



Naturally occurring workplace facilities to increase the leisure time physical activity of workers: A propensity-score weighted population study

Aviroop Biswas^{a,*}, Peter M. Smith^{a,b}, Monique A.M. Gignac^{a,b}

^a Institute for Work & Health, 481 University Avenue, Suite 800, Toronto, Ontario M5G 2E9, Canada

^b Dalla Lana School of Public Health, University of Toronto, 155 College Street, 6th Floor, Toronto, Ontario M5T 3M7, Canada

ARTICLE INFO

Keywords:

Physical activity
Workplace
Built environment
Health promotion
Exercise

ABSTRACT

The benefit of providing access to physical activity facilities at or near work to support the leisure time physical activity (LTPA) of workers is uncertain. We examined the association between access to physical activity facilities at or near work and the LTPA of workers after adjusting for a range of individual and occupational characteristics. Data was obtained from 60,650 respondents to the 2007–2008 Canadian Community Health Survey. Participants were employed adults ≥ 18 years of age who had no long-term health condition which reduced their participation in physical activity. Latent class analysis determined naturally occurring combinations of physical activity facilities at or near work. Each combination was balanced by 19 individual and occupational covariate characteristics using inverse probability of treatment weights derived from propensity scores. The association between combinations of physical activity facilities at or near work on LTPA level was estimated by multinomial logistic regression. Five different combinations of physical activity facilities were available to respondents at or near work. Data were analyzed in 2017. All possible physical facilities increased the likelihood for LTPA (OR, 2.08, 95% CI, 1.03–4.20) and other combinations were also positively associated. Respondents with no physical activity facilities were characterized as having a low education, low income, high physically demanding work, poor health and mental health, non-white racial background, and being an immigrant. Access to supportive workplace environments can help workers be physically active. Future research should assess a range of personal, social and environmental factors that may be driving this relationship.

1. Introduction

Regular physical activity confers substantial health benefits and is a main component of public health strategies and initiatives (Ainsworth and Macera, 2012; Warburton et al., 2006; Lee et al., 2012). Yet it is estimated that over half of adults fail to meet recommended levels of at least 150 min of moderate-intensity physical activity a week, and in turn, are at greater risk for several chronic diseases, premature mortality, anxiety and depression (Lee et al., 2012; World Health Organization, n.d.). Accordingly, improving physical activity participation is a major public health concern.

Workplaces are ideal settings to promote physical activity as the majority of working-aged adults spend a third of their day at work (Tudor-Locke et al., 2011; Harter and Arora, 2010). Evidence also suggests that physical activity participation boosts employee energy levels, morale, job satisfaction, the ability to cope with stress, and work productivity (Conn et al., 2009; Proper et al., 2002). Consequently,

workplaces are increasingly incorporating physical activity facilities on-site such as the provision of gyms and wellness initiatives or access to off-site playing fields and pleasant places to be active (Matke et al., 2013; Goetzel et al., 2014). Such strategies are supported by conceptual models suggesting that physical activity participation is not only influenced by personal, behavioral, and societal factors but also by environmental factors (Sallis et al., 2006; Saelens and Handy, 2008). These environmental factors (such as the built environment and access to facilities that promote physical activity) may influence constraints on behavior and perceptions making it easier or more difficult to participate in physical activity (Bauman et al., 2012; Booth et al., 2000). For example, more walkable environments may help those with health problems be active through recreational walking, while easy access to physical activity facilities can lower perceptions of inadequate time as a constraint to participation (Cerin et al., 2010).

To date, few studies have examined facilities and environmental factors in the workplace compared to other community settings. Yet

Abbreviations: LTPA, leisure time physical activity; CCHS, Canadian Community Health Survey; IPTW, inverse probability of treatment weights; KKD, kilocalories per kilogram of body weight per day

* Corresponding author.

E-mail address: abiswas@iwh.on.ca (A. Biswas).

<https://doi.org/10.1016/j.pmedr.2018.03.013>

Received 28 November 2017; Received in revised form 16 February 2018; Accepted 28 March 2018

Available online 03 April 2018

2211-3355/ © 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

initial findings have been promising in pointing to the value of the workplace environment in promoting physical activity (Lucove et al., 2007; Prodaniuk et al., 2004; Watts and Mâsse, 2013; Umstatt et al., 2011; Schwartz et al., 2009). For example, a study with a representative sample of Canadians found that workers with greater workplace physical activity facilities were more likely to be moderately active in their leisure time (Watts and Mâsse, 2013). Subsidized health club memberships for North Carolina workers were also associated with increased leisure time physical activity (LTPA) (Lucove et al., 2007). While any single type of workplace physical activity facility did not increase physical activity levels for Missouri workers, combinations of workplace facilities did (Dodson et al., 2018). For instance, providing outdoor facilities to incentivize physical activity at work did not help workers meet physical activity guidelines unless flexible time was also provided to be physically active while at work.

A drawback of previous research is that studies were generally not designed to disentangle the potential effects on physical activity levels related to individual characteristics (Bauman et al., 2012) and occupational factors (Kirk and Rhodes, 2011) in addition to the role of access to physical activities facilities at work. For example, differences in LTPA levels have been associated with age, gender, health and SES, while longer work hours, job strain and sedentary work have shown negative correlations. Furthermore, it is not clear which combinations of physical activity facilities that naturally occur in workplaces are most effective in promoting LTPA. For example, should workplaces invest in both a gym and fitness classes or is one or the other sufficient? Is access to a pleasant place to walk enough to promote LTPA? A more detailed examination of what types and combinations of physical activity facilities are currently available at or near workplaces and whether they are associated with increased participation in plausible types of activities (as opposed to estimates of overall LTPA that might have measured participation in less plausible activities) after controlling for other relevant factors is important. This information can help to better inform organizational decisions such as whether it is in a workplace's interests to incorporate some types of physical activity facilities given the potential costs and resources required.

This study drew on data from a national population health survey to examine the relationship of naturally occurring physical activity facilities at or near work (hereinafter referred to as “workplace facilities”) and worker LTPA levels after adjusting for a range of individual and occupational characteristics.

