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RESEARCH ARTICLE

Association of Membership at a Medical Fitness Facility With Adverse Health Outcomes

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Introduction: Interventions that increase physical activity behavior can reduce morbidity and prolong life, but long-term effects in large populations are unproven. This study investigates the association of medical fitness facility membership and frequency of attendance with all-cause mortality and rate of hospitalization.

Methods: A propensity weighted retrospective cohort study was conducted by linking individuals who attended medical fitness facilities in Winnipeg, Canada to provincial health administrative databases. Members aged ≥18 years who had ≥1 year of provincial health coverage from their index date between January 1, 2005 and December 31, 2015 were included. Controls were assigned a pseudo-index date at random on the basis of the frequency distribution of index dates in the intervention group. Members were stratified into low-frequency attenders (<1 weekly visit), moderate-frequency attenders (1−3 weekly visits), and high-frequency attenders (>3 weekly visits). The primary outcomes were time to all-cause mortality and rate of hospitalizations. Statistical analyses were performed between 2018 and 2020.

Results: Among 19,300 adult members and 515,810 controls, members had a 60% lower risk of all-cause mortality during the first 651 days and 48% after 651 days. Membership was associated with a 13% lower risk of hospitalizations. A dose−response effect was apparent because higher weekly attendance was associated with a lower risk of hospitalizations (low frequency: 9%, moderate frequency: 20%, high frequency: 39%).

Conclusions: Membership at a medical fitness facility was associated with a reduced risk of all-cause mortality and hospitalizations. Healthcare systems should consider the medical fitness model as a preventative public health strategy to encourage physical activity participation.

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INTRODUCTION

Physical inactivity is a leading independent risk factor for mortality.[1] The prevalence of physical inactivity is 30% worldwide.[2] In the U.S., approximately half of the population achieves the recommended physical activity (PA) levels, and a quarter of the population does not participate in any leisure-based PA.[3] These levels of physical inactivity are associated with an annual economic burden of approximately $27 billion (U.S. dollars).[4] Several observational studies found that individuals participating in less-vigorous (i.e., brisk walking) to highly vigorous (i.e., swimming, running, recreational sports) PA have a 15%–45% lower risk of mortality than inactive individuals.[5–8] Furthermore, regular PA has consistently been associated with reduced risk of noncommunicable diseases and their associated complications.[5,9–15]

Medical fitness facilities (MFFs) aim to attract both healthy individuals and populations with health risks, including older adults and individuals with chronic diseases. The main principle of the medical fitness model is to improve health status by providing evidence-based, medically integrated programming to promote health. The medical fitness model incorporates a greater degree of medical oversight, supervision, and guidance than traditional fitness centers. This includes clinical integration with the health system, a higher level of staff education and training, programs to help bridge acute hospital care and long-term medical services, and robust emergency response and safety plans.[16] Being a member at these facilities gives the opportunity to engage in many forms of PA by having access to cardio and weight training equipment, indoor recreation facilities, and a variety of group fitness classes. Therefore, attendance at these facilities may be used as a proxy for PA. In addition, they also provide health assessment and personal wellness plans; health education and challenges; and coaching services that focus on other aspects of lifestyle, including nutrition, stress management, sleep, smoking cessation, and disease management.

The primary aim of this study is to determine the association of MFF membership and frequency of attendance with all-cause mortality and the risk of hospitalization for any cause.

METHODS

A retrospective cohort with an intention-to-treat study design was used to compare members who attended either of 2 MFFs in Winnipeg, Canada with general population controls. Controls were identified through linked provincial health registries, which capture all individuals obtaining health services in Canada's single-payer universal health system.

Data were sourced from the Population Research Data Repository housed at the Manitoba Centre for Health Policy (Appendix Table 1, available online).[17,18] The study was approved by the Manitoba Health Information Privacy Committee (2017/2018-04) and received ethics approval from the University of Manitoba Research Ethics Board (HS19825 [H2016:224]). Repository data are deidentified, meaning that sensitive information that could identify the individual is removed before inclusion in the repository. However, individuals' data are linkable across databases using a scrambled coded identifier derived from an individuals' 9-digit personal health identification number (PHIN).

