of this study cannot be shared due to data use agreements; researchers can reach out to Merative MarketScan for data access. This research was considered exempt from institutional review board review under 45 Code of Federal Regulations 46.101[b] [5], which covers Department of Health and Human Services research and demonstration projects, which are designed to study, evaluate, or examine public benefit or service programs.

Analytic Cohort

The analytic cohort included those aged 18 years-64 years with ≥1 CR-qualifying event between January 1, 2017, and December 31, 2022, continuously enrolled in a fee-for-service commercial insurance plan from the CR-qualifying event to 12 months after the event (Figure S1). With 6 cohorts, the same individual could appear in ≥1 cohort. Events included acute myocardial infarction (AMI), coronary artery bypass graft, heart valve repair or replacement, percutaneous coronary intervention, or heart or heart-lung transplant, identified using the *International Classification of Diseases*, Tenth Revision, Clinical Modification diagnosis and procedure coding system (Table S1). Similar to our published study,[20] the analysis did not include heart failure with reduced ejection fraction and stable angina

because of differences in how the conditions are identified in claims data and medical protocol. Aligned with methodology in previous studies, individuals were excluded if they (1) had an extended hospital stay (ie, ≥90 consecutive days in any facility type), (2) received hospice care 90 days before or initiated within 21 days of the initial event, or (3) had end-stage renal disease 90 days before or after the event, because such events could prevent or limit participation.[8,20,21]

CR Qualifying Events

The CR-qualifying events were categorized into nonmutually exclusive groups, due to potential overlap between events, and thus will not sum to 100%: AMI (with or without a procedure); coronary artery bypass graft (with or without AMI); percutaneous coronary intervention (with or without AMI); heart valve repair or replacement (with or without AMI); heart or heart-lung transplant or ventricular assist device (with or without AMI); and combination event (with or without AMI). Consistent with previous methodology, individuals with ≥1 CR-qualifying event within 21 days were considered to have a combination event and analyzed separately.[8,21,22] If an individual had a subsequent CR-qualifying event within the same year, only the initial event was analyzed.

CR Claims

CR claims were identified by Healthcare Common Procedure Coding System codes within 365 days of the CR-qualifying event index date, according to our outpatient CR use surveillance methodology.[21] For single events, the CR-qualifying event index date was the inpatient hospital discharge date associated with the event or the outpatient procedure date. For combination events, the index date was the inpatient hospital discharge date associated with the last CR-qualifying event or the outpatient procedure date.[21] Additional details can be found in our outpatient CR surveillance methodology.[21]

CR Metrics

CR metrics were defined according to the Million Hearts outpatient CR use surveillance methodology.[21] Enrollment was defined as ≥1 CR session within 365 days of the index date among the total number of individuals within the measurement period. Days to enrollment, among those enrolled, was defined as the number of days from the index date to the first CR session date. The number of CR sessions, among those enrolled, was defined as the number of sessions attended within 365 days of the CR-qualifying event index date. Participation, among those enrolled, was defined as the total number of sessions attended within 365 days of the CR-qualifying event index date and categorized as 1 to 12, 13 to 24, 25 to 35, and ≥36 sessions (CR completion).[8,23]

Exposure

The year of the CR-qualifying event (2017–2022) was our primary variable of interest.

Covariates

Patient characteristics identified at the time of CR-qualifying events included age (18–44, 45–54, and 55–64 years), sex (men, women), patients' urbanicity as defined by MarketScan (rural [nonmetropolitan statistical area], urban [metropolitan/micropolitan statistical area]), and US Census division (Northeast [New England, Middle Atlantic], Midwest [East North Central, West North Central], South [South Atlantic, East South Central, West South Central], and West [Mountain, Pacific], missing). Race and ethnicity data were not available. Patient out-of-pocket costs included deductibles, copays, and coinsurance and were divided by the number of unique days of CR to obtain per-person costs per CR session. Out-of-pocket costs were adjusted to 2022 US dollars using the personal consumption expenditure price index from the Bureau of Economic Analysis.[24]

Statistical Analysis

Data were described using means±SD and median (interquartile range) for continuous variables and percentages for categorical variables. In adjusted analyses, from 2017 to 2022, we plotted predicted outcomes for the prevalence of enrollment and completion, average days to enrollment, and average number of sessions. We also estimated associations between calendar year (reference, 2017) and each outcome. For binary outcomes (enrollment and completion), we used Poisson log-linear models with robust standard errors and reported estimates as prevalence ratios (PRs). For count outcomes (days to enrollment, number of sessions), we used generalized linear models with a negative binomial distribution and log-link function and reported estimates as absolute differences (AD). All models were adjusted for control variables known to be associated with CR: age,[18,25,26] sex,[15–18,27,28] urbanicity,[29] Census Division,[8,22,30] and CR-qualifying event.[8] The models for CR participation included out-of-pocket costs as an additional covariate.[13,25,31] A $P<0.05$ was used to indicate statistical significance. In supplemental analyses, unadjusted trends in CR metrics were plotted from 2017 to 2022. In sensitivity analyses, we examined whether overall CR metrics (unadjusted) were similar without the year 2020 included.

RESULTS

Patient Characteristics

Over the 6 study years, 2017 to 2022, 143 870 unique individuals aged 18 to 64 years had a CR-qualifying event and continuous enrollment in a commercial insurance plan for ≥12 months after the event, contributing 173 448 annual observations to the data (Figure S1). By non-mutually exclusive CR-qualifying event type, 98.7% of individuals had an AMI, 37.3% had a percutaneous coronary intervention, 27.6% had a combination event, 9.4% had a coronary artery bypass graft, 6.4% had a heart valve repair/replacement, and 0.3% had a heart transplant (Table; see Table S2 for event type by age). Most people were in the 55-to-64-year age range (57.1%; mean age was 53.9; SD, 8.1). The majority of individuals were men (70.0%), and most resided in an urban area (84.6%).

