Program implementation and effectiveness of a national workplace physical activity intervention: UPnGO with ParticipACTION

Erica Y. Lau^{1,2} • Guy Faulkner³

Received: 19 April 2018 / Accepted: 14 December 2018 / Published online: 9 January 2019
© The Canadian Public Health Association 2019

Abstract

Intervention UPnGO with ParticipACTION (UPnGO) is a 6-week workplace physical activity (PA) initiative aiming to increase habitual PA (steps) during the workday. Core intervention components included (1) self-monitoring of steps and action planning behaviours using a Web/mobile app with incentives and (2) organizational support, which included senior management's role modeling and endorsement of the program.

Research question What is the effectiveness and levels of implementation of the UPnGO intervention? What is the relationship between effectiveness and levels of implementation?

Methods A single-arm, pre-/post-test study design was used. Participants were 660 employees from nine organizations who had valid step data and complete socio-demographic information at baseline. The primary outcome (mean daily steps) was assessed by Garmin VivoFit. Using the usage data from the UPnGO web-based system, a composite score for levels of implementation was calculated based on participant's compliance with the self-monitoring component and senior management's role modeling. Associations of interest were analyzed using linear mixed-effects models.

Results Levels of implementation were highly variable across organizations (mean = 68.22% ± 18.75, range = 19.8 to 100%). A significant Time × Implementation (IM) status interaction effect was observed. When stratified by IM status, a significant increase in mean daily steps at week 6 was found among participants in the high ($\beta = 540.01 \pm 202.69$, $p = 0.011$) but not low ($\beta = -81.54 \pm 291.96$, $p = 0.78$) implementation group.

Conclusion Findings suggest significant intervention effects in increasing average daily steps among participants who were exposed to optimal levels of implementation (~70%). UPnGO may be a scalable workplace PA intervention at a national level, although this needs further verification with more rigorous study designs.

Résumé

Intervention UPnGO with ParticipACTION (UPnGO) est une initiative d'activité physique (AP) en milieu de travail d'une durée de 6 semaines qui vise à augmenter l'AP habituelle (le nombre de pas) durant la journée de travail. Les éléments centraux de l'intervention étaient : 1) l'autosurveillance des pas et des comportements de planification d'actions avec une appli Web/mobile assortie d'incitations et 2) un appui organisationnel incluant l'exemple de la haute direction et son appui moral au programme.

Questions de recherche Quelle est l'efficacité et quels sont les niveaux de mise en œuvre de l'intervention UPnGO? Quelle est la relation entre l'efficacité et les niveaux de mise en œuvre?

Méthode Un protocole d'étude pré- et post-test sur groupe unique a été utilisé. Les participants étaient 660 employés de neuf organismes pour lesquels il existait au départ des données validées sur le nombre de pas et un profil sociodémographique complet. Le résultat principal (les pas moyens quotidiens) a été calculé avec l'appareil VivoFit de Garmin. À l'aide des données d'utilisation du système en ligne UPnGO, une note composite pour le niveau de mise en œuvre a été calculée d'après

✉ Erica Y. Lau
erica.lau@ubc.ca

¹ Vancouver Coastal Health Research Centre, Centre for Hip Health and Mobility, 7th Floor Robert H.N. Ho Research Centre, 796-2635 Laurel St, Vancouver, BC V5Z 1M9, Canada

² Department of Family Practice, University of British Columbia, 3rd Floor David Strangway Building, 5950 University Boulevard, Vancouver, BC V6T 1Z3, Canada

³ School of Kinesiology, University of British Columbia, Vancouver, BC V6T 1Z3, Canada

la conformité des participants à l'élément d'autosurveillance et l'exemple de la haute direction. Les associations intéressantes ont été analysées à l'aide de modèles linéaires à effets mixtes.

Résultats Les niveaux de mise en œuvre ont beaucoup varié d'un organisme à l'autre (moyenne = 68,22 % $\pm$ 18,75, intervalle = 19,8 % à 100 %). Un effet d'interaction significatif Temps $\times$ Mise en œuvre (MEO) a été observé. Après stratification selon le statut de MEO, une hausse significative des pas moyens quotidiens a été constatée la 6^e semaine chez les participants du groupe de mise en œuvre élevée ($\beta = 540,01 \pm 202,69$, $p = 0,011$), mais non dans ceux du groupe où la mise en œuvre était faible ($\beta = -81,54 \pm 291,96$, $p = 0,78$).

Conclusion Ces résultats indiquent que l'intervention a eu des effets sensibles en augmentant les pas moyens quotidiens des participants exposés à des niveaux optimaux de mise en œuvre (~ 70 %). UPnGO pourrait être une intervention d'AP en milieu de travail extensible à l'échelle nationale, mais cela nécessiterait de plus amples vérifications avec des protocoles d'étude plus rigoureux.

Keywords Telemedicine · Incentives · Implementation of health programs

Mots-clés Télémédecine · Incitations · Mise en œuvre des programmes de santé

Introduction

Chronic health conditions such as cardiovascular diseases, certain cancers, chronic respiratory diseases and type 2 diabetes not only are a major public health concern, they also greatly impact the Canadian economy through lost productivity due to absenteeism and through added healthcare costs (Janssen 2012). Regular physical activity (PA) reduces risks of these chronic diseases (Durstine et al. 2013). There is consistent evidence suggesting that ≥ 150 min of moderate-to-vigorous PA per week is needed for adults to elicit optimal health benefits (Warburton et al. 2006). Additionally, research suggests that even a modest increase in the amount of movement Canadians participate in can reduce the incidence of these chronic diseases, resulting in a 2.4% reduction in premature mortality (Mirolla 2004). Despite irrefutable evidence supporting the benefits of being active, 82% of Canadian adults fail to meet PA guidelines (Statistics Canada 2015). Therefore, promoting a more physically active lifestyle among Canadians is a public health priority.