The MFFs collect identifiers, including PHIN, first and last name, and date of birth. These databases were linked to the repository by Manitoba Health using PHIN if available or by identifying characteristics such as date of birth, sex, and postal code. The proportion of members that were not able to be linked owing to missing identifying characteristics was 9.6%. Both MFFs have introduced scanning systems to gain access to the facility.

Study Population

The intervention group included members (aged ≥18 years) at the MFFs who were living in the city of Winnipeg, Canada. These facilities are open to any member of the public to join. Members were included from the introduction of the facility scanning systems (January 1, 2005 for the Wellness Institute and August 1, 2006 for the Reh-Fit Centre) to 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 the start and end dates in the intervention group. The frequency distributions of time differences were then applied at random to controls.[19] The control group was restricted to individuals who had a pseudo-index date before the health registry end date, which would have indicated loss to follow-up or death. Individuals who had index dates that were not between their health coverage dates, those who had <1 year of health coverage before the index date, those with duplicate entries in the health registry, and those without a postal code (which was used to assign SES) were excluded from the analysis.

Measures

Demographic data were collected by linking scrambled 9-digit PHIN to health registry databases. Comorbidities were assessed using validated comorbidity indexes using well-defined ICD-9-CM and ICD-10 Canada codes collected from physician and hospital claims (Appendix Table 2, available online).[20,21] Income quintiles were used as a proxy for SES by linking postal codes to dissemination areas that are composed of an average population of 400–700 people providing data on average household income on the basis of national Census data.[22]

The intervention group included newly registered members at either MFF. Data were captured from each respective MFF on when members scanned in to access the facility to assess the dose–response relationship. Members were stratified into 3 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), moderate-frequency attenders (MFAs) (1–3 visits per week), and high-frequency attenders (HFAs) (>3 visits per week), as informed by previous literature.[23]

The primary outcome was time to all-cause mortality, with the date of death ascertained from the health insurance registry data. The Manitoba Centre for Health Policy follows a rigorous data quality framework with robust completeness of mortality data.[18] Individuals were censored at the end of the study period or were lost to follow-up. Individuals were considered lost to follow-up if they moved away from the province or had their health coverage terminated for unknown reasons. The secondary outcome of hospitalizations was determined by the frequency of hospitalizations during the study period. *A visit to the hospital* was defined as a single stay (>24 hours), irrespective of a possible transfer to a different hospital.

Statistical Analysis

Characteristics were presented by MFF membership status, with categorical variables presented as frequencies and percentages and continuous variables presented as means and SDs. A predicted probability (propensity score) of being assigned to the intervention group was developed using a logistic regression model that incorporated log(age), sex, income quintile, index year, and comorbidities. A multinomial logistic regression model that incorporated the same covariates was used to determine the propensity scores for the dose–response relationship.[24] Propensity scores were then used to estimate the treatment effect by the inverse probability treatment weighting (IPTW) adjustment method.[25,26] To account for extreme weights, stabilized weights were used.[27,28] Balance in covariates between groups was assessed using the standardized mean difference (SMD) before and after IPTW, with a balanced covariate having SMD <0.1 after IPTW.[29,30]

The association of the intervention with the outcome of time to all-cause mortality was analyzed with time-dependent Cox hazards regression models. Schoenfeld residuals were plotted against rank failure times to determine the time interaction term through visual inspection. Deviation of the residual plot occurred at 651 days (Appendix Figure 2, available online). Negative binomial regression models were used to analyze the association between membership and the rate of hospitalization. Similar models were applied in the dose–response cohort.

A sensitivity analysis was conducted, including only members who had continuous membership for ≥1 year. Control subjects who had <1 year of follow-up time were excluded to account for immortal time bias.

