Dose relations between goal setting, theory-based correlates of goal setting and increases in physical activity during a workplace trial

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Abstract

The effectiveness of an intervention depends on its dose and on moderators of dose, which usually are not studied. The purpose of the study is to determine whether goal setting and theory-based moderators of goal setting had dose relations with increases in goal-related physical activity during a successful workplace intervention. A group-randomized 12-week intervention that included personal goal setting was implemented in fall 2005, with a multiracial/ethnic sample of employees at 16 geographically diverse worksites. Here, we examined dose-related variables in the cohort of participants (N = 664) from the 8 worksites randomized to the intervention. Participants in the intervention exceeded 9000 daily pedometer steps and 300 weekly minutes of moderate-to-vigorous physical activity (MVPA) during the last 6 weeks of the study, which approximated or exceeded current public health guidelines. Linear growth modeling indicated that participants who set higher goals and sustained higher levels of self-efficacy, commitment and intention about attaining their goals had greater increases in pedometer steps and MVPA. The relation between change in participants’ satisfaction with current physical activity and increases in physical activity was mediated by increases in self-set goals. The results show a dose relation of increased physical activity with changes in goal setting, satisfaction, self-efficacy, commitment and intention, consistent with goal-setting theory.

Introduction

Physical activity among US adults is below levels recommended for health promotion [1–3] and is a target of public health intervention [1–4]. Goal setting is a powerful approach to changing the direction, regulation and persistence of effort [5]. Past studies that used goal setting to increase physical activity did not examine whether change in physical activity was related to participants’ actual goal setting (i.e. intervention dose), which might explain the mixed positive and null findings of the studies [6].

The dose of an intervention (i.e. the amount of exposure participants have to the intervention’s active components) [7] is a key determinant of intervention effectiveness [8] that has been neglected in reports of physical activity intervention [9–11]. Although dose depends on the adequate delivery of intervention elements [8], it also depends upon receipt and use of those elements by the participants [7]. We recently reported on the efficacy of a successful multisite, group-randomized workplace trial of employee goal setting [12]. We found that the increase in vigorous physical activity, a primary...
outcome measure in the study, was positively asso-
ciated with the level of implementation of the
intervention [13], defined as the intervention dose
received by participants [7] (i.e. full participation in
the goal-setting activities).

Our first purpose in this report is to extend the
test of intervention dose in that trial by examining
whether participants’ goals had a dose relation with
change in physical activity during the intervention.
The dose of an intervention can also depend upon
characteristics of the participants that moderate
their utilization of intervention elements [8]. Thus,
our second purpose here is to extend prior recom-
mendations to examine person-level moderators of
effectiveness [8] by choosing correlates of goal set-
ting derived from contemporary theory that can act
as moderators of goal setting [5].

According to goal-setting theory [5], people who
are not satisfied with their current level of physical
activity will be more likely to set goals to increase
activity and will be more satisfied when they are
successful. Hence, changes in satisfaction should be
related to changes in goals and physical activity.
Similarly, goals are most related to goal outcomes
when people are committed to the goals and
are confident that they can achieve them [5]. People
with high self-efficacy set higher goals, are more
committed to the goals, are more likely to act on
the goals and are more likely to develop tactics to
reach the goals [5, 14]. Hence, changes in goal
commitment, self-efficacy and intentions should
be related to changes in goals and physical activity.

Mediators of outcomes (i.e. mechanisms) are
variables in a causal sequence that transmit all or
part of the relation or effect of an independent vari-
able on a dependent variable [15]. Goal setting
works to increase behavior by enhancing the direc-
tion, self-regulation (e.g. use of tactics) and persis-
tence of task-directed effort [5, 14]. Moderators of
outcomes are variables not in a causal sequence but
that modify the relation or effect between an inde-
pendent variable and a dependent variable [16]. If
the link between goals and goal outcomes is stron-
ger in people with high goal commitment and self-
efficacy, those factors moderate the influence of
goals. Hence, moderation occurs when goals are
related to goal outcomes only, or more strongly,
in one level of an extraneous variable that is other-
wise unrelated to either goals or goal outcomes.
Recent studies have examined mediators or moder-
ators of the outcomes of physical activity interven-
tions [17, 18] and naturally occurring change in
physical activity [19], but not of goal setting or
the dose relation of goal setting with physical
activity, which is our focus.

