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Weight Loss and Diabetes Incidence with the VA Lifestyle Change Program

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Abstract

Background—Lifestyle change programs are aimed to improve health, yet little is known about their impact once translated into clinical settings. The Veterans Health Administration (VA) MOVE! program is the largest lifestyle change program in the U.S., and our objective was to determine whether participation in MOVE! is associated with reduced diabetes incidence.

Methods—This retrospective analysis used VA databases to examine patients with 3 years of continuous outpatient care during 2005–2012, who were overweight or obese. We used generalized estimating equations to examine characteristics associated with MOVE! participation, and Cox proportional hazards regression to analyze the association between participation and diabetes incidence (defined by ICD-9 code or diabetes prescription).

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Author contributions

Sandra Jackson conducted data analyses and drafted the manuscript, including literature search, production of figures, data interpretation, and writing. Lawrence Phillips provided guidance and input across all stages of study planning, analysis, and manuscript development and revisions. Qi Long provided statistical expertise for analyses and edited the manuscript. Mary Rhee, Darin Olson, Anne Tomolo, Solveig Cunningham, Usha Ramakrishnan, and K.M. Venkat Narayan contributed conceptually to study planning and edited manuscript revisions. Sandra Jackson (Emory University GDBBS) and Lawrence Phillips (Atlanta VA Medical Center and Emory University School of Medicine) had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. There was no medical writer or editor.

Conflict of interest statement

The authors declare that there is no duality of interest associated with this manuscript. With regard to potential conflicts of interest, within the past several years, Other authors have no potential conflicts of interest to declare.

Findings—Of 1·8 million eligible individuals, 238,540 (13%) participated in MOVE! between 2005–2012, and 19,367 (1% overall, 8% of participants) met criteria for “intense and sustained” participation. Intense and sustained participation was associated with greater weight loss at three years compared to less active participation and nonparticipation (−2·2% vs. −0·64% and +0·46%, respectively). Among patients who did not have diabetes at baseline, MOVE! participation was associated with lower diabetes incidence: the hazard ratio comparing less active participants to non-participants was 0·80 (95% CI, 0·77–0·83), and comparing intense and sustained participants to non-participants was 0·67 (95% CI, 0·61–0·74). These patterns were consistent across sex, race/ethnicity, and age. Participation appeared to be most beneficial among patients with higher BMI or random glucose (p-values <0·0001).

Interpretation—Participation in this large-scale, healthcare-based lifestyle change program was associated with weight loss and lower diabetes incidence. However, the observed impact may have been exaggerated by selection bias, as the program reached only a fraction of the eligible population.

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INTRODUCTION

Obesity and diabetes are public health problems of epidemic proportions, for which lifestyle change is primary management.¹ Randomized trials have shown that lifestyle change programs can facilitate weight loss and reduce diabetes incidence. For example, participants with impaired glucose tolerance who were randomized to lifestyle change in the U.S. Diabetes Prevention Program (DPP) exhibited six percent weight loss, and their progression to diabetes was reduced by 58% at 2·8 years and 34% over ten years.^{2,3} Similar results were obtained in other large studies,^{4,5} and in small-scale, community-based adaptations of the DPP, which yielded about four percent weight loss.⁶ Implementation of lifestyle interventions within healthcare systems has been recommended to scale up their reach,^{7,8} and this strategy is being employed in Europe with promising initial results.⁹ Although practice-based research is critical for informing change,¹⁰ studies of healthcare-based lifestyle change programs in the U.S. are lacking.

The Veterans Health Administration (VA) is the largest integrated healthcare system in the U.S., serving over 8 million patients each year.¹¹ Eligibility for VA care is based on service-connected disability or poverty, and the VA population is generally disadvantaged and in poorer health compared to patients receiving care in other settings.¹² In the VA, over two-thirds of veterans are overweight or obese,¹³ and nearly one in five had diabetes in 2000.¹⁴ Addressing these health issues is a priority, and the VA developed the MOVE!® Weight Management Program for Veterans. Since 2005, over 500,000 veterans have participated in MOVE!, making it the largest lifestyle change program nationwide. A preliminary evaluation found that weight loss was modest but sustained over one year.¹⁵ Our objective was to determine whether participation in MOVE! is associated with reduced diabetes incidence.