2. Methods

2.1. Data sources and sample

We analyzed the 2007–2008 Canadian Community Health Survey (CCHS), which collected cross-sectional information on the health status, health care utilization, and health determinants of the Canadian population (Béland, 2002). Responding to the CCHS was voluntary and data were collected over two years in non-overlapping two-month periods from January 2007 to December 2008, covering 97% of a target population, 12 years of age and over, living in the ten provinces and three territories of Canada. Excluded from data collection were persons living on Aboriginal settlements, full-time members of the Canadian armed forces, the institutionalized population, and certain regions of the provinces of Quebec and Nunavut. Data was collected directly from individuals representing 71,922 households agreeing to participate in 2007 and 72,580 in 2008. There was a national response rate of 77.6% in 2007 and 75.2% in 2008. More details about the CCHS are described elsewhere (Statistics Canada, 2009). Informed consent for the use of data for research purposes was obtained from all survey participants by Statistics Canada.

The study sample was drawn from employed or self-employed adults between the ages of 18 to 75 years, and had no long-term physical or mental health condition which frequently reduced their

participation in activities at home or work.

2.2. Main independent variable: workplace facilities

Each respondent's access to physical activity facilities at or near work (“workplace facilities”) was ascertained from seven questions: “At or near your place of work, do you have access to: 1) a pleasant place to walk, jog, bicycle or rollerblade? 2) Playing fields or open spaces for ball games or other sports? 3) A gym or physical fitness facilities? 4) Organized fitness classes? 5) Organized recreational sports teams? 6) Showers and/or change rooms? 7) Programs to improve health, physical fitness or nutrition?” As each of these aspects might have different impacts on LTPA, naturally occurring combinations of workplace facilities frequently reported by respondents were generated using latent class analysis and examined as exposure groups.

2.3. Outcome: LTPA level

LTPA level was the primary study outcome and respondents were characterized according to energy expenditure cut points. Cut points were derived from the frequency and duration spent in 21 activities (such as walking, running, skiing etc.) and categorized according to Statistics Canada's definitions (inactive = < 1.5 kcal/kg/day (e.g. walking less than half an hour each day), moderately active = between 1.5 and 2.9 kcal/kg/day (e.g. walking 30 to 60 min a day, or taking an hour-long exercise class three times a week); active = > 3 kcal/kg/day (e.g. walking an hour a day or jogging 20 min a day).

We examined LTPA as a single outcome and by specific types of activities undertaken. Engagement in specific activities was explored to compare the extent to which changes in LTPA levels were plausibly influenced by workplace facilities versus less plausible relationships. For example, having a pleasant place to walk is plausibly associated with workers engaging in walking and jogging and it is less plausible that they play ice hockey. Aggregate estimates for the relationship between workplace facilities and less plausible activities was considered an estimate of the potential bias due to unmeasured confounding as illustrated in Appendix Fig. 1. Unmeasured confounding might include reporting bias (where respondents over-report their participation in all types of physical activities) or selection bias (where respondents more likely to be active prefer to work where they have greater access to workplace facilities). Physical activities were categorized into cut-offs based on Canada's Physical Activity Guidelines (Canadian Society for Exercise Physiology, n.d.).

2.4. Study covariates

Because data were generated from a population survey and not a randomized control trial, the potential effects of unmeasured factors on study estimates were reduced by balancing combinations of the workplace facilities exposure variables by pre-specified baseline covariate characteristics of survey respondents using inverse probability of treatment weights (IPTW) derived from propensity scores. Nineteen covariate characteristics were selected a priori based on the physical activity and health behavior literature and used to generate propensity scores.

Individual factors: age; sex, marital status (and having a child under the age of 25); immigrant; education; ethnicity; BMI; daily fruit and vegetable intake; smoker status; alcohol consumption; perceived health and mental health.

Occupational covariates: income; hours worked per week; working at home; job stress; and physical demands of work (from Statistics Canada's National Occupational Classification). Seasonality effects on LTPA were considered and a seasonality variable was derived based on whether the CCHS was administered during cold weather months or warmer months. Details on all response variables are in Table 1.

Table 1
 Characteristics based on leisure time physical activity level and workplace facilities (n = 60,650). Data was analyzed in Canada in 2017.

Characteristics	% (SE)	P
Workplace facilities		*
Pleasant place to walk	58.1 (0.3)	
Playing fields	40.8 (0.3)	
Gym	44.4 (0.3)	
Fitness classes	34.8 (0.3)	
Organized sports teams	28.8 (0.3)	
Showers/change rooms	45.3 (0.4)	
Health programs	37.2 (0.3)	
Age		*
18–32 years	30.4 (0.3)	
33–47 years	37.1 (0.3)	
48–62 years	28.8 (0.3)	
63–75 years	3.7 (0.1)	
Sex		*
Male	53.5 (0.3)	
Female	46.5 (0.3)	
Marital status		*
Married/common law	65.4 (0.3)	
Children under 25 years	86.3 (0.4)	
Single/divorced/separated/widow	34.6 (0.3)	
Children under 25 years	13.7 (0.4)	
Personal income		*
< \$30,000	31.5 (0.3)	
\$30,000 to < \$60,000	40.3 (0.3)	
≥ \$60,000	28.2 (0.3)	
Education		*
< Secondary school	8.8 (0.2)	
Secondary school graduate	16.7 (0.2)	
Some post-secondary education	8.7 (0.2)	
Post-secondary graduate	65.8 (0.3)	
Ethnicity		*
White	80.0 (0.3)	
Other	20.0 (0.3)	
Immigrant		*
22.2 (0.3)		
BMI category, % (SE)		*
Underweight	2.3 (0.1)	
Normal weight	47.2 (0.3)	
Overweight	34.0 (0.3)	
Obese	16.5 (0.2)	
Daily fruits/vegetables		*
< 5 times/servings	57.4 (0.3)	
5–10 times/servings	37.8 (0.3)	
> 10 times/servings	4.8 (0.2)	
Hours worked per week		*
< 30 h	16.5 (0.2)	
30 to ≤ 40 h	52.0 (0.3)	
> 40 h	31.5 (0.3)	
Physical demands of work		*
1 (low)	56.7 (0.3)	
2	18.6 (0.2)	
3	19.4 (0.3)	
4 (high)	5.3 (0.1)	
Work stress		*
Not at all/not very	26.6 (0.3)	
A bit	43.3 (0.3)	
Quite/extremely	30.1 (0.3)	
Perceived health		*
Poor/fair	6.5 (0.2)	
Good	28.0 (0.3)	
Very good	41.0 (0.3)	
Excellent	24.6 (0.3)	
Perceived mental health		*
Poor/fair	3.7 (0.1)	
Good	18.5 (0.2)	
Very good	36.5 (0.3)	
Excellent	41.3 (0.3)	