CR Metrics and Trends Over Time

Unadjusted CR metrics by year are presented in Table S3 and Figure S2. On average, during 2017 to 2023,

Table. Patient Characteristics for Commercially Insured Individuals Aged 18–64 Years With a CR-Qualifying Event Between 2017 and 2022, MarketScan CCAE (2017–2023)

	Overall, N=173 448		2017, N=31 612		2018, N=31 134		2019, N=30 567		2020, N=25 815		2021, N=26 682		2022, N=27 638	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
CR-qualifying event														
PCI*	64 734	37.3	13 158	41.6	12 584	40.4	11 792	38.6	9542	37.0	8 923	33.4	8 735	31.6
AMI†	171 208	98.7	31 226	98.8	30 781	98.9	30 197	98.8	25 524	98.9	26 282	98.5	27 198	98.4
CABG*	16 235	9.4	3187	10.1	3091	9.9	2866	9.4	2261	8.8	2 398	9.0	2 432	8.8
Heart valve*‡	11 121	6.4	2080	6.6	2006	6.4	1971	6.5	1638	6.4	1 656	6.2	1 770	6.4
Heart transplant*,§	493	0.3	92	0.3	94	0.3	98	0.3	68	0.3	66	0.3	75	0.3
Combination*,‖	47 812	27.6	8602	27.2	8414	27.0	8263	27.0	7346	28.5	7 467	28.0	7 720	27.9
Age, y														
18–44	21 242	12.3	3467	11.0	3575	11.5	3571	11.7	3238	12.5	3 611	13.5	3 780	13.7
45–54	53 227	30.7	9718	30.7	9592	30.8	9227	30.2	7933	30.7	8 261	31.0	8 496	30.7
55–64	98 979	57.1	18 427	58.3	17 967	57.7	17 769	58.1	14 644	56.7	14 810	55.5	15 362	55.6
Sex														
Men	121 487	70.0	22 261	70.4	22 119	71.0	21 442	70.2	18 213	70.6	18 448	69.1	19 004	68.8
Women	51 961	30.0	9351	29.6	9015	29.0	9125	29.9	7602	29.5	8 234	30.9	8 634	31.2
Urbanicity														
Urban	146 753	84.6	26 478	83.8	26 272	84.4	25 929	84.8	21 762	84.3	22 682	85.0	23 628	85.5
Rural	26 695	15.4	5134	16.2	4862	15.6	4638	15.2	4053	15.7	4 000	15.0	4 010	14.5
US census division														
Northeast														
New England	7 302	4.2	976	3.1	1347	4.3	1284	4.2	879	3.4	1 374	5.2	1 441	5.2
Middle Atlantic	21 637	12.5	4506	14.3	4664	15.0	4696	15.4	2451	9.5	2 669	10.0	2 660	9.6
South														
South Atlantic	49 130	28.3	7031	22.2	7477	24.0	8355	27.3	8253	32.0	8 737	32.7	9 258	33.5
East South Central	16 090	9.3	2877	9.1	2732	8.8	2801	9.2	2481	9.6	2 600	9.7	2 591	9.4
West South Central	15 466	8.9	2747	8.7	3034	9.7	2735	9.0	2494	9.7	2 204	8.3	2 245	8.1
West														
Mountain	8 072	4.7	1292	4.1	1427	4.6	1462	4.8	1345	5.2	1 322	5.0	1 219	4.4
Pacific	10 036	5.8	1995	6.3	1623	5.2	1495	4.9	1483	5.7	1 545	5.8	1 908	6.9
Midwest														
East North Central	30 912	17.8	5798	18.3	5499	17.7	5280	17.3	4801	18.6	4 764	17.9	4 779	17.3
West North Central	8 862	5.1	1723	5.5	1324	4.3	1382	4.5	1532	5.9	1 418	5.3	1 483	5.4
Missing region	5 941	3.4	2667	8.4	2007	6.5	1077	3.5	96	0.4	49	0.2	54	0.2
Zero OOP costs ($)¶	N	%	N	%	N	%	N	%	N	%	N	%	N	%
	25 126	59.8	5212	65.1	5035	63.5	4721	60.9	3023	54.0	3407	55.0	3728	57.0
Median OOP costs ($)¶	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR	Median	IQR
	0	0–32	0	0–21	0	0–23	0	0–32	0	0–47	0	0–46	0	0–39
Mean OOP costs ($)¶	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	52	163	43	172	45	153	51	147	68	187	60	165	54	154

AMI indicates acute myocardial infarction; CABG, coronary artery bypass graft; CCAE, Commercial Claims and Encounters; CR, cardiac rehabilitation; IQR, interquartile range; OOP, out-of-pocket; PCI, percutaneous coronary intervention; and VAD, ventricular assist device.

*With or without AMI.

†With or without procedure.

‡Heart valve repair or replacement.

§Heart or heart-lung transplant or VAD.

‖Individuals with ≥1 CR-qualifying event within 21 days. This includes people who had events that occurred on the same day; these individuals were considered to have a combination event and treated separately from single events.

