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ORIGINAL RESEARCH

Impact of a Medical Fitness Model on Incident Major Adverse Cardiovascular Events: A Prospective Cohort Study of 11 000 Members

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BACKGROUND: Cardiovascular disease remains the leading cause of disease burden and death in the world. The medical fitness model may be an alternative public health strategy to address cardiovascular risk factors with medical integrated programming.

METHODS AND RESULTS: We performed a retrospective cohort study between January 1, 2005, and December 31, 2015. Adults (aged ≥18 years) who did not have a prior major adverse cardiovascular event were included. Controls were assigned a pseudo-index date at random on the basis of the frequency distribution of start dates in the medical fitness facility group. Multivariate Cox proportional hazards regression models were adjusted for age, sex, socioeconomic status, comorbidities, and year of index date. We stratified the medical fitness facility group into low-frequency attenders (≤1 weekly visit) and regular-frequency attenders (>1 weekly visit). Our primary outcome was a hospitalization for nonfatal myocardial infarction and stroke, heart failure, or cardiovascular death. We included 11 319 medical fitness facility members and 507 400 controls in our study. Compared with controls, members had a lower hazard risk of a major adverse cardiovascular event-plus (hazard ratio [HR], 0.88 [95% CI, 0.81–0.96]). Higher weekly attendance was associated with a lower hazard risk of a major adverse cardiovascular event-plus compared with controls, but the effect was not significant for lower weekly attendance (low-frequency attenders: HR, 0.94 [95% CI, 0.85–1.04]; regular-frequency attenders: HR, 0.77 [95% CI, 0.67–0.89]).

CONCLUSIONS: Medical fitness facility membership and attendance at least once per week may lower the risk of a major adverse cardiovascular event-plus. The medical fitness model should be considered as a public health intervention, especially for individuals at risk for cardiovascular disease.

Key Words: cardiovascular disease ■ major adverse cardiovascular event ■ medical fitness model

Cardiovascular disease (CVD) is a leading cause of health care use, disability, impaired quality of life, and death.[1] The prevalence of CVD (stroke, heart failure, and coronary heart disease) is ≈9%, with coronary heart disease and stroke being the leading causes of death.[2] In the United States, the estimated direct cost of CVD is $134 billion annually, with inpatient hospitalizations being the main cost driver.[3] The leading risk factors for CVD are diabetes, hypertension, tobacco use, poor dietary intake (higher sodium intake, lower potassium intake, and higher saturated fat intake), and physical inactivity.[2]

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CLINICAL PERSPECTIVE

What Is New?

- To our knowledge, this is the first study to evaluate the impact of the medical fitness model on major adverse cardiovascular events.
- Members at a medical fitness facility had a lower risk of a major adverse cardiovascular event.
- More frequent attenders at the medical fitness facility had a lower risk of a major adverse cardiovascular event as compared with members who attended less frequently.

What Are the Clinical Implications?

- The medical fitness model may be used as part of a public health strategy to promote physical activity and other positive lifestyle factors to modify cardiovascular risk factors and delay cardiovascular-related death.

Nonstandard Abbreviations and Acronyms

LFA	low-frequency attender
MACE	major adverse cardiovascular event
MFF	medical fitness facility
PA	physical activity
RFA	regular-frequency attender

Interventions to reduce CVD risk factors include smoking cessation programs (pharmacotherapy and addiction counseling), education, and specifically targeting at-risk groups.[4–9] Although these interventions have been shown to improve outcomes, participation in these programs is not consistent over the long term.[10] Physical activity (PA) is a positive health behavior that reduces the risk of all-cause hospitalizations, disability, CVD, and death.[11–13] Specifically, community-based and group-setting activities such as walking, yoga, and tai chi have been associated with a lower risk of CVD.[14–16] However, despite its benefits, less than half of adults meet the required leisure-time aerobic PA (>150 min/wk of moderate-intensity PA).[17]

The medical fitness facility (MFF) model may be an alternative public health strategy to address many of the CVD risk factors with medically integrated programming.[18] Compared with traditional fitness centers, the medical fitness model incorporates a greater degree of medical oversight, supervision, and guidance. Membership at these facilities gives the opportunity to engage in many forms of PA through access to aerobic (treadmill, ellipticals, row machines, bikes, and indoor track) and resistance (weightlifting, resistance strength) training equipment, sports recreational programs, and a variety of group fitness classes.[18] In addition, they also provide personalized health assessments, wellness plans, education, and coaching services that focus on other aspects of a healthy lifestyle, including nutrition, stress management, sleep, smoking cessation, and chronic disease management. In this study, we examined the association between frequency of attendance at an MFF and development of a major adverse cardiovascular event (MACE).

