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Randomized Controlled Trial of Collaborative Implementation Intentions Targeting Working Adults' Physical Activity

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Objective: The research tested the efficacy of planning and partner-based interventions to promote physical activity over six months. ***Method:*** Local government (council) employees ($N = 257$) were randomly allocated to one of four conditions (collaborative implementation intentions; partner-only; implementation intentions; control group) before completing measures at baseline and follow-ups at 1, 3 and 6 months. Outcome measures comprised validated self-report measures of physical activity: the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003) and Self-Report Walking and Exercise Tables (SWET; Prestwich et al., 2012); psychosocial mediators (enjoyment, intention, self-efficacy, social influence); weight and waist size (baseline and 6 months only). ***Results:*** As well as losing the most weight, there was evidence that participants in the collaborative implementation-intention group were more physically active than each of the other three groups at 1-, 3- and 6-month follow-ups. Those in the implementation-intention and partner-only conditions did not outperform the control group on most measures. ***Conclusion:*** Collaborative implementation intentions represent a potentially useful intervention to change important health behaviors that help reduce weight.

Keywords: U.K., implementation intention, collaborative implementation intention, partner, physical activity

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Despite physical (e.g., Myers et al., 2002) and psychological (e.g., Lawlor & Hopker, 2001) benefits, many adults in Europe (UKONS, 2006a) and the United States (USDHHS, 1996) fail to meet physical activity recommendations. Strategies that produce sustained physical activity and can be delivered efficiently could achieve widespread health benefits. The present research, the first randomized controlled trial of collaborative implementation intentions, examined the impact of three planning and/or partner-based strategies, embedded within questionnaires, on physical activity and body-weight outcomes over periods up to 6 months in a sample of working adults.

Implementation Intentions and Physical Activity

Many theoretical models of behavior have postulated intentions to be the key determinant of behavior (e.g., theory of planned behavior, Ajzen, 1991; protection motivation theory, Rogers, 1983), but recent work suggests intentions do not always translate into behavior change (e.g., Webb & Sheeran, 2006), giving rise to an intention-behavior gap. Consistent with such evidence, more recent theories (e.g., health action process approach, Schwarzer, 1992; model of action phases, Gollwitzer, 1990) suggest that a specific type of planning strategy, termed implementation intentions (Gollwitzer, 1993), helps bridge the intention-behavior gap by turning positive intentions into action. Implementation intentions (Gollwitzer, 1993) involve an individual planning when and where he or she will perform a particular behavior in the form of an if-then statement (e.g., "If I encounter situation X, then I will do

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Y!"; "If it is Wednesday and I've finished work in the office then I'll head straight to the gym and workout"). A recent meta-analysis supports the efficacy of implementation intentions in promoting physical activity (Bélanger-Gravel, Godin, & Amireault, in press).

Limitations of Implementation Intentions in Promoting Physical Activity

Despite supportive meta-analytic evidence, some studies have reported nonsignificant effects of implementation intentions on physical activity in the short term (e.g., Skår, Sniehotta, Molloy, Prestwich, & Araújo-Soares, in press) and midterm (e.g., Arbour & Martin-Ginis, 2004). In addition to this mixed evidence, there are five further issues which call into question the evidence concerning the effectiveness of implementation intentions in promoting physical activity.

First, we are aware of only two tests of implementation intentions in promoting physical activity at 6-months (or beyond).[1] Of these, one study reported that implementation intentions were beneficial (Luszczynska, 2006), but the other did not (De Vet, Oenema, Sheeran, & Brug, 2009). Second, the vast majority of studies have been conducted with students (e.g., Milne, Orbell, & Sheeran, 2002) or cardiac patients in rehabilitation (e.g., Sniehotta et al., 2005; Sniehotta, Scholz, & Schwarzer, 2006). Although a small number of studies have tested the efficacy of implementation intentions for physical activity in nonstudent/nonclinical samples, we are aware of only one study (De Vet et al., 2009) that tested the unique impact of planning, on such participants, over a period of time greater than 1 month. Third, only five studies have so far tested the effect of implementation-intention-based strategies promoting physical activity on weight loss. Of these, three reported significant benefits not necessarily attributable to implementation intentions, as their interventions comprised additional behavior-change techniques (Hurling et al., 2007; Prestwich, Perugini, & Hurling, 2010; Thoolen, De Ridder, Bensing, Gorter, & Rutten, 2009); one showed a positive impact, but only in an overweight/obese subsample (Luszczynska & Haynes, 2009), but another (De Vet et al., 2009) found no impact on self-reported weight (body-mass index; BMI). Fourth, although one implementation-intention study targeting physical activity tested its impact on waist-to-hip ratio (Prestwich et al., 2010) detecting no effect, no study has reported a test on waist size directly. Waist-related measures are important outcomes given their association with morbidity and mortality (Ross et al., 2008). Fifth, other studies have indicated that implementation intentions are only effective under particular conditions, i.e., when motivation is strong (e.g., Prestwich, Ayres, & Lawton, 2008; Sheeran, Webb, & Gollwitzer, 2005) or intrinsically driven (Koestner, Lekes, Powers, & Chicoine, 2002), or when paired with environmental cues (Prestwich, Perugini, & Hurling, 2009, 2010). The present research tested a new form of implementation intentions termed collaborative implementation intentions, which potentially address the above efficacy-related concerns.