The workplace, where Canadian adults spend a significant portion of their week (36.6 h/week) (Employment and Social Development Canada 2015), is an important setting for PA interventions. Unfortunately, the majority of Canadian office workers spend most of their day seated although they are aware of the potentially harmful effects of prolonged sitting time to their health (ParticipACTION 2016) (e.g., increased risks of cardio-metabolic diseases, type 2 diabetes and premature mortality (Dunstan et al. 2012)). These findings indicate the need for developing effective interventions to increase PA throughout the work day and interrupt prolonged bouts of sitting.

Given the importance of workplace settings in PA promotion, there is a growing evidence-base in this area. Several review studies have examined the effectiveness of workplace PA interventions on PA behaviour and report positive impact

on outcomes such as steps, time and frequency of PA, compliance to PA guidelines, active travel and stair climbing behaviours (Malik et al. 2014; Conn et al. 2009; Rongen et al. 2013; To et al. 2013). To inform the design of future studies, these reviews also identified strategies that appear associated with success. These strategies include the use of wearable technology and information communication technologies (e.g., Internet, mobile apps), involvement of weekly contact and integration of activities that target workplace social environments. An important area that has been neglected in this body of literature, however, is the extent to which these strategies were successfully implemented at the workplace as intended.

Establishing evidence of program implementation is particularly important in evaluating complex interventions (Campbell et al. 2007), like workplace health promotion interventions. Complex interventions are 'built up from a number of components, which may act both independently and interdependently' (Medical Research Council 2000). These components often involve the intervention, individuals and implementation settings. They could interact with, and adapt to, each other over time through a feedback loop, which creates a complex system to influence program effectiveness (Shiell et al. 2008). As such, effects of the intervention cannot be attributed to individual components, but to a synergy of them (Durlak 1998). To validly estimate intervention effects and identify core components that contribute to such effects, it is important to conduct process evaluation to assess levels of implementation (i.e., the extent to which a program was delivered as planned) and linking implementation with program effectiveness (Durlak 1998). Currently, few workplace PA interventions have reported findings regarding the level of implementation (Aittasalo et al. 2017; Wilson et al. 2010; Caperchione et al. 2016; Andersen and Zebis 2014; Wollesen et al. 2017; Verwey et al. 2016), and fewer have investigated its association with program effectiveness

(Aittasalo et al. 2017; Wilson et al. 2010; Caperchione et al. 2016).

The current study contributes to the literature by presenting the process evaluation findings from a workplace PA intervention (UPnGO with ParticipACTION; hereafter referred to as UPnGO) implemented in nine organizations in Ontario (ON) and British Columbia (BC), Canada. The specific objectives were to:

1. Assess the effects of UPnGO on increasing steps (program effectiveness)
2. Assess the extent to which workplaces delivered UPnGO to participants as planned (levels of implementation)
3. Examine the relationships between levels of implementation and program effectiveness of UPnGO

Methods

Background of UPnGO

UPnGO was developed by ParticipACTION (a Canadian non-profit organization focused on PA promotion). The intervention was supported by a cross-sectoral partnership among the Public Health Agency of Canada, BC Ministry of Health, PUBLIC Inc. (a marketing and communication agency), two industry partners, Ontario Trillium Foundation and AstraZeneca, and a technological partner, Sprout. UPnGO was planned as a national workplace PA intervention for dissemination across Canada. The short timeline to bring UPnGO from the stage of program development to dissemination expected by funding agencies and the industry partners had implications for the study design and evaluation methodology of UPnGO.

Study design

UPnGO was designed as a hybrid effectiveness-implementation study, which focused on testing intervention effects while explicitly collecting data on the implementation processes in a ‘real-world’ setting (Curran et al. 2012). This approach allowed the intervention development team to accumulate knowledge about the delivery settings (i.e., workplaces) through actual implementation. Such knowledge could then be used to enhance the intervention-context fit in subsequent implementation efforts, which has been suggested to be the key for successful dissemination (Indig et al. 2017).

A single-arm, pre-/post-test design was used to evaluate program effectiveness given a strong preference to be in the intervention group among the participating workplaces. Program implementation data were collected throughout the intervention period, and program outcome data were assessed

at baseline and post-intervention. This secondary data analysis used process and outcome evaluation data collected from the UPnGO evaluation, and ethics approval was obtained from the Behavioural Research Ethics Board at the University of British Columbia.

Participants

A sampling frame was developed including companies from ParticipACTION’s personal network, companies that publicly declared a focus on encouraging physically active workplaces and workplace wellness, and companies recognized as ‘top employers’ and ‘top places to work’. Organizations were eligible to participate if they were in either ON or BC, a small- to medium-sized company (1 to 499 employees) (Innovation Science and Economic Development Canada 2016), had employees physically present in the office on most days of the week, with a desk-centric office environment, and having no existing workplace PA intervention. Potential organizations were contacted by email and telephone. After considering pragmatic logistic issues and capacity, nine eligible organizations (four in ON and five in BC) were selected to implement the intervention. The characteristics of the included organizations varied. One organization had < 100 employees, four had 101–200 and four had 201–300. They were from various industry sectors: three organizations were from the information and cultural sector, two from public administration, and one each from the professional, scientific and technical services, telecommunications, management and manufacturing sectors.