METHODS

Availability of Data and Materials

Data used in this article were derived from administrative health and social data as a secondary use. The data were provided under specific data-sharing agreements only for approved use at the Manitoba Centre for Health Policy. The original source data are not owned by the researchers or the Manitoba Centre for Health Policy and, as such, cannot be provided to a public repository. The original data source and approval for use has been noted in the acknowledgments of the article. Where necessary, source data specific to this article or project may be reviewed at the Manitoba Centre for Health Policy with the consent of the original data providers, along with the required privacy and ethical review bodies. Requests to access the statistical and anonymous aggregate data associated with this paper, along with metadata describing the original source, can be made by contacting the corresponding author.

We conducted a retrospective cohort study comparing adult members who attended the Wellness Institute (an accredited MFF)[19] in Winnipeg, Manitoba, Canada, to adult general population controls. Controls were identified through a provincial health registry in Manitoba, which captures all individuals obtaining health services in Canada's single-payer universal health system. This retrospective cohort study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology guidelines (Table S1).

Data Sources

Data were sourced from the Population Research Data Repository housed at the Manitoba Centre for Health Policy (Table S2).[20] Repository data are deidentified, meaning sensitive information that could identify the individual is removed before inclusion in the repository. However, individuals' data are linkable across all administrative health databases using a scrambled coded identifier derived from an individual's' 9-digit personal health identification number. This study was approved by the University of Manitoba Research Ethics Board (Ethics No. HS19825 [H2016:224]). Informed consent was not required due to the retrospective nature of the study.

The Wellness Institute collects identifiers at the time of membership, including personal health identification number, first and last name, and date of birth. As such, membership data could be linked to the repository. The proportion of members that could not be linked owing to missing identifying characteristics was 9.6%. The Wellness Institute also has scanning systems to gain access to the facility that track attendance. The medical fitness facility is not publicly funded, and the cost of a membership may range from 50 to 60 CAD per month.

Study Population

The intervention group included adult members (aged ≥18 years) at the Wellness Institute living in Winnipeg. Any member of the public can join the Wellness Institute for a monthly fee. It is adjoined to a community hospital, and its membership typically includes healthy adults and individuals managing chronic disease. Members were included from the introduction of the facility scanning systems, January 1, 2005, until December 31, 2015. The intervention group was assigned an index date that matched their membership start date. Controls included adult residents of Winnipeg that were registered with the provincial health insurance registry under a single-payer health system between January 1, 2005, and December 31, 2015. A pseudo-index date was assigned to the control group on the basis of the time difference between start and end dates in the intervention group. The frequency distributions of time differences were then applied at random to controls.[21] The control group was restricted to individuals who had a pseudo-index date before their health registry end date, which would have indicated loss to follow-up or death. Individuals who had index dates outside their provincial health coverage dates, those who had <1 continuous year of health coverage before the index date, those without a postal code that was used to assign socioeconomic status, and those who had a prior MACE were excluded from the analysis.

Data Collection

Demographic data were obtained from the Manitoba Health Insurance registry. Comorbidities were assessed using validated comorbidity definitions using *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) and *Tenth Revision, Canada* (*ICD-10-CA*) codes collected from physician and hospital claims as well as appropriate laboratory cutoffs based on diagnostic laboratory reporting (Table S3).[22–26] Income quintiles were used as a proxy for socioeconomic status by linking postal codes to dissemination areas that are composed of an average population of 400 to 700 people providing data on average household income based on national census data.[27]

Exposures

The intervention group included new registered members at the Wellness Institute between January 1, 2005, and December 31, 2015. Data were captured when members scanned in to access the facility to assess for a dose–response relationship. Members were stratified into 2 groups on the basis of the total number of visits over the total duration in weeks of their membership during the study period: low-frequency attenders (LFAs; ≤1 visit per week), regular frequency attenders (RFAs; >1 visit per week).