Unlike categorical traits such as gender, race,
etnicity, education level or occupation, goal-
setting moderators such as commitment, self-
efficacy and intention are difficult to categorize into
meaningful levels and they can fluctuate across
time. This makes it difficult to study them as mod-
erators of longitudinal change in physical activity
[15, 16]. Because our interest here is the dose
relation of change in physical activity with change
in goal setting, we simultaneously tested whether
satisfaction, commitment, self-efficacy and inten-
tion had indirect relations with goal outcomes that
were mediated by goals or direct relations with goal
outcomes that were independent of goals. The act of
goal setting can motivate the development and use
of self-regulation skills (i.e. tactics) that increase
the likelihood of goal attainment [5, 14], so we
expected that these moderators of goal setting could
be related to change in physical activity that did not
depend on goals.

Consistent with theory [5, 14], we hypothesized
that increases in physical activity during the inter-
vention would be positively related to increases in
participants’ goals for physical activity, their satis-
faction with current levels of physical activity and
their self-efficacy, commitment and intention to at-
tain the new goals. We also hypothesized that
increases in the goals would fully or partly mediate
the relations of changes in satisfaction level and the
other moderators of goal setting with subsequent
change in physical activity. The quantitative
approach we took provides a method that comple-
ments the additive combination of indicators of inter-
vention impact [8] by describing shared correlates of implementation (in this case, goal set-
ting) and effectiveness (in this case, goal-related
physical activity).
A few randomized controlled trials of goal setting used pedometers to provide a concurrent, objective measure of physical activity [20–22], so we used pedometer steps and daily logs of accumulated minutes of moderate-to-vigorous physical activity (MVPA) to provide measures of goal-related physical activity. These measures were not the primary outcome measure of physical activity used to evaluate intervention efficacy in the trial [12]. Rather, the daily records of physical activity were part of the goal-setting intervention. Together with the measure of goal setting, they provided quantitative indicators of intervention dose throughout the 12-week study.

**Research design and methods**

**Subjects and setting**

Participants in this analysis were from a cohort of 664 employees (19–64 years of age; 36 ± 10) from 8 intervention worksites who did not report overt cardiovascular, pulmonary or metabolic disease and signed a consent form that was approved by the Institutional Review Board on 1 December 2004. The sites had been paired with 8 other sites according to number of employees and nature of work (i.e. division office, call center, etc.), and each of the paired sites was randomly assigned to the intervention or a health education control condition. Intervention participants were predominantly female (69%). Racial and ethnic percentages were white (59%), black (24%), Asian (5%), Pacific Islander or Native American (1%), other (7%) and Hispanic or Latino (6%). Procedures for recruitment and randomization, as well as other characteristics of the intervention and control conditions, have been described elsewhere [15]. At baseline, 849 employees at the intervention sites completed the primary outcome measure of physical activity (not used in our report here). One hundred and ninety-seven intervention participants (23.2%) were lost to follow-up and 55 joined soon after the baseline. The participants lost to follow-up at intervention sites did not differ ($P > 0.30$) at baseline from the intervention cohort analyzed here on the primary measure of physical activity, which assessed vigorous and moderate intensity of exercise habits and walking [12].

**Intervention**

Key features of the intervention were adapted from the Director’s 50th Anniversary Physical Activity Challenge implemented at the Centers for Disease Control and Prevention in Atlanta, GA [23, 24], which included both individual and organizational behavior change components. The intervention expanded the original goal-setting procedure employed by Cole *et al.* [23] by establishing personal goals according to the theoretical guidelines of Locke and Latham [5].

The goal-setting component of the intervention focused on setting and attaining personal goals that were self set, specific regarding performance and time, challenging but realistic and attainable and easily assessed [5]. The primary personal goals involved graduated increases in the accumulation of daily pedometer steps and 10-min blocks of MVPA during the 12-weeks of the intervention. Personal goals were targeted toward meeting or exceeding established public health recommendations for physical activity. These included accumulating 10 000 or more pedometer steps each day [25] and/or 150 or more minutes each week of MVPA [1, 4, 26].

