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Research

The influence of self-efficacy and outcome expectations on the relationship between perceived environment and physical activity in the workplace

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Abstract

Background: Recent research and commentary contends that ecological approaches may be particularly useful for understanding and promoting physical activity participation in various settings including the workplace. Yet within the physical activity domain there is a lack of understanding of how ecological environment factors influence behaviour. Thus, the purpose of this study was to examine the relationships between perceived environment, social-cognitive variables, and physical activity behaviour.

Methods: Participants (*N* = 897) were employees from three large worksites who completed self-report inventories containing measures of self-efficacy, outcome expectations, perceptions of the workplace environment (PWES), and physical activity behaviour during both leisure-time and incorporated throughout the workday.

Results: Results of both bivariate and multiple regression analyses indicated the global PWES scores had a limited association with leisure-time physical activity (R^2adj =.01). Sequential regression analyses supported a weak association between physical activity incorporated in the workplace and PWES (R^2adj = .04) and the partial mediation of self-efficacy on the relationship between PWES and workplace physical activity (variance accounted for reduced to R^2adj = .02 when self-efficacy was controlled).

Conclusion: Overall, the results of the present investigation indicate that self-efficacy acted as a partial mediator of the relationship between perceived environment and workplace physical activity participation. Implications of the findings for physical activity promotion using ecological-based approaches, and future directions for research from this perspective in worksite settings are discussed.

Background

Regular physical activity has been established as a mechanism to prevent and treat various chronic illnesses such as heart disease, diabetes, cancer, obesity, osteoporosis and psychological ailments [1-4]. However, the majority of adults in industrialized nations are not physically active enough to accrue health benefits [1,5-7]. In response to this important issue, researchers are investigating effective ways to increase physical activity by furthering our understanding of physical activity behaviour determinants in numerous settings [8].

The workplace has been identified by various governments [1,9,10] as a key setting to promote physical activity, due in part to the accessibility of people within their occupation [11]. The majority of Canadian adults are in the workforce and spend half of their waking hours in a workplace environment [10]. However, the modernization of today's workplaces has contributed to physical inactivity, as many workers are now sedentary during working hours [12]. Thus, there is a potential for many people to benefit by effective workplace initiatives promoting physical activity during or outside of work time [10].

Most workplace physical activity interventions have been focused at the individual level focusing on providing employees with physical activity and health information and targeting psychological factors related to physical activity behaviour [4,12-14]. Expected benefits and costs of performing a behaviour (i.e., outcome expectations), and one's belief that he or she is capable of performing a behaviour to get a desired result (i.e., self-efficacy), are constructs utilized from established cognitive-based theories, such as Social Cognitive Theory, to promote physical activity at the individual level [15]. Based on reviews of the literature however, workplace interventions using such theoretical constructs as a basis for intervention have only been modestly successful at increasing physical activity involvement [11,13].

Recent calls have been made to examine the potential of workplace environments for increasing employee physical activity levels using an ecologically-based approach [2-4,12-14,16,17]. The essence of ecological models is an emphasis on the environments in which people interact, such as their home, work, sociocultural setting, and climate where they live [18]. The ecological approach has been described as an attempt to simultaneously consider several levels of a person's life setting within an intervention [18].

As more focus is placed on employing an ecological approach in physical activity research, ecological models have emerged for understanding this behaviour. Recently, an ecological model for physical activity behaviour (Ecological Model of Physical Activity; EMPA) has been conceptualized [19]. The EMPA provides a comprehensive ecological framework from which several testable hypotheses concerning physical activity promotion have been proposed [19].

Further, based on the work of McLeroy and colleagues [20] and Sallis and Owen [21], Plotnikoff and colleagues [22] developed an ecological workplace physical activity model identifying six overlapping environment levels in the workplace: (a) Individual (i.e., factors in the workplace addressing individual employee characteristics related to physical activity behaviour such as skills, knowledge, confidence, age, and gender); (b) Social (i.e., the influence of the corporate culture, social relationships, peer, and supervisor relationships related to physical activity behaviour of employees); (c) Organizational (i.e., infrastructure, leadership, and desire of the workplace to promote physical activity, how the organization is structured); (d) Community (i.e., how the workplace interacts, partners with, or utilizes other organizations, community-based resources or government bodies that may foster physical activity behaviour of employees); (e) Policy (i.e., the workplace's policies regarding employees' physical activity behaviour); and (f) Physical Environment (i.e., the physical environment of the workplace including the buildings, workplace grounds, and surrounding area related to physical activity behaviour of employees). Additionally, Plotnikoff and colleagues developed an instrument (i.e., Workplace Physical Activity Assessment Tool; WPAAT) by identifying elements in each level of the model suggested as best practices by both the literature and stakeholders to promote physical activity in the workplace [22]. The WPAAT was designed to evaluate workplace physical activity programs using the ecological model as a framework.

