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Running Head: Partner-based interventions for diet change

# Partner and planning-based interventions to reduce fat consumption: A randomized controlled trial

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*Abstract*

Objective: The research tested the efficacy of partner and planning-based interventions to reduce dietary fat intake over a six-month period.

Design: Randomized controlled, blinded, parallel trial.

Methods: A computer randomization feature was used to allocate council employees ($N = 427$, of which 393 completed baseline measures) to one of four conditions (partner + implementation intentions; partner-only; implementation intentions; control group) before they completed measures at baseline and follow-ups at 1, 3 and 6-months post-baseline. Outcome measures were comprised of validated self-report measures of dietary fat intake (saturated fat intake; fat intake; ratio of 'good' fats to 'bad' fats); psychosocial mediators (enjoyment, intention, self-efficacy, social influence, partner support); weight and waist size (baseline and 6-months only).

Results: Data from 393 participants were analyzed in accordance with intention-to-treat analyses. All intervention groups reported greater reductions in fat intake than the control group at 3-months. The partner-based groups increased the ratio of 'good' fats to 'bad' fats at 3- and 6-months, and lost more inches on their waist, versus the non-partner groups. The impacts of the partner-based manipulations on outcomes were partially mediated by greater perceived social influences, partner support, and enjoyment of avoiding high fat foods. The partner-based interventions also increased intention and self-efficacy. However, the effects in this study were typically small and generally marginally significant.

Conclusions: Partner-based interventions had some positive benefits on dietary-related outcomes at 3- and 6-months. Support for implementation intentions was more limited.

Keywords: partner, buddy, implementation intention, collaborative implementation intention, diet.

Poor diet has been linked with greater heart disease risk (e.g., Hu, Manson, & Willett, 2001) thus achieving sustained dietary improvements is important. A review of maintenance effects (defined as 3 months follow-up) of dietary and physical activity interventions showed face-to-face contact was beneficial (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011). However, regular and widespread face-to-face intervention components are costly. One possible solution is to utilize existing support mechanisms including the partners of those targeted by the intervention who can provide regular face-to-face behaviour change support. In this study, we examined the efficacy of two minimal partner-based interventions, embedded within mailed out questionnaires, in improving dietary and physical outcomes over six-months. Minimal interventions, deliverable at the population level can achieve significant impact and can be integrated within broader stepped care approaches that provide intensive, costly interventions only to individuals in most need.

Partnering individuals with somebody else for support may aid health behaviour change (e.g., Stewart, Greaves, Kushner, Letourneau, Spitzer, & Boscoe, 2011; van Osch, Lechner, Reubsaet, Steenstra, Wigger, & de Vries, 2009) or may not (Cholewa & Irwin, 2008; May, West, Hajek, McEwen, & McRobbie, 2006). In the studies that imply partner benefits, there are limitations including self-selection bias (participants deciding whether to involve a partner or not: Prestwich, Conner, Lawton, Bailey, Litman, & Molyneaux, 2005), confounding the partner-based manipulation with additional behaviour change techniques (e.g., Jeffery, Wing, Sherwood, & Tate, 2003; McAuley, Courneya, Rudolph, & Lox, 1994), not employing fully-crossed designs (e.g., Trief et al., 2011), or incorporating non-experimental designs (e.g., Markey, Gomel, & Markey, 2008; Molloy, 2010; Stewart et al., 2011; van Osch et al., 2009). Reviews of family involvement in weight control interventions (e.g., Black, Gleser & Kooyers, 1990; Glenny, O'Meara, Melville, Sheldon, & Wilson, 1997; McLean, Griffin, Toney, & Hardeman, 2003)

have revealed inconsistent effects of family involvement: some studies showed benefits, some studies showed detrimental effects and other studies detected no difference.

These contradictory findings could be explained by the extent of partner involvement in behaviour change efforts. McLean et al. (2003) suggest that involving both partners in more behaviour change strategies leads to stronger effects. Similarly, Kitzmann et al.'s (2010) review examining lifestyle interventions for overweight youths indicated involving others (parents) more within the program leads to greater weight loss (see also Kumanyika et al., 2009).

Providing some structured support for the partner as well as the main participant, therefore, might be particularly effective. This is consistent with a recent trial (Prestwich et al., 2012) indicating that collaborative implementation intentions (Prestwich et al., 2005) increased physical activity and weight loss more than three other strategies (a partner only condition; an implementation intention only condition; full-control) over a 6-month period. Collaborative implementation intentions involve people jointly planning when and where they will perform the behaviour together ("If we're in the supermarket then we'll walk past the chocolate aisle"). The equivalent, non-partner, strategy termed implementation intentions (Gollwitzer, 1993) involve an *individual* planning when and where they will perform a particular behaviour ("If I'm in a supermarket then I'll walk past the chocolate aisle"). Implementation intentions have been shown to improve diet although their impact has been relatively small for reducing unhealthy eating habits (see Adriaanse et al., 2011, for a review) and appear to be unsuccessful in the short-term when delivered without an effective motivational manipulation (Prestwich, Ayres, & Lawton, 2008). There have been no tests of collaborative implementation intentions on dietary change. However, in support of the potential of partner-based interventions for dietary change,

Israel and Saccone (1979) revealed spouse participation was only beneficial when eating behaviours were targeted rather than weight loss.