**Procedures**

All employees who participated (i.e. completed baseline testing) in the study received an incentive (e.g. t-shirt, lunch cooler), including a pedometer and instructions for its use as part of goal setting. Each intervention participant received a participant handbook that detailed the components, benefits and incentives, participant responsibilities and timing of the intervention. The handbook also contained examples for use of the pedometers and daily logs of 10-min blocks of MVPA. It contained 6 sequential, biweekly “Tools” to guide and assist the participant through the intervention: (i) goal setting, (ii) overcoming obstacles, (iii) sedentary...
temptations, (iv) avoiding relapse, (v) staying motivated and (vi) keep on moving. Each tool was a practical application of theory-based behavior modification principles built around goal-setting theory [5]. The goal-setting intervention involved assessments of daily pedometer steps and the number of 10-min blocks of MVPA accumulated per week. The personal goals were evaluated and adjusted by participants biweekly. Team captains collected work sheets every 2 weeks from each team member that included the daily accumulation of pedometer steps and minutes of MVPA, as well as goals for the coming 2 weeks and biweekly participant ratings of their satisfaction with current physical activity and their confidence (i.e. self-efficacy), commitment, and intention to carry out the new goal. A complete description of the goal-setting procedures and the overall intervention is reported elsewhere [12].

Measures of goal-related physical activity
Goal-related physical activity was corroborated in the intervention group using concurrent records of daily pedometer steps and 10-min blocks of MVPA. Steps were assessed using the Yamax SW-200 pedometer (Yamax Corp, Tokyo, Japan), which has high accuracy for assessing level walking (±3\% of actual steps) [27, 28], a target of the intervention.

Correlates of goal setting
Participants were asked at baseline and subsequently every 2 weeks to self-set goals to [1] increase daily pedometer steps and the weekly number of 10-min blocks of MVPA accumulated during the subsequent 2-week period. They also provided biweekly self-ratings (1 = not at all, 2 = somewhat, 3 = moderately, 4 = very) of single-item indicators of their satisfaction with current physical activity levels and their confidence (i.e. self-efficacy), commitment, and intention to carry out the new goal, consistent with goal-setting theory [5]. The intraclass correlation coefficient-model 2 (ICC-2) reliabilities across weeks were satisfaction (0.746), self-efficacy (0.870), commitment (0.848), intention (0.870).

Self-efficacy, commitment and intention about attaining the biweekly physical activity goals were highly correlated each week, so they were modeled as indicators of a common factor (loadings ranged from 0.74 to 0.96; mean = 0.89) that had good fit to the data [comparative fit index (CFI) = 0.993, root mean square error of approximation (RMSEA) = 0.034] and had configural and metric invariance across time [29]. Subsequently, analyses were conducted on this latent factor of goal-setting moderators. The internal consistency reliability (ICC-2) of the factor ranged from 0.836 in week 1 to 0.953 in week 10. The stability coefficient of the biweekly factor scores averaged 0.596 for adjacent weeks and 0.514 across all paired weeks.

Latent growth modeling
Changes in the study variables across the 12-week intervention and the relations between those changes were analyzed using latent growth modeling (LGM) performed using Mplus 5.2 [30]. Missing data were 1% overall (range from 0% to 3%) and were estimated using full-information maximum likelihood estimation, which yields accurate fit indices and parameter estimates with up to 25\% simulated missing data [31]. Covariances could be computed for >75\% of the variables. LGM applies confirmatory factor analysis to variables measured longitudinally [32, 33]. It estimates parameters and their standard errors (SEs) for latent factors of initial status (i.e. the latent mean at the baseline in the study), change (i.e. the slope or trajectory of change from the baseline across the 12 weeks of the study), and the variances (i.e. interindividual differences) of initial status and change. Critical $z$ scores (parameter estimate/standard error) are used to test significance. Two-tailed probabilities are reported.

LGM was used as a three-stage process to estimate (i) change in physical activity, goals, satisfaction and the theoretical moderators of goal setting (i.e. self-efficacy, commitment and intention) across time; (ii) the relation of change in physical activity with initial status and change in satisfaction, goals and the goal-setting moderators and (iii) the comparison of direct and indirect (i.e. mediated by changes in goals) relations between
changes in satisfaction or the goal-setting moderators and change in physical activity.

A first-stage model tested linear and quadratic change functions (i.e. the slope or trajectory) of weekly change in goal-related physical activity (i.e. pedometer steps and minutes of MVPA), goals, satisfaction and the goal-setting moderators.

A second-stage model estimated the relations of change in pedometer steps and minutes of MVPA with change in goals, satisfaction and the moderators of goal-setting. The second-stage model included the specified relations (standardized β coefficients) in the first-stage model, plus the addition of relations between the initial status of the variables (β3,1) and between the change factors (β4,2). See Fig. 6.

