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Impact of a workplace physical activity tracking program on biometric health outcomes

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ABSTRACT

Wellness programs are a popular strategy utilized by large U.S. employers. As mobile health applications and wearable tracking devices increase in prevalence, many employers now offer physical activity tracking applications. This longitudinal study evaluates the impact of engagement with a web-based, physical activity tracking program on changes in individuals' biometric outcomes in an employer population. The study population includes active employees and adult dependents continuously enrolled in an eligible health plan and who have completed at least two biometric screenings (n = 36,882 person-years with 11,436 unique persons) between 2011 and 2014. Using difference-in-differences (DID) regression, we estimate the effect of participation in the physical activity tracking application on BMI, total cholesterol, and blood pressure. Participation was significantly associated with a reduction of 0.275 in BMI in the post-period, relative to the comparison group, representing a 1% change from baseline BMI. The program did not have a statistically significant impact on cholesterol or blood pressure. Sensitivity checks revealed slightly larger BMI reductions among participants with higher intensity of tracking activity and in the period following the employer's shift to an outcomes-based incentive design. Results are broadly consistent with the existing literature on changes in biometric outcomes from workplace initiatives promoting increased physical activity. Employers should have modest expectations about the potential health benefits of such programs, given current designs and implementation in real-world settings.

1. Introduction

Regular physical activity (PA) confers important health benefits, including reducing an individual's risk for obesity, cardiovascular disease, type-2 diabetes, and hypertension (Benefits of Physical Activity and National Institutes of Health, 2016). Additionally, physical activity is associated with reduced likelihood of depression and insomnia symptoms (Mammen and Faulkner, 2013; Teychenne et al., 2008; Spörndly-Nees et al., 2017). Despite these known benefits, current estimates from the Centers for Disease Control and Prevention indicate that only about 20% of U.S. adults ages 18 and older obtain the recommended levels of aerobic physical activity (Centers for Disease Control and Prevention, 2013).

Today many large, U.S. employers offer workplace wellness programs as part of their health management strategy (Kaiser, 2016). According to a 2014 survey by Willis Health and Productivity, among firms that offer a wellness program, 90% have a physical activity component (Willis Health and Productivity Survey Report, 2014). A wide variety of PA-focused, workplace initiatives have been implemented and evaluated for their impact on behavior and clinical outcomes. Examples include education and lifestyle coaching, persuasive messaging, onsite fitness centers or classes, gym membership discounts, activity challenges, and walking programs (Sallis et al., 1998; To, Q, et al., 2013; Norman et al., 2007; Freak-Poli et al., 2011; Crespin et al., 2016). In real-world settings, such initiatives may be implemented by themselves or as part of comprehensive wellness programming efforts.

Many PA promotion programs use pedometers (e.g., 10,000 steps walking programs). With the diffusion of wearable devices (e.g. Fitbit®, Jawbone®, or other similar fitness tracking devices) (Martin, 2014) and mobile applications that can automate data collection and provide immediate feedback to users, tracking programs are increasingly prevalent. Advocates suggest that these devices may promote more sustained engagement by presenting visual cues and reminders to individuals for prioritizing fitness, and allowing participants to quantify their exercise efforts. In turn, this can increase self-efficacy and support habit formation and goal achievement (Patel et al., 2015; Bandura, 2001).

Prior research on the effects of pedometer- and fitness-tracking device interventions in the workplace reveals mixed findings in terms of

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demonstrating increased physical activity and health improvement. Bravata et al. (2007) reviewed 26 studies through 2007, for a total sample of 2767 participants, and found that pedometer interventions offered specifically in the workplace were associated with small increases in physical activity, but users had a statistically significant decrease in their BMI and systolic blood pressure. These findings were corroborated in a 2013 review of four workplace-based randomized trials of health promotion programs that utilized pedometers. In this review, the authors noted that devices alone may be insufficient to generate health improvements, and that in some instances, consistent reminders of failing to meet one's step goals may actually decrease a person's motivation (Freak-Poli et al., 2013b).