Outcomes

The primary outcome was time to a 3-point MACE+ (nonfatal myocardial infarction, nonfatal stroke, heart failure) with a hospitalization for at least a single day (>24 hours) or cardiovascular death (Table S4).[28] Individuals were censored for non-cardiovascular death, the end of the study period, or loss to follow-up. Individuals were considered lost to follow-up if they moved away from the province or if their provincial health coverage was terminated.

Statistical Analysis

Baseline characteristics are presented by membership status and frequency of attendance. Continuous variables are presented as means and SD and categorical variables are presented as frequencies and percentages. Between-group comparisons were performed using the independent *t*-test for continuous variables and χ^2 test for categorical variables. Cox proportional hazards regression models were used to perform multivariate analyses adjusting for the following covariates: age, sex, index year, income quintile, dementia, chronic obstructive pulmonary disease, cirrhosis, diabetes, chronic kidney disease, cancer, metastatic cancer, hypertension, and dyslipidemia. Hazard ratios (HRs) and their corresponding 95% CIs were reported. Since 15 covariates were assessed, the statistical significance for Schoenfeld's residuals was further evaluated using a conservative Bonferroni *P* value (0.05/15=0.003). Given the nature of the administrative data, there were no missing data. Secondary competing risk analyses that accounted for non-cardiovascular death were performed using Fine–Gray subdistribution hazard models.[29] Sensitivity analyses were performed using inverse probability treatment weighting. Statistical analyses were performed using SAS/STAT software, version 9.4 (SAS Institute, Cary, NC).[30]

RESULTS

A total of 11 319 members at the Wellness Institute were included in the intervention group and 507 400 in the control group (Figure). In the intervention group, 7222 members were LFAs.

Baseline Characteristics

At baseline, members had a higher prevalence of diabetes, hypertension, and dyslipidemia compared with controls (Table 1). LFAs had a higher proportion of previously diagnosed chronic obstructive pulmonary disease, diabetes, hypertension, and dyslipidemia compared with RFAs. Members were more likely to be from a higher income quintile compared with controls.

Primary Outcome

The median follow-up time was 3052 (interquartile range, 1990–4143) days in the control group and 3306 (interquartile range, 2221–4407) days in the intervention group. The total numbers of MACEs+ were 558 (4.9%) and 35 306 (7.0%) in the intervention and control groups, respectively. Compared with controls, the intervention group demonstrated a lower risk of a MACE+ in unadjusted models (HR, 0.66 [95% CI, 0.61–0.72]) (Table 2; Table S5). This association persisted in adjusted models (HR, 0.88 [95% CI, 0.81–0.96]). In competing risk analyses, the total numbers of competing non-cardiovascular mortality events were 20 878 (4.1%) and 283 (2.5%) in the control and intervention groups, respectively. The association between MFF membership and reduced risk of MACE+ remained significant in adjusted competing risk analyses (subdistribution HR, 0.91 [95% CI, 0.84–0.99]; Table 2; Table S5).

In the primary outcome analysis that focused on frequency of MFF attendance, the median follow-up time was 3409 (interquartile range, 2314–4379) days in LFAs and 3312 (interquartile range, 2122–4424) days in RFAs. The total number of MACEs+ was 369 (5.2%) in LFAs and 177 (4.6%) in RFAs. Compared with controls, both groups were associated with a lower risk of a MACE+ in unadjusted models (LFAs: HR, 0.69 [95% CI, 0.62–0.76]; RFAs: HR, 0.60 [95% CI, 0.52–0.70]). A dose–response effect was apparent in adjusted models (LFAs: HR, 0.94 [95% CI, 0.85–1.04]; RFAs: HR, 0.77 [95% CI, 0.67–0.89]; Table 2; Table S5). The total numbers of competing non-cardiovascular mortality events were 173 (2.4%) in LFAs and 182 (4.4%) in RFAs, and the dose–response effect was still apparent in adjusted competing risk models (LFAs: subdistribution HR, 0.98 [95% CI, 0.88–1.08]; RFAs: subdistribution HR, 0.80 [95% CI, 0.69–0.92]; Table 2; Table S5). Results from our sensitivity analyses strengthened the association of membership and frequency of attendance with a MACE+ event (Table S6).

DISCUSSION

In this retrospective observational cohort study of 11 319 adult members at an MFF and 507 400 adult general population controls from Winnipeg, Canada, we found that membership and frequency of attendance at an MFF were associated with a decreased risk of a MACE+ over a median 8+ years of follow-up. MFF membership was associated with a 12% lower hazard risk of a MACE+, and members who attended an MFF more frequently (>1 weekly visit) were associated with a 23% lower hazard risk of a MACE+ when defined by hospitalizations or cardiovascular death.