Despite the emergence of ecological models to explain and promote physical activity behaviour [19,22], more work is required given that the crux of ecological-based approaches runs contrary to traditional social-cognitive models of behavioural change [19,23]. Social Cognitive Theory (SCT) [24] is similar to ecological models in the sense that it shares the perspective that environmental factors can be influential in shaping health-promoting behaviour [19,23-25]. On the other hand, it has been argued that a defining feature of ecological models is a direct relationship between the environment and behaviour without cognitive mediation [21]. Bandura describes this reasoning as 'unidirectional environmental determinism' that does not account for the bi-directional relationships he posits that occur between the environment and the person included in SCT (reciprocal determinism) [24]. SCT further presumes that people are active shapers of

their environments rather than merely passive reactors [24,26].

There has been some research supporting direct relationships between the environment and goal-directed behaviours. Bargh and Gollwitzer [27] conducted a series of studies testing hypotheses of the auto-motive model of behaviour that purports links can develop between situational and environmental features and behaviour when an individual makes a consistent and frequent choice to fulfill a goal in a certain situation (e.g., being polite). Over time, when individuals enter the situation, their goal directed behaviour will be automatically activated without cognitive mediation [27]. From Bargh and Gollwitzer's work, it seems reasonable to suggest that people with a long term goal to be physically active could be prompted to do physical activity in situations where they have continually chosen to be active over time, without cognitive mediation. This line of research however, has not been directly tested in the physical activity domain.

Conversely, other researchers have argued that factors in the environment provide a 'cue to decision' about whether to do physical activity, rather than a direct 'cue to action' [26]. For example, seeing your running shoes could provide a cue to decide whether to engage in physical activity, rather than prompting one to automatically go for a run. Furthermore, it has been suggested that physical activity in particular, is a very cognitive-initiated activity, as it can involve much preparation and planning in today's modernized environment [26]. In addition, physical activity interventions aimed solely at the environment may inadvertently instigate psychological alterations shaping behaviour change, such as influencing one's self-efficacy about engaging in physical activity.

In a more recent publication describing ecological concepts, Sallis and Owen [23] no longer describe the direct relationship between the environment and behaviour as a defining feature of ecological models, but acknowledge that the environment can, both directly and indirectly through one's perceptions, influence behaviour. This modified description resembles SCT's reciprocal determinism principle [24]. Indeed, some theorists [19] have purported that ecological models are largely a mirror of SCT with multiple levels identified in the environment. Two potential research aims suggested by Spence and Lee [19] to further the understanding of ecological models in the physical activity domain are (1) to determine if a direct relationship exists between the environment and physical activity, and (2) to determine if psychological variables mediate the observed relationship.

The mediating effects of cognitive constructs, (e.g., self-efficacy and outcome expectations), can be tested on the relationship between ecological variables and physical activity using a series of multiple regression equations [28]. In this type of analysis, the extent to which a variable (e.g., outcome expectations and self-efficacy) accounts for the relationship between a predictor variable (e.g., ecological variable) and a criterion variable (e.g., physical activity behaviour) is tested [28]. A hypothesis guiding such an analysis would be that ecological variables are associated with physical activity participation, and this association is mediated by social-cognitive variables [28].

Recent calls have been made for mediation analyses to be conducted in order to guide development of physical activity interventions based on ecological models [8,19,23,29,30]. Current theoretical approaches focussed on psychological constructs (e.g., Transtheoretical Model, Theory of Planned Behaviour, Social Cognitive Theory) to predict physical activity have been quite limited, at best explaining about 30% of variance in physical activity, suggesting a more comprehensive understanding of physical activity determinants is needed [29,31]. In a recent review of studies examining potential psychosocial mediators of physical activity, a dearth of such research was noted despite calls in the literature for such assessments [30]. The aims of this study therefore, are to determine if (1) perceptions of the workplace environment are associated with the physical activity of employees and (2) if this relationship is mediated by self-efficacy and outcome expectations.