Given evidence that implementation intentions can be effective (see Gollwitzer & Sheeran, 2006 for a review) but less so in reducing unhealthy eating habits (Adriaanse et al., 2011), there is scope to achieve stronger effects in this domain. Partner-based interventions encouraging greater partner involvement through, for example, joint planning (Prestwich et al., 2005, 2012) could represent a viable strategy. Partner-based interventions could influence motivation and intrinsic motivation (Prestwich et al., 2005), social influences, and self-efficacy via modeling (Bandura, 1977). Various theories link these, or related, constructs directly or indirectly to behaviour (e.g., Theory of Planned Behaviour, Ajzen, 1991; Social Cognitive Theory, Bandura, 1986; Self-Determination Theory, 1985) and empirical evidence has linked these constructs with healthy eating (e.g., Anderson-Bill, Winett, & Wojcik, 2011; Ball, Jeffery, Abbott, McNaughton, & Crawford, 2010; Conner, Norman, & Bell, 2002; Pelletier & Dion, 2007). Consequently, changing these constructs could mediate the impact of partner-based strategies on healthy eating outcomes.

*Summary & Objectives*

The primary objective of this study was to test the impact of two partner-based interventions (collaborative implementation intentions and partner-only) on dietary change. Partner-based interventions may be effective for helping dietary change (Israel & Saccone, 1979). Although the effect of implementation intentions on reducing the intake of unhealthy foods appears small (Adriaanse et al., 2011), greater partner involvement maximizes effects on dietary change (e.g., Kitzmann et al., 2010). To be able to disentangle the partner + implementation intentions effects, a full-crossed 2 x 2 design was employed. It was predicted

that participants randomized to the partner-based groups (hypothesis 1), the implementation intention groups (hypothesis 2) and particularly those in the partner + implementation intention (i.e., collaborative implementation intention) group (hypothesis 3) should reduce their (a) unhealthy eating, (b) weight and (c) waist size more than those in the other study conditions.

A secondary objective checked whether the partner-based interventions impacted on psychosocial mediators. Participants randomized to partner-based conditions were predicted to increase their a) perceived enjoyment; b) intentions; c) self-efficacy; d) social influence, more than those in non-partner-based conditions (hypotheses 4a-4d).

## *Methods*

There were no changes to the trial protocol following the commencement of the study.

### *Recruitment*

Participants were recruited into the study between 14th February, 2008 and 17th July, 2009. The last data was collected on 9th March, 2010. All participants were employees recruited from 14 UK-based councils. Councils are public sector organizations responsible for delivering local services and employ staff from a range of socio-economic groups. Councils were selected based on their proximity to the trial centre to allow face-to-face meetings to discuss the trial, if required, with council representatives. For each organization, a lead contact (usually from health and safety, or occupational health) aided recruitment. Depending on specific council preferences, recruitment involved either a note in payslips, email, newsletter or posters inviting staff to take part in a study on reducing saturated fat intake. The study aim was advertised to participants as examining the effects of a health information intervention on fat intake over a 6-month period.

To be eligible for this study, council employees (defined henceforth as 'participants') had to identify a partner (e.g., housemate, wife/husband) willing to participate with them. Participants were excluded if they had a BMI less than 18.5 or if they or their partner was pregnant, under the age of 16 or was at risk of malnutrition (identified as scoring 2 or above on the Malnutrition Screening Tool: Ferguson, Capra, Bauer, & Banks, 1999) 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 vouchers per couple on completion of the study at 6-months follow-up.

*Sample*

An effect size comparing collaborative implementation intentions against a control group for healthy eating was estimated based on: (i) The only study that had previously tested the benefit of collaborative implementation intentions over implementation intentions for health behaviour at the time the research was conducted ($d$ = .84, Prestwich et al., 2005); (ii) 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 the same health behaviour; (iii) The average effect of implementation intentions over controls for healthy eating ($d$ = .43, based on six studies reported by Gollwitzer & Sheeran, 2006) (i.e., $d$ = .49 = .84/.74 x .43). Given the estimated effect size of $d$ = .49, the required sample size in each condition, with 80% power at $p$ = .01, was 85 (thus 340 in total). Allowing for around 20% dropout, 393 pairs of participants, at least one of which was a council employee, completed the baseline materials. Forty-three percent of participants were in the normal weight range

(BMI=18.5-24.9) while 57% were overweight (BMI=25-29.9) or obese (BMI=30+). Underweight participants were not eligible for the trial.

*Randomization*

Participants were randomized to one of four groups: two of which were partner based (collaborative implementation intentions or partner-only) and two of which were non-partner based (implementation intentions or control). 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, RS 1-3 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, RS2-3 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 vs. non-specific measures to ensure data-entry of condition non-specific measures was completed blinded to condition. Data analysis was non-blinded.

*Manipulations (Interventions)*

Each manipulation was presented as written text following the baseline measures. All participants (including those in the *control group*) were provided with information describing saturated fats, how they are different from other fats, and what represents high (5% or more), moderate (1.5-5%) and low (below 1.5%) levels as defined by the UK Food Standards Agency. In addition, they were asked to try to reduce the level of saturated fat in their diet. After completing a food frequency questionnaire (Margetts, Cade & Osmond, 1989), all participants read one page of text based on Protection Motivation Theory (PMT; Rogers, 1983) linking saturated fat intake and heart disease to motivate dietary changes. Similar texts have been used in other diet-based implementation intention studies (e.g., Prestwich et al., 2008). To encourage careful reading, 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:-

*Partner + implementation intention (Collaborative Implementation Intentions).* This group was informed: 'Past research suggests that despite intending to eat more healthily, 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 avoid buying and consuming foods high in saturated fat.' Participants were then asked to consider and discuss, with their partner, the types of foods that might contain high levels of saturated fat that they should try to avoid, when and where they might usually buy or consume these foods and what they could do together to prevent them buying or consuming these foods. They were then asked to make plans in the form: 'IF (we're in situation X) THEN WE (will...) NOT (do Y...)' and were provided with 4 example plans.