Collaborative Implementation Intentions: Why Should They be Particularly Efficacious?

Collaborative implementation intentions involve two people planning when and where they will perform the behavior together (e.g., "If it is Wednesday and we've finished work in the office then we'll head straight to the gym and workout"). Previous work suggests by involving a partner in one's plans, the motivation to perform the planned action could be increased and made more intrinsic, and the likelihood of forgetting could be reduced (Prestwich et al., 2005). Given this, along with evidence suggesting that implementation intentions are more effective alongside environmental cues and when motivation is strong and intrinsically driven, collaborative implementation intentions should be a particularly efficacious behavior-change strategy.

More broadly, there are two lines of evidence that suggest partner-based strategies, and collaborative implementation intentions in particular, should promote physical activity and aid in weight loss. First, in a review examining lifestyle interventions for overweight youths (Kitzmann et al., 2010), involving others more (e.g., parents) within the program lead to greater weight loss. Similarly, in a study concerned with weight loss (Wing & Jeffery, 1999), participants were either recruited into the study alone or with three friends or family members. Those recruited with friends or family achieved greater initial weight loss at 4 months. At 10 months, the weight loss was sustained but not increased. Second, more recent work suggests the behavior of the partner is important. Gorin et al. (2005) demonstrated that support partners only helped an individual to lose weight when the partners themselves lost weight. General partner-based interventions may have some effectiveness, but greater partner involvement, such as when the partner contributes to behavioral planning, should lead to greater change.

Although potentially useful for changing health behaviors, just one study has previously tested the efficacy of collaborative implementation intentions (Prestwich et al., 2005). The results suggested that collaborative implementation intentions were effective in promoting breast self-examinations and potentially more beneficial than standard implementation intentions formed by an individual. However, the study did not fully randomize participants to condition (participants could choose whether to involve their partners or not); there was no a priori sample size calculation; the behavior was assessed with a nonvalidated measure at a short follow-up (1 month); and research staff were not blinded to experimental condition. These criticisms also apply to many studies testing individually formed (i.e., noncollaborative) implementation intentions (see Skår et al., in press).

Objectives

Given the potential efficacy of collaborative implementation intentions, and the limitations and inconsistencies inherent in previous tests of (individually formed) implementation intentions, the primary objective was to test the impact of collaborative implementation intentions, implementation intentions, and partner-no-planning manipulations against a control group on physical activity and weight loss over a 6-month period. A secondary objective was to check whether these interventions had any significant impact on psychosocial mediators. As collaborative implementa-

[1] Scholz, Knoll, Sniehotta, & Schwarzer (2006) and Thoolen et al. (2009) tested effects at 12 months, but paired implementation intentions with additional behavior-change techniques, thus their unique impact could not be determined.

tion intentions could influence motivation and intrinsic motivation (Prestwich et al., 2005), and partner-based interventions could also boost self-efficacy via modeling for example (Bandura, 1977), or social influence, these four constructs were tested as potential mediators.

In the present study, participants were asked to either plan with another person (such as a friend or family member) when and where they would do physical activity together (collaborative implementation-intention condition), plan by themselves when and where they would do physical activity (implementation-intention condition), recruit another person to help them be more physically active without an explicit request to plan their physical activity (partner-only condition), or were allocated to a control group. Physical activity and psychosocial mediators were assessed at three follow-ups (Time 1: 1 month; Time 2: 3 months; Time 3: 6 months). Physical outcomes were measured at 6 months. It was predicted that participants forming collaborative implementation intentions should (a) increase their physical activity and (b) lose more weight than those in the other study conditions (Hypothesis 1). In addition, participants randomized to partner-based conditions should increase their physical activity-related (a) perceived enjoyment, (b) intentions, (c) self-efficacy, and (d) social influence, more than those in nonpartner-based conditions (Hypothesis 2).

Method

No changes to trial outcomes were made following trial commencement.

Recruitment

All participants were employees recruited from 15 councils within the United Kingdom. Councils are public sector organizations responsible for providing local services and facilities. They employ staff from a range of socioeconomic groups. The councils were selected based on their proximity to the university where the research was based to allow face-to-face meetings to discuss the trial, if required, with council representatives. For each organization, a key contact was identified (usually from health and safety, or occupational health) to manage the recruitment process. Depending on specific council preferences, this involved either notes in pay slips, emails, newsletters, or posters, highlighting that the study would focus on increasing physical activity. Participation rates are impossible to determine for councils that only advertised the study through a poster or newsletter. In councils that used pay slips or emails, we estimate approximately 56,700 were approached and 456 potential participants requested, and were sent, a screening questionnaire for the study. An accurate participation rate, however, cannot be determined, as we were unable to verify that councils contacted *all* of their staff (e.g., only segments of council staff have email addresses); the staffing figures provided by councils were rough approximations; and we do not know how many of those contacted were eligible for our study. Participants were recruited into the study between February 14th, 2008 and July 17th, 2009. The last data were collected on March 2nd, 2010. Participant flow through each stage of the study is illustrated in Figure 1.