To our knowledge, this is the first study to explore the association of MFF membership and frequency

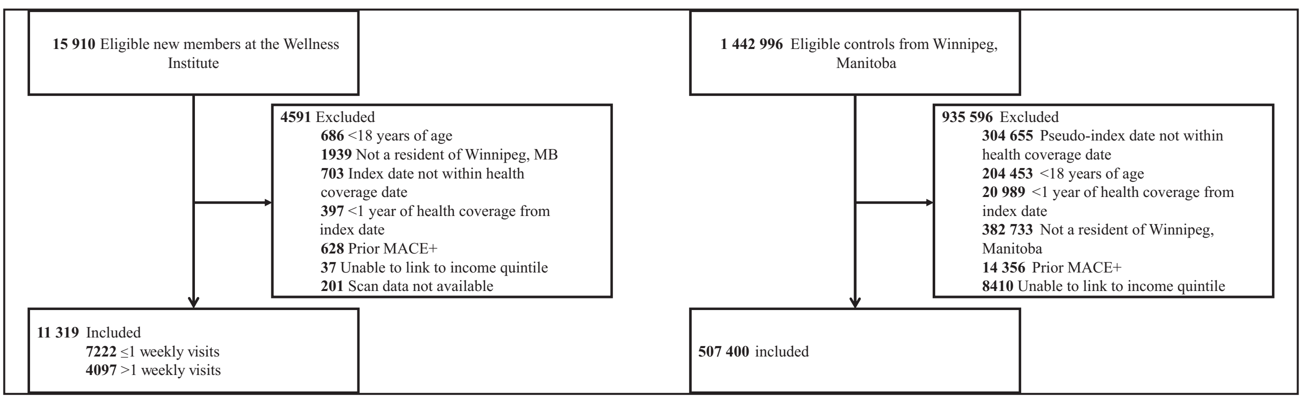

Figure 1. Strengthening the Reporting of Observational Studies in Epidemiology diagram.
MACE indicates major adverse cardiovascular event.

Table 1. Baseline Characteristics of Members at a Medical Fitness Facility and Controls

	Members	Controls	*P* value	≤1 weekly	>1 weekly	*P* value
N	11 319	420 777		7222	4097	
Age, y, mean (SD)	46.7 (18.1)	46.1 (17.6)		46.7 (18.1)	46.8 (17.4)	
Male sex, n (%)	5197 (45.9)	244 266 (48.1)	<0.001	3025 (41.9)	2172 (53.0)	<0.001
Previous diagnosis, n (%)						
COPD	663 (5.9)	29 438 (5.7)	0.79	438 (6.1)	225 (5.5)	0.44
Cirrhosis	478 (4.2)	20 719 (4.1)	0.46	313 (4.3)	165 (4.0)	0.55
Diabetes	1298 (11.5)	53 905 (10.6)	0.004	867 (12.0)	431 (10.5)	<0.001
CKD*	127 (1.1)	7034 (1.4)	0.02	92 (1.3)	36 (0.8)	0.02
Cancer	855 (7.6)	39 782 (7.8)	0.27	548 (7.6)	307 (7.5)	0.52
Metastatic carcinoma	65 (0.6)	3716 (0.7)	0.05	45 (0.6)	20 (0.5)	0.10
Hypertension	3326 (29.4)	141 789 (27.9)	<0.001	2151 (29.8)	1175 (28.7)	0.002
Dyslipidemia	2892 (25.5)	115 375 (22.7)	<0.001	1860 (25.8)	1032 (25.2)	<0.001
Index year, n (%)						
2005	1397 (12.3)	56 581 (11.2)	<0.001	819 (11.3)	578 (14.1)	<0.001
2006	1040 (9.2)	43 586 (8.6)	0.03	670 (9.3)	370 (9.0)	0.08
2007	1043 (9.2)	43 846 (8.6)	0.03	675 (9.4)	368 (9.0)	0.08
2008	1084 (9.6)	46 565 (9.2)	0.15	699 (9.7)	385 (9.4)	0.3
2009	1199 (10.6)	51 691 (10.2)	0.16	822 (11.4)	377 (9.2)	<0.001
2010	1175 (10.4)	50 377 (9.9)	0.11	825 (11.4)	350 (8.5)	<0.001
2011	908 (8.0)	42 417 (8.4)	0.20	604 (8.4)	304 (7.4)	0.10
2012	863 (7.6)	41 316 (8.1)	0.05	583 (8.1)	280 (6.8)	0.01
2013	898 (7.9)	45 479 (9.0)	<0.001	584 (8.1)	319 (7.8)	<0.001
2014	877 (7.8)	43 968 (8.7)	<0.001	558 (7.7)	319 (7.8)	0.003
2015	835 (7.4)	41 574 (8.2)	0.002	383 (5.3)	452 (11.0)	<0.001
Income quintiles, n (%)						
1 (lowest)	1266 (11.2)	101 202 (20.0)	<0.001	824 (11.4)	442 (10.8)	<0.001
2	2420 (21.4)	101 270 (20.0)	<0.001	1567 (21.7)	853 (20.8)	<0.001
3	2459 (21.7)	97 633 (19.2)	<0.001	1570 (21.7)	889 (21.7)	<0.001
4	3030 (26.8)	102 439 (20.2)	<0.001	1904 (26.4)	1126 (27.5)	<0.001
5 (highest)	2144 (18.9)	104 856 (20.7)	<0.001	1357 (18.8)	787 (19.2)	<0.001