* Denotes significant difference between groups (P < 0.001).

2.5. Statistical analyses

Statistical analyses was performed using SAS v. 9.4 (SAS Institute Inc.) and Mplus v. 7 (Muthén & Muthén, 1998-2012) in 2017. Tests

were two-sided and statistical significance set at P = 0.05. Estimates were weighted using Statistics Canada's original survey weights and representative of the Canadian population. A chi-square test of independence was calculated to compare differences between categories. Combinations of naturally occurring, real-world workplace facilities were based on their probability of being reported by respondents using latent class analysis functions. A propensity score for each individual was estimated using a multinomial logistic regression model that comprised the 19 study covariates previously stated. IPTW derived from propensity scores were used to balance each combination group. The IPTW method has been recommended over traditional statistical regression and matching methods for reducing systematic differences between treated and untreated subjects (Austin, 2011). Stabilization and trimming of IPTW was conducted to optimize balancing and minimize the influence of outliers.

The effect of natural combinations of workplace facilities on LTPA level, and activity type (associated or non-associated with facilities) were estimated by multinomial logistic regression using a generalized logit link. ORs and 95% CIs were obtained using bootstrap methods (Béland, 2002).

3. Results

Fig. 1 illustrates the study cohort creation. The selection criteria yielded 68,184 adults. Those with missing data for any variables (n = 7534) were excluded, leaving an analytical sample of 60,650 individuals. Table 1 describes sample characteristics. A pleasant place to walk (58.1%) was the most frequently reported workplace facility and having organized sports at work (28.8%) reported least. The sample was mostly white (80%), male (53.5%), aged 33–47 years (37.1%), in a domestic partnership (65.4%), with a post-secondary education (65.8%), having a normal BMI (47.2%), working 30–40 h per week (52%) in low physically demanding occupations (56.7%), with an income between \$30,000 to \$60,000 (40.3%), experiencing slight job stress (43.3%), with very good health (41%), and excellent mental health (41.3%). There was variability across some characteristics with a sizeable proportion of individuals aged 48–62 years (28.8%), having an income < \$30,000 (31.5%), being overweight (34%), working > 40 h per week (31.5%), and experiencing high (30.1%) job stress.

Fig. 2 shows natural combinations of workplace facilities. About a quarter of respondents reported having access to all the different workplace facilities (combination 1 = “All”: 24.4%). Just under 15% of respondents reported combination 2, which was characterized by a high probability of having a pleasant place to walk and playing fields (W/P), with a similar proportion reporting combination 3 – a pleasant place to walk, a gym, fitness classes, showers/change rooms, and health programs (W/G/F/S/H). Far fewer reported combination 4, with 4.5% having a combination of access to showers/change rooms, health programs, and a pleasant place to walk (W/S/H). Combination 5 showed a low probability of most facilities, but some access to a pleasant place to walk and showers/change rooms (W/S) (17.7%). Finally, 23.9% of respondents had no access to any workplace facilities (“None”).

Table 2 describes the relationship of various sample characteristics with the different combinations of physical activity facilities at or near work. Combination 1 (All) was comprised of the largest proportion of 18 to 32 year olds and unmarried/non-common law individuals with a child under 25 years. Participants were more likely to have a white racial background, report experiencing a bit of work stress, with very good to excellent self-perceived health and mental health. Combination 2 (W/P) had the largest proportion of underweight individuals, respondents who reported working < 30 h per week, and reporting not at all or not very much work stress. Combination 3 (W/G/F/S/H) was comprised of the largest proportion of females, unmarried/non-common law individuals, participants with an income ≥ \$60,000, those with at least a postsecondary education, participants with a normal weight, individuals working in a job requiring low physical demands,