After indicating their interest in the study, each participant was sent an information sheet, a consent form, and a screening ques-

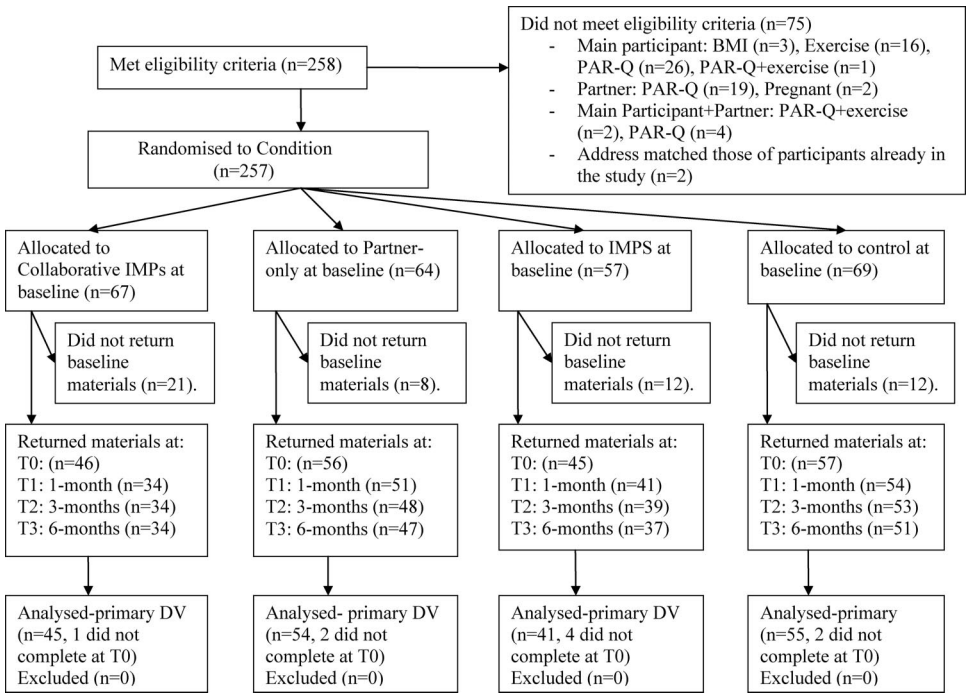

Figure 1. Participant flow chart. IMPs = implementation intentions; T0 = Time 0; T1 = Time 1; T2 = Time 2; T3 = Time 3.

tionnaire. Participants were excluded if they had BMIs less than 18.5, did 30 minutes or more exercise on at least 5 days of the week, if they or their partners were pregnant, were under the age of 16, or could not exercise as defined by the revised version of the Physical Activity Readiness Questionnaire (PAR-Q; Thomas, Reading, & Shephard, 1992) at recruitment. Research Staff Member 4 (RS4) screened participants without knowledge of the allocation sequence. The list of eligible participants was then forwarded to Research Staff Members 2 and 3 (RS2 and RS3) who prepared the intervention materials. Participants received £35 (approximately $50) worth of High Street gift-shop vouchers per couple upon completion of the study at 6-months follow-up.

Sample

An effect size comparing collaborative implementation intentions against a control group for physical activity was estimated based on: (a) The relative benefit of collaborative implementation intentions over implementation intentions for breast self-examinations ($d = .84$, Prestwich et al., 2005); (b) the relative benefit of implementation intentions over controls (mean $d = .74$, $k = 3$, one study identified by Gollwitzer & Sheeran, 2006; plus two from Prestwich et al., 2005) for breast self-examination; (c) the average effect of implementation intentions over controls for physical activity ($d = .61$—the median d based on five studies reported by Gollwitzer & Sheeran, 2006; i.e., $d = .69 = .84/.74 \times .61$). Given the estimated effect size of $d = .69$, the required sample size in each condition, with 80% power at $p = .01$, was 44 (thus 176 in total). A total of 333 people were screened, of which 75 were ineligible. Allowing for dropout, 258 pairs of participants, at least one of which was a council employee, were thus initially recruited, of which 204 pairs completed the baseline materials.

Randomization

Participants were randomized to one of four groups: collaborative implementation intentions (implementation intention + partner), partner-only (no implementation intention + partner), implementation intention (implementation intention + no partner) or control (no implementation intention + no partner). There was an equal likelihood of being allocated to each group. An allocation sequence, with no restrictions, was prepared by Research Staff Member 1 (RS1) using a computer-generated randomization program.

On the basis of the allocation sequence, RS2 and RS3 placed the relevant study materials in a series of numbered envelopes, which were immediately sealed. These envelopes were posted to participants by Research Staff Members 5–7 (RS5–7), whose contact details were provided should the participants encounter any difficulties in completing the materials. Consequently, RS1–3 were aware of the allocation sequence but had no contact with participants and RS4 was unaware of the allocation sequence and had no participant contact. RS5–7 fielded any questions from participants, but were unaware of the allocation sequence and were blinded to condition during the testing phase. A freepost service was provided to help maximize return rates.