CKD indicates chronic kidney disease; and COPD, chronic obstructive pulmonary disease.
*Defined as estimated glomerular filtration rate <60 mL/min per 1.73 m^2.

of attendance with MACE+ defined by a hospitalization/physician claims for cardiovascular events and death, when compared with a control group adjusted for demographics, socioeconomic status, and comorbidities in a universal health care system. MFF is a complex intervention that may be used in conjunction with primary care and subspecialty physicians to reduce cardiovascular risk. Individuals may benefit by engaging in aerobic and anaerobic exercise, resistance training, having access to nutrition and dietary counseling, education classes on chronic disease management, and being part of a social support network.[5,7,16,31,32] This is particularly important in the management of traditional CVD risk factors such as diabetes, hypertension, dyslipidemia, and smoking, but it is unclear to what degree each aspect of this multimodal intervention impacts overall cardiovascular risk.

Although previous studies have not explored the relationship between MFFs and MACEs, many have investigated the impact of behavioral interventions offered at MFFs on the primary and secondary prevention of CVD and have found similar results. In a study of 88 140 primarily White adults (aged >40 years) from the United States, performing at least 60 minutes of PA per week was associated with a lower risk of incident cardiovascular death compared with being inactive after adjusting for sex, age, ethnicity, education, marital status, body mass index, smoking, and drinking status.[33] Similarly, a study of 104 046 adults from the Copenhagen General Population study found that compared with low leisure time PA (almost completely sedentary or light PA <2 h/wk), moderate (2–4 h/wk) and high PA (>4 h/wk) were associated with a 14% and 23% lower hazard risk of an incident MACE, when

Table 2. Association of Members at a Medical Fitness Facility and Major Adverse Cardiovascular Events*

Cox proportional hazards models			Competing risk models†	
Model (reference=controls)‡	HR	95% CI	HR	95% CI
Main				
Unadjusted	0.66	0.61–0.72	0.67	0.61–0.72
Adjusted	0.88	0.81–0.96	0.91	0.84–0.99
Dose response				
Unadjusted				
Low-frequency attenders	0.69	0.62–0.77	0.70	0.63–0.77
Regular-frequency attenders	0.60	0.52–0.70	0.61	0.53–0.70
Adjusted				
Low-frequency attenders	0.94	0.85–1.04	0.98	0.88–1.08
Regular-frequency attenders	0.77	0.67–0.89	0.80	0.69–0.92

HR indicates hazard ratio.
*MACE+ is defined as a hospitalization (>24 hours) for myocardial infarction, stroke, or heart failure *or* cardiovascular death.
†Competing risk models are adjusted for any non-cardiovascular death during the follow-up period.
‡Models adjusted for age, sex, index year, income quintile, dementia, chronic obstructive pulmonary disease, cirrhosis, diabetes, chronic kidney disease, cancer, metastatic cancer, hypertension, and dyslipidemia.