All employees from these nine organizations who were 18 years or older, English speaking, had no contraindications to PA participation (PAR-Q (Exercise Society for Exercise Physiology 2012) or physician clearance) and had a personal smartphone or a computer connected to the Internet were eligible and invited to participate in the intervention. Recruitment strategies included onsite posters, company-wide emails and face-to-face-communication through organizational personnel. Of the 1613 employees from these nine organizations, 1187 (73.6%) of them registered for the UPnGO intervention.

Program overview

The intervention was guided by the Behaviour Change Wheel (BCW) theory, which posits that an individual’s PA behaviour is influenced by capability, opportunity and motivation (COM-B-Model) (Michie et al. 2011). To define these three factors in the context of a workplace PA intervention, the UPnGO team conducted literature reviews of workplace PA interventions and focus groups with employers and employees (who were not enrolled in UPnGO) to elicit relevant information. Based on the findings, the UPnGO intervention hypothesizes that through a combination of (a) increasing employees’

Table 1 Detailed descriptions of the UPnGO components

	Core elements	Optional elements
Individual level	Self-monitoring 1. Use the web/mobile application to self-monitor steps with a wrist-worn activity monitor everyday Action Planning 2. Use the web/mobile application to plan and record activities related to personal step goal (e.g., plan a walking meeting) everyday	Educational content Topics related to action planning and self-monitoring skills that are delivered via blogs, notifications, stream posts, and videos Interactive tools to enhance social support 1. Engage with discussion board to enlist social support 2. Use leaderboard for comparing personal ranking among colleagues 3. Use activity calendar to schedule events Program emails Email two to three times per week with participation reminders, ‘fun facts’ and program updates Incentives ParticipPOINTS were offered for each activity logged through the UPnGO app. For every 10,000 points, participant would earn a ‘level achievement’. There were five levels of achievement and each level unlocked ‘ParticipPOINTS’ that could be redeemed for rewards (e.g., coffee shop gift card, movie tickets, etc.) or donated to charity organizations. Each participant could redeem up to 50,000 ParticipPOINTS (approximately \$50 CAN)
Organizational level	Organizational support 1. Role modeling: Senior management role modeling through actively engaging in at least 50% of the UPnGO events 2. Endorsement: Senior management at each participating workplace were expected to provide a formal communication of support to their employees, such as through company-wide email/official announcements and the display of UPnGO materials. They were also expected to communicate and encourage managers/supervisors to provide permission for a flexible work schedule allowing employees to engage in intervention activities.	Weekly PA opportunities organized by UPnGO champions 1. Buddy UPnGO: Champions to arrange group walks and encourage colleagues to bring a walking buddy to participate 2. UPnGO Plan It: Champions to suggest PA planning strategies to their department and encourage colleagues to schedule active breaks at work 3. UPnGO Farther: Champions to schedule 20–30 group walk and encourage colleagues to participate 4. UPnGO Outside: Champions to organize breaks with sports equipment and encourage colleagues to participate 5. UPnGO Faster: Champions to share a planned walking routine and assist colleagues to time their walk 6. UPnGO Bring It Home: Champions to organize a final group walk and encourage colleagues to attend the wrap-up event Environmental prompts Environmental prompts (e.g., desk and boardroom tent cards, posters, floor decals, signage) provided by the UPnGO team were set up in different physical spaces throughout the workplace to remind participants about the program and provide cues to integrate active opportunities throughout the workday

behaviour change capability through planning and self-monitoring PA behaviour and (b) creating supportive workplace PA social environments by increasing active opportunities and organization support, employees' motivation to engage in PA in the workplace would be positively affected. This would consequently lead to increased steps among employees.

UPnGO is a 6-week workplace PA initiative aiming to increase habitual PA (steps) during the workday. It consists of components targeting individual- and organizational-level influences of PA. To enhance intervention-context fit, the intervention included core and optional components. The core components are the 'active ingredients' (Campbell et al. 2007) for initiating PA behaviour change. Core components had prescribed dosage, and all workplaces were encouraged to comply with these (e.g., self-monitoring of steps). In contrast, the optional components (e.g., educational content on PA knowledge, social support) provided additional support to facilitate changes. Optional components did not have a standardized dosage, and workplaces and participants were given the flexibility to adapt these components to their own contexts. For example, participants were asked to read educational blogs on the benefits of PA, and workplaces were asked to organize weekly PA opportunities based on their work schedule and employees' interests. A detailed description of the UPnGO components is provided in Table 1.

Individual-level components

The individual-level components aimed to enhance individuals' capability in self-regulating their PA behaviours. The core components included goal setting, self-monitoring and planning—a cluster of self-regulatory behaviour change techniques associated with intervention effectiveness (Greaves et al. 2011). Participants were assigned a personal daily step goal: ≥ 5000 steps/day, ≥ 7500 steps/day, $\geq 10,000$ steps/day and $\geq 12,500$ steps/day (Tudor-Locke and Bassett 2004). The goal was determined based on their baseline activity levels assessed by self-reported survey. To achieve their daily step goals, participants were given a commercially available and previously validated PA monitor (Garmin Vivofit, [Garmin, Olathe, KS, USA]) as a motivational and self-monitoring tool. They were asked to use the activity monitor together with the UPnGO Web/mobile phone app to self-monitor steps and activities related to action planning daily.

Optional components included asking participants to self-direct their engagement with educational blogs, a discussion board, leaderboard, and an activity calendar, and program emails. Content was developed by the UPnGO team who also created email prompts/reminders delivered through the app to participants throughout the study. To increase program engagement, participants were also offered modest incentives (a maximum of \$50 CAN could be redeemed in total) for each activity logged on the UPnGO app.

