



The Effect of an Augmented Commercial Weight Loss Program on Increasing Physical Activity and Reducing Psychological Distress in Women with Overweight or Obesity: a Clustered Randomised Controlled Trial.

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1 **Title**

2 The Effect of an Augmented Commercial Weight Loss Program on Increasing Physical
3 Activity and Reducing Psychological Distress in Women with Overweight or Obesity: a
4 Clustered Randomised Controlled Trial.

5 **Abstract**

6 Objective: The present study tested the effects of integrating an evidence-based physical
7 activity intervention within an existing commercial weight loss program to assess effects on
8 increasing physical activity and reducing psychological distress. Method and results: The
9 CONSORT guidelines were adopted for the study. Forty nine women with overweight or
10 obesity (M age = 39.5, SD:12.4; M Body Mass Index = 31.02, SD: 2.10) enrolled in a six
11 week commercial weight loss program were randomized to an intervention or a control
12 group. Participants in the control group received care as usual; participants in the intervention
13 group additionally received an evidence-based intervention to increase physical activity that
14 included behaviour change techniques including implementation intentions, goal-setting and
15 self-monitoring. Weekly steps increased in the intervention group (M=31516.25;
16 SD=9310.17 to M=62851.36; SD=13840.4) significantly more ($p < .001$, $\eta_p^2 = .32$) than in
17 the control group (M=30207.67; SD=7833.29) to M=46969.33 (SD=9470.96), along with
18 experiencing significantly lower anxiety ($p < .001$, $\eta_p^2 = .15$), social dysfunction ($p < .001$,
19 $\eta_p^2 = .16$) and depression symptoms ($p < .05$, $\eta_p^2 = .08$) at follow-up. Implications: this
20 intervention warrants extension to those seeking to improve mental health through physical
21 activity.

22 **Keywords:** Physical activity, health, behavior change, goal intentions, anxiety, wellbeing.

23

24 **1a. Background**

25 Globally, more than 1.9 billion adults are overweight (World Health Organization,
26 2014) which increases the risk of psychosocial, physiological, cardiovascular, metabolic
27 and musculoskeletal health problems (Shultz, Byrne & Hills, 2014). Commercial weight
28 loss programs represent culturally popular means of achieving weight loss (Bye, Avery, &
29 Lavin, 2005; Lowe, Miller-Kovach, Fry, et al., 1999; Tsai & Wadden, 2005). Most
30 commercial programs focus on reducing caloric intake through food restriction, which
31 when done moderately may offer a way to achieve a negative energy balance and
32 subsequent improvements in cardiovascular and glucoregulatory biomarkers
33 (Trepanowski, Canale, Marshall, Kabir & Bloomer, 2011), at least in the short term
34 (Yanovski, 2000). However, the early stages of dietary restraint is associated with deficits
35 in central executive functioning and increases in stress (Green, Elliman, & Kretsch, 2005;
36 Kemps, Tiggemann, Marshall, 2005), which may contribute to poorer self-regulation of
37 eating behaviours (Dohle, Diel, & Hofmann, 2017). These psychological outcomes may
38 explain the poor retention rates in commercial programs (Finley, Barlow, Greenway,
39 Rock, Rolls, & Blair, 2007), in addition to the increased likelihood of weigh regain
40 following programs (Sainsbury et al., 2018), ultimately undermining any short-term
41 positive effects. Programs that focus on a healthy lifestyle by concurrently offering dietary
42 advice with behavioural strategies such as increasing physical activity are more effective
43 than programs that focus on dietary restriction alone, suggesting a holistic lifestyle
44 approach is warranted (Baetge et.al, 2017).