METHODS

The MOVE! program, similar to several translations of the DPP, involves interactive educational sessions pertaining to nutrition, physical activity, self-management, and goal-setting.¹⁶ The standard MOVE! curriculum includes ten core modules emphasizing improving nutrition, evaluating portions, walking with a pedometer and exercise modifications for wheelchair users, and overcoming barriers. However, MOVE! implementation was initiated in the VA with no designated funds or staff, and implementation varies across facilities in terms of organization and delivery (most sessions are in-person and group-based, but some sessions are one-on-one).¹⁷

Databases

We used VA clinical and administrative system data to conduct a retrospective cohort analysis. Data are available from 1999, and include patient demographics, vital signs, diagnoses, procedures, and prescriptions. All data were accessed through the Veterans Informatics, Information, and Computing Infrastructure (VINCI) data processing environment.

Study Population

From nearly ten million veterans receiving care between 2005–2012 (Figure 1), we selected 4.5 million veterans with at least one outpatient visit per year for at least three consecutive years, who were eligible to participate in MOVE!: patients who were either obese (body mass index [BMI] ≥ 30 kg/m²), or overweight (BMI ≥ 25) with a weight-related health condition (diabetes, coronary artery disease, hypertension, dyslipidemia, sleep apnea, or osteoarthritis). From these, we excluded patients over age 70 because MOVE! is not targeted at individuals above this age, due to uncertainty about adverse effects of overweight.¹⁸ To allow comparisons with a previous study of MOVE!,¹⁹ we also excluded veterans who would be unlikely to be able to participate in a weight loss program due to contraindications, or who would be likely to experience weight change for reasons unrelated to MOVE!, such as anorexia or cancer. Lastly, we excluded veterans missing data for key demographic and clinical indicators (such as BMI and race/ethnicity), leaving 1,844,797 patients eligible for analysis.

Measurements

MOVE! participation—The independent variable, level of MOVE! participation, was grouped into categories based on previous work.²⁰ “Intense and sustained” participation, defined as attending at least eight sessions within six months (“intense”) with a span of ≤ 129 days between the first and the last session (“sustained”), has been associated with substantially greater weight loss compared to lesser amounts of participation.²⁰ We defined “less active” participants as those who engaged in at least one session but did not meet criteria for “intense and sustained” participation. We counted MOVE! encounters for each patient from administrative data.

Diabetes incidence—The primary dependent variable of Cox proportional hazards models was diabetes incidence. For time-to-event data, baseline was assigned as a veteran’s

first MOVE! visit for participants and as the first visit at which weight was recorded after January 1, 2005 (the initial year of MOVE! roll-out) for non-participants. All regressions were adjusted for baseline year as a categorical variable, to allow for potential differences in management across years. Among patients who did not have diabetes at baseline, diabetes incidence was defined as a new use of the 250-xx ICD-9 code or prescription of a diabetes drug. The use of similar indicators has been validated;¹⁴ in sensitivity analyses, a more stringent definition of diabetes (requiring two uses of the ICD-9 code or a diabetes prescription) yielded a slightly smaller sample but equivalent results. Although we did not exclude type 1 diabetes, it is unusual in the VA population, and prevalent cases of any form of diabetes were excluded in Cox models examining diabetes incidence.

BMI—BMI was assessed using clinically recorded weight and height, after excluding implausible values (approximately 0.1%). Average height was used, if multiple measures were available for a patient. Weight was recorded as the patient's baseline weight, and follow-up weights as average weight within subsequent time windows (6 mo: 3–9 mo; 12 mo: 9–15 mo; 24 mo: 21–27 mo; 36 mo: 33–39 mo).