A third-stage model simultaneously examined whether satisfaction (or in a separate model, goal-setting moderators) had a direct relation with change in either pedometer steps or minutes of MVPA and/or an indirect relation, mediated through change in goals. The third-stage model included the specified relations in the second-stage model for satisfaction (see Fig. 7) or goal-setting moderators (see Fig. 8), plus the addition of relations between the initial status and change factors for goals to initial status (β3,5) and change (β4,6) of pedometer steps or MVPA and from initial status and change factors for satisfaction (or goal-setting moderators) to initial status (β5,1) and change (β6,2) of goals.

Model fit was evaluated with multiple indices. The chi-square statistic assessed absolute fit of the model to the data [34]. It is usually significant with large samples, so other fit indices were used to judge overall fit [35]. Values of the CFI ≥0.90 and 0.95 were used to indicate acceptable and good fit. Values of the RMSEA ≤0.08 and ≤0.06 were used to represent acceptable and close fit. Values ≥0.96 for CFI along with values of the standardized root mean square residual <0.08 result in the least sum of Type I and Type II error rates [35]. The sample size provided adequate statistical power for model tests [36].

To account for nesting effects of worksites that might confound interpretation of the findings, models were adjusted by correcting the standard errors of the parameter estimates for between-site variance using the Huber–White sandwich estimator [30]. To account for relations of the study variables with demographic factors that might differ between worksites, variables of gender, race (black versus white and all others versus white), ethnicity, education level and job title (manager.supervisor versus nonmanager.supervisor) were added to the LGM models as exogenous covariates. Models were not substantively different after covariate adjustment, so unadjusted models are presented.

**Results**

All the models tested had acceptable fit to the data and most had a good, close fit. See Table I. The trajectories of change during the intervention differed according to variable. Pedometer steps (Fig. 1) and minutes of MVPA (Fig. 2), physical activity goals (Fig. 3) and satisfaction levels (Fig. 4) mainly not only increased linearly but also leveled off after the middle of the intervention. Pedometer steps continued to increase during the last 4 weeks of the study even though participants’ goals for steps stayed about the same. In contrast, the putative moderators of goal setting (self-efficacy, commitment and intention) declined linearly during the intervention (Fig. 5).

More important than mean changes in the variables were the relations among changes in the variables. Significant between-person differences in the trajectories of within-person change (i.e. variance in change functions) permitted modeling of correlated changes. Consistent with theory and the study’s hypotheses, there were linear dose relations between increases in participants’ goals and their increases in pedometer steps and minutes of MVPA. Also, consistent with our hypotheses, satisfaction and the goal-setting moderators each had direct and indirect (mediated by participant goals) relations with physical activity.

**First-stage models**

**Physical activity**

The growth in physical activity had linear and quadratic components. The linear increase (standard
error) in daily pedometer steps was 471 (51.4) steps from a mean of 7865 steps during the first week of the study ($P < 0.001$). Weekly minutes of MVPA increased by 65 (4.75) min from a mean of 139 min at the beginning of the study. The variance (i.e. interindivial differences) was significant ($P < 0.001$) for initial status and the linear and quadratic change of pedometer steps and for the linear change in MVPA. Linear change was weakly related to initial status for pedometer steps ($r = 0.17$, $P < 0.05$) and MVPA ($r = 0.24$, $P < 0.05$).

**Goals**

Pedometer step goals and goals for weekly minutes of MVPA increased linearly during the intervention but the rate of increase slowed during the last 4 weeks of goal setting. The quadratic function was significant ($P < 0.01$) for MVPA but not pedometer steps. Variances were significant ($P < 0.01$) for initial status and change ($P < 0.05$) for both variables but linear change was not related to initial status ($P > 0.90$).

**Satisfaction**

Satisfaction increased linearly during the first 4 weeks of the intervention and then reached a stable

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**Table I. Model fit for latent growth models across the 12-week intervention**