When the materials were returned, RS2 and RS3 split the measures that were unrelated to study condition (i.e., those completed by all participants) from condition-specific measures before passing them onto Research Staff Members 5–13 for data entry. Different research staff entered the condition-specific versus nonspecific measures to ensure that data entry of condition-nonspecific measures was completed blinded to condition. Data analysis was nonblinded.

Manipulations (Interventions)

Each manipulation was presented as written text following the baseline measures. All participants (including those in the *control group*) were provided with a definition of regular physical activity, were asked to complete the study with a study partner, and were asked to try to increase their physical activity in line with government guidelines (UKDH, 2004). These guidelines indicate that at least 30 minutes a day of at least moderate-intensity physical activity on 5 or more days of the week, in bouts of 10 minutes or more, is needed for general health benefits in adults. After completing baseline physical-activity measures the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003) and Self-Report Walking and Exercise Tables (SWET; Prestwich et al., 2012), all participants read one page of text based on protection motivation theory (PMT, Rogers, 1983). This text illustrated the link between low physical activity levels and heart disease as a means to provide some degree of motivation to be more physically active. Similar texts have been used in other physical activity-based implementation-intention studies (e.g., Milne et al., 2002; Prestwich et al., 2009). To encourage participants to engage with the text, all participants were asked two questions relating to the text. After the two questions, the information presented differed in accordance with the condition to which the participants had been randomly assigned. The information within each manipulation was matched with the following exceptions:

Collaborative implementation intentions. This group was informed: "Past research suggests that despite intending to undertake regular physical activity, many people fail to do so. To give yourself the best chance of succeeding, it seems that it can be helpful to *make very specific plans with a partner* (e.g., husband, wife, girlfriend, boyfriend, housemate etc.) about how *together* you will go about increasing the amount of regular physical activity you do." Participants were then asked to think about, and discuss with their partners, the types of physical activity they would find enjoyable and convenient to do together and when and where they could do these activities to meet the government guidelines. They were then asked to make plans in the form: "IF (we're in situation X) THEN (we will do Y)" and were provided with four example plans. They were reminded that they were free to choose when, where, and how they would do physical activity that was easy and enjoyable for them to do together. They were provided with space to write up to five plans, and there was a 3-item checklist to help ensure that plans were formed appropriately: "Do your plan(s) contain the words, IF, THEN and WE? Do your plan(s) identify enough situations for you to meet the guidelines of doing *30 minutes of moderate or vigorous intensity physical activity (in bouts of at least 10 minutes) at least five times per week*? Do your plan(s) identify how you will undertake physical activity *together* in the situations identified in your plans?" If they answered "no" to any of these questions, they were asked to form new plans that meet the criteria. Similar checklists have been used in implementation-intention research (e.g., Prestwich et al., 2010).

Partner only. Participants in this group were asked to recruit a partner to help them to be more physically active but were not asked to form a collaborative implementation intention. Specifically they were informed: "Past research suggests that despite intending to undertake more physical activity, many people fail to do so. To give yourself the best chance of succeeding, it seems that it can be helpful to *recruit a partner* (e.g., husband, wife, girlfriend, boyfriend, housemate, etc.), to assist you in increasing the amount of physical activity that you do."

Implementation intentions. Like the participants in the collaborative implementation intention condition, those assigned to the implementation intention condition were asked to form a plan, but to do so individually. The format was the same, but in this condition, plans were made individually "IF (I'm in situation X) THEN (I will do Y)." The example plans, number of spaces provided for plans, format of instructions, and plan checklist were consistent with those provided in the collaborative implementation-intentions manipulation.

Measurement of Outcomes

All measures were completed outside of the laboratory. In the baseline assessment (0 months), participants in each condition completed the physical activity measures premanipulation and again on follow-up at 1, 3 and 6 months. The physical measures were also taken at baseline and 6-months follow-up. The following measures, with the exception of the physical activity measures (SWET, IPAQ), were presented after the manipulations in the baseline materials.

Primary outcome measures. The primary outcome was self-reported physical activity which was assessed using the short-form IPAQ. This measure assesses the duration (number of days $\times$ hours/minutes per day) that an individual has engaged in vigorous, moderate, walking, and sitting activity over the last 7 days. Don't know/not sure options were available for the items assessing duration. Based on participant responses, a metabolic equivalent (MET)-based score was generated by weighting each type of activity by its MET energy requirements: (3.3 $\times$ walking duration) + (4 $\times$ moderate activity duration) + (8 $\times$ vigorous activity duration). IPAQ validity has been established against the Computer Science and Applications, Inc. (now Manufacturing Technologies, Inc.) accelerometer (Craig et al., 2003), although it appears prone to overreporting physical activity levels in a high proportion of sedentary individuals (Fogelholm et al., 2006).