Random Plasma Glucose (RPG)—Laboratory glucose values were available for a subset of patients (N=814,387), and were used to conduct sub group analyses examining the association between MOVE! participation and diabetes incidence across levels of baseline RPG. We used the most recent outpatient serum or plasma glucose value measured within six months prior to a patient's baseline visit. Although patients missing RPG values were similar to other patients across factors such as baseline BMI and age, restricting our sample to this subset with available laboratory data had the potential to introduce additional selection bias, so we conducted the primary analysis of diabetes incidence on the full sample.

Weight-related illnesses and comorbidities—Illnesses were assessed using ICD-9 codes and procedure codes. The Charlson Comorbidity Index (CCI) was employed using the enhanced ICD-9 coding algorithm developed by Quan et al.²¹

Smoking—Text-based information was used to classify patients as “Current Smoker”, “Former Smoker”, or “Never / Lifetime Non-Smoker,” as previously described and validated by McGinniss et al.²²

Other Clinical and Demographic characteristics—Our models also included other factors likely to be associated with diabetes incidence and weight change, including prescription medications for weight loss and prescription medications with a known risk of weight gain, as used previously.¹⁹ We also included factors that may be associated with ascertainment of outcomes, such as use of VA health services (total number of years with at least one VA primary care visit, and average number of primary care visits per year). Distance to the nearest facility offering MOVE! was calculated using the geographic midpoint of the patient's zip code and facility coordinates. Available demographic information included age, sex, race/ethnicity, marital status, and VA facility. Race/ethnicity was defined as White, African American, and Other, the latter combining Hispanics, Asian/Pacific Islanders, and American Indians/Alaska Natives (each <2%). A simple measure of

socioeconomic status (SES) and disability status has been used previously²³ and was employed in these analyses: service-connected disability was assessed by the VA in percentages, with higher percentages indicating more severe disability, and “no disability” indicating that a veteran qualified for VA care based on low SES.

Statistical Analysis

Descriptive characteristics were calculated across levels of MOVE! participation and bivariate associations were analyzed using ANOVA (continuous variables) and Cochran-Armitage tests for trend (binomial variables). To examine patterns of weight change over three years, individuals with available weight data across four time points were compared across levels of participation.

In regression analyses, the covariates considered for inclusion in the primary model examining diabetes incidence were identified as clinical factors strongly associated with new-onset diabetes. For additional analyses (examination of characteristics associated with participation), the same demographic and clinical characteristics were examined. We conducted stepwise model selection and assessed model fit based on the Akaike information criterion (AIC) and the quasi-likelihood adaptation, QIC. We used generalized estimating equations (GEE) to account for clustering within clinics in models examining characteristics associated with enrollment and extent of participation. After verifying that assumptions were met, Cox proportional-hazards models were constructed to estimate hazard ratios for diabetes incidence among participants who had not been diagnosed with diabetes at baseline. Robust sandwich covariance matrix estimates were used to adjust for clustering at the clinic level. In addition, analyses were performed to examine the association between participation and diabetes incidence among subgroups likely to have different diabetes risk (age, sex, race/ethnicity, BMI, and RPG).

Sensitivity analyses included an examination of the impact of our health status exclusion criteria, in which we conducted analyses with both more strict criteria [excluding patients with additional conditions such as heart failure¹⁹] and more inclusive criteria, such as including veterans older than 70 years. All analyses were conducted using SAS[®] version 9.2 (Cary, NC).

Role of the funding source

The sponsors had no role in the design and conduct of the study or writing of the manuscript. SLJ and LSP had full access to raw data and the final responsibility to submit for publication. This study was approved by the Emory IRB and Atlanta VA Medical Center Research and Development Committee.

RESULTS

Characteristics of MOVE! participants

Of 1.8 million patients eligible for MOVE!, nearly 13% participated in at least one session. On average, participants were older, heavier, and sicker than nonparticipants (Table 1). Participants included more women and African Americans than non-participants, and fewer

current smokers. In GEE models, characteristics associated with greater likelihood of participation included being female or African American, having less severe disability, having more mental health conditions, or having greater BMI, greater CCI, or more years of care in the VA (Table 2).