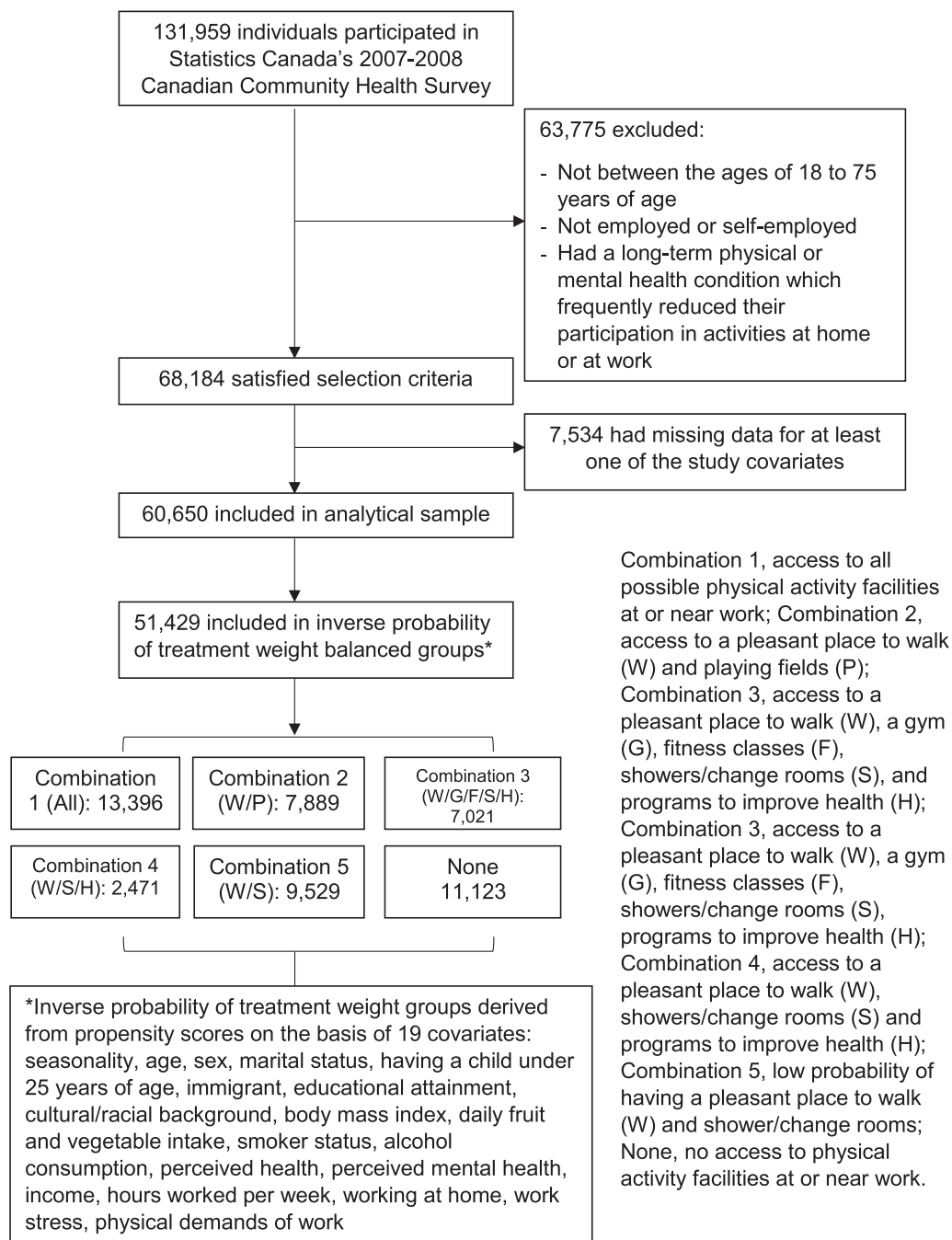
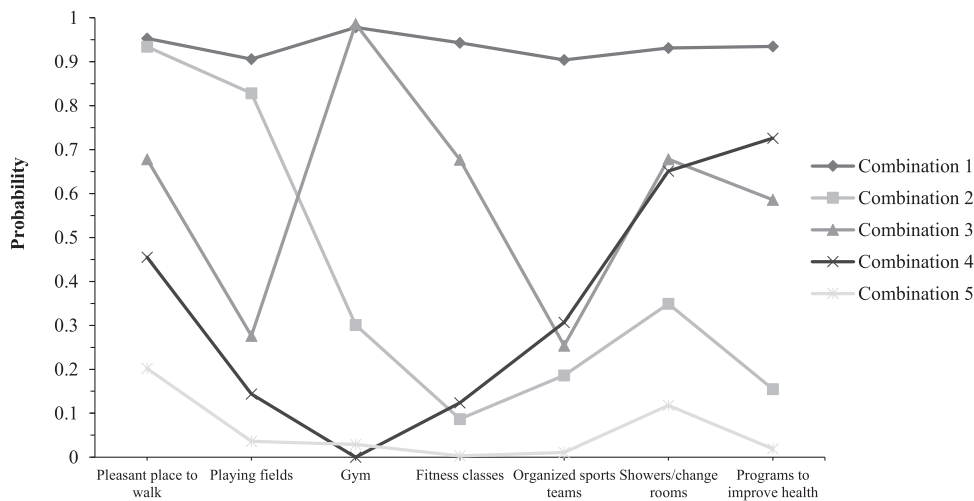


Fig. 1. Flow chart illustrating the creation of the study cohort. Data was analyzed in Canada in 2017.

and participants reporting quite/extreme work stress. Combination 4 (W/S/H) had the largest proportion of 33 to 62 year olds, participants who were married/common law, individuals with an income from \$30,000 to \$60,000, individuals of non-normal weight (underweight, overweight, or obese), and participants working 30 to 40 h a week. Combination 5 (W/S) and those with no access to physical activity facilities at work (None) had the largest proportion of males, individuals who were married/common-law with a child under 25 years, individuals with a personal income under \$30,000, participants with a secondary school education or less, who were of a non-white racial background, who reported being an immigrant, were working in a job requiring medium to high physical demands, who worked over 40 h a week, and who reported poor to good perceived health and mental health.

Individuals with a moderate-high probability of having access to at least one workplace facility (combinations 1 to 4) were more likely to be physically active compared to having no workplace facilities available, with the highest odds observed for combination 1 (All) (OR = 2.08; 95% CI: 1.03, 4.20) (Table 3). For the likelihood of moderate physical activity, all combinations had increased odds, but statistical significance was only observed for combination 4 (W/S/H) (OR = 1.39; 95% CI: 1.07, 1.80) compared to having no workplace facilities available (None), although the highest estimate was still observed for combination 1 (All) (OR = 1.47; 95% CI: 0.78, 2.79).

Associations between workplace facilities and plausible activities (e.g. jogging) as compared to, associations between workplace facilities and less plausible activities (e.g. skiing) are presented in Table 4, and provides insight on the extent to which the observed associations are



Workplace Facilities	Combination*					None
	1 (All)	2 (W/P)	3 (W/G/F/S/H)	4 (W/S/H)	5 (W/S)	
Pleasant place to walk	0.953	0.934	0.678	0.455	0.202	0
Playing fields	0.906	0.828	0.276	0.144	0.036	0
Gym	0.978	0.301	0.986	0.000	0.029	0
Fitness classes	0.943	0.087	0.677	0.124	0.003	0
Organized sports teams	0.904	0.186	0.254	0.307	0.011	0
Showers/change rooms	0.931	0.349	0.678	0.651	0.118	0
Programs to improve health	0.935	0.155	0.586	0.726	0.019	0
Percent of survey respondents,	24.4	14.6	14.9	4.5	17.7	23.9
%						

Probabilities ≥ 0.5 highlighted in **bold**.