A negative control sensitivity analysis was conducted to compare the risk of a major bleeding event in the intervention group with that in the controls. *Bleeding* was defined as an incident major bleeding event (gastrointestinal, intracranial, or joint hemorrhage) captured using International Classification of Diseases diagnosis codes in medical claims and hospitalizations data from the time of index or pseudo-index date to death, loss to follow-up, or study end (Appendix Table 3, available online). Unadjusted Cox proportional hazards regression was used to compare the confounding structure of the negative control and mortality.[31] Statistical analyses were performed using SAS/STAT, version 9.4, from 2018 to 2020.

RESULTS

A total of 19,300 MFF members were included in the intervention group and 515,810 in the control group (Appendix Figure 1, available online). Among the intervention group, 12,171 members were LFAs, 6,457 were MFAs, and 672 were LFAs.

Members were more likely to be from a higher income quintile and had more comorbidities at baseline (myocardial infarction, diabetes, cancer, depression, hypertension, and coronary artery disease) than controls (Table 1). LFAs and MFAs had a higher proportion of previously diagnosed cancer, depression, and hypertension than HFAs (Appendix Table 4, available online). All groups were more likely to be from a higher income quintile than the controls. All covariates were balanced with an SMD <0.1 (Table 1 and Appendix Table 5, available online).

Propensity scores demonstrated a significant overlap between controls and all study cohorts, satisfying the positivity assumption of propensity score methods (Figure 1A–D). The mean stabilized weight in controls was 0.99 (SD=0.02), and that in the intervention group was 0.99 (SD=0.47). LFAs, MFAs, HFAs, and controls had mean stabilized weights of 0.99 (SD=0.52), 1.00 (SD=0.49), 0.99 (SD=0.77), and 1.00 (SD=0.02), respectively.

The median follow-up time was 4.94 years in the control group and 5.35 years in the intervention group. The total number of deaths was 500 (2.6%) in the intervention group and 27,789 (5.4%) in the control group. The intervention group demonstrated a lower risk of all-cause mortality during the first 651 days in the stabilized IPTW model than controls (hazard ratio [HR]=0.40, 95% CI=0.33, 0.58) (Figure 2). This association persisted after 651 days (HR=0.52, 95% CI=0.48, 0.58).

The median follow-up time was 5.75 years in LFAs, 5.00 years in MFAs, and 3.74 years in HFAs. The total number of deaths was 321 (2.6%) in LFAs, 170 (2.6%) in MFAs, and 9 (1.3%) in HFAs. All groups were associated with a lower risk of all-cause mortality during the first 651 days (LFAs: HR=0.37, 95% CI=0.35, 0.38; MFAs: HR=0.40, 95% CI=0.38, 0.42; HFAs: HR=0.84, 95% CI=0.81, 0.87); however, a significant dose–response relationship was not observed (Figure 2). After 651 days, a larger effect was found in HFAs (HR=0.26, 95% CI=0.25, 0.26) compared with that in MFAs (HR=0.54, 95% CI=0.53, 055) and LFAs (HR=0.53, 95% CI=0.52, 0.54).

MFF members had a lower risk of hospitalization in the stabilized IPTW model than the controls (rate ratio=0.87, 95% CI=0.83, 0.91) (Figure 3). A dose