Recent studies of workplace-based, PA tracking programs continue to produce modest effect sizes (Freak-Poli et al., 2013a; Glance et al., 2016). For example, Finkelstein et al. (2016) tested the impact of activity trackers alone or combined with incentives (e.g., cash-based or charitable contributions) on increases in physical activity and health outcomes. In this individual-level, randomized controlled trial of 800 full-time workers in Singapore, the authors reported evidence of significant, increased step activity, but no detectable improvements in health outcomes, regardless of whether or not individuals received an incentive. Smith-McLallen et al. (2017) compared the effects of two worksite-based walking interventions offered to 474 employees on participation, step counts, and biometric outcomes. The interventions included accelerometers, a website on which to log steps, as well other enhancements. The authors found that each 1000 step increase in average steps was associated with reductions in body mass index of 0.41 for males and 0.31 for females, on average. As noted by Conn et al. (2009) research on workplace physical activity interventions is highly diverse with respect to sample size, design, timeframe and population studied. And, in general, many studies within this literature find modest changes in behavioral and biometric outcomes.

Conducted in 2016, our study examines the relationship between individuals' participation in a workplace PA tracking program and changes in body mass index (BMI), total cholesterol, and blood pressure over a four-year period. Our study employs a large sample, and we improve upon a number of past observational studies using biometric outcomes, by employing a comparison group of non-participants, and utilizing causal statistical methods to isolate the program's impact. Additionally, we include a fixed effects specification that examines a within-person variation in biometric outcomes, and removes all time-invariant confounders that might bias the results. We also conduct an analysis to examine changes in self-reported physical activity as a result of program participation. These results enable us to better understand the underlying mechanism for any program effects. Our analyses also include an examination of whether the program's effectiveness varies by intensity of participation and institutional changes in incentive design. Findings from this research can inform employers' expectations regarding the potential impact of PA tracking programs in real-world settings, including those that integrate wearable technologies into the design.

2. Methods

2.1. Study setting

The study setting is a large, national employer headquartered in the Midwestern United States with operations in the food manufacturing sector. The wellness program in this study is available to active employees and adult dependents enrolled in one of the firm's eligible health plans. The overall program includes three components: a health risk assessment (HRA); biometric screening offered at multiple sites; and wellness activities offered by the firm's wellness program vendor, including personalized online behavior change programs for forming healthier lifestyle habits, participation in organized sports, and the PA tracking program. Eligible employees and adult dependents can earn up to $1200 in cash incentives per household by participating in wellness activities and/or achieving certain health standards based on biometric screening values (e.g., BMI of 18.5–27.5; total cholesterol of < 200; blood pressure of < 120/80 mm Hg). In turn, these incentives can be used to pay for out-of-pocket medical care expenses.

We focus specifically on investigating the impact of the PA tracking program because of its potential effect on health and its broad appeal; 83% of those who participated in any wellness activities participated in the tracking program. The PA tracking application, housed on the vendor's online platform, allows individuals to choose from a list of 200 activities and indicate the time spent doing the activity as well as calories burned. Individuals can either access the tracking system online, or sync their mobile phones or wearable devices to the online platform. Individuals are recognized as tracking their activity on the application each time they record at least 30 min of a physical activity on a given day.

2.2. Data

We use three data sources: 1) health benefits eligibility data for 2011–2014; 2) administrative medical claims for 2011–2014, and 3) wellness program participation data, including HRA responses, biometric outcomes, and indicators of PA tracking program participation throughout the study period. The eligibility file contains individuals' demographic information which we link with HRAs, biometric screening results, and wellness program participation using a unique, encrypted identifier generated by a trusted third-party vendor. The study was declared exempt from the University of Minnesota's Institutional Review Board and the authors report no conflicts of interest.

2.3. Study population

The study population includes all employees and adult dependents enrolled in the employer's health benefits program and continuously eligible to participate in the wellness program between 2011 and 2014. Using the eligibility and wellness participation data, we first restrict our study population to individuals who provided HRA responses. This represents approximately 49.7% of full population eligible for the employer wellness program. Next, we limited the analysis to those who completed biometric screens in at least two program years during the study period. This final analytic sample represents approximately 30.0% of the full population eligible for the employer wellness program.

2.4. Measures

We obtain biometric measures for BMI, total cholesterol, and blood pressure (systolic and diastolic) from the screening file, which reports values from the site where the individual was screened. Because data collection occurs at a specific screening site or doctor's office, the clinical measures obtained are more reliable and consistent across time than self-reported survey responses.