¶Per person out-of-pocket costs per CR session.

enrollment was 24.2%, median days to enrollment was 33 (interquartile range, 18–55 days; mean, 46.4 days; SD, 51.2 days), median number of sessions attended was 8 (interquartile range, 3–24; mean, 13.9; SD, 12.8), and completion (≥36 sessions) was 9.6%. In addition, 44.3% completed ≥12 sessions. Overall, CR metrics were similar without the year 2020 included (Table S3). In adjusted analysis for the predicted outcomes, all metrics worsened in 2020 but rebounded to prepandemic levels in subsequent years, except for days to enrollment (Figure 1). Enrollment decreased from 24.5% in 2017 (95% CI, 24.0%–24.9%) to 21.3% in 2020 (95% CI, 20.9%–21.8%), but rebounded to around 24% in subsequent years. Mean days to enrollment were 44.7 (95% CI, 43.7–45.7) in 2017 and increased to 50.7 days (95% CI, 49.4–52.1) in 2020, but did not recover and remained at 48.5 days in 2021 (95% CI, 47.3–49.8) and 2022 (95% CI, 47.3–49.7). The mean number of sessions was 14.2 (95% CI, 13.9–14.5) in 2017 and decreased to 13.0 (95% CI, 12.6–13.3) in 2020 and recovered to about 14 in subsequent years. Completion was 9.9% (95% CI, 9.3%–10.6%) in 2017 and decreased to 8.6% (95% CI, 7.8%–9.3%) in 2020, but increased to around 10% in subsequent years.

Examining associations between year and the CR metrics (Figure 2; Table S4), CR enrollment was 12% lower in 2020 (adjusted PR, 0.88 [95% CI, 0.85–0.90]), but not significantly different in 2021 (adjusted PR, 0.98 [95% CI, 0.95–1.01]) or 2022 (adjusted PR, 1.01 [95% CI, 0.98–1.04]), compared with 2017. The number of days to enrollment was 6 days longer in 2020 (adjusted AD, 6.04 [95% CI, 4.36–7.72]) and about 4 days longer in 2021 (adjusted AD, 3.83 [95% CI, 2.24–5.42]) and 2022 (adjusted AD, 3.78, [95% CI, 2.22–5.34]), compared with 2017. The number of CR sessions was lower by 1.24 sessions in 2020 (adjusted AD, −1.24 [95% CI, −1.72 to −0.75]), but not significantly different in 2021 (adjusted AD, −0.44 [95% CI, −0.92 to 0.06]) and 2022 (adjusted AD, −0.47 [95% CI, −0.95 to 0.01]), compared with 2017. CR completion was 13% lower in 2020 (adjusted PR, 0.87 [95% CI, 0.78–0.97]), but not significantly different in 2021 (adjusted PR, 1.04 [95% CI, 0.94–1.14]) or 2022 (adjusted PR, 1.00 [95% CI, 0.90–1.10]), compared with 2017.

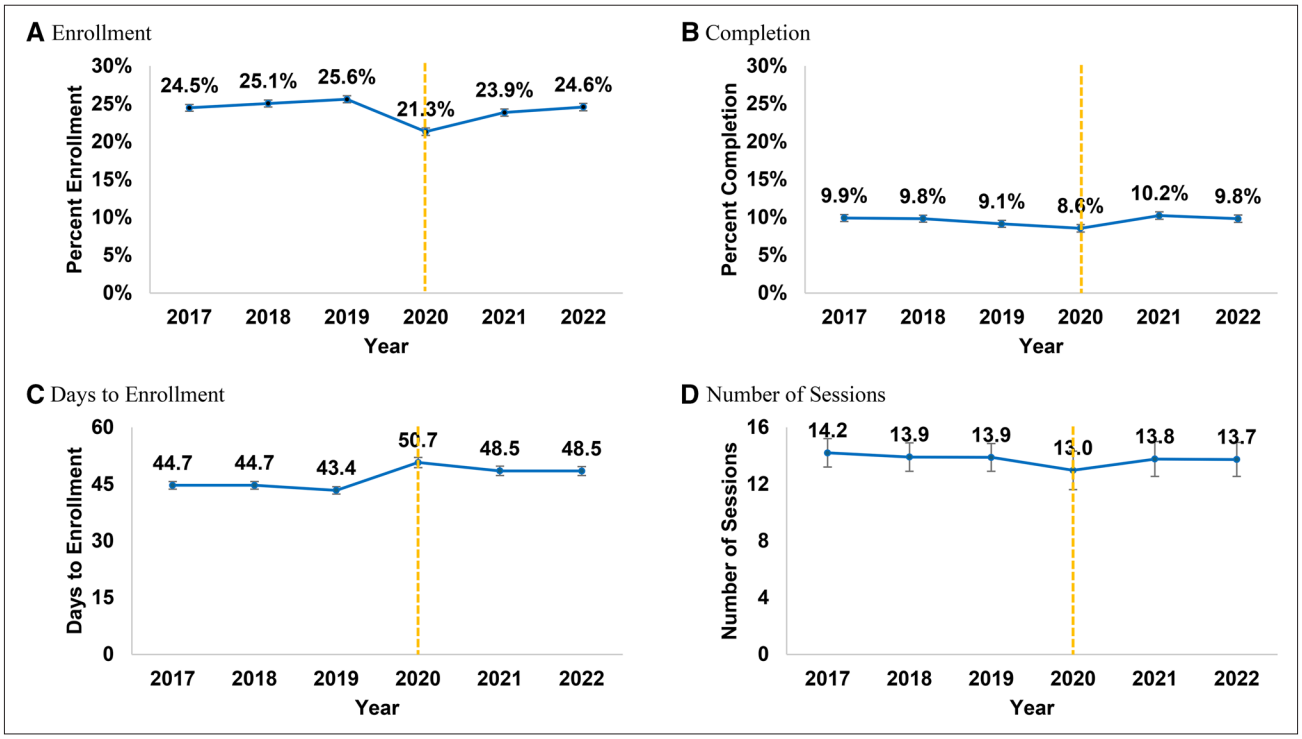


Figure 1. Predicted average cardiac rehabilitation (CR) metrics by year among commercially insured individuals aged 18 to 64 years with a CR-qualifying event between 2017 and 2022, MarketScan Commercial Claims and Encounters (CCAE, 2017–2023; A through D*.