* Combination 1, access to all workplace facilities; Combination 2, access to a pleasant place to walk and playing fields; Combination 3, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, and programs to improve health; Combination 4, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, programs to improve health; Combination 5, low probability of having a pleasant place to walk and shower/change rooms; None, no access to workplace facilities.

Fig. 2. Combinations of workplace facilities (probabilities shown). Data was analyzed in Canada in 2017.

influenced by unmeasured confounding. Estimates were similar across activity types for combinations 2, 3 and 5, suggesting that the observed effects may be due to unmeasured confounding. However, for combination 1 (All) and combination 4 (W/S/H), the associations observed for plausible activities were stronger than for less plausible activities (combination 1: OR = 1.89; 95% CI: 1.19, 2.25 versus OR = 1.51; 95% CI: 0.94, 2.42; combination 4: OR = 1.40; 95% CI: 1.13, 1.72 versus OR = 1.25; 95% CI: 0.92, 1.55), suggesting some association between these combinations of workplace facilities with meeting physical activity recommendations is greater than by spurious effects alone.

4. Discussion

This study is among the first to examine a population sample of individuals reporting access to workplace facilities, factors associated with the presence of workplace facilities, and the relationship between

naturally occurring combinations of workplace facilities with LTPA. We found that only a quarter of respondents reported having access to all types of workplace facilities while another quarter of the sample reported having little to no access to workplace facilities. Differences in the characteristics of those with access to facilities were complex, but suggested that those with less education and income, immigrants, and who had poorer physical or mental health were employed in occupations with less access to workplace facilities. While we observed a clear positive relationship between having workplace facilities and LTPA, our analyses examining activities most likely to be influenced by facilities compared to less plausible activities, suggested that a non-trivial proportion of this association could be due to unmeasured confounding. The two combinations of workplace facilities where the observed association between associated activities was stronger than non-associated activities were having all facilities available at or near work; and having a pleasant place to walk, showers/change rooms and programs

Table 2
Characteristics of respondents based on combinations of workplace facilities (N = 60,650). Data was analyzed in Canada in 2017.

Characteristics	Combination ^a						P
	1 (All)	2 (W/P)	3 (W/G/F/S/H)	4 (W/S/H)	5 (W/S)	None	
Age							**
18–32 years	31.5	30.6	30.6	27.8	30.5	31.5	
33–47 years	36.8	37.2	39.9	40.1	36.3	35.9	
48–62 years	28.6	27.9	26.8	30.0	29.0	28.6	
63–75 years	3.2	4.3	2.8	2.4	4.2	4.0	
Sex							**
Male	52.3	50.9	47.0	55.0	58.9	61.1	
Female	47.8	49.2	53.0	45.0	41.2	38.9	
Marital status							**
Married/common law	64.2	65.1	63.9	65.9	65.0	64.7	
Children under 25 years	84.8	86.7	85.8	84.1	86.8	87.1	
Single/divorced/separated/widowed	35.8	34.9	36.1	34.1	35.0	35.3	
Children under 25 years	25.9	13.3	14.3	15.9	13.2	12.9	
Personal income							**
< \$30,000	28.1	35.5	22.8	21.4	35.6	36.9	
\$30,000 to < \$60,000	38.4	39.5	39.6	42.8	42.1	42.6	
≥ \$60,000	33.5	25.1	37.6	35.8	22.3	20.5	
Education							**
< Secondary school	5.1	8.3	3.9	7.6	12.4	13.5	
Secondary school grad	14.8	15.8	13.1	15.7	19.7	21.4	
Some post-secondary	8.7	8.9	8.3	7.1	9.2	9.3	
Post-secondary grad	71.4	67.0	74.7	69.6	58.7	55.8	
Ethnicity							**
White	83.9	82.7	80.3	80.7	76.3	74.3	
Other	16.1	17.3	19.7	19.3	23.4	25.7	
Immigrant	17.9	18.7	22.2	20.7	26.4	28.9	**
BMI category							**
Underweight	2.2	2.5	2.1	2.5	2.3	2.4	
Normal weight	48.2	46.9	49.3	44.1	46.5	46.3	
Overweight	34.8	33.9	32.6	35.5	34.2	34.5	
Obese	14.8	16.8	15.9	17.9	17.0	16.8	
Minimum strength used in occupation							**
1 (low)	65.0	57.3	71.0	57.9	34.5	44.6	
2	16.1	18.5	15.4	16.9	21.5	21.6	
3	15.2	20.5	10.3	18.8	24.2	25.9	
4 (high)	3.7	3.8	3.3	6.4	7.0	8.0	
Hours worked per week							**
< 30 h	18.4	19.7	13.3	11.4	15.2	14.3	
30 to ≤ 40 h	49.8	50.6	54.7	61.6	51.6	51.7	
> 40 h	31.9	29.7	32.1	27.0	33.2	33.9	
Work stress							**
Not at all/not very	26.6	28.4	21.9	26.6	27.4	27.4	
A bit	45.2	43.5	44.2	41.9	42.3	41.8	
Quite/extremely	28.2	28.1	34.0	31.5	30.2	30.8	
Perceived health							**
Poor/fair	5.1	5.5	5.0	6.0	7.3	7.7	
Good	24.1	28.8	27.0	28.6	30.1	30.6	
Very good	43.1	42.1	43.0	41.1	39.5	38.6	
Excellent	27.8	23.6	25.0	24.4	23.2	23.1	
Perceived mental health							**
Poor/fair	3.2	3.7	3.4	2.3	4.0	4.1	
Good	15.9	19.3	17.2	19.8	19.8	20.4	
Very good	37.7	36.6	37.3	36.8	35.5	34.9	

Table 2 (continued)

Characteristics	Combination ^a					
	1 (All)	2 (W/P)	3 (W/G/F/S/H)	4 (W/S/H)	5 (W/S)	None
Excellent	43.2	40.4	42.1	41.1	40.7	40.5

Sample percentages within each combination are shown.