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

	Unweighted			IPTW		
Characteristics	**Controls**	**Intervention**	**Standardized mean difference**	**Controls**	**Intervention**	**Standardized mean difference**
n	515,810	19,300		515,795.0	19,298.7	
Age in years, mean (SD)	47.3 (18.2)	46.8 (17.3)	0.026	47.2 (18.2)	47.2 (17.4)	0.005
Male sex, *n* (%)	250,091 (48.5)	8,848 (45.8)	0.053	249,587.0 (48.4)	9,196.8 (47.7)	0.015
Previous diagnosis of, *n* (%)						
Myocardial infarction	11,195 (2.2)	737 (3.8)	0.097	11,504.2 (2.2)	447.5 (2.3)	0.006
Congestive heart failure	16,689 (3.2)	589 (3.1)	0.011	16,724.4 (3.4)	673.3 (3.4)	0.010
Peripheral vascular disease	16,935 (3.3)	670 (3.5)	0.010	16,971.9 (3.3)	672.7 (3.5)	0.011
Cerebrovascular disease	22,621 (4.4)	871 (4.5)	0.006	22,644.7 (4.4)	56.5 (4.4)	0.002
Dementia	9,997 (1.9)	196 (1.0)	0.077	9,825.7 (1.9)	396.0 (2.1)	0.011
COPD	34,188 (6.6)	1,176 (6.1)	0.022	34,088.9 (6.6)	1,312.9 (6.8)	0.008
Rheumatic disease	14,741 (2.9)	584 (3.0)	0.010	14,773.1 (2.9)	573.7 (3.0)	0.006
Peptic ulcer disease	15,170 (2.9)	464 (2.4)	0.033	15,069.2 (2.9)	538.8 (2.8)	0.008
Cirrhosis	21,561 (4.2)	784 (4.1)	0.006	21,539.4 (4.2)	818.5 (4.2)	0.003
Diabetes	58,764 (11.4)	2,336 (12.1)	0.022	58,896.9 (11.4)	2,234.2 (11.6)	0.005
Paraplegia and hemiplegia	5,300 (1.0)	191 (1.0)	0.004	5,293.2 (1.0)	202.6 (1.1)	0.002
Renal disease	9,382 (1.8)	309 (1.6)	0.017	9,342.1 (1.8)	374.0 (1.9)	0.009
Cancer	42,333 (8.2)	1,894 (9.8)	0.056	42,633.3 (8.3)	1,622.1 (8.4)	0.005
Metastatic carcinoma	3,916 (0.8)	157 (0.8)	0.006	3,926.5 (0.8)	159.8 (0.8)	0.008
HIV/AIDS	735 (0.1)	10 (0.1)	0.029	718.1 (0.1)	16.3 (0.1)	0.016
Anxiety disorder	2,188 (0.4)	86 (0.5)	0.003	2,192.1 (0.4)	91.2 (0.5)	0.007
Depression	119,281 (23.1)	4,986 (25.8)	0.063	119,786.0 (23.2)	4,575.8 (23.7)	0.011
Hypertension	152,672 (29.6)	6,507 (33.7)	0.089	153,434.0 (29.8)	5,725.9 (29.7)	0.002
Coronary artery disease	40,563 (7.9)	1,939 (10.1)	0.077	40,971.0 (7.9)	1,557.9 (8.1)	0.005
Index year, *n* (%)						
2005	36,408 (7.1)	1,458 (7.6)	0.019	36,502.7 (7.1)	1,420.4 (7.4)	0.011
2006	49,124 (9.5)	2,018 (10.5)	0.031	49,291.9 (9.6)	1,754.7 (9.1)	0.016
2007	53,164 (10.3)	2,113 (11.0)	0.021	53,279.7 (10.3)	1,933.7 (10.0)	0.010
2008	46,401 (9.0)	1,728 (9.0)	0.001	46,393.7 (9.0)	1,774.0 (9.2)	0.007
2009	53,715 (10.4)	2,062 (10.7)	0.009	53,762.1 (10.4)	1,997.1 (10.3)	0.002
2010	47,069 (9.1)	1,787 (9.3)	0.005	47,095.1 (9.1)	1,816.1 (9.4)	0.010
2011	45,065 (8.7)	1,787 (9.3)	0.008	45,022.4 (8.7)	1,701.4 (8.8)	0.003
2012	46,031 (8.9)	1,664 (8.6)	0.011	45,974.3 (8.9)	1,735.3 (9.0)	0.003
2013	49,580 (9.6)	1,743 (9.0)	0.020	49,470.3 (9.6)	1,858.8 (9.6)	0.001
2014	47,085 (9.1)	1,654 (8.6)	0.020	46,978.9 (9.1)	1,750.1 (9.1)	0.001
2015	42,168 (8.2)	1,430 (7.4)	0.029	42,024.3 (8.2)	1,557.1 (8.1)	0.003
Income quintiles, *n* (%)						
1 (lowest)	104,468 (20.3)	1,845 (9.6)	0.304[a]	102,476.0 (19.9)	3,867.3 (20.0)	0.004
2	103,949 (20.2)	3,274 (17.0)	0.082	103,351.0 (20.0)	3,818.0 (19.8)	0.006
3	100,065 (19.4)	3,566 (18.5)	0.024	99,889.1 (19.4)	3,721.0 (19.3)	0.002
4	103,453 (20.1)	4,656 (24.1)	0.098	104,207.0 (20.2)	3,904.6 (20.2)	0.001
5 (highest)	103,875 (20.1)	5,959 (30.9)	0.248[a]	105,872.0 (20.5)	3,987.9 (20.7)	0.003

[a]Standardized mean difference was >0.1.
COPD, chronic obstructive pulmonary disease; IPTW, inverse probability treatment weighting.