Methods

Procedures

This study complied with appropriate ethical standards in the treatment of participants and was approved by a University Research Ethics Committee. To recruit the sample, the study was advertised by email and posters in three large organizations located in Western Canada for two weeks prior to the actual distribution of questionnaires. Every employee was sent a research package, containing an information letter, consent form, and questionnaire, within the internal mail system of his or her workplace. Employees choosing to participate returned completed questionnaires by the internal mail of his or her respective workplace.

Sample

A total sample of 897 employees (11.2% response rate) provided complete data for this study. The sample was comprised of the following sub-samples: (1) a regional health authority (n = 409); (2) a post secondary educational institution (n = 170); and (3) city workers from a large urban centre (n = 318). The sample had a mean age of 42.2 years (SD = 9.91) and was comprised of a greater number of women than men (661 [74%] women, and 232 [26%] men, with 4 individuals not indicating sex). A

Table 1: Items of the Perceived Workplace Environment Scale (PWES)

Item in the PWES	Question
Individual level item	How much information is provided in your workplace educating and/or encouraging employees about physical activity?
Social level item	Is there a positive social climate that encourages physical activity in your workplace?
Community level item	Has your organization used any services or resources in the community to support the physical activity of employees? (examples: local recreation centre, community events)
Organizational level item	How much organizational capacity (i.e. infrastructure, will, and leadership) is there in your workplace that promotes physical activity for employees?
Policy level item	Does your workplace have policies that promote the physical activity of employees? (examples: no meetings scheduled over lunch, subsidized memberships at a fitness centre)
Physical Environment level item	Are there convenient and appropriate facilities that you can access in order to do physical activity during the workday?

Note: Employees indicated their answers by circling the phrase and number they most agreed with on a 5-point response option scale (1 = none; 5 = a great amount). These six items were used as a composite scale by adding the scores for each item and dividing by six.

diverse worker population was represented with 73% of participants being full-time employees, 25% part-time workers, 25% shift-workers, 5 participants were volunteer workers, and 9 did not indicate employment status.

Measures

Perceived Workplace Environment Scale (PWES)

The global perceived workplace environment scale was developed based on the ecological Workplace Physical Activity Assessment Tool (WPAAT) [22]. A single item was used to assess perceptions associated with each environmental level of the ecological model of the WPAAT (i.e., individual, social, organization, policy, community, and physical environment) to provide a brief, six-item global measure of perceptions of the ecological climate operating in the workplace. Each item (see Table 1) was formed by modifying the central concept defining each level of the WPAAT. Participants responded to each item on a 5-point Likert-type scale anchored at the extremes by (1) "none", and (5) a "great amount". Confirmatory factor analysis (CFA) procedures performed on the PWES responses in the present investigation supported the unidimensional factor structure (Q = 11.73; *NFI* = .95; *IFI* = .95; *CFI* = .95; *SRMSR* = .06; *RMSEA* = .11 [90% *CI* = .09 to.13]), as well as the internal consistency reliability of the 6-item scale (Cronbach's Coefficient α = .83). Intraclass correlation coefficients conducted on a sub-sample of employee's (n = 23) indicated that the PWES scores were relatively stable over a two-week period (intraclass r = .97; p < .01). Furthermore, during the development stage, the scale was assessed for item content relevance [32] via an expert review using an expert sample (n = 15) comprised of researchers, workplace physical activity practitioners, and workers.

Self-efficacy

A nine-item self-efficacy scale that assessed one's confidence for engaging in physical activity in different situations (e.g., when tired, when it becomes boring, etc.) was employed in this study. Participants responded to each item on a 5-point Likert-type scale ranging from (1) "not at all confident" to (5) "extremely confident". Consistent with previous research attesting to the psychometric properties of this instrument [33], CFA procedures conducted on responses in the present investigation suggested the unidimensional factor structure of the scale was satisfactory (Q = 16.54; *NFI* = .91; *IFI* = .92; *CFI* = .92; *SRMSR* = .05; *RMSEA* = .13 [90% *CI* = .12 to.14]). The internal consistency (Cronbach's Coefficient α) reliability of the self-efficacy scores in this sample was .92.