<table>
<thead>
<tr>
<th>Variables</th>
<th>$\chi^2$</th>
<th>df</th>
<th>$P$-value</th>
<th>CFI</th>
<th>TLI</th>
<th>RMSEA (90% CI)</th>
<th>SRMR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stage 1 models</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Pedometer steps</td>
<td>105.38</td>
<td>63</td>
<td>0.001</td>
<td>0.987</td>
<td>0.986</td>
<td>0.033 (0.021–0.043)</td>
<td>0.026</td>
</tr>
<tr>
<td>MVPA</td>
<td>112.70</td>
<td>76</td>
<td>0.010</td>
<td>0.985</td>
<td>0.985</td>
<td>0.027 (0.016–0.037)</td>
<td>0.044</td>
</tr>
<tr>
<td>Goals for steps</td>
<td>10.53</td>
<td>9</td>
<td>0.309</td>
<td>0.978</td>
<td>0.976</td>
<td>0.017 (0.000–0.050)</td>
<td>0.021</td>
</tr>
<tr>
<td>Goals for MVPA</td>
<td>6.44</td>
<td>6</td>
<td>0.376</td>
<td>0.997</td>
<td>0.995</td>
<td>0.011 (0.000–0.053)</td>
<td>0.034</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>44.24</td>
<td>11</td>
<td>0.001</td>
<td>0.956</td>
<td>0.940</td>
<td>0.068 (0.048–0.089)</td>
<td>0.046</td>
</tr>
<tr>
<td>Goal correlates</td>
<td>241.82</td>
<td>103</td>
<td>0.001</td>
<td>0.983</td>
<td>0.975</td>
<td>0.045 (0.038–0.053)</td>
<td>0.077</td>
</tr>
<tr>
<td><strong>Stage 2 models</strong></td>
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<td></td>
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</tr>
<tr>
<td>Goals and steps</td>
<td>225.88</td>
<td>127</td>
<td>0.001</td>
<td>0.963</td>
<td>0.960</td>
<td>0.035 (0.027–0.042)</td>
<td>0.033</td>
</tr>
<tr>
<td>Goals and MVPA</td>
<td>371.10</td>
<td>152</td>
<td>0.001</td>
<td>0.922</td>
<td>0.922</td>
<td>0.047 (0.041–0.053)</td>
<td>0.077</td>
</tr>
<tr>
<td>Satisfaction and step goals</td>
<td>90.18</td>
<td>47</td>
<td>0.001</td>
<td>0.920</td>
<td>0.906</td>
<td>0.037 (0.025–0.049)</td>
<td>0.037</td>
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<tr>
<td>Satisfaction and MVPA goals</td>
<td>82.84</td>
<td>41</td>
<td>0.001</td>
<td>0.950</td>
<td>0.932</td>
<td>0.039 (0.027–0.051)</td>
<td>0.040</td>
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<td>Satisfaction and steps</td>
<td>355.87</td>
<td>140</td>
<td>0.001</td>
<td>0.956</td>
<td>0.952</td>
<td>0.048 (0.042–0.055)</td>
<td>0.037</td>
</tr>
<tr>
<td>Satisfaction and MVPA</td>
<td>345.91</td>
<td>161</td>
<td>0.001</td>
<td>0.958</td>
<td>0.956</td>
<td>0.042 (0.036–0.048)</td>
<td>0.050</td>
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<tr>
<td>Goal-setting moderators and steps</td>
<td>680.16</td>
<td>377</td>
<td>0.001</td>
<td>0.979</td>
<td>0.976</td>
<td>0.035 (0.031–0.039)</td>
<td>0.058</td>
</tr>
<tr>
<td>Goal-setting moderators and MVPA</td>
<td>710.85</td>
<td>408</td>
<td>0.001</td>
<td>0.979</td>
<td>0.976</td>
<td>0.034 (0.029–0.038)</td>
<td>0.055</td>
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<tr>
<td>Goal-setting moderators and step goals</td>
<td>380.58</td>
<td>199</td>
<td>0.001</td>
<td>0.975</td>
<td>0.968</td>
<td>0.037 (0.031–0.043)</td>
<td>0.064</td>
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<tr>
<td>Goal-setting moderators and MVPA goals</td>
<td>429.34</td>
<td>194</td>
<td>0.001</td>
<td>0.970</td>
<td>0.961</td>
<td>0.043 (0.037–0.048)</td>
<td>0.068</td>
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<tr>
<td><strong>Stage 3 models</strong></td>
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</tr>
<tr>
<td>Satisfaction and goals and steps</td>
<td>550.44</td>
<td>239</td>
<td>0.001</td>
<td>0.928</td>
<td>0.924</td>
<td>0.044 (0.040–0.049)</td>
<td>0.045</td>
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<tr>
<td>Satisfaction and goals and MVPA</td>
<td>609.71</td>
<td>261</td>
<td>0.001</td>
<td>0.926</td>
<td>0.922</td>
<td>0.045 (0.040–0.050)</td>
<td>0.062</td>
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<tr>
<td>Goal-setting moderators and goals and steps</td>
<td>965.20</td>
<td>531</td>
<td>0.001</td>
<td>0.967</td>
<td>0.963</td>
<td>0.035 (0.032–0.039)</td>
<td>0.055</td>
</tr>
<tr>
<td>Goal-setting moderators and goals and MVPA</td>
<td>1148.0</td>
<td>568</td>
<td>0.001</td>
<td>0.958</td>
<td>0.953</td>
<td>0.039 (0.036–0.043)</td>
<td>0.058</td>
</tr>
</tbody>
</table>