*The plots represent predicted average enrollment (**A**), completion (ie, ≥36 sessions among those enrolled; **B**), days to enrollment (**C**), and number of sessions (**D**) by year. All models included the year of the CR-qualifying event (reference, 2017) as the main covariate of interest and the following control variables: age (reference, 55–64 years), sex (reference, men), urbanicity (reference, rural), Census division (reference, New England), and CR-qualifying event (reference, not having the respective CR-qualifying event). The models for days to enrollment, completion, and number of sessions included out-of-pocket costs as an additional control variable. The full sample was used for estimation in **A**, and a subset sample restricted to individuals enrolled in CR was used in **B** through **D**. Models in **A** and **B** are Poisson log-linear models with robust standard errors (estimates presented as adjusted prevalence ratios). Models in **C** and **D** are generalized linear models with a negative binomial distribution and log-link function (estimates presented as adjusted absolute differences).

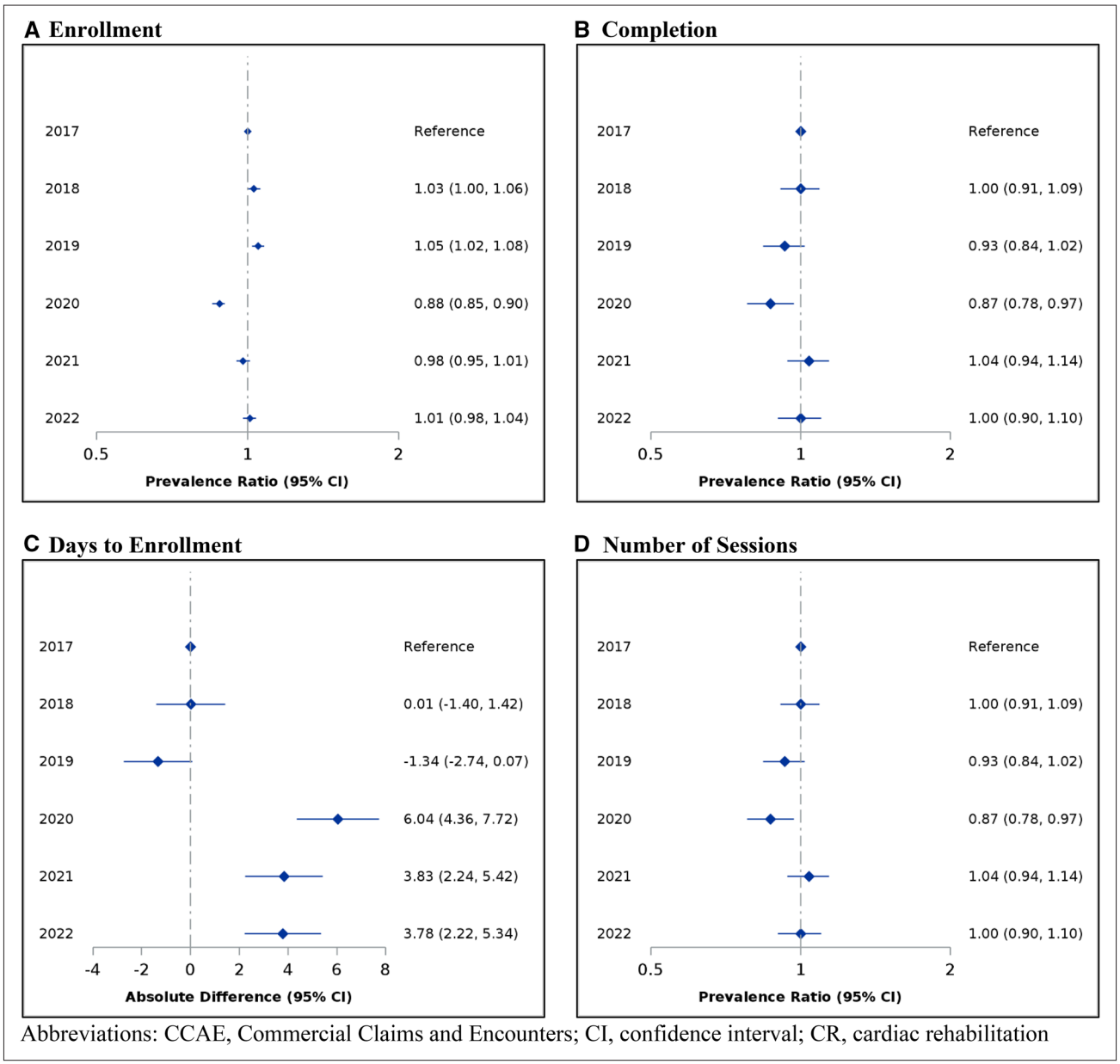


Figure 2. Adjusted differences in cardiac rehabilitation (CR) participation by year among commercially insured individuals aged 18–64 years with a CR-qualifying event between 2017 and 2022, MarketScan Commercial Claims and Encounters (CCAE, 2017–2023; A through D)*.