Outcome expectations

A measure of outcome expectations was obtained by asking individuals how much various statements about outcomes to physical activity would influence their decision to do regular physical activity. Responses were measured on a 5-point Likert-type scale from (1) "not at all" to (5) "very much". Both negative and positive assessments were obtained and calculated separately as outcome expectations pros (5 items; α = .81; sample item = "Physical activity would help me reduce tension or manage stress"), and outcome expectation cons (6 items; α = .74; sample item = "Physical activity would take too much of my time"). Previous research using a large representative sample of Canadian adults (N = 703; aged 18–65 years) has supported the factorial structure, internal consistency reliability, and factorial structure and invariance of scale scores across a 12-month time period (i.e., on three, six-month time points) [34]. CFA applied to the data in the present sample supported the 2-factor oblique measurement model underpinning the outcome expectation data

(Q = 4.93; *NFI* = .93; *IFI* = .94; *CFI* = .94; *SRMSR* = .05; *RMSEA* = .07 [90% *CI* = .06 to .08]).

Workplace physical activity

Physical activity incorporated into the workday was assessed with one question. The question was as follows: "How much do you incorporate physical activity into your workday (e.g., during breaks, active commuting to and from work)?" Participants responded on a 5-point option scale ranging from (1) "none" to (5) "a great deal". As part of the development of this measure a 14-day test-retest reliability assessment was conducted using a sample of 23 employed adults. Test-retest reliability estimates using intraclass correlation coefficients calculated over the 2-week administration period suggested adequate stability (coefficient = .86) in workplace physical activity scores. Additionally, similar one-item measures of physical activity have demonstrated a degree of concurrent validity and reliability when administered to samples of employees in previous studies [35,36].

Leisure-Time physical activity

Leisure-time physical activity was measured using a modified version of the Godin Leisure-Time Exercise Questionnaire (GLTEQ) [37]. This instrument asked participants how many times per week they engaged in strenuous (heart beats rapidly, sweating), moderate (not exhausting, light perspiration), and mild (minimal effort, no perspiration) physical activity for a minimum of 10 minutes per session. In an attempt to retain consistency with the physical activity recommendations of Canada's Physical Activity Guide [38], participants were instructed to include only those activities with a duration of 10 minutes or more. The GLTEQ specifies the metabolic equivalent (MET) values for strenuous physical activity as 9 METS; moderate physical activity as 5 METS; and mild physical activity as 3 METS [37]. The total leisure activity score was calculated using the following formula:

$$\text{LTPA} = (\text{N} \cdot \text{MET})_{\text{mild}} + (\text{N} \cdot \text{MET})_{\text{moderate}} + (\text{N} \cdot \text{MET})_{\text{hard}}$$

Where: LTPA = Leisure-time physical activity

N = number of bouts per week lasting 10 minutes or longer for each physical activity category

Results

Preliminary analyses

Prior to evaluating the study aims, data were screened for missing values, out of range responses (>|3.0| standard deviations away from the mean on any measure), and examined for conformity with relevant statistical assumptions [39]. An inspection of the data indicated that less than 5% of the sample recorded missing values on any one variable. The sample sizes for each regression equation ranged from 820 to 860. No variables presented any particular problems on the basis of extreme responses, and an inspection of the standardized residuals for each variable indicated no critical distributional concerns in the present data.

Bivariate correlations were computed between each PWES item and the global PWES construct, the cognitive constructs, and physical activity. All PWES items were moderately to highly correlated [*range* = .30 to .63 (p =.01)] adding further support for their construct validity. LTPA was weakly correlated with each PWES item [*range* = .07 to .13 (p = .05 to .01)] and the PWES construct [.13 (p =.01)], and was moderately correlated with self-efficacy [.47 (p =.01)], outcome expectations pros [.20 (p =.01)], outcome expectations cons [-.25 (p =.01)], and workplace physical activity [.39 (p =.01)]. The workplace physical activity measure was weakly correlated with each PWES item [*range* = .14 to .19 (p =.01)], PWES construct [.23 (p =.01)], both pros [.17 (p =.01)] and cons [-.18 (p =.01)], and moderately correlated with self-efficacy [.37 (p =.01)] (see Table 2 for a summary of the results).