^a Combination 1, access to all possible workplace facilities; Combination 2, access to a pleasant place to walk and playing fields; Combination 3, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, and health programs; Combination 3, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, health programs; Combination 4, access to showers/change rooms and health programs; Combination 5, low probability of having a pleasant place to walk and shower/change rooms; None, no access to workplace facilities.

** Denotes significant difference between groups (P < 0.001).

Table 3

Associations between combinations of IPTW-weighted workplace facilities and leisure time physical activity level. Data was analyzed in Canada in 2017.

Combination ^a	Leisure time physical activity level		
	Active	Moderately active	Inactive
	Odds ratio (95% CI)		
1 (All)	2.08 (1.03, 4.20)**	1.47 (0.78, 2.79)	Reference
2 (W/P)	1.56 (1.14, 2.13)**	1.28 (0.96, 1.70)	Reference
3 (W/G/F/S/H)	1.76 (1.24, 2.50)**	1.35 (0.91, 2.00)	Reference
4 (W/S/H)	1.57 (1.28, 1.92)**	1.39 (1.07, 1.80)**	Reference
5 (W/S)	1.29 (0.93, 1.79)	1.17 (0.87, 1.58)	Reference
None	Reference	Reference	Reference

^a Combination 1, access to all possible workplace facilities; Combination 2, access to a pleasant place to walk and playing fields; Combination 3, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, and health programs; Combination 3, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, health programs; Combination 4, access to showers/change rooms and health programs; Combination 5, low probability of having a pleasant place to walk and shower/change rooms; None, no access to workplace facilities.

** Significant difference as compared to reference categories (physically inactive and access to no workplace facilities).

to improve health.

We know of one other study that considered natural combinations of facilities provided directly by workplaces (such as health programs or gyms) or indirectly through the built environment (having a pleasant place to walk) (Dodson et al., 2018). Using latent class analysis on a population survey, our study is the first to examine and identify the range of real-world combinations of workplace facilities that many workplaces may be able to provide their workers. For example, a pleasant place to walk was provided in tandem with playing fields, gyms, fitness classes, showers/change rooms, and health programs, while showers/change rooms often were provided along with health programs. The variety of workplace facilities within each combination suggests that a sizeable proportion of workplaces may have a variety of facilities available or are implementing workplace facilities. This is encouraging as many workplaces are less likely to implement workplace facilities due to insufficient support and guidance (Harris et al., 2014). While more research is needed to inform how best to encourage workers to use workplace facilities, our findings suggest that there may

Table 4

The association between IPTW-weighted combinations of physical activity facilities at or near work (“workplace facilities”) and meeting physical activity guidelines by participating in specific activities. Data was analyzed in Canada in 2017.

Activity type			Combinations ^a				
			1 (All)	2 (W/P)	3 (W/G/F/S/H)	4 (W/S/H)	5 (W/S)
n			13,396	7889	7021	2471	9529
Time/week			Odds ratio (95% CI)				
Associated activities	Walking for exercise	≥ 150 min	1.41 (1.33, 1.50)**	1.25 (1.17, 1.34)**	1.22 (1.13, 1.32)**	1.22 (1.09, 1.36)**	1.13 (1.06, 1.21)**
	Jogging or running	≥ 75 min	1.89 (0.84, 4.27)	1.37 (0.91, 2.05)	1.80 (0.95, 3.41)	1.32 (0.94, 1.85)	1.20 (0.92, 1.57)
	Exercise class/aerobics	≥ 75 min	1.25 (0.73, 2.14)	0.84 (0.49, 1.43)	1.27 (0.61, 2.67)	0.87 (0.65, 1.16)	0.99 (0.74, 1.33)
	Bicycling	≥ 75 min	1.43 (1.10, 1.85)**	1.14 (0.91, 1.43)	1.29 (1.03, 1.62)**	1.24 (0.89, 1.73)	1.07 (0.87, 1.31)
	Field sports ^b	≥ 75 min	1.76 (1.34, 2.36)**	1.42 (1.00, 2.02)**	1.78 (1.19, 2.65)**	1.17 (0.72, 1.92)	1.10 (0.60, 2.05)
	Weight-training	≥ 75 min	1.71 (1.06, 2.77)**	1.18 (0.90, 1.55)	1.91 (1.41, 2.60)**	1.21 (0.83, 1.77)	1.14 (0.91, 1.42)
Aggregate of associated activities			1.89 (1.19, 2.25)**	1.23 (1.03, 1.48)**	1.41 (1.20, 1.65)**	1.40 (1.13, 1.72)**	1.12 (0.92, 1.39)
Non-associated activities	Popular/social dance	≥ 150 min	1.21 (0.82, 1.78)	1.00 (0.63, 1.58)	0.97 (0.59, 1.60)	1.51 (0.84, 2.72)	0.87 (0.55, 1.36)
	Home exercises	≥ 150 min	1.56 (1.40, 1.74)**	1.28 (1.13, 1.45)**	1.55 (1.36, 1.76)**	1.45 (1.22, 1.73)**	1.26 (1.12, 1.41)**
	Swimming	≥ 75 min	1.54 (0.83, 2.84)	1.15 (0.82, 1.61)	1.31 (0.95, 1.72)	1.31 (0.85, 2.02)	1.22 (0.95, 1.55)
	Ice hockey	≥ 75 min	1.13 (0.84, 1.53)	1.16 (0.85, 1.59)	1.22 (0.89, 1.68)	1.19 (0.74, 1.93)	0.88 (0.64, 1.20)
	In-line skating/rollerblading	≥ 75 min	1.39 (0.77, 2.50)	1.10 (0.50, 2.39)	1.15 (0.36, 3.67)	1.32 (0.47, 3.70)	1.11 (0.55, 2.23)
	Skiing/snowboarding	≥ 75 min	1.37 (0.45, 4.19)	0.82 (0.32, 2.10)	0.98 (0.32, 3.02)	1.12 (0.26, 4.72)	1.17 (0.58, 2.37)
Aggregate of non-associated activities			1.51 (0.94, 2.42)	1.25 (0.95, 1.66)	1.39 (0.93, 2.08)	1.25 (0.92, 1.55)**	1.15 (0.91, 1.44)

Odds ratios compared to not meeting weekly physical guidelines and having no workplace facilities.