For our baseline analysis, we define participants ("treatment group") as those individuals who enrolled in the PA tracking program and recorded at least one 30 min period of physical activity during the study period. We include several demographic and health status measures that are hypothesized to influence an individual's biometric outcomes as control variables: age category (< 25 years (reference), 25–34, 35–44, 45–54, 55–64, 65 + years), female (reference is male), relationship status to policyholder (reference is employee), and whether the person is non-white (reference is white). Using ICD-9 codes from each individual's medical claims and the algorithm from the Medicare Chronic Conditions Warehouse (CCW), we construct indicators for the following pre-existing, chronic condition diagnoses: cancer, asthma or chronic obstructive pulmonary disease (COPD), heart disease or congestive heart failure (CHF), back pain, chronic kidney disease (CKD), hypertension, diabetes, and depression. We also specify a binary measure of self-reported fair or poor health status (reference is excellent, very good, or good health) (Centers for Medicare and Medicaid Services, 2017). Finally, we include a set of indicator variables to measure the percentage of an individual's sitting time during the day (< 33%, 33–66%, > 66%).

2.5. Statistical analysis

We specify difference-in-differences (DID) regression models to estimate the average treatment effect of PA tracking program participation on each biometric outcome, controlling for demographics and baseline health status. Because there is a moving window for participation in the wellness program activity, we aligned the pre-treatment and post-treatment program years for the treatment group. We normalize each person's initial pre- and post-program years, before and after the first date of participation in the PA tracking program, to be the first year of pre- and post-biometric screening data, respectively. We include, after the date of initial participation, a 3-month "burn-in" period, during which individuals are initiating their activities and acclimating to the program. Measurements taken before the first participation date and after the burn-in period are used to show pre- and post-biometric trends, respectively.

Individuals in the final analytic sample who never participate in the PA program constitute our comparison group. In our DID specification, we randomize individuals who never participated to a pseudo start date for the PA activity such that the distribution of initiation dates matches that of the overall treatment group. Prior to our DID analysis, we further refined the comparison group by constructing propensity scores to estimate the likelihood of being a PA tracking program participant using gender, age, race, self-reported health status, sitting time and indicators for chronic conditions. Next, we eliminated observations outside the region of common support, defined as the overlap between the distributions of treatment and comparison groups' propensity scores. By keeping only observations in this area of common support, we retained comparison observations that have the same propensities to participate as treatment units, and are therefore are more likely to serve as an adequate counterfactual. We also tested that the slopes of the biometric measures' time trends were the same in the participant and non-participant groups in the pre-intervention period and found that they were not significantly different.

The DID model compares changes from the pre-intervention to the post-intervention period in the treatment and comparison groups, controlling for any time-invariant confounders which may otherwise bias the regression results. Our regression equation for the change in biometric outcome is as follows:

$$Y_{it} = b_0 + b_1T_i + b_2Post_t + b_3T_i{}^{*}\,Post_t + b_4X_{it} + b_5Z_i + e_{it} \tag{1}$$

where Y is the biometric outcome and T indicates whether the individual is a tracking program participant and therefore in the treatment group. The variable Post indicates if the biometric measurement occurred after the initial burn-in period of participation. The vector of demographic characteristics is given by X and baseline health status characteristics by Z. The parameter of interest is b_3, which represents the effect of participation in the activity tracking program on BMI, cholesterol, and blood pressure in the post-participation years.

We also conduct several sensitivity checks. First, we examine whether the impact of program participation varies by the intensity of an individual's engagement in the tracking activity (e.g., the number of times an individual records at least 30 min of activity per day). Based on the overall frequency distribution of activity tracking by program year, we categorize individuals into low and high intensity participants, depending on whether their number of annual tracked activities was below or above the sample median, respectively. In the model, we included indicators for each treatment group as well as interactions with the post period indicators to evaluate whether more intensive program participation yields a larger effect on biometric outcome changes.

Second, at the beginning of program year three, the employer transitioned from a participatory incentive design, which provided cash incentives to all eligible individuals who engaged in program activities, to an outcomes-based design. Under this new design, for those who did not fall within the "healthy" biometric ranges at baseline, financial incentives could be earned only through participation in one or more wellness activities and/or demonstrating a marked improvement over their previous results in a subsequent biometric screening. We augment our main specification by including an interaction between program type (based on program year) and participation, allowing the estimated treatment effect to vary by program incentive type.