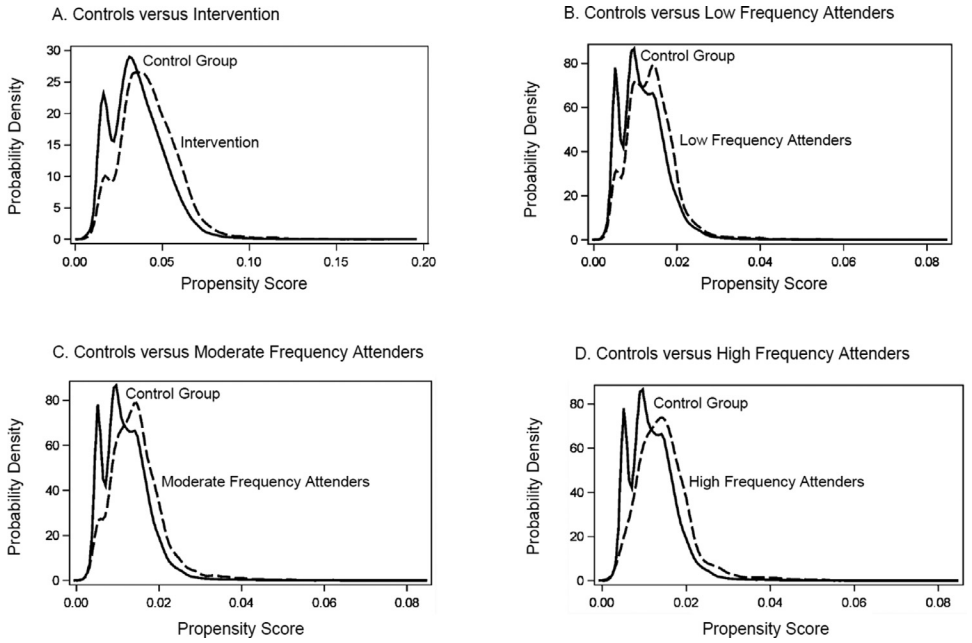

Figure 1. Propensity score distribution of members at a medical fitness facility and controls.

Note: (A) Propensity scores based on logistic regression models that included log(age), sex, index year, and comorbidities (myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, chronic pulmonary disease, rheumatic disease, peptic ulcer disease, liver disease, diabetes, paraplegia and hemiplegia, renal disease, cancer, metastatic carcinoma, HIV/AIDS, anxiety disorder, depression, hypertension, and coronary artery disease). (B–D) Propensity scores based on multinomial logistic regression models of dose–response groups with similar covariates. For intervals along the x-axis, the area under the probability density curve represents the probability of those propensity scores.

–response effect was evident because increased attendance had a lower risk of hospitalization (Figure 3).

The baseline characteristics for individuals included in the sensitivity analysis are presented in Appendix Tables 6 and 7 (available online). The SMDs of covariates were <0.1 after weighting (Appendix Tables 6 and 8, available online). Active membership for ≥1 year was associated with a lower risk of all-cause mortality (HR=0.49, 95% CI=0.44, 0.54) than the controls in stabilized IPTW models (Appendix Figure 3, available online). LFAs had a lower risk of all-cause mortality than the controls (HR=0.50, 95% CI=0.43, 0.56). No dose–response relationship was evident.

Active members for ≥1 year were less likely to be hospitalized (rate ratio=0.81, 95% CI=0.77, 0.85) than the controls in stabilized IPTW models (Appendix Figure 3, available online). A dose–response relationship was evident because increased attendance had a lower risk of hospitalization.