They were reminded that they were free to choose when, where and how they would avoid buying or consuming foods high in saturated fat in ways that they would find easy to do together. They were provided with space to write up to 5 plans and there was a 3-item checklist to help ensure plans were formed appropriately (e.g., Do your plan(s) identify all of the situations in which you could potentially buy or consume foods that are high in saturated fat?). Similar checklists have been used previously (e.g., Prestwich et al., 2010).

*Partner Only.* Participants in this group were asked to recruit a partner to help them to avoid foods high in saturated fat but were not asked to form a collaborative implementation intention. They were provided with the following text: 'Past research suggests that despite intending to eat less saturated fat, many people fail to make real changes to their diet. 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 avoiding the purchasing and consumption of foods high in saturated fat.'

*Implementation Intentions.* Equivalent to the participants in the collaborative implementation intention condition, those randomized to the implementation intention condition were asked to form a plan although they were not asked to develop or discuss these plans with a partner. Thus, the format was the same but, in this condition, plans were made individually 'IF (I'm in situation X) THEN I (will...) NOT (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 including demographics were completed, without face-to-face interaction with a researcher, outside of the laboratory via the post. No changes to trial outcomes were made following trial commencement.

*Primary Outcome Measures.* A validated self-report index of food intake (Margetts et al., 1989) measured fat intake. Participants rated the frequency that they consumed 63 common foods over the previous month using a 6-point scale (two or more times per day; everyday; three to five times per week; one to two times per week; one to three times per month; rarely or never). We provided additional space for participants to list foods they had consumed outside of the other 63 foods listed. The scale has good test-retest reliability, $r = .61$; Armitage & Conner, 1999), convergent validity with 24-hour dietary records (e.g., Margetts et al., 1989) and 10-day weighed records (Thompson & Margetts, 1993), and construct validity (Armitage & Conner, 2001). Based on their responses, dietary scores were generated for each participant (percentage fat intake; percentage saturated fat intake; ratio of good fats to bad fats- i.e., polyunsaturated fat intake divided by saturated fat intake). This measure was completed at baseline (pre-manipulation) and follow-ups (1-, 3- and 6-months).

*Secondary Outcome Measures.* *Weight* and *waist size* were self-reported at the screening stage and 6-months. For guidance, 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.* Following recommendations (Conner & Sparks, 2005), *behavioural intention* (e.g., 'I intend to avoid foods that are high in saturated fat' [1=extremely unlikely, 7=extremely likely]) and *self-efficacy* (e.g.,'How much control do you believe you have over whether or not you avoid foods that are high in saturated fat?' [1=no control, 7=complete

control]) were assessed (intention: α = .80 - .87; self-efficacy: α = .78 - .84). *Perceived social influence* (I avoid foods high in saturated fat because: e.g., '…significant others want me to avoid foods high in saturated fat', α = .69 - .83) and *perceived enjoyment* (Hagger et al., 2003; Ryan & Connell, 1989: I avoid foods high in saturated fat because: e.g., '…I enjoy avoiding foods high in saturated fat') were also measured as potential mediators of the intervention on dietary intake. Perceived social influence and perceived enjoyment were assessed on 4-point scales (1=not true at all, 4=very true). Items relating to each of the proposed mediators were combined into a mean. These constructs were each assessed at baseline (post-manipulation) and all follow-ups (1-, 3- and 6-months). *Partner support* was assessed at 6-months only using Sallis, Grossman, Pinski, Patterson, and Nader's (1987) measure (encouragement scale: α = .88; sabotage scale: α = .76).

*Statistical Methods*

ANOVA and chi-square tested differences between those completing the study and those who did not as well as the success of randomization. ANCOVA tested the effects of the interventions on outcomes during the intervention period. Outliers ($z > 3.5$) were removed prior to the main analyses. Bootstrapping tested mediation (Preacher & Hayes, 2004). Data were analyzed based on the condition to which participants were randomized and with missing data (including dropouts) for the measures completed at baseline and follow-ups replaced using multiple imputation (i.e., intention-to-treat). The multiple imputation was conducted for all participants completing baseline measures ($N = 393$). For the multiple imputation, implementation intentions (yes/no) and partner (yes/no) were first entered as categorical predictors followed by the mean scores of all of the outcome variables structured by time-point (earlier time-points before later time-points) and type of outcome (psychosocial then behavioural

then physical). These variables were imputed and used as predictors. This was followed by multiple regressions, controlling for the baseline measure, to derive pooled results in SPSS. Where substantive differences between the results of intention-to-treat and per-protocol (missing data not replaced) analyses exist, these are reported. One-tailed p-values, effect sizes (*d*), and corresponding CIs are also reported.