Finally, we estimate a fixed effects model specification including program year indicators to account for year-to-year trends in the biometric outcomes. This model uses only within-person variation to identify the effect of program participation on the outcomes of interest. As with the DID specification above, we also allow the estimated treatment effect to vary by incentive program type.

3. Results

3.1. Descriptive analysis

Table 1 provides descriptive statistics reported for the overall sample (n = 36,882 person-years, with 11,436 unique persons), stratified by participation status and time period. This sample includes only observations with propensity scores in the overlapping region of common support between treatment and control units. Across the full sample, the average BMI is 28.3, which is considered to be in the overweight range (Centers for Disease Control and Prevention, 2017). Average cholesterol is 184.8, while average systolic and diastolic blood pressures are 120.6 and 76.5, respectively. At baseline, participants are more likely to have BMI, cholesterol, and blood pressure measures that are in "healthy ranges" relative to non-participants. Program participants, who comprise 61% of the analytic sample, are more likely to be female, younger, and white, relative to non-participants. Relative to non-participants, individuals in the PA-tracking program are more likely to have back pain or depression, but are less likely to have asthma or COPD, hypertension, or diabetes.

3.2. Impact analysis results

Fig. 1 summarizes the average effect of participation in the PA program on BMI, cholesterol, and blood pressure in the post-participation years. Full model results are available in Appendix Table 1.

Fig. 1 shows that PA program participation is associated with a statistically significant reduction in BMI of 0.275 in the post-period, relative to the comparison group. When considered relative to the average BMI value at baseline among participants, this corresponds to a 1% decrease (0.275/27.7 = 0.01). The model results do not suggest any significant effect of program participation on the cholesterol or blood pressure outcomes.

The association of age with BMI and cholesterol is non-linear. The pattern of estimates indicates that BMI is increasing in age initially and then begins to decrease as individuals reach 55 to 64 years of age. The pattern for cholesterol shows an increasing rate up to age 45 to 54 and then leveling out. Additionally, individuals with diagnoses of hypertension, diabetes, and depression have higher BMI and blood pressure levels, on average. Individuals who report being in fair or poor health status and those who report sitting at least 67% of the time also have higher BMI levels, all else constant.

To understand the mechanism underlying the relationship between program participation and BMI, we used information from individuals' HRA responses on exercise frequency to test whether participants actually increased self-reported exercise as a result of the program. We

Table 1
Descriptive statistics.

	Total sample	Participants	Non-participants	Pre-participation, Participants	Pre-participation, non-participants	Post-participation, participants	Post-participation, non-participants
Biometric measures							
BMI	(n = 36,882)	(n = 22,481)	(n = 14,401)	(n = 12,164)	(n = 7776)	(n = 10,317)	(n = 6625)
Mean	28.3	27.7	29.0	27.6	28.6	27.9	29.4
% Out of healthy range	49.4	56.1	44.5	43.8	53.4	45.3	57.9
Cholesterol	(n = 23,196)	(n = 11,866)	(n = 11,330)	(n = 3748)	(n = 3615)	(n = 8118)	(n = 7715)
Mean	184.8	184.9*	184.6*	184.4	183.5	185.3	184.1
% Out of healthy range	62.1	73.9	62.3	29.3	29.0	30.8	29.7
Systolic blood pressure	(n = 25,259)	(n = 16,820)	(n = 8439)	(n = 8288)	(n = 4175)	(n = 8532)	(n = 4264)
Mean	120.6	119.2	122.9	119.0	121.8	119.4	122.6
% Out of healthy range	44.7	40.4	52.0	40.6	49.9	40.3	53.0
Diastolic blood pressure	(n = 25,431)	(n = 16,901)	(n = 8530)	(n = 8366)	(n = 4251)	(n = 8535)	(n = 4279)
Mean	76.5	75.7	77.9	76.0	77.8	75.5	77.6
% Out of healthy range	27.6	25.0	32.1	25.5	31.1	24.8	32.5
Demographic characteristics							
Mean age	41.5	40.4	43.2	–	–	–	–
Percentage female	46.6	53.2	37.5	–	–	–	–
Percentage spouse	20.9	18.5	24.3	–	–	–	–
Chronic conditions (%)				–	–	–	–
Cancer	0.6	0.6*	0.6*	–	–	–	–
Asthma or COPD	5.0	4.8	5.4	–	–	–	–
Heart disease or congestive heart failure	0.4	0.4	0.6	–	–	–	–
Back pain	14.8	15.4	13.9	–	–	–	–
Chronic kidney disease	0.1	0.1*	0.1*	–	–	–	–
Hypertension	15.9	13.4	19.5	–	–	–	–
Diabetes	6.4	4.8	8.6	–	–	–	–
Depression	10.1	10.5	9.6	–	–	–	–
Other HRA variables				–	–	–	–
Percent reporting fair/poor health	3.3	3.0	3.7	–	–	–	–
Percentage non-white	14.8	12.4	18.5	–	–	–	–
Mean percent of time spent sitting per day	51.7	55.7	45.5	–	–	–	–