adjusted for lifestyle and socioeconomic factors.[34] In the Atherosclerosis Risk in Communities study, it was found that those who engaged in leisure-time PA in the past year had a longer life expectancy free of nonfatal incident coronary heart disease (1.5–1.6 years), stroke (1.8 years), and heart failure (1.6–1.7 years) compared with those who did not engage in leisure-time PA.[35] A study among Norwegian adults found that increased PA (≥1 h/wk of strenuous PA) accounted for 9% of the decline in hospitalized and nonhospitalized fatal and nonfatal CVD events.[36] However, they quantified PA through self-reported PA questionnaires, whereas this study was able to objectively determine the frequency of attendance through scan data required for entry to the facilities (a proxy for PA). Previous studies have also shown a dose–response effect based on objectively measured 7-day accelerometer data. Compared with the lowest quartile of moderate- and vigorous-intensity PA, higher quartiles were associated with an adjusted lower risk of incident CVD.[37]

Behavioral interventions other than PA can also be beneficial for reducing CVD risk. The MFF model offers members programs such as weight loss clinics, healthy eating, and smoking cessation classes and provides educational seminars on better sleep strategies. In 4500 participants from the Second Manifestations of ARTerial disease cohort, those who stopped smoking after their first cardiovascular event had a 44% lower hazard risk of a recurrent MACE, as compared with patients who continued smoking.[4] In a recent systematic review, smoking cessation among stroke survivors was associated with a reduced risk of a reoccurring vascular event. Moreover, providing counseling support for survivors of stroke increased the likelihood of abstaining from smoking.[38] In a large prospective cohort study of 17 000 individuals with no known CVD, investigators found that a dietary pattern characteristic of added fats, fried food, eggs, processed meats, and sugar-sweetened beverages was at a 56% higher hazard risk of acute coronary heart disease, after adjusting for lifestyle factors and socioeconomic status.[39] Furthermore, many studies have demonstrated that adherence to a Mediterranean-like dietary pattern (consisting of fish, monosaturated fats from olive oil, vegetables, whole grains, legumes/nuts, and moderate alcohol consumption) has the potential benefit to lower cardiovascular risk factors, disease, and death.[40–42] In 20 000 Dutch participants with no prior CVD and a median follow-up of 10 years, researchers found that individuals who slept for a shorter duration and had poorer sleep quality were at 63% increased hazard risk of CVD, as compared with normal sleepers with good sleep quality.[43]

The strengths of this study include its large sample size of verified MFF members and controls that are representative of the general population without any previous MACEs; the use of swipe access at facility entry, which allowed for an accurate estimate of facility attendance; linking to provincial health administrative databases; use of validated algorithms for the ascertainment of covariates and outcomes; and the long follow-up period with many end point events. However, this study also has limitations. First, we were not able to adjust for some key comorbidities, ethnicity, and lifestyle factors that may be associated with both the exposure and outcomes that may have resulted in confounding, including body mass index, smoking and alcohol intake, diet, sleep, and medication use. Second, we were not able to capture the type, duration, and intensity of PA or other behavioral interventions that members participated in, and therefore could not measure the magnitude that each activity contributed to reducing the risk of a MACE. Similarly, we do not have data on nonmembers and what types of behavioral interventions they are engaging in. Third, there may be a selection bias, as members at an MFF may be more likely to engage in positive health behaviors as compared with controls, and these members may not be representative of the general population, as they may not have access to the facilities. Finally, it may also be possible that the majority of visits to the facilities came at the start of an individual's membership, and therefore the effect of various attendance patterns could not be controlled for as a time-varying covariate given the known issues with long-term adherence to exercise.

The results of this study have important individual and public health implications. From an individual patient perspective, MFFs may be an intervention used in conjunction with medical care to optimize CVD risk factors and promote positive health behaviors that may be beyond the scope of primary or subspecialty care. From a public health perspective, incentivizing MFF membership through private membership rebates or the creation of public facilities and services may be cost effective in reducing cardiovascular morbidity and death, but this requires additional research, ideally in the form of a large pragmatic cluster randomized controlled trial focused on cardiovascular outcomes and cost effectiveness.

CONCLUSIONS

The MFF model, which offers a multimodal approach aimed at lifestyle modification, may improve risk in members. These findings were more pronounced among more frequent attendees. Confirmatory studies should be performed to consider including MFFs as a public health intervention, especially for populations at risk for CVD, to manage traditional CVD risk factors, delay death, and reduce health care costs associated with hospitalizations.

ARTICLE INFORMATION

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Supplemental Material

Tables S1–S6.

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