Since the sample was derived from three different organizations, a series of univariate one-way ANOVA's were conducted to assess sub-sample compatibility across the different study constructs. The ANOVA's revealed significant differences across all measures except self-efficacy and outcome expectation pros. Scheffe post-hoc tests were computed to further assess the source of the mean differences. The educational institution differed from the other two sub-samples on outcome expectation cons, LTPA, and workplace physical activity. Additionally, all three sub-samples differed on the PWES.

To test the effect of site on the relationships between the criterion and predictor variables, two dummy variables were created for site with values 1 and 0. Only two dummy variables were included in each equation, as the third does not add further explanation to the model since each dummy variable is a mathematical function of the others [40]. This procedure controlled for possible site effects on the four-step mediation analysis described below as the site variables are entered first in hierarchical regression. Subsequently, minimal site effects were observed eliminating the need to report results for each sub-site separately.

Step one: Does PWES predict both self-efficacy and outcome expectations?

In the mediation analysis, the predictor variable (PWES) must be significantly associated with the potential mediators (i.e., self-efficacy and outcome expectations) [28]. Self-efficacy and outcome expectations were regressed on the PWES. The dummy variables for site were included in

Table 2: Pearson Correlations between the PWES items and construct, physical activity measures, and cognitive constructs.

	WPA	SE	PRO	CON	*IND*	*SOC*	*COM*	*ORG*	*POL*	*PHY*	PWES
LPA	.39**	.47**	.20**	-.25**	.07*	.12**	.08*	.11**	.09**	.08*	.13**
WPA		.37**	.17**	-.18**	.19**	.17**	.14**	.19**	.17**	.16**	.23**
SE			.31**	-.44**	.15**	.18**	.10**	.16**	.14**	.18**	.20**
PRO				-.13**	.05	.06	.03	.05	.04	.13**	.08*
CON					-.18**	-.09**	-.14**	-.10**	-.07*	-.14**	-.15**
IND						***.57***	***.46***	***.62***	***.41***	***.33***	***.75***
SOC							***.47***	***.63***	***.41***	***.38***	***.77***
COM								***.54***	***.56***	***.27***	***.74***
ORG									***.46***	***.46***	***.83***
POL										***.30***	***.72***
PHY											***.64***
PWES											

** Correlation is significant at the 0.01 level (2-tailed). * Correlation is significant at the 0.05 level (2-tailed). Note: PWE variables comprising the PWES are presented in bold italics LPA = Leisure Time Physical Activity, WPA = Workplace Physical Activity, SE = Self-Efficacy, PRO = Outcome Expectations Pros, CON = Outcome Expectations Cons, *IND* = *Individual Level Item*, *SOC* = *Social Level Item*, *COM* = *Community Level Item*, *ORG* = *Organization Level Item*, *POL* = *Policy Level Item*, *PHY* = *Physical Environment Item*, PWES = Global Ecological Construct

hierarchical regression as block one, with the PWES being included as block two. The entire model accounted for 4% of the variance in self-efficacy (see Table 3 for a summary of results). Site predicted 0% of the variance, while the PWES predicted the entire 4% (β = 0.2 [*p* =. 01]). The entire model accounted for only 1% of the variance in outcome expectation pros. Site had no association with outcome expectation (pros) (R^2adj = .00), with the PWES predicting 1% (β = 0.1 [*p* =. 01]). The entire model accounted for 3% of the variance in outcome expectation cons. Site predicted 2% of the variance, with the PWES adding an additional 1% (R^2adj = .03) (β = -.12 [*p* =. 01]).

Site had a minimal effect on the relationships observed in the full sample for self-efficacy and outcome expectation pros, but did have an effect on the small relationship between the PWES and outcome expectations cons. The associations between the PWES and the cognitive constructs were marginal. Self-efficacy had the strongest association without site effects; therefore, it was decided to conduct subsequent steps of the mediation analysis assessing only self-efficacy as a mediator.

Step two: Does PWES predict physical activity behaviour?