Intense and sustained compared with less active participants

Only 1% of the eligible population participated actively enough to meet criteria for “intense and sustained” participation (8% of participants). Nearly one third of intense and sustained participants had BMIs in the range of Class III Obesity (BMI ≥ 40), compared to 22% of less active participants and 6% of non-participants (Table 1). Multivariable regression comparing intense and sustained participants vs. less active participants revealed that women were more likely to meet criteria for intense and sustained participation than men (Table 2).

Patterns of Weight Change

Among veterans with available weight data across all four time points (6, 12, 24, and 36 months, N=562,023), any participation in MOVE! was associated with modest but sustained weight loss (Figure 2). Intense and sustained participants lost approximately 2.7% of their body weight in the first six months, and maintained a loss of 2.2% over three years.

Diabetes Incidence

Among eligible patients without diabetes at baseline (N=1,400,935), participation in MOVE! was associated with lower diabetes incidence in Cox proportional hazards models (Table 3), over a mean observation period of 5 years. In the multivariable model, the adjusted hazard ratio for diabetes incidence among intense and sustained participants in MOVE!, as compared to those who did not participate, was 0.67 (95% CI, 0.61–0.74). For less active participants compared to non-participants, the hazard ratio was 0.80 (95% CI, 0.77–0.83). Greater age and BMI were also associated with increased risk of diabetes incidence, as were minority race/ethnicity and disability. Among participants, those with substantial weight loss had lower diabetes incidence [for example, HR 0.57 for those who lost >10% body weight at 6 months, compared to those who did not lose (95% CI 0.52–0.62)]. Results remained robust in sensitivity analyses using more strict, and more sensitive, inclusion criteria.

Subgroup Analyses

Analyses stratified by socio-demographic characteristics revealed no significant heterogeneity in the association between intense and sustained participation in MOVE! and diabetes incidence by gender, race/ethnicity, or age (Figure 3). However, there were statistically significant differences in the association between participation and diabetes incidence across baseline BMI and glucose categories, suggesting greater benefit of participation among those with higher BMI or RPG (both $p < 0.0001$ for interaction).

DISCUSSION

This practice-based research study examined patterns of weight loss and diabetes incidence associated with participation in a national healthcare system-based lifestyle change program.

The VA's MOVE! program did not reach a substantial proportion of the eligible population: only 13% participated in one or more sessions. Among participants, a significant, dose-dependent inverse association between diabetes incidence and participation was observed. Compared with lack of participation, intense and sustained participation was associated with 33% lower diabetes incidence, and less active participation was associated with 20% lower incidence. Subgroup analyses suggested that while results were consistent across gender, race/ethnicity, and age categories, participation may be particularly beneficial for some patients at higher risk of diabetes because of higher BMI or RPG.

Our findings are consistent with other studies that have demonstrated that participating in lifestyle change programs is associated with weight loss.^{3,6} However, the observed weight loss was much lower than the ~4% reported in translations of the DPP,⁶ which may be partly due to fewer sessions attended. Among DPP translation studies, each session attended was associated with a weight loss of -0.22 percentage points.⁶ The mean number of sessions attended among intense and sustained MOVE! participants was 12.9, which would correspond to an expected weight change of -2.8%, while less active participants attended 2.5 sessions, which would correspond to an expected loss of -0.6%. The observed weight changes among participants with 12-month data were -2.8% and -0.7%, respectively. Given the consistency of these findings with expected results, MOVE! may be as effective as other programs on a per-session-attended basis.