A major bleeding event was associated with age, previous comorbidities, and some evidence with lower SES (Appendix Table 9, available online). Besides sex, covariates had a similar pattern with mortality, suggesting that the negative control was appropriate. Being an MFF member was not associated with a major bleeding event (Appendix Table 10, available online). There was no significant difference in risk between frequency of attendance and the likelihood of having a major bleeding event.

DISCUSSION

Membership and attendance at an MFF were associated with improved survival and a decreased risk of hospitalization. Membership was associated with a 60% and 48% lower risk of all-cause mortality during early and longer follow-up, respectively. Members were also 13% less likely to be hospitalized than population controls. Hospitalizations were even lower in those that attended more frequently.

On the basis of previous literature, this is the first study to explore the association of MFF membership and frequency of attendance with mortality, when compared with a carefully selected control group in a universal healthcare system. Previous studies have investigated the impact of PA intensity on mortality and obtained similar estimates. In a pooled analysis of 600,000 participants, researchers found an inverse dose–response relationship, with higher self-reported PA levels being associated with decreasing risk of all-cause mortality

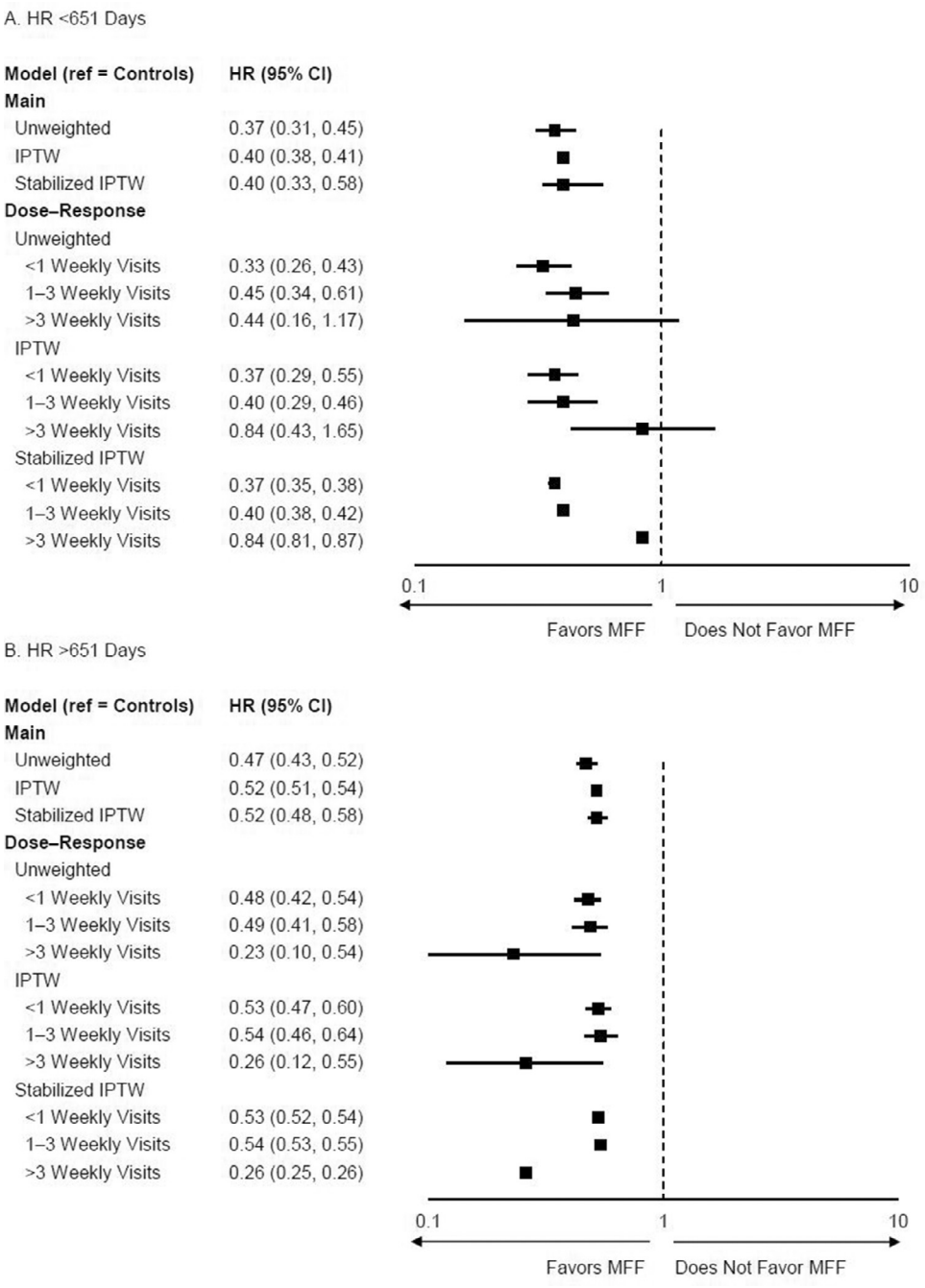

Figure 2. Association of being a member at a medical fitness facility with all-cause mortality.
HR, hazard ratio; IPTW, inverse probability treatment weighting; MFF, medical fitness facility.