To continue on to Step Three of the mediation analysis, the PWES must be significantly associated with physical activity behaviour [28]. The dummy variables for site were included in hierarchical regression models as block one, and the PWES as block two. The full model accounted for 2% of the variance in leisure-time physical activity (see Table 4 for results of these equations). Site predicted 1% of the variance, with the PWES adding a further 1% (β =. 09 [*p* =. 01]). The entire model accounted for 5% of the variance in workplace physical activity. Site predicted 1% of the variance, with the PWES adding a further 4% (β =. 23 [*p* =. 01]).

Since the magnitude of the relationship between the PWES and LTPA was small (R^2adj = .01), further examination of the determinants of LTPA was not pursued in the present investigation. The mediation analysis continued on to Step Three with workplace related physical activity as the only criterion variable.

Step three: Does self-efficacy predict workplace physical activity?

In order to act as a mediator, self-efficacy must be a significant predictor of workplace physical activity. The next regressions were completed with self-efficacy as the predictor variable and workplace physical activity as the criterion. The site dummy variables were included in the hierarchical regression as block one and self-efficacy as block two. The full model accounted for 14% of the variance in workplace related physical activity (see Table 4). Site predicted 1% of the variance, with self-efficacy adding the additional 13% (β =. 36 [*p* =. 01]).

Step four: Does self-efficacy mediate the relationship between PWES and physical activity behaviour?

In this final step, workplace physical activity was regressed on self-efficacy and the PWES. In order to show mediation, the relationship between the PWES and workplace physical activity must be less in this equation than in Step two, and will show perfect mediation if the PWES has no effect on physical activity behaviour when self-efficacy is controlled [28]. Site was not included in this regression as it was determined by previous steps to have minimal influence on the relationships observed between the crite-

Table 3: Hierarchical regression: Mediators regressed on the PWES and site dummy variables

Step one: Site and the PWES as predictors					
Self-efficacy n = 836	R^2adj	R^2 *change*	F *change*	Beta 1	Beta 2
Block 1	.00	.01	2.62		
Site one				.06	
Site two				.08	
Block 2	.04	.04	30.81*		
PWES					.20*
Outcome Exp. Pros n = 844	R^2adj	R^2 *change*	F *change*	Beta 1	Beta 2
Block 1	.00	.00	1.00		
Site one				-.05	
Site two				-.01	
Block 2	.01	.01	8.04*		
PWES					.10*
Outcome Exp. Cons n = 840	R^2adj	R^2 *change*	F *change*	Beta 1	Beta 2
Block 1	.02	.02	7.59*		
Site one				-.05	
Site two				-.14*	
Block 2	.03	.01	12.22*		
PWES					-.12*

*p < .01 Note: Beta 1 and Beta 2 are the standardised regression coefficients for the linear equations represented by blocks one and two.

rion and predictor variables in this equation. Self-efficacy was entered into the hierarchical equation as block one, with the PWES being entered as block two.

The entire model accounted for 16% of the variance in workplace-related physical activity. Self-efficacy predicted 13% of the variance, with the PWES adding a further 3%. Table 4 shows the results of this equation. Results indicate slight mediation by self-efficacy on the relationship between the PWES and workplace-related physical activity, as there was a reduction in the beta value of this relationship from $\beta = .23$ to $\beta = .16$. Furthermore, the variance in workplace physical activity explained by the PWES declined from 4% in step two of the mediation analysis, to 2% in this final regression when considering the 1% variance accounted for by site determined in Step two.

Discussion

The aims of this study were to (1), determine if the perceived workplace environment is related to physical activity of workplace employees; and (2), to employ a regression analysis [28] to assess whether this relationship is mediated by self-efficacy and outcome expectations. In regard to aim 1, the PWES was not related to leisure-time physical activity of employees ($R^2adj. = 0.01$), and only slightly associated with physical activity incorporated into their workday ($R^2adj. = 0.04$). Although significant predictive relationships were observed between the PWES and both physical activity indicators, the magnitude of these relationships was small and likely significant due to the size of the sample employed in the present investigation [39]. The small correlations between the environment and physical activity could be due to the broad spectrum of factors that influence physical activity participation (e.g., biological factors) [41]. Previous studies assessing the relationship between physical activity and the perceived environment in school and neighbourhood settings have noted similar sized correlations [42,43].