*The plots represent adjusted prevalence ratios in enrollment (**A**), adjusted prevalence ratios in completion (ie, ≥36 sessions among those enrolled; **B**), adjusted absolute differences in days to enrollment (**C**), and adjusted absolute differences in number of sessions (**D**) by year, compared with 2017. All models included the year of CR-qualifying event (reference, 2017) as the main covariate of interest and the following control variables: age (reference, 55–64 years), sex (reference, men), urbanicity (reference, rural), Census division (reference, New England), and CR-qualifying event (reference, not having the respective CR-qualifying event). The models for days to enrollment, completion, and number of sessions included out-of-pocket costs as an additional control variable. The full sample was used for estimation in **A**, and a subset sample restricted to individuals enrolled in CR was used in **B** through **D**. Models in **A** and **B** are Poisson log-linear models with robust standard errors (estimates presented as adjusted prevalence ratios). Models in **C** and **D** are generalized linear models with a negative binomial distribution and log-link function (estimates presented as adjusted absolute differences).

Out-of-Pocket Costs

Overall, among individuals enrolled in CR, 59.8% had zero out-of-pocket costs per session for CR (median, $0 [interquartile range, $0–$32]; mean, $52; SD, 163; Table). In adjusted analysis, every $10 increase in out-of-pocket costs was associated with an 8% lower prevalence of completion (PR, 0.92 [95% CI, 0.91–0.93]), controlling for year, age, sex, urbanicity, US Census region, and CR-qualifying event (Table S4).

DISCUSSION

In this cross-sectional time-series analysis of commercially enrolled individuals aged 18 to 64 years, we examined trends in CR metrics among individuals with CR-qualifying events between 2017 and 2022 and follow-up through 2023. Overall, only one in 4 eligible individuals enrolled in CR, and among those who enrolled, only one in 10 completed all 36 CR sessions. Year 2020 was associated with a decrease in all metrics—12% lower prevalence of enrollment, 6-day longer time to enrollment, 1.2 fewer sessions, and 13% lower prevalence of completion—likely due to the impact of the COVID-19 pandemic. After 2020, all CR metrics rebounded to prepandemic levels except for days to enrollment.

To our knowledge, this is the first large-scale analysis to assess postpandemic trends in CR metrics among working-age US adults. In line with 1 previous study focused on CR during the COVID-19 pandemic among Medicare beneficiaires,[9] we observed a decrease in enrollment and longer time to enrollment in 2020.[32] Decreased enrollment and longer time to enrollment could be attributed to decreased health care utilization and facility closures during the pandemic. The number of CR centers decreased from 2618 prepandemic to 2464 by late 2021.[9] Centers that closed were more likely to be associated with public hospitals, located in rural areas, and served the most vulnerable communities.[9] Alternative models, such as hybrid CR (ie, combining facility-based CR with virtual and remote CR), which became widely used during the pandemic, can be options for those who cannot attend center-based CR,[33] even among medically complex patients.[34] Recent guidelines include home-based programs for patients unable or unwilling to attend in person.[35] However, with the end of the COVID-19 public health emergency, insurance coverage for alternative models remains uncertain.[36,37]

Maintaining access to preventive services such as CR during public health emergencies is critical, as disruptions in care can exacerbate chronic conditions and increase the risk of acute events.[38] Delaying preventive interventions not only compromises individual health outcomes but may also contribute to future public health emergencies by increasing the burden of preventable complications on an already strained health care system.[38] Although there was a partial rebound in CR participation following the acute phase of the pandemic, 1 CR metric (days to enrollment) has not fully returned to prepandemic levels. Although the expansion of home-based and virtual CR options offers a promising adaptation, there may be challenges with nonuniform implementation, patient engagement, clinical monitoring, and reimbursement.[39]

Enrollment among the commercially insured (24.2%) was lower than that of Medicare beneficiaries reported in our previous work (28.6%).[8] Enrollment in our study was also lower than what has been reported in prior studies, including commercially insured individuals (35.8%), owing in part to differences in data, including CR-qualifying events, study years, and exclusion criteria.[11] Participation was far lower among commercial enrollees compared with Medicare beneficiaries, as measured by the number of sessions attended (14 versus 25) and completion (10% versus 28%).[8] However, among those enrolled in CR, over 44% of commercial enrollees completed at least 12 sessions, which is associated with fewer subsequent inpatient hospitalizations and expenditures.[20] Lower enrollment and participation among younger adults in this population could be due to factors, such as difficulties obtaining time off work and lack of classes outside of work hours,[14,18] and competing time demands (eg, caring for children).[15–18,27] In addition, cost-sharing responsibilities reduce participation,[13] and, consistent with previous studies,[13,25,31] higher out-of-pocket costs were associated with lower CR completion. Addressing barriers to CR enrollment and participation to improve secondary CVD prevention among young people is important, especially considering evidence of stagnation in CVD-related mortality in young adults and women.[40]

A short time to enrollment is important because for every 1-day increase in wait time from date of referral to enrollment, individuals are 1% less likely to enroll in CR[41]; early enrollment is also associated with better patient outcomes.[36,42] Automatic referral strategies may improve enrollment.[43] Flexible hours for center-based CR, as well as alternative models for delivering CR (home-based, telemedicine-based, smartphone-based) that can increase CR capacity, decrease wait times, and enhance convenience, may be tools to improve enrollment and participation.[29,36,44] We demonstrated that implementation of hybrid CR programs that include a telehealth component could expand CR availability to as many as 113 million US adults.[30] Million Hearts/American Association of Cardiovascular and Pulmonary Rehabilitation CR Change Package, second edition, includes these and other strategies, with tools and resources to support implementation, to increase CR participation.[45]