Organizational-level components

The organizational-level components aimed to provide organizational support to make PA a socially acceptable choice. Each workplace was asked to identify UPnGO champions and executive champions as the organizational change agents. The UPnGO champions were volunteers or someone who was identified through peer nominations. The executive champions were often the organization's director. Organizational support had two core features. First, senior management role-modeling was established by encouraging champions to self-monitor steps for at least 50% of the intervention days. Second, senior management endorsement was established by asking executive champions to provide permission to participate in UPnGO activities through formal communications (e.g., emails, verbal).

Optional organizational-level components included environmental prompts (e.g., signage) and engaging organizational champions to organize weekly PA opportunities and program emails.

Implementation approach

The UPnGO logic model (see Table 2) outlined how project activities were expected to increase employees' behaviour change capability to plan and self-monitor PA behaviour and to create active opportunities in the workplace through weekly PA activities and leadership support. Prior to the intervention, the UPnGO implementation specialists (who coordinated all the logistics and provided technical assistance) developed a working relationship with the workplace contact persons through site visits, emails, and phone calls. They collaborated with the workplace contact persons to identify and recruit executive champions and UPnGO champions. Both executive and UPnGO champions received a 1-day teleconference training together with a program handbook.

Interested participants were asked to download the UPnGO app which is available on the Apple iTunes and Google Play app stores. Upon installation of the app, participants were asked to complete a set of questionnaires to self-report their age, height, weight and readiness to participate in PA, PA level and sitting time. Then, they finished the registration process by creating a password-protected personal account. A launch event was held in each participating workplace to distribute program materials and the activity devices. The implementation specialists also attended the launch event to assist participants in installing the UPnGO app and Garmin app, and connect these apps with the activity device. Participants who did not have a smartphone but had access to a personal computer/tablet connected to the Internet (~3%) were instructed to record their time spent in physical activity and manually enter this information on the UPnGO platform (with built-in logarithm to convert PA time into steps). Registered participants

Table 2 Logic model for the UPnGO intervention

Process evaluation			Outcome and impact evaluation
Input	Activities	Output	
UPnGO team will provide an implementation specialist, the UPnGO program, and program materials	UPnGO team and the participating worksites will develop a partnership to adapt UPnGO into the worksites	Increased support for implementing UPnGO among pilot site senior management: • <i>Role modeling (engage in self-monitoring activities)</i> • <i>Endorsement of the program</i>	• <i>Increased average daily steps from weeks 1–6</i>
UPnGO team will provide training, technological support, and technical assistance (TA) to assist implementation at the participating worksites		Organizational level: Changes in workplace PA culture as reflected by: • Changes in employees' perceptions of support for PA Individual level: • Improved employees' skills in goal setting, action planning, and capability.	
		Increased support and confidence in UPnGO champion to: • Organize activities according to weekly themes • Provide onsite technical support to participants Employees sign up for and engage in the UPnGO program. • <i>Self-monitor steps and action-planning activities</i> • Participate in weekly PA activities	

Italics indicates components analyzed in the current study

were provided with a 2-week soak time to familiarize themselves with the procedures of tracking steps and other activities, and to try out different features on the UPnGO app. During the intervention phase, implementation specialists conducted weekly phone meetings and used emails to provide technical assistance to the workplace.

Measures

Daily steps Participants were asked to wear the Garmin Vivofit device on their dominant wrist every day to record their steps, except while sleeping, bathing or performing water sports. Step data recorded by the device were synced automatically to the Garmin Connect™ Mobile app and then to the UPnGO app using both Android and iOS system with Bluetooth. Garmin Vivofit was found to have good validity in measuring steps in 24-h free-living conditions (An et al. 2017). The step data were collected through the UPnGO web-based system embedded in the app throughout the intervention period. The data from baseline to week 6 were extracted, de-identified and used for the current analysis. A valid day was defined as any day with step counts between 1000 and 40,000 (Baerg et al. 2011). For each week, an average daily step count was calculated for participants who had three or more valid days in a specific week (Tudor-Locke et al. 2005).

The level of implementation

A holistic approach was employed to conceptualize the level of implementation. Two implementation aspects, fidelity and dose received, were assessed based on web metrics recorded throughout the intervention period. Fidelity was operationalized as the extent to which the organizations created a supportive social environment for PA. Based on UPnGO program monitoring data, all the organizations had delivered formal communication to officially endorse UPnGO. Therefore, we assessed fidelity based on champions' role modeling only, which was objectively measured by their engagement in self-monitoring of steps throughout the intervention period. We calculated the percentage of champions who self-monitored steps for at least 50% of the intervention days (total number of days with non-zero steps / the total number of intervention days (i.e., 42 days). Since this was measured at the organizational level, all participants within the same organization were assigned the same overall score.

The dose received was defined as the extent to which the participants engaged with the individual-level core components. It was assessed based on two indicators: (a) engagement with self-monitoring of steps, which was calculated based on the total number of days that individuals had non-zero steps divided by the total number of intervention days (i.e., 42 days), and (b) engagement with self-monitoring of action-planning activities, which was calculated based on the total number of

days that individuals had logged action-planning activities at least once per day divided by the total number of intervention days.

A composite score for levels of implementation was also calculated for each participant by averaging the scores of the three indicators: senior management role modeling, individual self-monitoring of steps, and self-monitoring of action-planning activities. Participants were categorized into low-implementation ($\leq$ median score) and high-implementation groups ($>$ median score).