The observed association between MOVE! participation and diabetes incidence was also consistent with – but more modest than – the impact achieved in clinical trials emphasizing lifestyle modification.^{3–5} This may be due in part to the lesser amount of weight loss in MOVE!, as weight change was a major predictor of diabetes incidence in the DPP²⁴ and in our analyses of MOVE!. In addition, if MOVE! participants attended fewer sessions than other program participants, they may have been less likely to change diet and physical activity behaviors, which can impact insulin sensitivity and glycemic control independent of weight loss.^{25–27} Also, the above trials were targeted to individuals with prediabetes, whereas enrollment in MOVE! is based on weight status. In subgroup analyses, we observed the strongest effects of participation among patients with elevated RPG, and it is conceivable that restricting MOVE! enrollment to individuals with high-risk prediabetes would increase the strength of the association with diabetes incidence. The relatively greater benefit for intense and sustained participants may also reflect the participants' being at higher baseline risk. It would have been expected that intense and sustained subjects would have more incident diabetes, just as they had more baseline diabetes. Lastly, compared to a general population, VA patients have higher rates of disability and mental illness,¹² which may impact intervention effectiveness. Given that MOVE! was implemented in routine clinical care with no special funding or staffing, achieving even modest impact among a disadvantaged population is worthy of note.

Although prior studies found that it may take several years for new onset diabetes to be clinically diagnosed, the time to diagnosis in well-medicalized populations may be shorter. In veterans in the southeastern U.S., diabetes-range hyperglycemia appears to precede the clinical diagnosis by only 1–2 years.²⁸ Accordingly, an impact of MOVE! participation on incident diabetes in our study is consistent with relatively early diabetes recognition in the

VA, and the finding of relatively tighter association with elevated random plasma glucose – making prediabetes or unrecognized diabetes more likely – is consistent as well.

A key challenge of MOVE! is participation, as only 13% of eligible patients participated, and far fewer met targets for intense and sustained participation. The VA has taken steps to increase participation, including the elimination of co-payments, but the program is still reaching only a fraction of eligible patients. Patient compliance with lifestyle change recommendations for the prevention and management of chronic diseases is notoriously low.²⁹ Since women are over-represented among MOVE! participants, MOVE! may be better at reaching women than men. Compared to men, women are more likely to perceive themselves as needing to lose weight, and more likely to attempt weight loss.³⁰ For MOVE! to improve participation, further work may be needed to increase acceptability and interest in a lifestyle change program among men – the majority of the VA population. In addition, the midday timing of many MOVE! sessions may affect participation, as it may be difficult for adults to attend if they must miss work. Offering evening sessions, or alternative formats such as online delivery, may enhance participation.

However, further research would be needed to determine if participation remains associated with lower diabetes incidence, as MOVE! reaches a larger proportion of the eligible population. The small percentage of the eligible population that participated in MOVE! likely introduced selection bias to our study, and loss to follow-up could also bias results. For example, patients who chose to participate in MOVE!, or chose to engage consistently enough to meet intense and sustained criteria, may have been particularly highly motivated, which would exaggerate the apparent effect of participation. It is difficult to determine the magnitude of bias, as it is impossible to know the actual participation rate relative to those who were invited – many patients deemed eligible in this study may not have realistically been candidates for MOVE!, as they may live far from VA clinics offering the program, may only use VA services to obtain low-cost prescriptions, and/or may have never been invited to participate. However, successfully recruiting a larger proportion of the population may enroll participants with less motivation, who are less likely to respond.

The strengths of this analysis include a large study population and the use of national data to examine the effectiveness of a large-scale lifestyle change program within a healthcare system setting – where participants are *patients* to whom participation is *recommended*, rather than study volunteers. However, the study has limitations. Due to the observational nature of the analyses, confounding is a concern. Although it is impossible to rule out confounding by unmeasured factors, the available data allowed adjustment for many factors that may impact participation and health outcomes, such as baseline weight, smoking status, and mental health conditions. To reduce the possibility of measurement error, we excluded implausible values and utilized averages when multiple values were available. Another limitation is that facility-level MOVE! implementation varies; exploration of these differences was beyond the scope of the current study, but may merit future investigation.

Oral glucose tolerance tests could not be used to define diabetes incidence precisely; it is likely that more incident diabetes would have been detected with glucose-based criteria, as compared to ICD-9 codes. While many veterans receive some care outside of the VA,

making it possible that some diagnoses are not captured in VA records, our requirement for three years of outpatient care at the VA assured multiple opportunities for reporting diagnoses. Results remained robust in sensitivity analyses restricted to veterans receiving three consecutive years of *primary* care (a more stringent requirement).