This large analysis of commercially insured individuals provides information about CR enrollment and participation among individuals <65 years—an understudied population of interest—and highlights the need to focus on supporting younger populations to enroll in CR programs. This study is not without limitations. First, MarketScan Commercial Claims and Encounters is a large convenience sample, and a higher percentage of enrollment comes from the southern region; thus is not nationally representative. Second, we excluded enrollees with partial-year coverage since their inclusion would bias the estimate of annual out-of-pocket costs if the partial-year medical care use was not

representative of medical care utilization over the course of a full year. Third, we did not include enrollees in capitated plans, as these plans include imputed rather than actual costs. Future studies could evaluate whether interventions designed to enhance enrollment and participation improve participation in CR among younger populations, such as hybrid CR, automated referrals, assisted enrollment, and enhanced flexibility in center-based CR.[15,16,29,31,36,44]

CONCLUSIONS

In this analysis of CR metrics among commercially insured enrollees aged 18 to 64 years with a CR-qualifying event between 2017 and 2022, CR participation among younger individuals, at ≈24%, was below the 70% participation goal set forth by Million Hearts, and below what has been observed among Medicare beneficiaries. CR metrics dipped during the start of the COVID-19 pandemic in 2020 and, with the exception of days to enrollment, rebounded to prepandemic levels in subsequent years. Our data can inform efforts to implement and scale evidence- and practice-based interventions that aim to increase CR participation and improve quality of life among individuals with CVD and eligible for CR.

ARTICLE INFORMATION

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Disclosures

None.

Supplemental Material

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REFERENCES

1. Dibben GO, Faulkner J, Oldridge N, Rees K, Thompson DR, Zwisler AD, Taylor RS. Exercise-based cardiac rehabilitation for coronary heart disease: a meta-analysis. *Eur Heart J*. 2023;44:452–469. doi: 10.1093/eurheartj/ehac747
2. Heidenreich PA, Bozkurt B, Aguilar D, Allen LA, Byun JJ, Colvin MM, Deswal A, Drazner MH, Dunlay SM, Evers LR, et al; ACC/AHA Joint Committee Members. 2022 AHA/ACC/HFSA guideline for the management of heart failure: a report of the American College of Cardiology/American Heart Association joint committee on clinical practice guidelines. *Circulation*. 2022;145:e895–e1032. doi: 10.1161/CIR.0000000000001063
3. Anderson L, Oldridge N, Thompson DR, Zwisler AD, Rees K, Martin N, Taylor RS. Exercise-based cardiac rehabilitation for coronary heart disease: Cochrane systematic review and meta-analysis. *J Am Coll Cardiol*. 2016;67:1–12. doi: 10.1016/j.jacc.2015.10.044
4. Suaya JA, Stason WB, Ades PA, Normand SL, Shepard DS. Cardiac rehabilitation and survival in older coronary patients. *J Am Coll Cardiol*. 2009;54:25–33. doi: 10.1016/j.jacc.2009.01.078
5. Patel DK, Duncan MS, Shah AS, Lindman BR, Greevy RA Jr, Savage PD, Whooley MA, Matheny ME, Freiberg MS, Bachmann JM. Association of cardiac rehabilitation with decreased hospitalization and mortality risk after cardiac valve surgery. *JAMA Cardiol*. 2019;4:1250–1259. doi: 10.1001/jamacardio.2019.4032
6. Suaya JA, Shepard DS, Normand SL, Ades PA, Prottas J, Stason WB. Use of cardiac rehabilitation by medicare beneficiaries after myocardial infarction or coronary bypass surgery. *Circulation*. 2007;116:1653–1662. doi: 10.1161/CIRCULATIONAHA.107.701466
7. Centers for Disease Control and Prevention. Receipt of outpatient cardiac rehabilitation among heart attack survivors-United States, 2005. *MMWR Morb Mortal Wkly Rep*. 2008;57:89–94.
8. Keteyian SJ, Jackson SL, Chang A, Brawner CA, Wall HK, Forman DE, Sukul D, Ritchey MD, Sperling LS. Tracking cardiac rehabilitation utilization in medicare beneficiaries: 2017 update. *J Cardiopulm Rehabil Prev*. 2022;42:235–245. doi: 10.1097/HCR.0000000000000675
9. Varghese MS, Beatty AL, Song Y, Xu J, Sperling LS, Fonarow GC, Keteyian SJ, McConeghy KW, Penko J, Yeh RW, et al. Cardiac rehabilitation and the COVID-19 pandemic: persistent declines in cardiac rehabilitation participation and access among US Medicare beneficiaries. *Circ Cardiovasc Qual Outcomes*. 2022;15:e009618. doi: 10.1161/CIRCOUTCOMES.122.009618
10. Whaley CM, Pera MF, Cantor J, Chang J, Velasco J, Hagg HK, Sood N, Bravata DM. Changes in health services use among commercially insured US populations during the COVID-19 pandemic. *JAMA Netw Open*. 2020;3:e2024984. doi: 10.1001/jamanetworkopen.2020.24984
11. Thompson MP, Yaser JM, Hou H, Syrjamaki JD, DeLucia A III, Likosky DS, Keteyian SJ, Prager RL, Gurm HS, Sukul D. Determinants of hospital variation in cardiac rehabilitation enrollment during coronary artery disease episodes of care. *Circ Cardiovasc Qual Outcomes*. 2021;14:e007144. doi: 10.1161/CIRCOUTCOMES.120.007144
12. Woodruff RC, Tong X, Khan SS, Shah NS, Jackson SL, Loustalot F, Vaughan AS. Trends in cardiovascular disease mortality rates and excess deaths, 2010-2022. *Am J Prev Med*. 2024;66:582–589. doi: 10.1016/j.amepre.2023.11.009
13. Farah M, Abdallah M, Szalai H, Berry R, Lagu T, Lindenauer PK, Pack QR. Association between patient cost sharing and cardiac rehabilitation adherence. *Mayo Clin Proc*. 2019;94:2390–2398. doi: 10.1016/j.mayocp.2019.07.018
14. Fraser MJ, Leslie SJ, Gorely T, Foster E, Walters R. Barriers and facilitators to participating in cardiac rehabilitation and physical activity: a cross-sectional survey. *World J Cardiol*. 2022;14:83–95. doi: 10.4330/wjc.v14.i2.83
15. Ghisi GLM, Kin SMR, Price J, Beckie TM, Mamataz T, Naheed A, Grace SL. Women-focused cardiovascular rehabilitation: an international council of cardiovascular prevention and rehabilitation clinical practice guideline. *Can J Cardiol*. 2022;38:1786–1798. doi: 10.1016/j.cjca.2022.06.021
16. Colella TJF, Hardy M, Hart D, Price JAD, Sarfi H, Mullen KA, Mulvagh S, Norris CM. The Canadian Women's Heart Health Alliance Atlas on the Epidemiology, Diagnosis, and Management of Cardiovascular Disease in women-chapter 3: Patient Perspectives. *CJC Open*. 2021;3:229–235. doi: 10.1016/j.cjco.2020.11.020
17. Supervia M, Medina-Inojosa JR, Yeung C, Lopez-Jimenez F, Squires RW, Perez-Terzic CM, Brewer LC, Leth SE, Thomas RJ. Cardiac rehabilitation for women: a systematic review of barriers and solutions. *Mayo Clin Proc*. 2017;92:565–577. doi: 10.1016/j.mayocp.2017.01.002
18. Gaalema DE, Savage PD, Rengo JL, Cutler AY, Elliott RJ, Priest JS, Higgins ST, Ades PA. Patient characteristics predictive of cardiac rehabilitation adherence. *J Cardiopulm Rehabil Prev*. 2017;37:103–110. doi: 10.1097/HCR.0000000000000225
19. Merative. Merative MarketScan research databases. Accessed January 1, 2023. https://www.merative.com/documents/brief/marketscan-explainer-general