Given the potential limitations of the IPAQ, and general issues regarding measuring physical activity through self-report measures, a second index of physical activity was also taken (Self-Report Walking and Exercise Tables, SWET; Prestwich et al., 2012). The SWET measure has been used in implementation-intention research (Prestwich et al., 2010) and has been shown to more strongly correlate with a validated pedometer (Yamax SW-200) than a range of other physical activity measures, including the Godin scale (Godin & Shepherd, 1985), the short-version IPAQ (Craig et al., 2003) and a self-report version of the 7-day physical activity recall (Sallis et al., 1985). The SWET measure requires participants to complete two tables. The first table relates to each instance, in the previous week, that participants walked for 10 minutes or more, as well as the speed of each walk: slow, steady, brisk, fast. The second table relates to any other instance of exercise and the duration of each session. From these tables, frequency (of bouts of exercise, brisk walking, or fast walking lasting at least 10 minutes) and duration of physical activity were calculated. These three outcomes (IPAQ METs; SWET frequency; SWET duration) all tap slightly different aspects of physical activity. IPAQ METs reflect physical activity duration weighted by energy requirements of specific activities, and the SWET provides measures specific to frequency and duration of physical activity.

Secondary outcome measures. Physical outcomes, while not necessarily solely indicative of physical activity, were recorded due to their association with health outcomes. Participants' *weight* and *waist size* were self-reported at baseline (0-months) and final follow-up (6-months). For guidance in relation to waist size, participants were informed 'Measure your waist at the narrowest point. To do this, find the bottom of your ribs and the top of your hips and measure in the middle. For most people this is where their tummy button is.'

Proposed mediators. In accordance with recommendations from Conner and Sparks (2005), behavioral intention (e.g., "I intend to undertake regular physical activity;" 1 = *extremely unlikely*, 7 = *extremely likely*) and self-efficacy (e.g., "For me to undertake regular physical activity would be" . . . 1 = *impossible*, 7 = *possible*) were assessed. Social influence ("I do physical activity because: . . . significant others want me to do physical activity;" . . . people I know well say I should; . . . I feel under pressure to do physical activity from people I know well") and perceived enjoyment (Ryan & Connell, 1989; Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003: "I do physical activity because: . . . I enjoy physical activity; . . . it is fun") were also measured as potential mediators of the intervention on physical activity. Social influence and perceived enjoyment were both assessed on 4-point scales (1 = *not true at all*, 4 = *very true*). All mediator measures were internally reliable at each time point with Cronbach's alphas ranging from .74 to .92.

Statistical Methods

ANOVA and chi square on baseline measures were used to examine differences between those completing the study and those who did not, and also differences between the four conditions. One-way ANCOVA tested the effects of the interventions on increasing physical activity (indexed by IPAQ and SWET) during the intervention period, using condition as the between-subjects factor, and baseline physical activity as the covariate. Any baseline differences across groups (sex, sex of partner) were also added as covariates. Age was included as a final covariate due to its moderating role on the impact of the interventions on outcomes. We plan to report moderator effects in a separate paper in the future. Outliers ($z > 3.5$) were removed prior to the main analyses. Bootstrapping was used to test for any mediated effects (Preacher & Hayes, 2004). Data were analyzed based on the condition to which participants were randomized. Effect sizes (d), and 95% CIs, are reported for significant primary and secondary outcomes.

Results

There was no investigator-determined exclusion of participants through poor adherence to trial protocol. Of the 204 participants completing baseline measures, only 35 dropped out between com-

pleting the baseline materials and the 6-month follow-up, reflecting a drop-out rate of 17.2% over 6-months. Dropout rates over these 6 months did not differ across groups, $\chi^2(3) = 4.40$, $p = .22$. There were no differences in baseline measures between those remaining in the study and those who dropped out, in terms of their age, study partner age, number of children, socioeconomic status, BMI, weight (kg), waist (inches), IPAQ (total METs), SWET (frequency), SWET (duration in min); all $F < 1.40$, all $p > .23$; or sex, sex of partner, ethnicity (% White British) or marital status (% married), all $\chi^2 < 2.54$, all $p > .10$. No adverse events were detected.

Baseline Characteristics of the Sample

There were significant differences across the four groups in terms of the sex of the main participants and their partners, with more men as main partners, and women as support partners, in the collaborative implementation intentions condition. These differences were controlled for in subsequent analyses. There were no other differences across the groups at baseline. The characteristics of the participants at baseline are summarized in Table 1. Reflecting the different aspects of physical activity assessed, the SWET measure was moderately associated with the IPAQ (SWET duration: mean $r = .47$; SWET frequency: mean $r = .21$).

Change in Physical Activity (Primary Outcomes)

Supporting Hypothesis 1a, the SWET measure revealed significant benefits of collaborative implementation intentions at all follow-ups: 1 month: $F(3, 168) = 2.67$, $p = .02$; 3 months: $F(3, 159) = 2.32$, $p = .04$; 6 months: $F(3, 159) = 1.97$, $p = .06$. Those in the collaborative implementation-intention condition were physically active more frequently at 1 month (vs. control, $p = .003$, $d = .63$, CI, $d = .24$–$.99$; vs. implementation intention, $p = .03$, $d = .44$, CI, $d = .04$–$.83$; vs. partner, $p = .02$, $d = .47$, CI, $d = .09$–$.84$) and 6 months (vs. control, $p = .02$, $d = .49$, CI, $d = .12$–$.86$; vs. implementation intention, $p = .02$, $d = .49$, CI, $d = .08$–$.88$; vs. partner, $p = .05$, $d = .38$, CI, $d = .00$–$.75$), and were physically active for more time at 3 months (vs. control, $p = .01$, $d = .59$, CI, $d = .20$–$.97$; vs. partner, $p = .04$; $d = .42$, CI, $d = .03$–$.79$).