In conclusion, we found that participation in the VA's MOVE! program was associated with modest but sustained weight loss and reduced diabetes incidence. However, only a small percentage of the eligible population participated, and low participation is a key limitation of this strategy for widespread prevention of diabetes. Further research must determine if participation can be improved, and if lifestyle change programs are effective among larger segments of the population. Initial findings such as ours, indicating potential health benefits among participants, may increase the frequency and strength of provider recommendations for patients to participate, and patient interest in participation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Research in Context Panel

Systematic Review

We conducted a scientific literature search using PubMed for clinic-based translations of lifestyle change interventions. We identified articles in English, with no publication date restrictions, using search terms including “Diabetes Prevention Program”, “lifestyle change”, “weight loss intervention”, and “translation”. We found a meta-analysis of community-based translations of the DPP, which demonstrated an average 4% weight loss.⁶ However, there were few clinic-based studies, few large-scale programs (>1000 participants), and few translation studies with diabetes incidence as an endpoint.

Interpretation

Our study adds to the literature of intervention studies, cohort studies, and meta-analyses showing that lifestyle change programs are associated with weight loss and lower diabetes incidence. We demonstrate this in a large-scale, clinic based translation, among a disadvantaged population. However, as only a small fraction of the eligible population participated in MOVE!, self-selection may have biased our results, and a key limitation of this strategy for diabetes prevention is the substantial challenge of engaging eligible patients. We hope that our findings will encourage health care providers to recommend such programs to patients, patients to participate, and researchers to conduct further evaluations of translated programs.

Figure 1. Study Population

This diagram illustrates how patients were identified for inclusion from the VA administrative database.

Figure 2. Weight Change (%) Over Three Years among Participants and Eligible Non-Participants

N=562,023. Calculations of percent weight loss were performed among veterans with data available across all four time points (6 months, 12 months, 24 months, and 36 months).

Diabetes Incidence Hazard Ratios by Subgroup

Figure 3. Hazard Ratios for Diabetes Incidence among Intense and Sustained Participants Compared to Non-Participants, by Subgroup

N=1,400,935. Examination of RPG was performed among a subgroup of patients with available laboratory data, N=814,387. Cox proportional hazards models included covariates as described in Table 3. Wald p-values for interaction terms are shown.

Table 1

Baseline Characteristics of Participants and Eligible Non-Participants, 2005–2012*

	Total	Non-Participants	MOVE! Participants		
			All	Less Active	Intense & Sustained
N	1,844,797	1,606,257	238,540	219,173	19,367
Age at baseline	53•6±11•4	53•5±11•4	54•4±10•7	54•2±10•8	56•9±9•0
Sex					
Male	93% 1,719,286	94% 1,511,135	87% 208,151	87% 191,392	87% 16,759
Female	7% 125,511	6% 95,122	13% 30,389	13% 27,781	14% 2,608
Race					
White	78% 1,435,891	79% 1,263,957	72% 171,934	72% 157,249	76% 14,685
African American	18% 333,447	17% 276,712	24% 56,735	24% 52,720	21% 4,015
Other	4% 75,459	4% 65,588	4% 9,871	4% 9,204	3% 667
BMI at baseline	32•1±5•3	31•5±5•3	36•0±6•4	35•9±6•3	37•6±7•0
25–29•9	40% 746,391	44% 711,278	15% 35,113	15% 33,154	10% 1,959
30–34•9	37% 673,376	37% 587,351	36% 86,025	37% 79,902	32% 6,123
35•0–39•9	15% 279,176	13% 215,110	27% 64,066	27% 58,676	28% 5,390
40	8% 145,854	6% 92,518	22% 53,336	22% 47,441	30% 5,895
Charlson Comorbidity Index					
0 Point	66% 1,215,121	86% 1,110,522	65% 104,599	66% 97,226	62% 7,373
1 Point	25% 469,750	11% 386,071	23% 83,679	23% 76,501	25% 7,178
2+ Points	9% 159,926	4% 109,664	11% 50,262	11% 45,446	14% 4,816
Weight-related conditions					
Diabetes	23% 429,095	21% 338,999	38% 90,096	37% 81,709	43% 8,387
Coronary Artery Disease	11% 197,944	10% 164,289	14% 33,655	14% 30,573	16% 3,082
Hypertension	55% 1,017,212	53% 848,247	71% 168,965	70% 154,353	76% 14,612
Osteoarthritis	22% 412,135	20% 324,606	37% 87,529	36% 79,770	40% 7,759
Dyslipidemia	48% 877,858	45% 720,410	66% 157,448	66% 143,783	71% 13,665