20. Pollack LM, Chang A, Lee JS, Shaffer T, Wall HK, Brawner CA, Thompson MP, Keteyian SJ, Sukul D, Luo F, et al. Health care use and expenditures associated with cardiac rehabilitation among eligible Medicare fee-for-service beneficiaries. *J Am Heart Assoc*. 2025;14:e037811. doi: 10.1161/JAHA.124.037811
21. Million Hearts® Cardiac Rehabilitation Collaborative Surveillance Workgroup members. Million Hearts® outpatient cardiac rehabilitation uses surveillance methodology (May 2025). 2025. Accessed March 6, 2023. https://millionhearts.hhs.gov/files/Cardiac-Rehab-Use-Surveillance-Guidance-508.pdf
22. Ritchey MD, Maresh S, McNeely J, Shaffer T, Jackson SL, Keteyian SJ, Brawner CA, Whooley MA, Chang T, Stolp H, 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:e005902. doi: 10.1161/CIRCOUTCOMES.119.005902
23. Cardiac rehabilitation: A new HEDIS measure for heart health. National Committee for Quality Assurance. Accessed January 1, 2023. https://www.ncqa.org/blog/cardiac-rehabilitation-a-new-hedis-measure-for-heart-health/
24. Dunn A, Grosse SD, Zuvekas SH. Adjusting health expenditures for inflation: a review of measures for health services research in the United States. *Health Serv Res*. 2018;53:175–196. doi: 10.1111/1475-6773.12612
25. Zhang L, Sobolev M, Pina IL, Prince DZ, Taub CC. Predictors of cardiac rehabilitation initiation and adherence in a multiracial urban population. *J Cardiopulm Rehabil Prev*. 2017;37:30–38. doi: 10.1097/HCR.0000000000000226
26. Pack QR, Visintainer P, Farah M, LaValley G, Szalai H, Lindenauer PK, Lagu T. Development of a simple clinical tool for predicting early dropout in cardiac rehabilitation: a single-center risk model. *J Cardiopulm Rehabil Prev*. 2021;41:159–165. doi: 10.1097/HCR.0000000000000541
27. Clark AM, King-Shier KM, Thompson DR, Spaling MA, Duncan AS, Stone JA, Jaglal SB, Angus JE. A qualitative systematic review of influences on attendance at cardiac rehabilitation programs after referral. *Am Heart J*. 2012;164:835–845. doi: 10.1016/j.ahj.2012.08.020
28. Colella TJ, Gravely S, Marzolini S, Grace SL, Francis JA, Oh P, Scott LB. Sex bias in referral of women to outpatient cardiac rehabilitation? A meta-analysis. *Eur J Prev Cardiol*. 2015;22:423–441. doi: 10.1177/2047487314520783
29. Mathews L, Brewer LC. A review of disparities in cardiac rehabilitation: evidence, drivers, and solutions. *J Cardiopulm Rehabil Prev*. 2021;41:375–382. doi: 10.1097/HCR.0000000000000659
30. DeLara DL, Pollack LM, Wall HK, Chang A, Schieb L, Matthews K, Stolp H, Pack QR, Casper M, Jackson SL. County-level cardiac rehabilitation and broadband availability: opportunities for hybrid care in the United States. *J Cardiopulm Rehabil Prev*. 2024;44:231–238. doi: 10.1097/HCR.0000000000000865
31. Ades PA, Keteyian SJ, Wright JS, Hamm LF, Lui K, Newlin K, Shepard DS, Thomas RJ. Increasing cardiac rehabilitation participation from 20% to 70%: a road map from the Million Hearts cardiac rehabilitation collaborative. *Mayo Clin Proc*. 2017;92:234–242. doi: 10.1016/j.mayocp.2016.10.014
32. CDC museum COVID-19 timeline. Centers for Disease Control and Prevention. Accessed January 1, 2023. https://www.cdc.gov/museum/timeline/covid19.html
33. Keteyian SJ, Ades PA, Beatty AL, Gavic-Ott A, Hines S, Lui K, Schopfer DW, Thomas RJ, Sperling LS. A review of the design and implementation of a hybrid cardiac rehabilitation program: an expanding opportunity for optimizing cardiovascular care. *J Cardiopulm Rehabil Prev*. 2022;42:1–9. doi: 10.1097/HCR.0000000000000634