Main effects of condition were also revealed on the IPAQ measure: 3 months: $F(3, 143) = 1.66$, $p = .09$; 6 months: $F(3, 141) = 3.20$, $p = .03$. Post hoc tests showed those in the control ($p = .06$, $d = .36$, CI, $d = -.01$–$.74$) and partner-only ($p = .02$, $d = .50$, CI, $d = .03$–$.96$) groups reported lower METs compared with the implementation-intention group at 3 months, and those in the partner-only group reported lower METs than those in the implementation-intention ($p = .07$, $d = .44$, CI, $d = -.05$–$.92$) and control ($p = .004$, $d = -.66$, CI, $d = -1.08$–$-.22$) groups at 6 months. There were no other between-groups differences. In sum, collaborative implementation intentions particularly increased physical activity frequency, but there was some evidence suggesting the partner-only manipulation lead to the smallest increase in METs compared to the other conditions (including the control group).

Change in Physical Outcomes

Following on from the main effects of condition favoring the collaborative implementation intention group on physical activity at 1-, 3- and 6-month follow-ups, there was also a main effect of condition on weight, $F(3, 157) = 2.37$, $p = .04$, supporting Hypothesis 1b. Compared with the other conditions (control: -1.07 kg; implementation intention: -1.12 kg; partner only: -1.14 kg), the collaborative implementation-intention condition (-3.21 kg) reported losing the most weight over 6 months. Post hoc tests revealed those in the collaborative implementation-intention condition lost more weight than those allocated to each of the other groups (vs. control, $p = .01$, $d = .50$, CI, $d = .12-.87$; vs. implementation intentions, $p = .01$, $d = .57$, CI, $d = .16-.96$; vs. partner-only, $p = .02$, $d = .48$, CI, $d = .10-.86$). Similarly, for waist size, $F(3, 141) = 2.48$, $p = .03$, compared with the other conditions (control: -1.14 in; implementation intention: -0.68 in; partner only: -1.30 in), the collaborative implementation intention condition (-2.15 in) reduced their waist size the most during the 6-month study period. Post hoc tests revealed those in the collab-

Table 1
Means (SD) of Baseline Characteristics Across Conditions

Measure	Collaborative implementation intention	Partner only	Implementation intention	Control	*p*
Age[a]	42.46 (10.35)	42.36 (11.03)	42.33 (10.62)	41.55 (10.71)	.96
Study-partner age[b]	41.53 (12.16)	40.69 (11.60)	40.93 (12.41)	41.29 (12.54)	.98
Sex (% males)[b]	34.8%	14.1%	22.8%	18.8%	.03
Sex of partner (% of males)[b]	57.6%	78.1%	57.9%	79.7%	.004
Number of children[c]	1.55 (1.21)	1.27 (1.27)	1.30 (1.17)	1.22 (1.17)	.43
SES (% managerial or professional occupation)[f]	74.2%	73.4%	66.7%	72.5%	.22
Ethnicity (% White British)[d]	89.4%	98.4%	94.6%	88.4%	.25
Marital status (% married)[b]	72.7%	60.9%	71.9%	60.9%	.72
BMI[a]	26.58 (4.37)	26.38 (6.15)	26.02 (4.03)	26.13 (5.09)	.92
Weight (kg)[a]	74.72 (15.45)	72.05 (16.46)	74.67 (13.83)	72.06 (15.44)	.60
Waist (inches)[e]	34.61 (4.50)	33.72 (5.84)	33.85 (4.44)	33.51 (4.90)	.63
IPAQ (total METs)[g]	1354 (1200)	1049 (985)	1336 (1065)	1216 (1124)	.50
SWET (frequency)[h]	4.07 (4.29)	3.11 (3.27)	2.89 (3.57)	3.75 (4.10)	.40
SWET (duration, mins)[i]	139.73 (163.35)	97.54 (110.69)	117.27 (141.16)	139.73 (145.72)	.34

[a] $n = 257$. [b] $n = 256$. [c] $n = 250$. [d] $n = 255$. [e] $n = 246$. [f] $n = 252$. [g] $n = 192$ (2 extreme outliers removed, $z > 6.8$). [h] $n = 202$. [i] $n = 201$.

Table 2
Post-Intervention Primary and Secondary Outcome Marginal Means (Standard Error)