df, degrees of freedom; CI, confidence interval; SRMR, standardized root mean square residual; TLI, Tucker-Lewis Index.
plateau ($P < 0.01$). Variance was significant ($P < 0.01$) for initial status and change. Initial status was related to both linear ($r = 0.57$) and quadratic ($r = 0.47$) change. Participants who had higher satisfaction with their level of physical activity at the beginning of the study had less of an increase and more of a leveling off during the intervention.

**Goal-setting moderators**

Participant ratings of their self-efficacy, commitment and intention about attaining their physical activity goals decreased linearly ($P < 0.001$). The variances for initial status and change were significant ($P < 0.001$) but change was not related to initial status ($P > 0.70$).

**Second-stage models**

**Goal setting and physical activity**

Changes in goals had linear relations ($P < 0.001$) with change in daily pedometer steps ($\beta = 0.618$, $SE = 0.110$) (see Fig. 6) and weekly minutes of MVPA ($\beta = 0.832$, $SE = 0.124$) that were unrelated to goals at the beginning of the study ($P > 0.680$).

**Satisfaction, goals and physical activity**

Change in satisfaction level had a significant ($P < .001$) linear relation with pedometer step goals ($\beta = 0.254$, $SE = 0.141$) and linear ($\beta = 0.179$, $SE = .071$) and quadratic ($\beta = 0.634$, $SE = 0.177$) relations between the changes in goals for MVPA. Similarly, there were significant relations between change in satisfaction with linear ($\beta = 0.749$, $SE = 0.174$, $P < 0.001$) and quadratic ($\beta = 0.896$, $SE = 0.350$, $P < 0.01$) change in pedometer steps and with linear ($\beta = 0.507$, $SE = 0.104$, $P < 0.001$) and quadratic ($\beta = 0.746$, $SE = 0.404$, $P = 0.065$) change in MVPA. Changes were unrelated to initial levels of satisfaction ($P > 0.185$).

**Moderators of goal setting, goals and physical activity**

The linear change in goal-setting moderators was related to the linear ($\beta = 0.210$, $SE = 0.043$, $P < 0.001$) change in pedometer steps and the linear ($\beta = 0.254$, $SE = 0.070$, $P < 0.001$) and quadratic ($\beta = -0.258$, $SE = 0.116$, $P < 0.026$) change in MVPA. Change in goal-setting moderators was also related to the linear change in MVPA goals ($\beta = 0.210$, $SE = 0.048$, $P < 0.001$) but the relation with linear change in pedometer step goals did not reach significance ($\beta = 0.232$, $SE = 0.171$).

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**Fig. 2.** Weekly minutes (mean ± 95% confidence interval) accumulated from 10-min blocks of MVPA reported biweekly by participants during the intervention.

**Fig. 3.** Goals (mean ± SE) set biweekly by the participants for daily pedometer steps and weekly minutes of MVPA for the subsequent two weeks during the intervention.
Third-stage models
Final models simultaneously estimated the direct and indirect (i.e. mediated by change in participant goals) relations of change in pedometer steps or minutes of MVPA with change in satisfaction level or change in goal-setting moderators.

Satisfaction
Linear change in pedometer steps had direct relations with linear changes in satisfaction ($\beta = 0.802$, SE = 0.057, $P < 0.001$) and goals ($\beta = 0.295$, SE = 0.043, $P < 0.001$) and an indirect relation with change in satisfaction ($\beta = 0.122$, SE = 0.028, $P < 0.001$) that was mediated by the relation between changes in satisfaction and goals ($\beta = 0.413$, SE = 0.053, $P < 0.001$). See Fig. 7.