34. Nkonde-Price C, Reynolds K, Najem M, Yang SJ, Batiste C, Cotter T, Lahti D, Gin N, Funahashi T. Comparison of home-based vs center-based cardiac rehabilitation in hospitalization, medication adherence, and risk factor control among patients with cardiovascular disease. *JAMA Netw Open*. 2022;5:e2228720. doi: 10.1001/jamanetworkopen.2022.28720
35. Rao SV, O'Donoghue ML, Ruel M, Rab T, Tamis-Holland JE, Alexander JH, Baber U, Baker H, Cohen MG, Cruz-Ruiz M, et al. 2025 ACC/AHA/ACEP/NAEMSP/SCAI guideline for the management of patients with acute coronary syndromes: a report of the American College of Cardiology/American Heart Association joint committee on clinical practice guidelines. *Circulation*. 2025;151:e771–e862. doi: 10.1161/CIR.0000000000001309
36. Thomas RJ. Cardiac rehabilitation - challenges, advances, and the road ahead. *N Engl J Med*. 2024;390:830–841. doi: 10.1056/NEJMra2302291
37. Pedamallu H, Brown TM, Keteyian SJ, Thompson MP. A bipartisan path for Congress to expand cardiac rehabilitation capacity and access. Health Affairs Forefront. Accessed April 18, 2024. https://www.healthaffairs.org/content/forefront/bipartisan-path-congress-expand-cardiac-rehabilitation-capacity-and-access
38. Balasuriya L, Briss PA, Twentyman E, Wiltz JL, Richardson LC, Bigman ET, Wright JS, Petersen R, Hannan CJ, Thomas CW, et al. Impacts of the COVID-19 pandemic on nationwide chronic disease prevention and health promotion activities. *Am J Prev Med*. 2023;64:452–458. doi: 10.1016/j.amepre.2022.09.012
39. Chindhy S, Taub PR, Lavie CJ, Shen J. Current challenges in cardiac rehabilitation: strategies to overcome social factors and attendance barriers. *Expert Rev Cardiovasc Ther*. 2020;18:777–789. doi: 10.1080/14779072.2020.1816464
40. Wilmot KA, O'Flaherty M, Capewell S, Ford ES, Vaccarino V. Coronary heart disease mortality declines in the United States from 1979 through 2011: evidence for stagnation in young adults, especially women. *Circulation*. 2015;132:997–1002. doi: 10.1161/CIRCULATIONAHA.115.015293
41. Russell KL, Holloway TM, Brum M, Caruso V, Chessex C, Grace SL. Cardiac rehabilitation wait times: effect on enrollment. *J Cardiopulm Rehabil Prev*. 2011;31:373–377. doi: 10.1097/HCR.0b013e318228a32f
42. Candelaria D, Zecchin R, Ferry C, Ladak L, Randall S, Gallagher R. Shorter wait times to cardiac rehabilitation associated with greater exercise capacity improvements: a multisite study. *J Cardiopulm Rehabil Prev*. 2021;41:243–248. doi: 10.1097/HCR.0000000000000548
43. Grace SL, Leung YW, Reid R, Oh P, Wu G, Alter DA, Investigators C. The role of systematic inpatient cardiac rehabilitation referral in increasing equitable access and utilization. *J Cardiopulm Rehabil Prev*. 2012;32:41–47. doi: 10.1097/HCR.0b013e31823be13b
44. Sawan MA, Calhoun AE, Fatade YA, Wenger NK. Cardiac rehabilitation in women, challenges and opportunities. *Prog Cardiovasc Dis*. 2022;70:111–118. doi: 10.1016/j.pcad.2022.01.007
45. Centers for Disease Control and Prevention. Cardiac rehabilitation change package, second edition. Centers for Disease Control and Prevention, US Department of Health and Human Services. Accessed 2023, October 23. https://millionhearts.hhs.gov/files/Cardiac_Rehab_Change_Pkg.pdf
46. Samayoa L, Grace SL, Gravely S, Scott LB, Marzolini S, Colella TJ. Sex differences in cardiac rehabilitation enrollment: a meta-analysis. *Can J Cardiol*. 2014;30:793–800. doi: 10.1016/j.cjca.2013.11.007