Measure	Time	Collaborative implementation intention	Partner only	Implementation intention	Control	*p*
IPAQ (METs/wk)	1-month[a]	2063 (291)	1932 (232)	2261 (262)	1958 (223)	.40
	3-month[b]	2411 (347)[3]	1869 (292)[1]	2810 (327)[1,2]	2127 (270)[2]	.09
	6-months[c]	1852 (259)[3]	1410 (234)[1,2]	2057 (269)[1]	2405 (212)[2]	.02
SWET (duration: mins/wk)	1-month[d]	191.32 (23.24)	180.26 (18.44)	160.15 (21.16)	183.43 (18.31)	.39
	3-month[e]	326.96 (43.21)[1,2]	225.93 (34.77)[1]	250.50 (39.71)[3]	183.54 (33.81)[2]	.04
	6-months[f]	230.51 (33.12)	186.85 (28.66)	170.89 (32.43)	235.07 (27.79)	.19
SWET (frequency: times/wk)	1-month[g]	6.21 (.56)[1,2,3]	4.71 (.44)[1]	4.80 (.51)[2]	4.22 (.44)[3]	.03
	3-months[h]	6.55 (.86)	5.21 (.68)	5.59 (.77)	4.87 (.66)	.23
	6-months[e]	6.71 (.77)[1,2,3]	5.02 (.65)[1]	4.52 (.73)[2]	4.51 (.63)[3]	.06
Weight (kg)	6-months[f]	69.59 (.66)[1,2,3]	71.43 (.56)[1]	71.76 (.63)[2]	71.49 (.55)[3]	.04
Waist (inches)	6-months[c]	31.49 (.36)[1]	32.05 (.30)[2]	32.84 (.33)[1,2]	32.10 (.31)[3]	.03
Social influence	immediate[i]	2.16 (.12)[1,2]	2.07 (.11)[3,4]	1.73 (.12)[1,3]	1.71 (.11)[2,3]	.004
	1-month[j]	2.16 (.14)[1]	2.16 (.11)[2]	1.95 (.13)[3]	1.83 (.11)[1,2]	.06
	3-months[k]	2.10 (.14)[1,2]	2.29 (.12)[3,4]	1.96 (.13)[1,3]	1.71 (.11)[2,4]	.002
	6-months[l]	2.19 (.14)[3]	2.44 (.12)[1,2]	1.90 (.13)[1]	1.96 (.11)[2]	.004
Enjoyment	immediate[i]	2.38 (.12)	2.37 (.11)	2.44 (.12)	2.65 (.10)	.21
	1-month[j]	2.70 (.13)	2.80 (.11)	2.68 (.12)	2.87 (.10)	.61
	3-months[k]	2.98 (.13)	2.97 (.11)	2.84 (.12)	3.06 (.10)	.57
	6-months[l]	2.87 (.13)	2.82 (.11)	2.79 (.12)	3.02 (.10)	.43
Intention	immediate[m]	5.89 (.12)[1]	5.70 (.11)[2]	6.28 (.12)[1,2]	5.98 (.11)[3]	.004
	1-month[n]	5.61 (.18)	5.67 (.15)	5.84 (.16)	5.85 (.15)	.61
	3-months[k]	5.36 (.19)	5.91 (.16)	5.62 (.18)	5.80 (.15)	.15
	6-months[h]	5.45 (.21)	5.76 (.18)	5.51 (.20)	5.80 (.17)	.46
Self-efficacy	immediate[m]	5.40 (.17)	5.09 (.15)	5.45 (.17)	5.55 (.15)	.18
	1-month[j]	5.01 (.22)	5.13 (.17)	5.49 (.19)	5.27 (.17)	.36
	3-months[k]	5.13 (.23)	5.41 (.19)	5.13 (.21)	5.33 (.18)	.69
	6-months[h]	4.99 (.24)	5.15 (.21)	5.14 (.23)	5.44 (.20)	.52

Note. [1,2,3,4] significant differences across study conditions are denoted through matching numbered superscripts.
[a] $n = 162$. [b] $n = 151$. [c] $n = 149$. [d] $n = 174$. [e] $n = 167$. [f] $n = 165$. [g] $n = 176$. [h] $n = 169$. [i] $n = 204$. [j] $n = 178$. [k] $n = 172$. [l] $n = 168$. [m] $n = 201$. [n] $n = 177$.

orative implementation intention condition reduced their waist size marginally more than those in the control ($p = .09$, $d = .33$, CI, $d = -.07$–.72) and significantly more than the implementation-intention group, $p = .004$, $d = .66$, CI, $d = .23$–1.07).

Change in Psychosocial Mediators

The proposed mediators (enjoyment, intention, self-efficacy, and social influence) were assessed immediately postmanipulation at baseline, and then again at each follow-up (1, 3-and 6 months). There was no strong evidence of mediation on the behavior outcomes, though there were some changes in the proposed mediators as a function of the partner-based manipulations.

There were main effects of condition on social influence, supporting Hypothesis 2d, immediately postmanipulation, $F(3, 197) = 3.95$, $p = .005$, at 1 month, $F(3, 171) = 2.04$, $p = .06$, 3 months, $F(3, 165) = 4.58$, $p = .002$, and 6 months, $F(3, 161) = 4.14$, $p = .004$. Post hoc tests revealed the partner-based groups reported greater social influences on their physical activity levels. Specifically, the partner-only group reported higher levels of social influence than the control at all four time-points (all p's $< .04$) and the implementation-intention group immediately ($p = .04$), at 3 ($p = .06$) and at 6months ($p = .003$); the collaborative implementation-intention group also reported more social influence than the control (immediate: $p = .008$; 1 month: $p = .06$; 3 months: $p = .03$) and implementation intention (immediate: $p = .01$) groups.