*Results*

There was no investigator-determined exclusion of participants through poor adherence to trial protocol. Of the 393 participants completing baseline measures, only 36 dropped out between completing the baseline materials and the 6-month follow-up, reflecting a drop-out rate of 9.2% over 6-months. Dropout rates over these 6-months did not differ across groups, $\chi^2(3) = 1.04$, $p = .79$. Participant flow through each stage of the study is illustrated in Figure 1.

*Insert Figure 1 here*

There were no differences in baseline measures between those remaining in the study and those that dropped out in terms of their diet (% fat; % saturated fat; ratio of good fats:bad fats), age, study partner age, number of children, BMI, weight (kg) or waist size (inches), socio-economic status (% managerial or professional occupation), sex, sex of partner, or ethnicity. No adverse events were detected. There were no significant differences across the four groups at baseline (see Table 1).

*Insert Table 1 here*

*Change in diet (primary outcomes)*

Providing some support for hypothesis 1a, participants randomized to the partner-based groups reported marginally greater improvements in the ratio of good fat:bad fats at 3-months, *B* = .03, *SE* = .02, *p* = .08, *d* = .16, *CI* = .00 - .33. Under per-protocol analyses, the partner-based

groups reported significantly greater improvements in the ratio of good fat:bad fats at 3-months, $F(1, 348) = 3.64$, $p = .03$, $d = .20$, $CI = .03$ - $.38$, and marginally greater improvements at 6-months, $F(1, 345) = 2.53$, $p = .06$, $d = .20$, $CI = -.01$ - $.34$.

Support for hypotheses 2a and 3a were much more limited with the implementation intention manipulations producing broadly similar effects to the control group. One exception was a marginally significant partner x planning interaction on the percentage of food energy derived from fat at 3-months, $B = 1.31$, $SE = 0.98$, $p = .09$, $d = .14$, $CI = -.02$ - $.31$, indicating those randomized to the control condition (-0.64%) reduced their fat content the least during this period (collaborative implementation intention: -1.06%; partner-only: -1.50%; implementation intention: -1.49%, based on multiple imputation). There were no significant effects at 1 or 6-months on this measure. Moreover, there were no significant effects on the percentage of food energy derived from saturated fat.

*Insert Table 2 here*

*Change in Physical Outcomes*

Supporting hypothesis 1c, participants in the partner-based groups lost more around their waist than those in the non-partner based groups ($F(1, 328) = 3.23$, $p = .04$, $d = .19$, $CI = .01$ - $.38$, per protocol; $B = -.29$, $SE = .23$, $p < .10$, $d = .13$, $CI = -.03$ - $.30$, intention-to-treat). Those in the implementation intention groups reported a smaller reduction in waist size than those not in the implementation intentions conditions going against hypothesis 2c. There were no significant effects on weight thus hypotheses 1b, 2b and 3b were not supported.

*Change in Psychosocial Mediators*

The proposed mediators (enjoyment, intention, self-efficacy, and social influence) were assessed immediately post-manipulation at baseline and then again at each follow-up (1, 3 and 6-

months). There were main effects of partner on social influence, enjoyment, intention and self-efficacy, with the partner-based groups reporting higher levels on each measure at various time-points supporting hypotheses 4a, 4b, 4c and 4d. Specifically, main effects of partner emerged on social influence at 1-month, $B = .16$, $SE = .09$, $p = .04$, $d = .19$, $CI = .03$ - $.36$, 3-months, $B = .23$, $SE = .09$, $p = .005$, $d = .27$, $CI = .11$ - $.44$, and 6-months, $B = .26$, $SE = .09$, $p = .002$, $d = .30$, $CI = .13$ - $.47$; enjoyment at 3-months, $B = .19$, $SE = .08$, $p = .01$, $d = .26$, $CI = .09$ - $.42$; intentions at 1-month $B = .14$, $SE = .10$, $p = .07$, $d = .15$, $CI = -.01$ - $.32$ and 3-months, $B = .19$, $SE = .10$, $p = .04$, $d = .19$, $CI = .02$ - $.35$; and on self-efficacy at 3-months, $B = .16$, $SE = .10$, $p = .06$, $d = .16$, $CI = -.01$ - $.32$ (significant under per protocol: $F(1, 353) = 3.74$, $p = .03$, $d = .20$, $CI = .03$ - $.38$, and 6-months, $B = .18$, $SE = .10$, $p = .03$, $d = .19$, $CI = .02$ - $.36$. Partner support (assessed only at 6-months) was also greater in the partner-based groups (encouragement: $B = .23$, $SE = .10$, $p = .01$, $d = .24$, $CI = .08$ - $.41$; sabotage: $B = .25$, $SE = .08$, $p = .001$, $d = .37$, $CI = .20$ - $.53$).

As the partner-based manipulations impacted on the proposed theoretical mediators as well as behavioural and physical outcomes, mediation analyses were conducted.[1] Social influence at 3-months partially mediated the effect of the partner-interventions on increasing the ratio of good fats:bad fats at 3-months, Sobel $Z = 1.66$, $p = .049$, one-tailed, $CI = -.00$ - $.01$. Enjoyment at 3-months (Sobel $Z = -1.97$, $p = .04$, $CI = -.17$ - $-.00$) and partner support at 6-months (encouragement: Sobel $Z = -1.68$, $p = .047$, one-tailed, $CI = -.17$ - $.01$; sabotage: Sobel $Z = -1.63$, $p = .05$, one-tailed, $CI = -.17$ - $.02$) partially mediated the effect of the partner-interventions on reducing waist size. Self-efficacy and intention did not mediate the effects of the partner-based interventions on outcomes.