than reporting no PA.[32] However, they quantified PA through subjective measures, 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 20%–40% mortality reduction with moderate-to-vigorous PA on the basis of 7-day accelerometer data, compared with the reduction with low levels of vigorous PA.[33,34] Although these findings are consistent, the magnitude of the effect was greater in this study.

Few studies have explored the association of PA with hospitalization rates. A randomized trial explored the effectiveness of a supervised 6-month exercise intervention program and found that the intervention group had a lower number of outpatient visits and no significant difference in hospitalizations after an 18-month follow-up period, compared with the controls who were not

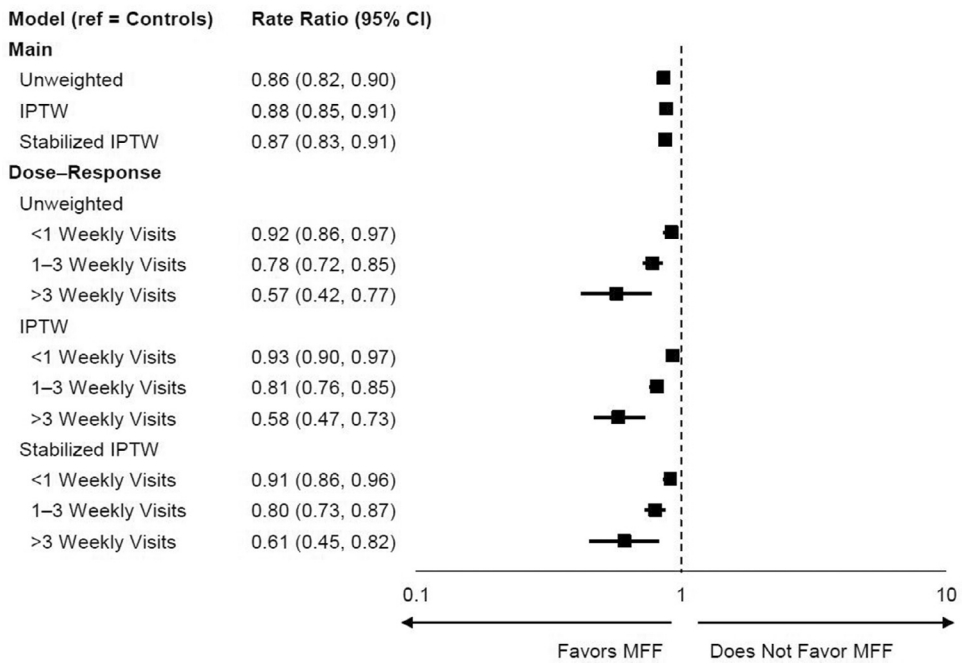

Figure 3. Association of being a member at a medical fitness facility with hospitalizations.
IPTW, inverse probability treatment weighting; MFF, medical fitness facility.

enrolled in the exercise program.[35] A cross-sectional survey study found that participants in the high PA group were less likely to have had a hospitalization in the last 12 months than their inactive counterparts.[36] However, these studies were composed of a small cohort of older adults and a short length of intervention and had a shorter follow-up period than this study. Most importantly, all healthcare encounters, including hospitalizations, were universally captured in the single-payer provincial registry. As such, the ascertainment of exposure and outcome was unique, complete, and reliable.