	Total	Non-Participants	MOVE! Participants		
			All	Less Active	Intense & Sustained
Sleep Apnea	1% 24,865	<1% 5775	8% 19,090	8% 17,075	10% 2,015
Mental health conditions					
Depression	22% 405,401	19% 304,753	42% 100,648	42% 92,279	43% 8,369
Psychoses	19% 355,849	17% 265,869	38% 89,980	38% 82,429	39% 7,551
PTSD	11% 200,245	9% 147,517	22% 52,728	22% 48,266	23% 4,462
Drug abuse	6% 103,965	5% 78,154	11% 25,811	11% 23,928	10% 1,883
Alcohol abuse	9% 157,753	8% 124,374	14% 33,379	14% 30,952	13% 2,427
Smoking Status					
Current Smoker	36% 658,045	37% 587,535	30% 70,510	30% 66,206	22% 4,304
Former Smoker	31% 568,083	31% 489,124	33% 78,959	33% 71,288	40% 7,671
Lifetime Non-smoker	34% 618,669	33% 529,598	37% 89,071	37% 81,679	38% 7,392
Rx for weight loss medication	6% 104,212	5% 79,445	10% 24,767	10% 21,528	17% 3,239
Rx with weight gain risk	72% 1,320,296	70% 1,123,355	83% 196,941	82% 180,569	85% 16,372
Married	58% 1,067,383	59% 939,697	54% 127,686	53% 117,135	55% 10,551
No Disability	52% 954,370	53% 849,827	44% 104,543	44% 96,236	43% 8,307
Primary care visits/year	3•5±2•2	3•4±2•2	4•2±2•6	4•2±2•6	4•8±3•1
Years with a visit	8•7±3•5	8•7±3•5	9•2±3•4	9•2±3•4	9•5±3•4
Distance to MOVE! Clinic >48 km	59% 1,091,283	60% 963,208	54% 128,075	54% 117,787	53% 10,288

* ± values are means ±SD. All percents are followed by N for the cell. All associations between patient characteristics and level of MOVE! participation were significant (p <0•001), according to chi-squared tests and Cochran-Armitage tests for trend (categorical variables) and ANOVA (continuous variables).

Table 2

Baseline Characteristics Associated with Any Participation (All Participants vs. Eligible Non-participants) and Intense and Sustained Participation (Intense and Sustained Participants vs. Less Active Participants).