Despite the positive impact of the partner-based manipulations on social influence, this did not translate into positive intentions—in fact, the reverse was true. The main effect of condition on intentions immediately postmanipulation, $F(3, 194) = 4.53$, $p = .004$, showed that those allocated to the partner groups had weaker intentions to do physical activity than those allocated to the implementation intention group (vs. partner, $p < .0005$, $r > .34$; vs. collaborative implementation intentions, $p = .02$, $r = .24$). There were no differences between groups in intentions at 1-, 3- or 6-month follow-ups (all $p > .14$). Enjoyment and self-efficacy did not vary as a function of the manipulations. Hypotheses 2a, 2b and 2c, therefore, were not supported.

Discussion

The findings support the use of collaborative implementation intentions in relation to promoting physical activity and associated weight reduction. Compared with participants in each of the other three groups (partner only, implementation intentions, control), they engaged more frequently in physical activity, in bouts lasting at least 10 minutes, at 1- and 6-month follow-ups, and were physically active for more time at 3 months (supporting Hypothesis 1a). This effect on physical activity was coupled with similar effects on weight loss (supporting Hypothesis 1b). This study is the first to provide evidence based on a fully randomized design supporting the use of collaborative imple-

mentation intentions. Evidence supporting implementation intention and partner (no implementation intention) interventions were more limited.

The mechanisms underlying the effects of collaborative implementation intentions on physical activity were not clear, as there were no mediation effects in this study. Consistent with recent work suggesting that asking people to think about how others can help them achieve their goals can actually undermine motivation (Fitzsimmons & Finkel, in press), motivation in the partner-based conditions was lower than for the other intervention condition (implementation intentions). However, this reduction in motivation was short-term, as it was detected immediately postmanipulation, but not at subsequent follow-ups. Moreover, collaborative implementation intentions could have been effective, as partners may provide salient environmental cues that reinforce one's plans (see Prestwich et al., 2009), encourage better quality of plans or more intense physical activity due to greater competition between partners, or drive change in other weight-related behaviors (i.e., food intake). These possibilities were not tested. However, an important first step in developing a new intervention is to first demonstrate its efficacy on key health behaviors and associated health outcomes. The findings of this study were strengthened by minimizing bias through fully randomizing participants to conditions, conducting an a priori sample-size calculation, using validated measures, and blinding key researchers to condition. Generalizability of the research was aided by recruiting participants from councils, which are large public-sector organizations that employ staff from a range of socioeconomic groups.

Evidence favoring implementation intentions was limited. Only at 3 months, on IPAQ METs, did the implementation-intention condition outperform the control group, supporting some recent work (e.g., Skår et al., in press) or suggesting that they are effective only under specific conditions (see Prestwich & Kellar, in press). Not all partner-based strategies were beneficial in promoting physical activity, particularly in the longer term. Asking participants to recruit partners to help them to be more physically active, but not offering volitional strategies (such as collaborative implementation intentions) in support, did not increase physical activity or improve physical outcomes relative to the control group at any time point. Moreover, participants in this group performed worse than: (a) the control group on the IPAQ measure at 6 months, (b) the collaborative implementation intention group on follow-up behavioral measures at all follow-ups, and (c) the implementation intention group at 3 and 6 months (based on IPAQ MET scores). As the behavior of partners will likely influence the health behaviors of focal participants (Gorin et al., 2005) partner-based strategies could lead to ineffective (even detrimental) partnerships.

While the research provides promising evidence, based on a fully randomized design, that collaborative implementation intentions can improve physical activity levels and physical outcomes, there are some study limitations. First, the final follow-up, at 6 months, was not particularly long-term, although only two other published studies (De Vet et al., 2009; Luszczynska, 2006) have tested implementation-intention effects on physical activity at 6 months or beyond. Second, the study relied on self-reports, although these behavioral measures had been previously validated against objective measures. As the physical activity measures (IPAQ MET, SWET frequency/duration) tap slightly different aspects of physical activity, the moderate interrelationships in this study support their validity. Furthermore, changes in physical activity from baseline to 6 months as indexed by the SWET ($r = -.14$), but not the IPAQ ($r = -.06$), were significantly related to weight reduction. This may provide greater confidence in the SWET rather than IPAQ measure. Moreover, all participants (including those in the control condition) were asked to try to meet physical activity guidelines, thereby reducing demand effects. Confirming the present results with objective measures would be a useful way to extend the present research as they may be seen as more reliable indices of behavior. Nevertheless, it is worth noting that an extensive review of implementation intentions found no difference in the effect size for studies employing self-report or objective measures (Gollwitzer & Sheeran, 2006).

Promoting physical activity has been associated with various benefits (e.g., Myers et al., 2002) thus identifying effective, widely deliverable interventions is important. The interventions tested in this study could feasibly be implemented on a large scale, in population or clinic-based settings, because they take the form of simple written instructions, do not require face-to-face communication and are widely applicable to anybody, irrespective of factors such as race and class. They could be delivered via a range of modes including leaflets, emails, and websites.

To summarize, a methodologically rigorous study demonstrated that collaborative implementation intentions promoted physical activity through 1-, 3- and 6-month follow-ups and helped reduce weight at 6 months. In contrast, asking participants to form implementation intentions was largely ineffective, and recruiting a partner to help increase physical activity (without forming collaborative implementation intentions) could be detrimental, relative to other approaches, in the long term. Further research should test the efficacy of collaborative implementation intentions and establish the mechanisms underlying any positive effects.

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