^a Combination 1, access to all possible workplace facilities; Combination 2, access to a pleasant place to walk and playing fields; Combination 3, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, and health programs; Combination 3, access to a pleasant place to walk, a gym, fitness classes, showers/change rooms, health programs; Combination 4, access to showers/change rooms and health programs; Combination 5 low probability of having a pleasant place to walk and shower/change rooms; None, no access to workplace facilities.

^b Field sports comprise tennis, volleyball, basketball and soccer.

** Difference significant for $P < 0.05$ as compared to not meeting physical activity guidelines.

be more opportunities than previously thought to take advantage of or consciously implement greater access to workplace facilities.

As noted, the relationship between various characteristics and access to workplace facilities was complex. However, we found that many of the characteristics associated with high physical inactivity in North America were similar to those associated with little or no workplace facilities. Specifically those with low education, low income, physically demanding work, poor self-rated health and mental health, non-white ethnicity, and who reported being an immigrant (Marshall et al., 2007; Lindström et al., 2001) were more likely to be employed in jobs with less access to workplace facilities. Data are correlational and causal directions cannot be inferred. However, our findings are in keeping with previous studies showing that those with greater SES have fewer barriers to LTPA (McNeill et al., 2006; Cerin and Leslie, 2008). Previous studies have emphasized the role of SES in terms of enabling people to live in environments more conducive to physical activity (Cerin and Leslie, 2008; Giles-Corti and Donovan, 2003). This research also links the potential benefits of SES to workplace environments. Further research is needed to examine these findings in terms of whether disadvantaged populations at high risk of physical inactivity would benefit from having greater access to workplace facilities.

Given the impracticability of randomized trials to examine naturally occurring combinations of workplace facilities, the selection bias from using observational data was reduced considerably by our use of the IPTW method to balance workplace facility combinations with a range of individual and occupational characteristics. Additionally, our study of associations with less plausible activities as negative controls to estimate the potential impact of unobserved confounding served to strengthen research in this area. Thus, our study presents the strongest evidence so far on the relationship between real-world combinations of workplace facilities and LTPA. In support of previous work (Lucove et al., 2007; Dodson et al., 2018; Hipp et al., 2017), the provision of more workplace facilities was likely to increase worker LTPA. Yet apart from combination 1 (All) and combination 4 (W/S/H), three combinations of workplace facilities had similar associations with plausible

and less plausible activities in increasing LTPA, suggesting that unmeasured confounding may be driving these effects. Possible unmeasured factors might include reporting bias, selection bias, or the built environment itself such as accessibility and perceived safety (Edmunds et al., 2013). Workplace facilities may have also partly contributed to the influence of unobserved factors. For example, workplaces with a culture of promoting physical activity may influence a person to participate in LTPA outside of their work. In this case, the association between workplace facilities and non-related activities, which we have attributed solely to unobserved confounding, will overestimate this effect. Nonetheless, given multiple and often complex factors that determine physical activity participation, organizations providing access to workplace facilities can at least enable some individuals to increase their LTPA. It is possible that features unique to combination 1 (All) and combination 4 (W/S/H) may explain their stronger associations with LTPA, and further interpretation is required.

4.1. Study limitations

Along with limitations mentioned earlier, other important limitations should be acknowledged. First, this is a cross-sectional study and although findings represent associations with a calculable level of confidence that are generalizable at the population-level, causal inferences and the direction of the association between access to workplace facilities and changes in LTPA needs further elucidation. Second, LTPA may be inaccurate as it was self-reported and susceptible to social desirability bias. Future studies are needed to verify these findings using objective methods of measuring physical activity such as accelerometers. Third, information on the extent that individuals used workplace facilities or the associated costs (if any) of using these facilities were not collected and as such, it is unclear whether findings will differ when workplace facilities are actually used. Further work on facility usage and their related costs can illuminate the potential barriers and enablers of using the facilities themselves.

In conclusion, this study drew on real-world combinations of

workplace facilities to show that promoting greater access to supportive workplace environments may help workers meet physical activity recommendations. While combinations of workplace facilities may have varying influences on LTPA attainment, providing more options may minimize potential physical activity barriers and have potential to meet individual preferences for activity. Future research needs to understand ways to improve access to workplace facilities and examine other unmeasured factors that also influence LTPA.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

The authors declare there is no conflict of interest.

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2018.03.013>.