Source: Administrative claims, biometric, and HRA data, 2011–2014, for a large Midwestern employer population.
Note: Sample sizes vary because biometric values are not balanced across all individuals. Demographic, chronic conditions and HRA variable summaries are calculated using the BMI sample.
* Difference is not statistically significant. All other differences in means or proportions between participants and non-participants are statistically significant at $p < 0.05$.

began by constructing a measure for the total number of minutes per week that a person engaged in vigorous and moderate exercise activity and then estimated an analogous DID regression model using the same covariates as described above. Full model results are reported in Appendix Table 2. Participants increased minutes of exercise an estimated 15.967 min per week in the post-period, relative to non-participants. This corresponds to a 6% increase from the baseline, pre-period average. These results align with other observational studies that have

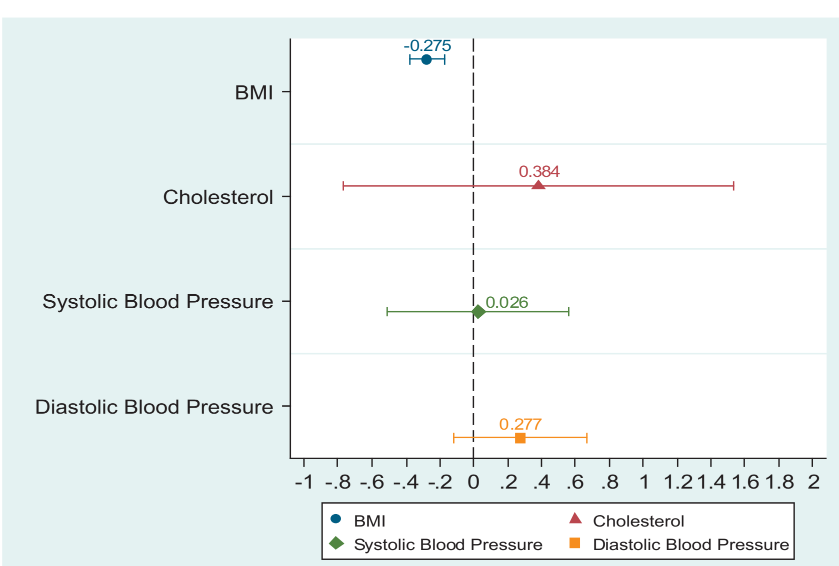

Fig. 1. Effect of PA program participation on biometric outcomes. Average treatment effect and 95% confidence interval shown. Source: Administrative claims, biometric, and HRA data, 2011–2014, from a large employer-based population.