Statistical analysis

All analyses were conducted using SAS 9.4 version (Cary, NC). Of the 1187 registrants, 843 participants (71%) had valid Garmin-derived step data at baseline; 646 participants (54.4%) had valid step data at the end of the intervention. We used an intent-to-treat approach, participants only required to have valid step data at baseline to be included in the analysis. For participants who did not provide complete step data at post-intervention, we conservatively assumed no change in outcomes by carrying forward baseline values. Of the 843 participants who had valid step data at baseline, 183 participants were excluded due to incomplete demographic information, leading to a final sample size of 660 (55.6%). Two-sample *t* test and chi-square tests were conducted to examine whether demographic characteristics were systematically different between the included and excluded participants. For those included in the final analysis, descriptive analyses (e.g., means and frequencies) were conducted for age, sex, steps, senior management role modeling, individual self-monitoring of steps, and self-monitoring of action-planning activities, and levels of implementation. Normality assumptions of the dependent variable (steps) and independent variable (levels of implementation) were verified graphically based on P-P and Q-Q plots. We also conducted independent sample *t* tests to compare participants' age, sex, and steps at baseline by IM status.

To examine changes in average daily steps between baseline and week 6 and the association between implementation and program outcomes, we fitted two linear mixed-effect models using PROC MIXED procedures with the maximum likelihood estimation method and a variance components covariance structure. Model 1 included steps as the outcome variable, time (0 = baseline, 6 = week 6) as the independent variable, age (mean-centred) and sex as fixed-effect covariates. Individual and site were included as random effects to adjust for the clustering of repeated measurements nested within participants and participants nested within sites. Model 2 further included implementation (IM) status and IM status $\times$ time interaction as the independent variables. Statistical significance was set at $p < 0.05$ for all models.

Results

Age ($p = 0.183$) and gender ($p = 0.376$) were not significantly different between the included and excluded participants. Among the participants included in the current analysis, 60% were female and the mean age was 40.56 ± 11.50 years. The mean level of implementation was $68.22\% \pm 18.75$ (median = 69.8%). Levels of implementation were highly variable and ranged between 19.8% and 100%. On average, participants engaged in self-monitoring of action-planning activities and self-monitoring of steps for 44.7% and 72.2% of the total intervention days, respectively. Approximately, 81.8% of the champions engaged in self-monitoring of steps $\geq 50\%$ of the intervention days. Approximately 60% of the participants were categorized into the high implementation group. Compared to the low implementation group, those in the high implementation group reported significantly higher step counts at baseline ($p < 0.0001$); no significant difference was found by age and sex.

Step counts at baseline were 8853.12 ± 3360.89 steps/day, suggesting that participants in the analytical sample were 'somewhat active' (Tudor-Locke and Bassett 2004) at baseline. As presented in Fig. 1, there was a non-linear increase in average daily steps over time. The greatest increase in average daily steps was observed in week 1 (+1136.15 steps) and the least in week 4 (+301.39 steps). On average, daily step counts increased by 591.5 steps (6.86%) over the 6-week period. Results from Model 1 suggested that UPnGO had no significant intervention effects on increasing steps. Average daily steps were not significantly different between baseline and week 6, although significant differences were observed in weeks 1, 2, 3 and 5.

However, Model 2 revealed a significant interaction effect between time and IM status. This indicated that the intervention effect was dependent on IM status. Changes in steps were significantly greater in the high compared to low implementation group in all weeks, except week 1 (p values ranged from < 0.0007 to < 0.05). A subgroup analysis was performed to investigate changes in steps by IM status. As illustrated in Fig. 2, for participants in the high-implementation group, the greatest increase in average daily steps was observed in week 1 (+1203.01 steps) and the least in week 4 (+280.28 steps). On average, daily step counts increased by 788.37 steps (8.76%) over the 6-week period. A significant intervention effect was observed, as average daily steps were significantly greater in week 6 than baseline. Average daily steps were also significantly greater than baseline in weeks 1, 2, 3 and 5.

For those in the low-implementation group, a different pattern of change was observed. The greatest change in average daily steps was observed in week 1 (+976.8 steps) and the least in week 4 (−524.11 steps). On average, daily step counts increased by 170.63 steps (2.12%) over the 6-week period. No significant intervention effect was found, as average daily

Fig. 1 Changes in average daily steps over the intervention period in the total sample. Linear-mixed effect models adjusted for age and sex as covariates; individual and site as random effects. *Significantly different from baseline at $p < 0.05$. **Significantly different from baseline at $p < 0.0001$

steps were not significantly different between baseline and week 6. Average daily steps were not significantly different between baseline and other weeks, except week 1.

Discussion

A significant interaction effect between *Time* and *IM status* was found in the current study, indicating that the effect of UPnGO on increasing a participant's average daily steps was dependent on level of implementation. Only participants in the high-implementation group showed a significant increase between baseline and week 6 with no significant change for those in the low-implementation group. These findings reaffirm the importance of incorporating implementation evidence when determining intervention effectiveness. Without such information, researchers may erroneously conclude that the program is ineffective when, in fact, the insignificant outcomes are a result of suboptimal program delivery and poor uptake (Type III error) (Dobson and Cook 1980).