References

- Ainsworth, B.E., Macera, C.A., 2012. *Physical Activity and Public Health Practice*. Taylor & Francis.
- Austin, P.C., 2011. An introduction to propensity score methods for reducing the effects of confounding in observational studies. *Multivar. Behav. Res.* 46 (3), 399–424.
- Bauman, A.E., Reis, R.S., Sallis, J.F., et al., 2012. Correlates of physical activity: why are some people physically active and others not? *Lancet* 380 (9838), 258–271.
- Béland, Y., 2002. Canadian community health survey - methodological overview. *Health Rep.* 13 (3), 9.
- Booth, M.L., Owen, N., Bauman, A., Clavisi, O., Leslie, E., 2000. Social-cognitive and perceived environment influences associated with physical activity in older Australians. *Prev. Med.* 31 (1), 15–22.
- Canadian Society for Exercise Physiology, 2013. *Canadian Physical Activity, and Sedentary Behaviour Guidelines*. <http://www.csep.ca/guidelines> (Accessed August 28 2014).
- Cerin, E., Leslie, E., 2008. How socio-economic status contributes to participation in leisure-time physical activity. *Soc. Sci. Med.* 66 (12), 2596–2609.
- Cerin, E., Leslie, E., Sugiyama, T., Owen, N., 2010. Perceived barriers to leisure-time physical activity in adults: an ecological perspective. *J. Phys. Act. Health* 7 (4), 451–459.
- Conn, V.S., Hafdahl, A.R., Cooper, P.S., Brown, L.M., Lusk, S.L., 2009. Meta-analysis of workplace physical activity interventions. *Am. J. Prev. Med.* 37 (4), 330–339.
- Dodson, E.A., Hipp, J.A., Lee, J.A., et al., 2018. Does availability of worksite supports for physical activity differ by industry and occupation? *Am. J. Health Promot.* 32 (3), 517–526.
- Edmunds, S., Hurst, L., Harvey, K., 2013. Physical activity barriers in the workplace: an exploration of factors contributing to non-participation in a UK workplace physical activity intervention. *Int. J. Work. Health Manag.* 6 (3), 227–240.
- Giles-Corti, B., Donovan, R.J., 2003. Relative influences of individual, social environmental, and physical environmental correlates of walking. *Am. J. Public Health* 93 (9), 1583–1589.
- Goetzel, R.Z., Henke, R.M., Tabrizi, M., et al., 2014. Do workplace health promotion (wellness) programs work? *J. Occup. Environ. Med.* 56 (9), 927–934.
- Harris, J.R., Hannon, P.A., Beresford, S.A., Linnan, L.A., McLellan, D.L., 2014. Health promotion in smaller workplaces in the United States. *Annu. Rev. Public Health* 35, 327–342.
- Harter, J.K., Arora, R., 2010. *The Impact of Time Spent Working and Job Fit on Well-being around the World*. London, UK, Oxford Scholarship Online.
- Hipp, J.A., Dodson, E.A., Lee, J.A., et al., 2017. Mixed methods analysis of eighteen worksite policies, programs, and environments for physical activity. *Int. J. Behav. Nutr. Phys. Act.* 14 (1), 79.
- Kirk, M.A., Rhodes, R.E., 2011. Occupation correlates of adults' participation in leisure-time physical activity: a systematic review. *Am. J. Prev. Med.* 40 (4), 476–485.
- Lee, I.M., Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N., Katzmarzyk, P.T., 2012. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* 380 (9838), 219–229.
- Lindström, M., Hanson, B.S., Östergren, P.-O., 2001. Socioeconomic differences in leisure-time physical activity: the role of social participation and social capital in shaping health related behaviour. *Soc. Sci. Med.* 52 (3), 441–451.
- Lucove, J.C., Huston, S.L., Evenson, K.R., 2007. Workers' perceptions about worksite policies and environments and their association with leisure-time physical activity. *Am. J. Health Promot.* 21 (3), 196–200.
- Marshall, S.J., Jones, D.A., Ainsworth, B.E., Reis, J.P., Levy, S.S., Macera, C.A., 2007. Race/ethnicity, social class, and leisure-time physical inactivity. *Med. Sci. Sports Exerc.* 39 (1), 44–51.
- Mattke, S., Liu, H., Caloyeras, J., et al., 2013. Workplace wellness programs study. *Rand. Health Q.* 3 (2).
- McNeill, L.H., Kreuter, M.W., Subramanian, S., 2006. Social environment and physical activity: a review of concepts and evidence. *Soc. Sci. Med.* 63 (4), 1011–1022.
- Muthén, L.K., Muthén, B.O., 1998–2012. *Mplus User's Guide*, Seventh Edition. Muthén & Muthén, Los Angeles, CA.
- Prodanik, T.R., Plotnikoff, R.C., Spence, J.C., Wilson, P.M., 2004. The influence of self-efficacy and outcome expectations on the relationship between perceived environment and physical activity in the workplace. *Int. J. Behav. Nutr. Phys. Act.* 1 (1), 7.
- Proper, K.I., Staal, B.J., Hildebrandt, V.H., Van der Beek, A.J., Van Mechelen, W., 2002. Effectiveness of physical activity programs at worksites with respect to work-related outcomes. *Scand. J. Work Environ. Health* 75–84.
- Saelens, B.E., Handy, S.L., 2008. Built environment correlates of walking: a review. *Med. Sci. Sports Exerc.* 40 (7 Suppl), S550.
- Sallis, J.F., Certero, R.B., Ascher, W., Henderson, K.A., Kraft, M.K., Kerr, J., 2006. An ecological approach to creating active living communities. *Annu. Rev. Public Health* 27, 297–322.
- Schwartz, M.A., Aytur, S.A., Evenson, K.R., Rodríguez, D.A., 2009. Are perceptions about worksite neighborhoods and policies associated with walking? *Am. J. Health Promot.* 24 (2), 146–151.
- Statistics Canada, 2009. *Canadian Community Health Survey - Annual Component - User guide 2007–2008 Microdata Files*. http://www23.statcan.gc.ca/imdb-bmdi/document/3226_D7_T9_V5-eng.pdf (Accessed June 2017, 2017).
- Tudor-Locke, C., Leonardi, C., Johnson, W.D., Katzmarzyk, P.T., 2011. Time spent in physical activity and sedentary behaviors on the working day: the American time use survey. *J. Occup. Environ. Med.* 53 (12), 1382–1387.
- Umstadt, M.R., Baller, S.L., Blunt, G.H., Darst, M.L., 2011. Correlates of perceived worksite environmental support for physical activity. *J. Phys. Act. Health* 8 (s2), S222–S227.
- Warburton, D.E., Nicol, C.W., Bredin, S.S., 2006. Health benefits of physical activity: the evidence. *Can. Med. Assoc. J.* 174 (6), 801–809.
- Watts, A.W., Mäse, L.C., 2013. Is access to workplace amenities associated with leisure-time physical activity among Canadian adults. *Can. J. Public Health*. 104 (1), e87–e91.
- World Health Organization, 2016. *Physical Inactivity: A Global Public Health Problem*. http://www.who.int/dietphysicalactivity/factsheet_inactivity/en/ (Accessed March, 2017).