Main effects of implementation intentions emerged on intentions immediately, $B = .22$, $SE = .10$, $p = .01$, $d = .22$, $CI = .05$ - 39, and at 1-month, $B = .24$, $SE = .10$, $p = .01$, $d = .25$, $CI =$

.08 - .42, as well as on encouragement, *B* = .31, *SE* = .14, *p* = .01, *d* = .20, *CI* = .04 - .37, with those asked to form implementation intentions reporting more positive intentions and encouragement to reduce saturated fat intake. Partner x planning interactions emerged on intentions immediately, *B* = -.34, *SE* = .20, *p* = .05, *d* = .17, *CI* = .00 - .34, at 1-month, *B* = -.48, *SE* = .20, *p* = .01, *d* = .26, *CI* = .09 - .42, and 3-months, *B* = -.35, *SE* = .21, *p* = .04, *d* = .18, *CI* = .01 - .34. At all three time-points, the control group reported the weakest intentions. Similar interactions were detected immediately on self-efficacy, *B* = -.31, *SE* = .22, *p* = .08, *d* = .14, *CI* = -.02 - .31, and social influence at time 3, *B* = -.25, *SE* = .18, *p* = .09, *d* = .15, *CI* = -.02 - .31, with the control group weaker than the other groups.

## Discussion

The findings provide *some* support for partner-based over non-partner-based interventions to improve dietary behaviours (ratio of good fats : bad fats only; hypothesis 1a) and related physical outcomes (waist size only; hypothesis 1c). However, these effects were not (at least marginally) significant across all behavioural and physical outcomes. The partner-based manipulation impacted on each of the proposed psychological variables: social influence, enjoyment, intention and self-efficacy (supporting hypotheses 4a-4d), although the effects on self-efficacy were significant only under per-protocol analysis. Support for (individual) implementation intentions was restricted to a single item measure of saturated fat intake (see footnote 1) and an interaction effect at 3-months indicating the control group consumed a greater percentage of fat than those in the other three conditions.

Previous research targeting partners over individuals has produced mixed results for weight loss though they appear more promising when focused on eating behaviour (Israel & Saccone, 1979). Our results generally support these findings with small but significant benefits

of partner-based interventions on some behavioural and physical outcomes. Partner-based strategies were not enhanced by introducing a planning-based element to create collaborative implementation intentions. Given that the effect of implementation intentions on reducing the intake of unhealthy foods appear to be small (Adriaanse et al., 2011), the lack of additional benefit of collaborative implementation intentions in reducing the intake of unhealthy foods is perhaps unsurprising. It may be easier for people to identify a sufficient number of opportunities to enact a behaviour (e.g., to eat a healthy food; engage in physical activity, Prestwich et al., 2012) than to identify all situations that prompt risky behaviours (i.e. eating unhealthy foods) and this may undermine both implementation intention and collaborative implementation intention effects. Only at 3-months, on fat intake, did the implementation intention condition outperform the control group supporting evidence that the impact of this strategy on reducing the intake of unhealthy foods is fairly limited (Adriaanse et al., 2011), or work only under specific conditions (see Prestwich & Kellar, in press). Interestingly, of the studies trying to reduce unhealthy food intake in Adriaanse et al.'s review most had a final follow-up at 1-month or shorter. The study with the longest follow-up (De Vries et al., 2008) reported effects sizes of implementation intentions close to zero. Moreover, the short-term effects of implementation intentions on intentions were surprising (cf. Webb & Sheeran, 2008) and warrant further investigation.

Measuring psychosocial constructs post-intervention enabled examination of possible mechanisms underlying partner effects on outcomes (Michie & Prestwich, 2010). As predicted, participants in the partner-based conditions were more motivated, had more self-efficacy and enjoyment, and were more likely to report that they avoided unhealthy foods because others wanted them to. The mechanisms underlying the effects of the partner-based manipulations on dietary outcomes, however, were not comprehensive although there was some indication that

perceived social influence, enjoyment and partner support played some role. Nevertheless, an important first step in developing a new intervention is to first demonstrate its efficacy on key health behaviours 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 socio-economic groups.

While the research provides evidence that partner-based interventions can improve dietary and physical outcomes, there are study limitations. There were no formal manipulation checks of the partner-based interventions to compare partner involvement across all four conditions. This was necessary to minimize mere measurement effects which could have prompted greater partner involvement in the non-partner groups. However, at 6-months, there were clear effects of the partner manipulation on partner support and on social influence at other follow-ups. The study used self-reported behavioural measures. However, these measures had been previously validated against objective measures; the same food-frequency questionnaire has been used in shorter-term studies reporting significant effects of implementation intentions (Armitage, 2004; Prestwich et al., 2008); and all participants (including those in the control condition) were asked to try to reduce their unhealthy food intake thus reducing demand effects. Using self-reports rather than objective measures for physical outcomes such as waist size could be problematic but measuring these outcomes objectively causes problems by increasing delivery cost, introducing face-to-face components that can positively impact on behaviour change (Fjeldsoe et al., 2011), and challenges the ethos of minimal interventions deliverable at the population level. Moreover, given self-reported physical measures introduce noise (e.g.,

measurement accuracy) that should *decrease* the likelihood of detecting significant differences, the effect of partner interventions on waist size is impressive.