Establishing the linkage between the level of implementation and program outcomes can help identify the active ingredients that contribute to the observed effects. In the current study, we considered senior management role modeling, individual self-monitoring of steps and self-monitoring of action-planning activities as the active ingredients of UPnGO because they were used to comprise the composite score of levels of implementation, which was found to be significantly and positively associated with changes in participant's steps. Of those in the high-implementation group, implementation of

these three strategies produced an 8.7% increase in average daily steps between baseline and week 6. This magnitude can be compared with similar interventions that utilized more rigorous study designs. For example, Behrens et al. (2007) tested the effect of a pedometer-based PA program on increasing employees' weekly step counts over 12 weeks with a quasi-experimental controlled trial. They found that participants' weekly step counts increased by 8.36% between baseline and week 6, although no significant intervention effect was found at week 12. Gilson et al. (2009) evaluated the effects of a 10-week walking program implemented in white-collar university employees using a randomized controlled trial (RCT) study design. Intervention components included goal setting, self-monitoring steps using a pedometer, and weekly emails that contained motivational messages. They found a significant intervention effect favouring the intervention group, with an increase in average daily steps by 10% between baseline and week 10 in the intervention group and a reduction by 4% in the control group. The increase in daily steps by week 5 was approximately 8.8%. However, the magnitude was smaller than that reported in Faghri et al. (2008) where they used similar strategies, but involved a less active population (> 20% increase at week 6) or in Wilson et al. (2010) where they included more intervention strategies focusing on the organizational level, such as establishing staff steering committees and company-wide participation competition (> 10% increase at week 6). The effects were also smaller than another incentivized, FitBit-based PA intervention, in which the analyses only included participants with complete data (12% increase at week 6) (Mason et al. 2018). These

Fig. 2 Changes in average daily steps over the intervention period stratified by implementation status. A composite score for levels of implementation was calculated for each participant by averaging the scores of three indicators: self-monitoring of steps, self-monitoring of action-planning activities, and senior management's role modeling. Based on this score, participants were classified into two categories: low ($\leq$ median score) and high ($>$ median score) implementation. Linear-mixed effect models adjusted for age and sex as covariates; individual and site as random effects. *Significantly different from baseline at $p < 0.05$. **Significantly different from baseline at $p < 0.0001$

comparisons provide preliminary support of the theoretical framework used for the UPnGO program as well as information to inform the direction of future program refinement and evaluation.

To our knowledge, only three workplace PA interventions (Aittasalo et al. 2017; Wilson et al. 2010; Caperchione et al. 2016) have examined the relationship between program implementation and program outcomes and the results were mixed. Similar to the current findings, positive associations between program implementation and program outcome were demonstrated in two interventions. In Move to Improve, Wilson et al. (2010) evaluated two implementation aspects (i.e., fidelity and dose received) in relation to changes in vigorous PA, moderate PA, and walking. Fidelity was assessed based on workplaces' implementation of the environmental support components, and dose received was assessed based on participant engagement in the personal goal-setting component. Workplaces and individual participants were then classified into low and high implementation based on the median. Compared to the low-implementation groups, participants in high-fidelity sites had a greater increase in vigorous PA over time and participants in the high engagement group reported greater changes in walking over time. The second intervention, POWERPLAY (Caperchione et al. 2016), assessed dose received based on participants' self-reported exposure to the intervention activities (e.g., attendance of launch events) and materials (e.g., use of pedometer). They found that PA knowledge and self-reported walking time were significantly higher among participants in the high- (above median) than low-exposure groups. The third workplace intervention, Move to Business, reported a null association. Aittasalo and colleagues (Aittasalo et al. 2017) found that

the implementation status (high vs. low), determined by the median number of intervention actions being implemented, was not associated with the changes in employees' PA or sedentary behaviour. The mixed results could be due to many reasons, such as differences in the conceptualization and measures of the level of implementation and the variability of implementation across sites. More studies are needed to strengthen the evidence base to facilitate our understanding of what works in which settings, for whom, and to what extent.

Compared to previous studies, we used a holistic approach to conceptualize the level of implementation. We combined fidelity and dose received to derive a composite score. Workplaces were then classified into high- and low-implementation groups based on this score instead of a ranking. In addition to linking implementation with program outcomes, this approach also allowed us to identify a potential implementation threshold necessary for yielding significant intervention effects. In the current study, significant intervention effects were observed when the level of implementation achieved approximately 70%. This potential implementation threshold provides an important insight and indication for future interventions regarding the extent to which a program like UPnGO needs to be implemented in order to obtain desired program outcomes. Although this threshold could vary across studies depending on many other factors (e.g., types of intervention and the target population), it is in line with the $\geq 60\%$ cut-point suggested in preventive interventions by Durlak and DuPre (2008).

The current findings should be interpreted cautiously with the consideration of the following limitations. The absence of randomization and a comparison group could hinder the

internal validity of our conclusion, but the incorporation of program implementation information when determining the intervention effects may have partly counter-balanced that potential bias. As suggested in previous studies (Woods et al. 1999; Tones 2000), RCTs are not always feasible in real-world trials delivered by non-governmental organizations, and they may not always be appropriate for evaluating complex interventions. If feasible, further evaluation of the UPnGO program is recommended to include at least a comparison group. Due to time and resource constraints, we focused our evaluation on the core components and did not collect information on whether, and how well, the optional components were implemented. Only two implementation aspects, fidelity and dose received, were used to construct the composite score of level of implementation, but they were suggested to be influential to program outcomes in environmental-oriented interventions (Saunders 2016). Only quantitative data were considered in the current analysis because our intent was to verify the theoretical framework of the UPnGO program. Future studies that incorporate qualitative data are needed to inform program refinement, such as source of variability in implementation (e.g., engagement in optional components of UPnGO) and preferences of the participants. We did not consider other potential confounders that may influence the intervention effect, such as physical layout of the workplace (e.g., access to staircases). However, our pilot data indicated that measured attributes of the workplace environment did not correlate with changes in participants' steps. Strengths of the current study included the incorporation of implementation data when determining intervention effectiveness, the use of objective measures for PA and implementation indicators, and the inclusion of multiple time-points in the analysis to more precisely reflect patterns of change over time.