The relation between linear change in satisfaction and linear change in MVPA was not direct ($\beta = 0.119$, SE = 0.069, $P = 0.084$) but was indirect ($\beta = 0.463$, SE = 0.082, $P < 0.001$), mediated by the relation between change in satisfaction and change in goals ($\beta = 0.532$, SE = 0.067, $P < 0.001$) and the relation between changes in goals and MVPA ($\beta = 0.871$, SE = 0.066, $P < 0.001$).

Goal-setting moderators
Linear change in pedometer steps had direct relations with linear changes in goal-setting moderators ($\beta = 0.139$, SE = 0.063, $P = 0.027$) and goals ($\beta = 0.512$, SE = 0.083, $P < 0.001$) but the indirect relation with change in goal-setting moderators was not significant ($\beta = 0.100$, SE = 0.060, $P = 0.094$) because of the nonsignificant relation between changes in goal-setting moderators and goals ($\beta = 0.196$, SE = 0.107, $P = 0.066$). See Fig. 8.

The relation between linear change in goal-setting moderators and linear change in MVPA was not direct ($\beta = 0.032$, SE = 0.018, $P = 0.068$) but was indirect ($\beta = 0.219$, SE = 0.045, $P < 0.001$), mediated by the relations between change in goal-setting moderators and change in goals ($\beta = 0.243$, SE = 0.041, $P < 0.001$) and between changes in goals and MVPA ($\beta = 0.902$, SE = 0.044, $P < 0.001$).

Discussion
The results show that changes in goals and putative moderators of goal setting had dose relations with increases in goal-related physical activity during a successful goal-setting intervention. Participants who set higher physical activity goals and sustained higher levels of self-efficacy, commitment and intention about attaining their goals had greater increases in daily pedometer steps and the weekly accumulation of minutes of MVPA. The results confirm hypotheses derived from goal-setting theory [5]: (i) goal setting mediated the relation between changes in satisfaction with current physical activity and subsequent changes in both daily pedometer steps and weekly minutes of MVPA and (ii) participants’ self-efficacy, commitment and intention about their goals were directly or indirectly...
(mediated by increases in goals) related to changes in physical activity, consistent with their theorized influence on goal-setting behavior [5].

The approach we took to evaluate the dose of the goal setting complements prior recommendations that the impact of health promotion programs be judged by multiple indicators of internal validity including effectiveness and implementation [8]. Rather than computing a composite index that was additive or interactive, we used LGM to describe the relations between concurrent changes in goal-setting (i.e. an indicator of implementation) and changes in goal-related physical activity (i.e. an indicator of effectiveness). We also extended the dual evaluation of implementation and effectiveness by examining whether changes in goal setting...
and goal-related physical activity were related to theory-derived moderators of goal setting (i.e. self-efficacy, satisfaction, commitment and intention). This approach offers an alternative way of quantifying person-level moderators of the impact of an intervention [8]. Identifying theory-derived correlates of the behavioral dose of the intervention is also consistent with the Consolidated Standards of Reporting Trials statement extended to behavioral interventions, which calls for quantitative, as well as qualitative, data on the components of interventions [37].

Moderators and mediators of change in physical activity that can guide successful interventions to increase physical activity among adults are poorly understood [38]. Tests of moderation and mediation of intervention effects on primary outcomes in a randomized controlled trial require comparisons between intervention and control groups. Our purpose here was not to test moderators or mediators of the impact of an intervention’s primary outcome. That was not possible or appropriate because goal setting was inherent to the intervention and the goal-related measures were completed only by the intervention participants [12]. The daily records of pedometer steps and logs of physical activity were part of the goal-setting intervention. Together with the measure of goal setting, they provided quantitative indicators of intervention dose (i.e. participants’ utilization of the intervention components) throughout the 12-week study. Nonetheless, participants’ records are subject to biased reporting. Confirmation by observational measures or electronic records of activity (e.g. accelerometry) would enhance the objectivity of future studies like this one.

Our purpose in this paper was to describe dose relations of the key intervention element (i.e. personal goal setting) with change in goal-related outcomes (i.e. pedometer steps and minutes of MVPA) and with theory-derived influences on goal setting. Variation in these measures between and within participants provided indicators of implementation dose that complement existing frameworks used to evaluate the impact of health promotion.
interventions [7, 8]. The findings reinforce the importance of measuring participants’ use of the components of an intervention (in this case, goal setting) and theoretical influences on goal setting when evaluating whether the intervention is effective in changing the primary outcome.

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**Conflict of interest statement**

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**References**


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