The impacts of the partner-based interventions were sometimes significant ($p < .05$), marginal ($.05 < p < .10$), or non-significant and tended to be small. Small effects can, however, be important (Rosenthal, Rosnow, & Rubin, 2000) and most of the estimated effects are likely to be robust given the large sample size, intention-to-treat analyses and other methodological procedures adopted. Minimal interventions may have greater public health impact through improved reach, adoption, implementation and maintenance (e.g., Glasgow, Vogt & Boles, 1999). Partner-based interventions could be delivered on a wider scale because they do not require face-to-face contact with health care professionals, appealing to individuals reluctant to enter formal treatment.

To summarize, partner-based strategies had a small impact on some psychosocial, behavioural and physical outcomes up to 6-months. Further research should identify whether similar manipulations can modify other behaviours and clarify the underlying mechanisms.

## Footnote

[1] Bootstrapping mediation is reported following the last observation carried forward method. We are unaware of a SPSS bootstrapping method to produce pooled results following multiple imputation.

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*Table 1: Means (SD) of Characteristics Across Conditions at Screening and Baseline stages*

| Measure | *N* | Collaborative Implementation Intention | Partner only | Implementation Intention | Control | *p* |
|---|---|---|---|---|---|---|
| Age | 426 | 44.87 (10.22) | 45.33 (10.30) | 43.29 (10.99) | 43.18 (10.64) | .33 |
| Study Partner Age | 426 | 44.78 (12.50) | 43.85 (12.65) | 43.41 (11.60) | 44.80 (12.53) | .80 |
| Sex (% males) | 427 | 22.6% | 23.4% | 23.0% | 14.3% | .30 |
| Sex of Partner (% of males) | 427 | 67.8% | 65.4% | 71.0% | 80.0% | .10 |
| Number of children | 412 | 1.59 (1.04) | 1.72 (1.13) | 1.31 (1.14) | 1.46 (1.11) | .06 |
| SES (% managerial or professional occupation) | 425 | 65.8% | 70.1% | 74.0% | 73.1% | .54 |
| Ethnicity (% White British) | 426 | 87.8% | 91.6% | 93.9% | 92.4% | .43 |
| BMI | 427 | 25.80 (4.13) | 26.93 (5.02) | 26.85 (4.68) | 26.27 (4.59) | .23 |
| Weight (kg) | 427 | 71.49 (14.31) | 74.38 (15.93) | 75.50 (14.18) | 72.55 (13.53) | .18 |
| Waist (inches) | 421 | 33.57 (4.36) | 34.91 (4.86) | 34.22 (4.93) | 33.87 (4.47) | .18 |
| % Fat intake | 391 | 37.62 (5.51) | 38.23 (5.93) | 36.94 (4.53) | 37.37 (5.67) | .42 |
| Ratio of good fat/bad fats | 391 | .50 (.19) | .51 (.32) | .53 (.23) | .48 (.15) | .52 |
| % Saturated fat intake | 391 | 14.46 (2.76) | 14.74 (3.10) | 14.08 (2.75) | 14.42 (2.71) | .46 |

*Table 2: Post-Intervention Primary and Secondary Outcome Means (Standard Error) and Regression Statistics (pooled statistics following multiple imputation; outliers removed)*

| Measure | Time | *N* | Collaborative Implementation Intention | Partner only | Implementation Intention | Control |
|---|---|---|---|---|---|---|
| Good:bad fats ratio | 1-month | 389 | 0.55 (.02) | 0.56 (.03) | 0.55 (.02) | 0.54 (.02) |
| | 3-months | 389 | 0.57 (.02) | 0.55 (.02) | 0.53 (.03) | 0.53 (.02) |
| | 6-months | 389 | 0.56 (.03) | 0.56 (.03) | 0.54 (.02) | 0.52 (.02) |
| % fat intake | 1-month | 391 | 36.63 (.57) | 37.11 (.49) | 36.19 (.60) | 36.12 (.51) |
| | 3-months | 391 | 36.57 (.60) | 36.52 (.50) | 35.42 (.59) | 36.71 (.56) |
| | 6-months | 393 | 36.38 (.66) | 36.04 (.66) | 35.55 (.59) | 36.07 (.54) |
| % saturated fat intake | 1-month | 390 | 13.66 (.27) | 13.96 (.26) | 13.53 (.29) | 13.51 (.24) |
| | 3-months | 391 | 13.51 (.30) | 13.71 (.27) | 13.36 (.29) | 13.68 (.29) |
| | 6-months | 391 | 13.76 (.35) | 13.62 (.34) | 13.18 (.31) | 13.54 (.27) |
| Weight (kg) | 6-months | 390 | 69.61 (1.29) | 72.04 (1.43) | 74.53 (1.56) | 71.02 (1.34) |
| Waist (inches) | 6-months | 391 | 32.45 (.40) | 33.06 (.43) | 33.02 (.47) | 32.69 (.49) |
| Social Influence | immediate | 393 | 1.96 (.08) | 2.02 (.09) | 2.12 (.09) | 2.02 (.08) |
| | 1-month | 393 | 2.12 (.08) | 2.26 (.09) | 2.03 (.10) | 2.04 (.09) |
| | 3-months | 393 | 2.36 (.09) | 2.38 (.09) | 2.25 (.10) | 2.03 (.09) |
| | 6-months | 392 | 2.46 (.09) | 2.46 (.09) | 2.28 (.10) | 2.13 (.09) |
| Enjoyment | immediate | 393 | 1.90 (.08) | 1.89 (.07) | 1.91 (.07) | 1.89 (.07) |
| | 1-month | 393 | 2.10 (.08) | 2.14 (.08) | 2.05 (.08) | 2.13 (.08) |
| | 3-months | 393 | 2.28 (.08) | 2.41 (.07) | 2.15 (.09) | 2.16 (.09) |
| | 6-months | 393 | 2.44 (.08) | 2.44 (.07) | 2.40 (.09) | 2.33 (.08) |