Conclusion

UPnGO is the result of a novel multi-sectoral collaboration, and preliminary evidence suggests that it may constitute the basis of a scalable physical activity intervention for Canadian office-based workplaces. Overall, the current findings suggest that UPnGO had significant intervention effects on increasing average daily steps among participants who were exposed to optimal levels of implementation (~70% of program uptake). This potential implementation threshold provides an important insight and indication for future interventions regarding the extent to which a program like UPnGO needs to be implemented in order to obtain desired program outcomes. An important next step for UPnGO is to sustain the positive health impact. The program has now evolved and expanded its length from 6 weeks to 1 year, and we will continue to examine program effectiveness and sustainability.

Acknowledgements Dr. Faulkner is a Canadian Institutes of Health Research (CIHR)-Public Health Agency of Canada (PHAC) Chair in Applied Public Health. The authors also wish to acknowledge Ms. Lisa Fender, Dr. Allana LeBlanc and the UPnGO team for their assistance in the evaluation.

Funding information UPnGO with ParticipACTION was supported by a multi-sectoral partnership grant from the Public Health Agency of Canada, ParticipACTION, Public Inc., the British Columbia Ministry of Health, the Ontario Trillium Foundation and AstraZeneca.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

References

- Aittasalo, M., Livson, M., Lusa, S., Romo, A., Vaha-Ypya, H., Tokola, K., et al. (2017). Moving to business—changes in physical activity and sedentary behavior after multilevel intervention in small and medium-size workplaces. *BMC Public Health*, 17(1), 319. <https://doi.org/10.1186/s12889-017-4229-4>.
- An, H.-S., Jones, G. C., Kang, S.-K., Welk, G. J., & Lee, J.-M. (2017). How valid are wearable physical activity trackers for measuring steps? *European Journal of Sport Science*, 17(3), 360–368. <https://doi.org/10.1080/17461391.2016.1255261>.
- Andersen, L. L., & Zebis, M. K. (2014). Process evaluation of workplace interventions with physical exercise to reduce musculoskeletal disorders. *International Journal of Rheumatology*, 2014, 761363. <https://doi.org/10.1155/2014/761363>.
- Baerg, S., Cairney, J., Hay, J., Rempel, L., Mahlberg, N., & Faught, B. E. (2011). Evaluating physical activity using accelerometry in children at risk of developmental coordination disorder in the presence of attention deficit hyperactivity disorder. *Research in Developmental Disabilities*, 32(4), 1343–1350. <https://doi.org/10.1016/j.ridd.2011.02.009>.
- Behrens, T. K., Domina, L., & Fletcher, G. M. (2007). Evaluation of an employer-sponsored pedometer-based physical activity program. *Perceptual and Motor Skills*, 105(3), 968–976. <https://doi.org/10.2466/pms.105.3.968-976>.
- Campbell, N. C., Murray, E., Darbyshire, J., Emery, J., Farmer, A., Griffiths, F., et al. (2007). Designing and evaluating complex interventions to improve health care. *BMJ*, 334(7591), 455–459. <https://doi.org/10.1136/bmj.39108.379965.BE>.
- Caperchione, C. M., Stolp, S., Bortorff, J. L., Oliffe, J. L., Johnson, S. T., Seaton, C., et al. (2016). Changes in men's physical activity and healthy eating knowledge and behavior as a result of program exposure: findings from the workplace POWERPLAY program. *Journal of Physical Activity and Health*, 13(12), 1364–1371. <https://doi.org/10.1123/jpah.2016-0111>.
- Conn, V. S., Hafdahl, A. R., Cooper, P. S., Brown, L. M., & Lusk, S. L. (2009). Meta-analysis of workplace physical activity interventions. *American Journal of Preventive Medicine*, 37(4), 330–339. <https://doi.org/10.1016/j.amepre.2009.06.008>.
- Curran, G. M., Bauer, M., Mittman, B., Pyne, J. M., & Stetler, C. (2012). Effectiveness-implementation hybrid designs: combining elements of clinical effectiveness and implementation research to enhance