Another possible factor accounting for the small relationships observed between the PWES and physical activity could be the degree of ambient support for such behaviours in the workplace environment itself. This non-intervention assessment was conducted by evaluating current conditions of the workplace. If the workplace was a neutral environment, it is logical to assume it could have no, or minimal association with physical activity behaviour, and other settings could be having a stronger influence (i.e., home environment, neighbourhood environment). It can be interpreted that employee perceptions of the workplace environment may be a stronger correlate of workday physical activity of an active living type (i.e., tak-

Table 4: Hierarchical regressions for steps two, three, and four

Step two: Site and PWES as predictors					
Leisure Time PA n = 820	R^2adj	R^2 *change*	F *change*	Beta 1	Beta 2
Block 1	.01	.02	6.37*		
Site one				.11*	
Site two				.11*	
Block 2	.02	.01	6.45		
PWES					.09*
Work Time PA n = 846	R^2adj	R^2 *change*	F *change*	Beta 1	Beta 2
Block 1	.01	.01	3.33		
Site one				.09	
Site two				.07	
Block 2	.05	.05	42.53*		
PWES					.23*
Step three: Site and self-efficacy as predictors					
Work Time PA n = 860	R^2adj	R^2 *change*	F *change*	Beta 1	Beta 2
Block 1	.01	.01	3.11		
Site one				.08	
Site two				.06	
Block 2	.14	.13	129.39*		
Self-efficacy					.36*
Step four: Self-efficacy and PWES as predictors					
Work Time PA n = 836	R^2adj	R^2 *change*	F *change*	Beta 1	Beta 2
Block 1	.13	.13	128.32*		
Self-efficacy				.37*	
Block 2	.16	.02	23.27*		
PWES			*Previous* β = *.23**		.16*

*p < .01 Note: Beta 1 and Beta 2 are the standardised regression coefficients for the linear equations represented by blocks one and two.

ing the stairs instead of the elevator, taking active breaks instead of coffee breaks), as opposed to leisure-time physical activity. It is also possible that employees who try to include physical activity into their workday perceive their workplace environment as more supportive of physical activity. As this study employed a cross-sectional design, the causal implications of these statements cannot be assessed with confidence and await replication and extension in future research using both experimental and multi-wave designs.

In regard to aim 2, self-efficacy was found to marginally mediate the relationship between the PWES and workplace physical activity, and outcome expectations did not act as a mediator. In this case, self-efficacy cognitions accounted for more than twice the variance in workplace physical activity than the PWES. Self-efficacy has received more support as a mediator than outcome expectations in the limited physical activity research assessing mediators [30]. Moreover, self-efficacy has been shown to be a stronger correlate of physical activity in workplace samples [44]. Such findings support the inclusion of self-efficacy in understanding physical activity, and suggest the environment should not be examined in isolation when assessing environmental associations with physical activity. These results also imply that the perceived workplace environment may influence employee's self-efficacy to engage in physical activity at work, thereby influencing the physical activity individuals incorporate into their workday. The finding that outcome expectations did not mediate the environment-physical activity behaviour relationship is similar to a conclusion drawn from a recent

review of research assessing mediators where outcome expectations had inconclusive findings [30]. It could be possible that psychological mediators may differ across settings.

The study findings from aim 1 and 2 must be interpreted with some caution. As in most behavioural research, an assumption is that the behaviour in question, potential mediating variables, and predictor variables can be adequately measured [31]. Given that only one item was used to assess each environment level of the workplace, it is possible that the restrictive focus of the PWES failed to adequately cover the domain of experience operating in the workplace environment that is associated with physical activity behaviour. For example, several other workplace environment characteristics not specific to physical activity behaviour are shown to be related to health outcomes in worker samples such as job insecurity [45], decisional latitude and job control [46], and stress [47]. Employing a broader measure of the workplace environment that considers such features could enhance understanding of the environment, cognitive, and behavioural relationships observed in the present study.

While there are limitations in pooling items into multidimensional environment constructs [25], utilizing the PWES construct was preferable for the mediation analysis, as it minimized the number of regressions to be completed, reducing the possibility for relationships to be found by chance [48]. For example, if the global construct had not been employed, regressions would have to be conducted for each of the six PWES items separately, creating 24 possible regression equations for each potential mediator, as opposed to four. Additionally, there was reasonable support from the data to employ the PWES as a global construct. All of the PWES items were moderately to highly correlated, the scale had adequate internal consistency, and the CFA suggested that each item assessed one latent PWES construct. This could be due to the global nature of the PWES items and the fact that the levels of the ecological workplace physical activity model overlap [22], but also suggests that perceptions of the different levels of the workplace environment are related. This finding is similar to those reported in another study [42] where significant associations between perceived neighbourhood environment items were found.