The WHO has declared that insufficient PA is a global public health issue and has set a target of a 10% worldwide increase in PA levels by 2025.[37] By targeting and supporting activity in older adults and in individuals with chronic disease who may have more physical (e.g., mobility) and psychological (e.g., fear of a subsequent event after myocardial infarction) barriers to PA participation, the medical fitness model may be an alternative to traditional PA promotion strategies that generally attract healthy individuals. The higher burden of several comorbid conditions in this study than in the general population suggests that by offering programs for chronic disease rehabilitation, nutrition counseling, and personalized health risk assessments along with traditional fitness facility amenities, the medical fitness model can be used effectively to target these high-risk individuals.

Adults who attended the MFF minimally still observed a survival benefit. This finding suggests that LFAs may be obtaining other positive health benefits that are reinforced by the medical fitness model (i.e., focus on nutrition, visiting a family physician). Furthermore, a linear reduction in hospitalizations with increased frequency of attendance was observed. Hospitalizations are a major cost driver of the healthcare system, and as such, the medical fitness model has the potential to contribute to notable cost savings. Cost-effectiveness analyses are needed to determine whether membership costs could offset costs of hospitalizations in a single-payer healthcare system. Such evidence could encourage policymakers to develop financial incentive models on the basis of confirmed attendance. These incentives could be used to support low-SES individuals who are not well represented at MFFs. Furthermore, future studies should explore the impact of social interactions that may have contributed to the effectiveness of the medical fitness model.

One of the main strengths of this study is the large sample size of verified members and controls and the unique access to swipe data at facility entry, which allowed for the accurate estimate of facility attendance. This study also had an extensive follow-up period, which has often not been possible in past studies using accelerometer data. Linking to provincial health administrative databases provided the unique opportunity to minimize

selection bias in the intervention and control groups using ITPW, capturing a representative sample of the entire population.

Limitations

A limitation of this study was that data controlling for lifestyle (BMI, smoking, alcohol intake, or dietary habits), frailty, and personality factors were not available. However, models were controlled for certain chronic diseases (cirrhosis and chronic obstructive pulmonary disease) that may serve as a proxy for these lifestyle factors (more severe alcohol and smoking use). PA occurring outside of the MFF in members and in controls could not be accounted for. Therefore, members may have generally been more active at baseline than controls. In addition, attendees could have been more motivated to seek health benefits at an MFF, causing concern for residual confounding; however, the negative control analysis found that there was no difference in risk between controls and members in respect to a major bleeding event. A major bleed was specifically chosen because patients with arthritis and/or increased cardiovascular risk may consume over-the-counter acetylsalicylic acid or nonsteroidal anti-inflammatory agents, and an excess of these risk factors in the control population should have led to a protective effect on bleeding in members. Furthermore, the findings may not be generalizable to populations not under a universal healthcare system or to regions where population demographics may differ. It may also be possible that most 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. In addition, attendance at an MFF does not solely reflect a measure of PA or the amount and type that was obtained. Members may be receiving other lifestyle management interventions such as nutrition counseling, disease management, and lifestyle behavior education. However, engaging in some capacity of PA is the main intervention that members participate in. Finally, there is no literature on a suitable index for the frequency of attendance at MFFs; therefore, the results should be replicated from data at similar facilities.

CONCLUSIONS

Membership at an MFF is associated with reduced all-cause mortality and with rates of hospitalization. These findings were more pronounced among more frequent attendees. Healthcare payers should consider including MFFs as a public health intervention, especially for at-risk populations, to prevent morbidity, delay mortality, and reduce the healthcare costs associated with hospitalizations.

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SUPPLEMENTAL MATERIAL

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