- public health impact. *Medical Care*, 50(3), 217–226. <https://doi.org/10.1097/MLR.0b013e3182408812>.
- Dobson, D., & Cook, T. J. (1980). Avoiding type III error in program evaluation: results from a field experiment. *Evaluation and Program Planning*, 3(4), 269–276. [https://doi.org/10.1016/0149-7189\(80\)90042-7](https://doi.org/10.1016/0149-7189(80)90042-7).
- Dunstan, D. W., Howard, B., Healy, G. N., & Owen, N. (2012). Too much sitting—a health hazard. *Diabetes Research and Clinical Practice*, 97(3), 368–376. <https://doi.org/10.1016/j.diabres.2012.05.020>.
- Durlak, J. A. (1998). Why program implementation is important. *Journal of Prevention & Intervention in the Community*, 17(2), 5–18. https://doi.org/10.1300/J005v17n02_02.
- Durlak, J., & DuPre, E. (2008). Implementation matters: a review of research on the influence of implementation on program outcomes and the factors affecting implementation. *American Journal of Community Psychology*, 41(3–4), 327–350. <https://doi.org/10.1007/s10464-008-9165-0>.
- Durstine, J. L., Gordon, B., Wang, Z., & Luo, X. (2013). Chronic disease and the link to physical activity. *Journal of Sport and Health Science*, 2(1), 3–11. <https://doi.org/10.1016/j.jshs.2012.07.009>.
- Employment and Social Development Canada. (2015). Indicators of well-being in Canada. <http://well-being.esdc.gc.ca/misme-iowb/d.4m.1.3n@-eng.jsp?did=3>. Accessed 09-04-2018.
- Exercise Society for Exercise Physiology. (2012). The physical activity questionnaire for everyone.
- Faghri, P. D., Omokaro, C., Parker, C., Nichols, E., Gustavesen, S., & Blozie, E. (2008). E-technology and pedometer walking program to increase physical activity at work. *The Journal of Primary Prevention*, 29(1), 73–91. <https://doi.org/10.1007/s10935-007-0121-9>.
- Gilson, N. D., Puig-Ribera, A., McKenna, J., Brown, W. J., Burton, N. W., & Cooke, C. B. (2009). Do walking strategies to increase physical activity reduce reported sitting in workplaces: a randomized control trial. *International Journal of Behavioral Nutrition and Physical Activity*, 6(1), 43. <https://doi.org/10.1186/1479-5868-6-43>.
- Greaves, C. J., Sheppard, K. E., Abraham, C., Hardeman, W., Roden, M., Evans, P. H., et al. (2011). Systematic review of reviews of intervention components associated with increased effectiveness in dietary and physical activity interventions. *BMC Public Health*, 11(1), 119. <https://doi.org/10.1186/1471-2458-11-119>.
- Indig, D., Lee, K., Grunseit, A., Milat, A., & Bauman, A. (2017). Pathways for scaling up public health interventions. *BMC Public Health*, 18(1), 68. <https://doi.org/10.1186/s12889-017-4572-5>.
- Innovation Science and Economic Development Canada. (2016). Key small business statistics.
- Janssen, I. (2012). Health care costs of physical inactivity in Canadian adults. *Applied Physiology, Nutrition, and Metabolism*, 37(4), 803–806. <https://doi.org/10.1139/h2012-061>.
- Malik, S. H., Blake, H., & Suggs, L. S. (2014). A systematic review of workplace health promotion interventions for increasing physical activity. *British Journal of Health Psychology*, 19(1), 149–180. <https://doi.org/10.1111/bjhp.12052>.
- Mason, M. R., Ickes, M. J., Campbell, M. S., & Bollinger, L. M. (2018). An incentivized, workplace physical activity intervention preferentially increases daily steps in inactive employees. *American Journal of Health Promotion*, 32(3), 638–645. <https://doi.org/10.1177/0890117117723803>.
- Medical Research Council. (2000). *A framework for the development and evaluation of RCTs for complex interventions to improve health*. London: MRC.
- Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation Science*, 6(1), 42. <https://doi.org/10.1186/1748-5908-6-42>.
- Mirolla, M. (2004). The cost of chronic diseases in Canada.
- ParticipACTION. (2016). Sitting and restless: It's time to take a stand against 'meeting culture' in Canada.
- Rongen, A., Robroek, S. J., van Lenthe, F. J., & Burdorf, A. (2013). Workplace health promotion: a meta-analysis of effectiveness. *American Journal of Preventive Medicine*, 44(4), 406–415. <https://doi.org/10.1016/j.amepre.2012.12.007>.
- Saunders, R. (2016). *Implementation monitoring and process evaluation*. Sage Publication, Inc..
- Shiell, A., Hawe, P., & Gold, L. (2008). Complex interventions or complex systems? Implications for health economic evaluation. *BMJ*, 336(7656), 1281–1283. <https://doi.org/10.1136/bmj.39569.510521.AD>.
- Statistics Canada. (2015). Table 117-0019—distribution of the household population meeting/not meeting the Canadian physical activity guidelines, by sex and age group, occasional (percentage). Accessed 24-08-2018.
- To, Q. G., Chen, T. T., Magnussen, C. G., & To, K. G. (2013). Workplace physical activity interventions: a systematic review. *American Journal of Health Promotion*, 27(6), e113–e123. <https://doi.org/10.4278/ajhp.120425-LIT-222>.
- Tones, K. (2000). Evaluating health promotion: a tale of three errors. *Patient Education and Counseling*, 39(2–3), 227–236.
- Tudor-Locke, C., & Bassett, D. R., Jr. (2004). How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Medicine*, 34(1), 1–8.
- Tudor-Locke, C., Burkett, L., Reis, J. P., Ainsworth, B. E., Macera, C. A., & Wilson, D. K. (2005). How many days of pedometer monitoring predict weekly physical activity in adults? *Preventive Medicine*, 40(3), 293–298. <https://doi.org/10.1016/j.ypmed.2004.06.003>.
- Verwey, R., van der Weegen, S., Spreeuwenberg, M., Tange, H., van der Weijden, T., & de Witte, L. (2016). Process evaluation of physical activity counselling with and without the use of mobile technology: a mixed methods study. *International Journal of Nursing Studies*, 53, 3–16. <https://doi.org/10.1016/j.ijnurstu.2015.10.008>.
- Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. *Canadian Medical Association Journal*, 174(6), 801–809. <https://doi.org/10.1503/cmaj.051351>.
- Wilson, M. G., Basta, T. B., Bynum, B. H., DeJoy, D. M., Vandenberg, R. J., & Dishman, R. K. (2010). Do intervention fidelity and dose influence outcomes? Results from the move to improve workplace physical activity program. *Health Education Research*, 25(2), 294–305. <https://doi.org/10.1093/her/cyn065>.
- Wollesen, B., Menzel, J., Drögemüller, R., Hartwig, C., & Mattes, K. (2017). The effects of a workplace health promotion program in small and middle-sized companies: a pre-post analysis. *Journal of Public Health*, 25(1), 37–47. <https://doi.org/10.1007/s10389-016-0763-2>.
- Woods, W. G., Bernstein, M., & Lemieux, B. (1999). Randomized controlled trials in population-based intervention studies are not always feasible. *Medical and Pediatric Oncology*, 33(4), 360–361.