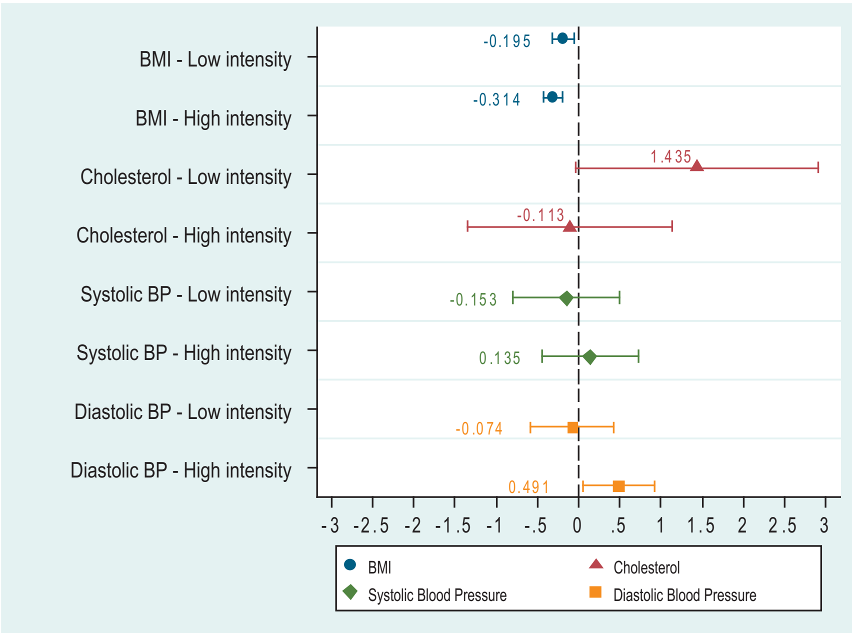

Fig. 2. Impact of the physical activity program participation on biometric outcomes, by treatment intensity. Note: Each line represents the point estimate and 95% confidence interval. The reference group is no participation.

examined the relationship between participation in an incentivized wellness programs and exercise habits (Crespin et al., 2016; Hooker et al., 2017; Strohacker et al., 2014).

We conducted several specification checks. Fig. 2 summarizes top-line findings from our model that tests for the presence of heterogeneous effects based on activity tracking intensity (high intensity, low intensity, and non-participant). High intensity participants experienced an average decrease in BMI of 0.314 relative to non-participants, whereas low intensity participants had a smaller estimated decrease of 0.195. Again, we find no effects of participation on cholesterol or blood pressure. Full model results are reported in Appendix Table 3.

Table 2 shows that the effect of program participation on changes in BMI is concentrated in the time period when the incentive program changed from participation-based to achievement of outcomes. We see that the program had a larger impact after the transition to an outcomes-based program (− 0.276), although we are unable to attribute this difference exclusively to the program design in the event that other factors were also changing.

Finally, as an alternative to our DID model, we estimated two fixed effects specifications. The first includes individual-level fixed effects with program year indicators, while the second specification augments this model with two triple interaction terms to test for the presence of heterogeneous effects by program type, given the shift in incentive design from participatory to outcomes-based. From this output, we observe that the program's impact on BMI remains statistically significant, although estimates from the second model reinforce earlier findings that suggest the impact is concentrated in the period of the outcomes-based program type. In both specifications, average treatment effects are attenuated relative to the DID specifications. Model results are provided in Appendix Tables 4a and b.

4. Discussion and conclusions

Given high rates of obesity and overweight status among U.S. adults as well as the increasingly sedentary nature of work, (Henry J. Kaiser Family Foundation, 2015) many large employers are implementing wellness programs to encourage lifestyle behavior changes, (Owen et al., 2010) including interventions to increase physical activity. Utilizing four years of data from a national employer, this study investigates the impact of participation in a physical activity tracking program on BMI, total cholesterol, and blood pressure. Our findings suggest that program participation leads to a small but statistically significant reduction in BMI. No significant impacts were detected for cholesterol or blood pressure. Our findings related to BMI align with other observational studies that have investigated changes in biometric outcomes among wellness program participants, including Goetzel et al. (2009), Goetzel et al. (2010) and Barleen et al. (2017). However, other recent studies, including LaCaille et al. (2016) and Fu et al. (2016), find null results.

The results from our analysis of participants' self-reported exercise time suggests that despite small reductions in BMI, and no changes in other biometric outcomes, individuals are changing their exercise behaviors in response to the intervention. The modest increases in exercise time per week support our findings of small BMI reductions among participants, and highlight the importance of analyzing the intermediary effects of a workplace wellness program. By understanding the underlying pathways by which BMI and other biometric outcomes may improve, employers can more effectively target certain measures.