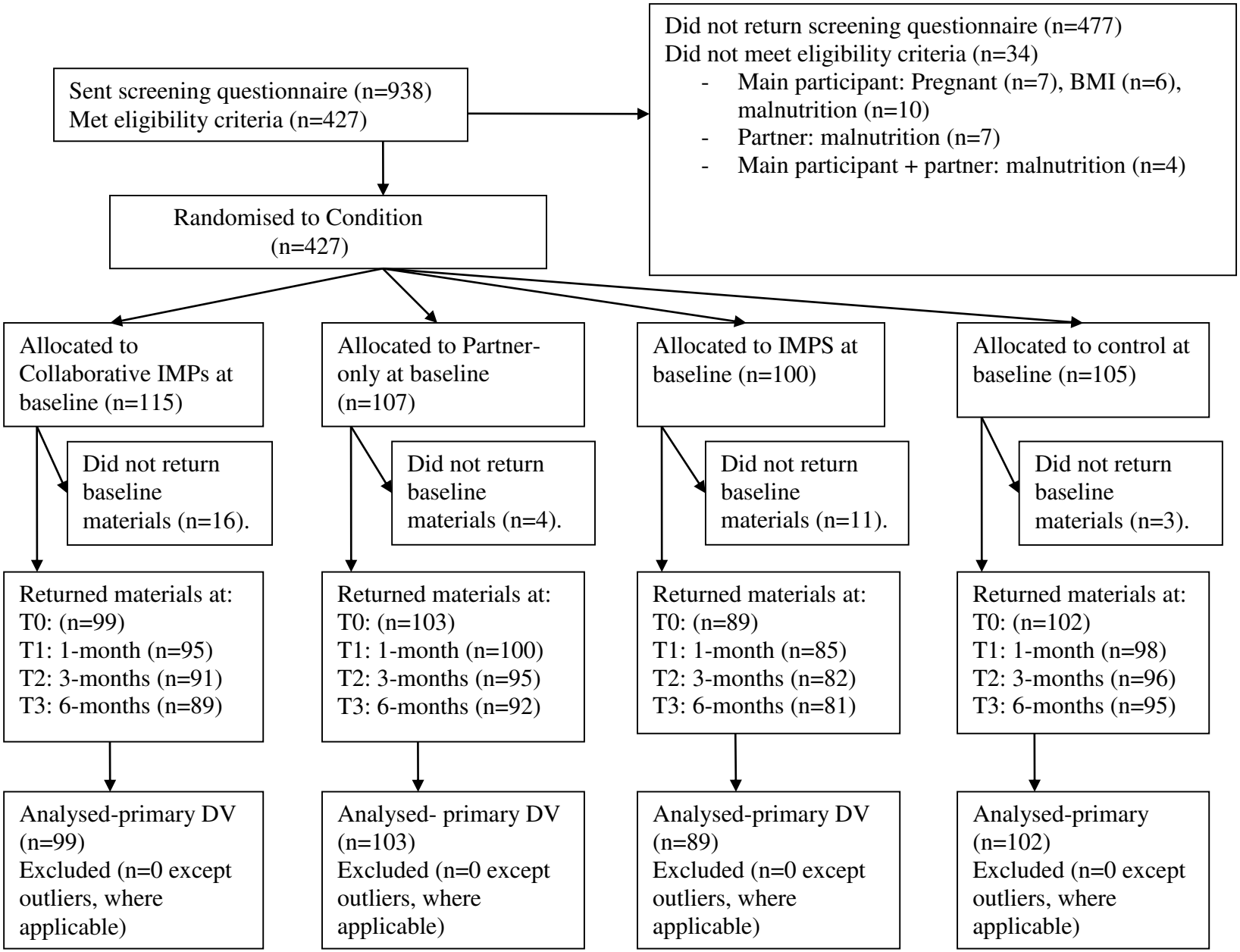
| | | | | | | |
|---|---|---|---|---|---|---|
| Intention | immediate | 393 | 5.77 (.10) | 5.72 (.10) | 5.94 (.10) | 5.55 (.10) |
| | 1-month | 392 | 5.80 (.09) | 5.80 (.09) | 5.91 (.09) | 5.42 (.12) |
| | 3-months | 393 | 5.83 (.10) | 5.93 (.09) | 5.83 (.09) | 5.58 (.12) |
| | 6-months | 392 | 5.95 (.09) | 5.78 (.11) | 5.90 (.10) | 5.86 (.09) |
| Self-efficacy | immediate | 393 | 5.43 (.12) | 5.53 (.10) | 5.57 (.10) | 5.36 (.12) |
| | 1-month | 392 | 5.63 (.09) | 5.63 (.09) | 5.69 (.08) | 5.53 (.11) |
| | 3-months | 392 | 5.67 (.11) | 5.68 (.11) | 5.54 (.11) | 5.49 (.12) |
| | 6-months | 391 | 5.81 (.10) | 5.83 (.09) | 5.62 (.11) | 5.64 (.11) |
| Encourage | 6-months | 393 | 3.39 (.09) | 3.15 (.10) | 3.20 (.11) | 2.89 (.10) |
| Sabotage | 6-months | 393 | 4.14 (.17) | 4.20 (.07) | 3.91 (.07) | 3.93 (.07) |