	All Participants vs. Eligible Non- Participants		Intense and Sustained Participants vs. Less Active Participants	
	N=1,844,797		N=238,540	
	OR	95% CI	OR	95% CI
Age at baseline	0.99	(0.99–0.99)	1.03	(1.03–1.04)
Female	2.02	(1.90–2.14)	1.40	(1.30–1.50)
Race (ref=White)				
African American	1.35	(1.20–1.51)	0.93	(0.81–1.07)
Other	1.05	(0.92–1.19)	0.84	(0.73–0.97)
BMI at baseline	1.13	(1.12–1.14)	1.04	(1.03–1.04)
Charlson Comorbidity Index (ref=no points)				
1 Point	2.78	(2.62–2.94)	1.04	(0.98–1.10)
2 or more Points	6.27	(5.67–6.94)	1.05	(0.97–1.14)
Weight-related conditions				
Diabetes	0.41	(0.38–0.43)	0.85	(0.80–0.91)
Coronary Artery Disease	0.88	(0.85–0.92)	0.92	(0.86–0.99)
Hypertension	1.30	(1.27–1.34)	0.92	(0.88–0.96)
Osteoarthritis	1.47	(1.42–1.52)	0.97	(0.93–1.02)
Dyslipidemia	1.42	(1.39–1.45)	1.02	(1.00–1.05)
Sleep Apnea	4.86	(4.34–5.45)	1.15	(1.06–1.25)
Mental health conditions				
Depression	1.42	(1.37–1.48)	0.97	(0.93–1.02)
Psychoses	1.44	(1.38–1.50)	0.94	(0.89–1.00)
PTSD	1.48	(1.41–1.54)	1.02	(0.95–1.08)
Drug abuse	1.33	(1.23–1.43)	1.01	(0.91–1.11)
Alcohol abuse	1.24	(1.19–1.30)	0.98	(0.92–1.05)
Smoking Status				
Current Smoker (ref=Never)	0.79	(0.76–0.81)	0.81	(0.78–0.85)
Former Smoker (ref=Never)	1.11	(1.05–1.17)	1.14	(1.08–1.21)
Prescription medication for weight loss	1.60	(1.44–1.79)	1.53	(1.25–1.88)
Prescription medication with weight gain risk	1.27	(1.22–1.33)	0.99	(0.94–1.05)
Disability (ref=no disability)				
0–20%	1.04	(1.01–1.08)	1.07	(1.01–1.13)
30–60%	0.99	(0.95–1.03)	1.10	(1.03–1.17)
70–100%	0.85	(0.80–0.91)	1.16	(1.08–1.25)
No primary care visits/year	1.07	(1.06–1.09)	1.06	(1.05–1.08)
No years with a visit	1.35	(1.33–1.37)	1.00	(0.99–1.02)

* GEE models adjusted for clustering by clinic. Additional covariates included baseline year (categorical), distance to a facility offering MOVE!, marital status, and other comorbidities that may affect weight status and ability to be physically active such as hypothyroidism, COPD, heart failure, liver disease, and renal disease. Continuous variable odds ratios are calculated per 1-unit increase.

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Table 3

Diabetes incidence in multivariable Cox proportional hazards model

	Diabetes Incidence	
	HR	95% CI
MOVE! Participation		
Less active	0•80	(0•77–0•83)
Intense / Sustained	0•67	(0•61–0•74)
Age at baseline	1•04	(1•03–1•04)
Female	0•82	(0•80–0•84)
Race (ref=White)		
African American	1•35	(1•31–1•40)
Other	1•32	(1•26–1•37)
BMI at baseline	1•05	(1•04–1•05)
Weight-related conditions		
Coronary Artery Disease	1•14	(1•13–1•16)
Hypertension	1•19	(1•17–1•21)
Osteoarthritis	0•85	(0•84–0•87)
Dyslipidemia	1•02	(1•01–1•04)
Mental health conditions		
Depression	0•94	(0•93–0•96)
Psychoses	0•97	(0•95–0•98)
PTSD	0•87	(0•85–0•89)
Alcohol abuse	0•95	(0•93–0•96)
Smoking Status		
Current Smoker (ref=Never)	1•20	(1•17–1•22)
Former Smoker (ref=Never)	1•06	(1•03–1•09)
Prescription medication for weight loss	3•68	(3•14–4•30)
Prescription medication with weight gain risk	1•58	(1•55–1•62)
Disability (ref=no disability)		
0–20%	1•17	(1•14–1•21)
30–60%	1•24	(1•22–1•26)
70–100%	1•43	(1•40–1•47)
No• visits/year	1•08	(1•08–1•09)
No• years with a visit	0•97	(0•97–0•98)

* N=1,400,935. Cox proportional hazards model also adjusted for baseline year (categorical), marital status, weight-related comorbidities, and distance to a facility offering MOVE!. Charlson comorbidity index, sleep apnea, COPD, and drug abuse were considered for inclusion but eliminated through model selection based on AIC. Continuous variable hazards ratios are calculated per 1-unit increase. The model was stratified by BMI category due to the presence of interaction and was adjusted for clustering by clinic.