Some limitations are worth noting. First, this study examines the experiences of a single employer. While this employer's workforce is diverse on the dimensions of geography, occupation, and socio-economic status, individuals' experiences may have been shaped by the program's implementation and organizational culture. Second, participation in the physical activity tracking program was voluntary and our final analytic sample includes the subset of individuals who completed at least two biometric screenings and an HRA. As such, this sample may be more motivated relative to the entire eligible population. In turn, this may contribute to our pattern of results. Third, measurement error with respect to total cholesterol and blood pressure may be a contributing factor to our null findings for these outcomes. Relative to BMI, measurement of these outcomes may be more sensitive to the specific conditions under which an individual was tested (e.g., fasting for cholesterol, environmental stressors for blood pressure). Finally, increased physical activity represents only one contributing factor to weight management and BMI. Increasing physical activity by itself may be insufficient for losing weight without additional changes to caloric intake as well (Swift et al., 2014).

Based on the cumulative evidence including findings from this study, employers should have modest expectations about the potential health benefits of PA tracking programs, given current designs and implementation in real-world settings. Additional research is needed to investigate whether larger health benefits may be generated through

Table 2
Impact of PA program on biometric outcomes by program incentive design type (participatory vs. outcomes-based).

	BMI	Std. error	Cholesterol	Std. error	Systolic blood pressure	Std. error	Diastolic blood pressure	Std. error
Program – participatory	0.982***	0.226	−3.235	3.317	1.983	1.248	−1.076	0.886
Program – outcomes-based	0.749***	0.045	1.101*	0.482	0.389	0.223	−0.329*	0.163
Participant	−0.770***	0.117	0.752	0.819	−0.843**	0.288	−0.963***	0.219
Post ∗ participant ∗ participatory	−0.065	0.271	4.936	4.083	−1.637	1.516	1.761	1.180
Post ∗ participant ∗ outcomes-based	−0.276***	0.054	0.337	0.588	0.053	0.225	0.259	0.202
Female	−0.789***	0.110	1.375	0.702	−5.678***	0.225	−3.690***	0.159
Relation-spouse	−1.255***	0.130	−3.645**	1.052	−3.910***	0.337	−2.013***	0.257
25–34 years old	0.616*	0.247	6.930***	1.742	0.025	0.533	0.460	0.379
35–44 years old	1.411***	0.249	14.745***	1.748	0.445	0.537	1.844***	0.382
45–54 years old	1.159***	0.250	20.426***	1.753	1.847**	0.545	2.360***	0.385
55–64 years old	0.775**	0.276	18.130***	1.924	3.107***	0.603	1.431**	0.416
65 + years old	−0.072	0.598	19.524***	4.307	4.954**	1.700	0.148	1.357
Cancer	−0.109	0.688	6.760	4.000	1.472	1.559	0.879	0.918
Asthma, COPD	0.646**	0.219	1.487	1.518	1.892	0.476	0.365	0.334
Heart disease, CHF	1.139	0.654	−12.504*	5.505	1.948	1.473	1.329	1.178
Back pain	0.552***	0.147	0.801	0.974	−0.257	0.307	−0.356	0.225
CKD	−0.356	1.258	11.104	12.643	1.021	3.354	−1.084	1.668
Hypertension	3.612***	0.166	−0.129	1.024	8.146***	0.335	4.749***	0.233
Diabetes	5.828***	0.263	−12.527***	1.624	6.076***	0.515	2.796***	0.369
Depression	2.062***	0.193	1.082	1.199	1.748***	0.400	0.777**	0.286
Health status – fair/poor	1.828***	0.328	1.896	2.159	1.926**	0.607	1.331**	0.430
Non-white	−0.103	0.146	−0.392	0.989	−0.732*	0.326	0.189	0.224
Sitting time – 33%–67% of the day	0.146	0.128	−1.343	0.972	−1.792***	0.313	−0.150	0.225
Sitting time – 67%–100% of the day	0.609***	0.150	−1.293	1.048	−2.208***	0.330	−0.370	0.239
Constant	26.556***	0.260	170.783***	1.872	122.466***	0.594	76.712***	0.429
Observations	36,882		23,196		25,259		25,431	

Source: Administrative claims, biometric, and HRA data, 2011–2014, from a large employer population.
Note: Reference group is non-participants.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

modifications in program design, such as the explicit use of goal setting, targeted incentives to encourage sustained engagement, group-based challenges and support systems, and organizational communication strategies that encourage higher levels of physical activity among those at greatest risk for onset of obesity-related, chronic conditions.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2017.09.002.

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