Since assessment of the environment was perceived rather than objective, the findings do not refute the possibility of a direct influence of the environment on physical activity. Due to the small number of sites (i.e., 3) in the present study, such objective measures were not completed. Although support exists for employing perceived environment measures [41], the use of objective measures in the mediation analysis would strengthen the assessment of the environment and behaviour relationship, and is recommended for future research. For example, it is possible the influence of the environment on behaviour is mediated by perceptions of the environment, which in turn are mediated by physical activity self-efficacy. Further, the environment may have a different degree of association with physical activity than the perceived environment. Future studies could employ different sampling techniques to increase the number of sites used, and conduct objective assessments of the workplace environment through auditing techniques of workplace characteristics [22].

One must use caution when corroborating these findings with previous research that has suggested self-efficacy is a significant mediator of physical activity behaviour. For example, self-efficacy and outcome expectations may be a result of physical activity behaviour, and not the cause, making their role as a mediator dynamic and more complex than the mediation model employed in the present study. Further, self-efficacy and outcome expectations were measured using generic scales developed for the physical activity domain. Future research may wish to consider using more domain-specific measures to ensure more accurate representation and measurement of each psychological construct within the workplace.

Another important limitation of the present study that must be considered is the study's low response rate. The response rate indicates that the study sample is likely not representative of the entire population of workers from the three sites, nor are the three sites representative of the entire workforce. The low response rate may have been due to a combination of the method of recruitment through the internal mail system of the worksites, the lengthy nature of the questionnaire, or the busy nature of the worksites themselves (i.e., healthcare, education, and city workers such as emergency services). Making time to fill out the questionnaire could have been challenging for busy or unmotivated employees. A larger sample may have been obtained by randomly telephoning employees and surveying them over the phone as opposed to having them complete the questionnaires on hardcopy and send them in by mail. E-mailing employees and having them fill out questionnaires electronically may also be more successful than hard-copy surveys.

A strength of this study is that the setting was well defined, making the environment levels potentially easier for participants to interpret. The workplace is a specific environment which makes it useful for testing ecological variables and relationships with physical activity behaviour and cognitive constructs. It may be much easier to assess the social environment of the workplace, for example, than that of an entire community.

Conclusions

Notwithstanding the limitations discussed above, this study adds support to the concept of an interplay occurring between the environment, cognitions, and behaviour as described by reciprocal determinism in SCT [24], and further endorses the strong cognitive component underpinning the occurrence of physical activity suggested elsewhere [26]. Additionally, this study provides further empirical evidence to support the notion that psychological constructs mediate the relationship between environmental factors (perceived or otherwise) and physical activity behaviour [19]. From the discussion of the present study's findings, limitations, and strengths, researchers can build on and improve future studies examining relationships between the environment, cognitions and physical activity.

As recommended by other researchers in the physical activity domain [8,19,23,29], additional studies examining mediators should be conducted. Mediation is most effectively assessed employing longitudinal study designs which test the influence of an intervention on potential mediators and behaviour over time [8]. Future studies could implement a randomized controlled trial of a multi-level physical activity intervention in the workplace setting, and assess it's impact on potential mediators and physical activity of employees over time. Such research could greatly increase the understanding of how interventions influence physical activity behaviour, and could aid in the development of ecological interventions focussed on levels of the environment, rather than on psychological characteristics. Longitudinal study designs assessing an intervention's influence on potential mediators, like self-efficacy, could provide a way to evaluate the efficacy of the intervention, and would help establish a needed understanding of causal relationships. The present investigation exemplifies the complexity of such relationships that are yet to be fully examined and understood. This study provides some direction towards this end.

Competing interests

None declared.

Authors' contributions

TRP conducted the main study components, analyzed the data, and drafted the manuscript. RCP helped conceptualize the study and the writing of the manuscript. JCS contributed to the conceptualization of the study and analyses, and the writing of the manuscript. PMW helped with the data analyses, interpretation, and the writing of the manuscript. All authors read and approved the final manuscript.

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