*Table 2 (Continued): Post-Intervention Primary and Secondary Outcome Means (Standard Error) and Regression Statistics (pooled statistics following multiple imputation; outliers removed)*

| Measure | Time | Partner<br>*B (SE)* | Implementation Intention<br>*B (SE)* | Partner x Implementation Intention<br>*B (SE)* |
|---|---|---|---|---|
| Good:bad fats ratio | 1-month | .006 (.02) | -.01 (.02) | .01 (.04) |
| | 3-month | .03 (.02)† | -.004 (.02) | .03 (.04) |
| | 6-months | .03 (.02) | -.002 (.02) | -.01 (.04) |
| % fat intake | 1-month | .31 (.45) | .04 (.45) | -.52 (.91) |
| | 3-month | .09 (.48) | -.39 (.48) | 1.31 (.98)† |
| | 6-months | .03 (.55) | .15 (.57) | .95 (1.16) |
| % saturated fat intake | 1-month | .12 (.22) | -.03 (.23) | -.40 (.45) |
| | 3-months | -.05 (.27) | -.13 (.25) | .03 (.53) |
| | 6-months | .20 (.29) | .001 (.30) | .43 (.63) |
| Weight (kg) | 6-months | .04 (.35) | .22 (.37) | -.88 (.65) |
| Waist (inches) | 6-months | -.29 (.23)† | .33 (.24)† | .22 (.48) |
| Social influence | immediate | -.08 (.09) | .02 (.09) | -.15 (.17) |
| | 1-month | .16 (.09)* | -.08 (.09) | -.12 (.18) |
| | 3-months | .23 (.09)** | .09 (.09) | -.25 (.18)† |
| | 6-months | .26 (.09)** | .07 (.09) | -.14 (.18) |
| Enjoyment | immediate | -.004 (.07) | .02 (.07) | -.01 (.14) |
| | 1-month | .03 (.08) | -.06 (.08) | .03 (.15) |
| | 3-months | .19 (.08)** | -.07 (.08) | -.12 (.16) |
| | 6-months | .07 (.08) | .03 (.09) | -.08 (.16) |

| | | | | |
|---|---|---|---|---|
| Intention | immediate | .01 (.10) | .22 (.10)* | -.34 (.20)* |
| | 1-month | .14 (.10)† | .24 (.10)** | -.48 (.20)** |
| | 3-months | .19 (.10)* | .07 (.10) | -.35 (.21)* |
| | 6-months | -.03 (.10) | .11 (.10) | .13 (.20) |
| Self-efficacy | immediate | .02 (.11) | .05 (.11) | -.31 (.22)† |
| | 1-month | .03 (.10) | .08 (.09) | -.16 (.19) |
| | 3-months | .16 (.10)† | .02 (.11) | -.06 (.22) |
| | 6-months | .18 (.10)* | -.02 (.10) | .004 (.20) |
| Encourage | 6-months | .23 (.10)* | .28 (.10)** | -.07 (.20) |
| Sabotage | 6-months | .25 (.08)** | -.04 (.07) | -.05 (.15) |

Note: † $p < .10$, * $p < .05$, ** $p < .01$, one-tailed p-values.


Sent screening questionnaire (n=938)
Met eligibility criteria (n=427)
Did not return screening questionnaire (n=477)
Did not meet eligibility criteria (n=34)
- Main participant: Pregnant (n=7), BMI (n=6), malnutrition (n=10)
- Partner: malnutrition (n=7)
- Main participant + partner: malnutrition (n=4)
Randomised to Condition (n=427)
Allocated to Collaborative IMPs at baseline (n=115)
Allocated to Partner-only at baseline (n=107)
Allocated to IMPS at baseline (n=100)
Allocated to control at baseline (n=105)
Did not return baseline materials (n=16).
Did not return baseline materials (n=4).
Did not return baseline materials (n=11).
Did not return baseline materials (n=3).
Returned materials at: T0: (n=99) T1: 1-month (n=95) T2: 3-months (n=91) T3: 6-months (n=89)
Returned materials at: T0: (n=103) T1: 1-month (n=100) T2: 3-months (n=95) T3: 6-months (n=92)
Returned materials at: T0: (n=89) T1: 1-month (n=85) T2: 3-months (n=82) T3: 6-months (n=81)
Returned materials at: T0: (n=102) T1: 1-month (n=98) T2: 3-months (n=96) T3: 6-months (n=95)
Analysed-primary DV (n=99) Excluded (n=0 except outliers, where applicable)
Analysed- primary DV (n=103) Excluded (n=0 except outliers, where applicable)
Analysed-primary DV (n=89) Excluded (n=0 except outliers, where applicable)
Analysed-primary (n=102) Excluded (n=0 except outliers, where applicable)