45 Physical activity levels are usually low in adults, with 59% of male respondents aged
46 16 and over meeting the recommended levels while 49% of women reached the
47 recommended levels (British Heart Foundation, 2015). Research has established that regular
48 physical activity can improve a plethora of physiological outcomes (e.g. blood pressure, body
49 composition), including improved body composition (Chastin et al., 2018), and reduced

50 incidence of all-cause mortality (Stamatakis, Kelly, Strain, Murtagh, Ding & Murphy, 2018).
51 Furthermore, it is well established that physical activity has positive associations with mental
52 wellbeing, and may protect against ill-being including psychological distress (Malcom et al.,
53 2013; Biddle, Mutrie & Gorely, 2015; Mansfeild et al., 2018), defined as emotional suffering
54 characterised by somatic, social and psychological symptoms of depression and anxiety
55 (Keyes, 2002). Physical activity levels are markedly lower in populations that are overweight
56 or have obesity, and psychological distress is higher (Petroni et al., 2007). Many of such
57 populations enrolled in commercial weight loss programs struggle with emotional regulation
58 during and after weight loss (Sainsbury et al., 2018), with those displaying more extreme
59 weight loss often showing an increase in psychological distress (Balliot et al., 2017).
60 However, physical activity exerts a moderate effect on the reduction of depressive moods
61 across various clinical and non-clinical populations, and can improve emotional regulation
62 (Rimmer, et al 2012; Cooney et al, 2013; Dunn et al, 2013). Given the above evidence, the
63 addition of physical activity may help populations with overweight or obesity regulate
64 emotional symptoms and thus reduce the likelihood of distress. However, a recent systematic
65 review (Baker et al., 2016) urged caution on the link between exercise and distress in such
66 populations, warranting additional interventions that assess the effects of physical activity on
67 both physical and psychosocial outcomes.

68 The Medical Research Council (MRC) outline that theory-based interventions
69 demonstrate larger effects on physical activity behaviours than interventions not underpinned
70 by a theory (Craig et al., 2013). Theory-based physical activity interventions can explain
71 psychological mechanisms assumed to regulate the behaviour change process by identifying
72 active techniques that can be implemented in the design and implementation of programs
73 (Hagger & Chatzarantis, 2014). One active intervention ingredient related to physical activity
74 is implementation intentions, which refer to ‘if-then’ plans. Interventions applying

75 implementation intentions techniques assumed to improve behaviour change by helping the
76 individual making critical environmental cues salient (e.g. ‘if I don’t enjoy exercising
77 alone’), and associated responses automatic (e.g. ‘then I will call a friend to go for a walk’).
78 A meta-analysis by Carraro and Gaudreau (2013) found a large unique effect of
79 implementation intentions, $d = 1.03$, on physical activity. Moreover, Bélanger-Gravel, Godin,
80 and Amireault (2013) showed that implementation intentions still exert a unique effect on
81 behaviour when integrated within existing physical activity programs.

82 **1b Objectives and hypotheses**

83 Hence, the aim of this study was to test the effects of augmenting a commercial weight loss
84 program with a theory-based module designed to boost physical activity and help emotional
85 regulation during dietary restriction. The theoretical component utilised in the present study
86 was a physical activity consultation based on the work of Kirk et al (2007; see also Tanham
87 et al., 2014). The intervention consisted of four sessions lasting approximately 20 minutes
88 during which participants are encouraged to set goals and to self-monitor their activity that
89 was augmented in the present research by adding the behavior change technique of
90 implementation intentions (Gollwitzer, 1993).

91 Three hypotheses were tested: i) women randomized to receive the physical activity
92 intervention will be significantly more active at follow up than those receiving the standard
93 version of a commercial weight loss program; ii) women randomized to receive the physical
94 activity intervention will report better emotional regulation, with reductions in anxiety,
95 depression, social dysfunction, somatic symptoms and general-ill health compared to those
96 who received a standard version of the program at follow-up; (iii) both groups would lose
97 weight, with the intervention group displaying greater weight loss because of the addition of
98 physical activity.

99 **2. Method**

100 *2a Trial design*

101 The present study was conducted using a clustered randomised controlled trial, and all
102 reporting adhered to the CONSORT guidelines. Individuals enrolled in a commercial weight
103 loss program were randomised into one of two clustered groups: an intervention group who
104 received a multicomponent physical activity consultation in addition to the standard weight
105 loss program ($n = 25$, $M_{\text{age}} = 40.70$, $SD = 12.10$), and, a second control group who received
106 the standard commercial weight loss program only ($n = 24$, $M_{\text{age}} = 38.30$, $SD = 12.80$).

107 *2b Participants and sample size*

108 One hundred women attending a commercial weight loss program in a town in the Republic
109 of Ireland were invited to take part in the study, based on the inclusion criteria of having a
110 Body Mass Index score of ≥ 25 , designating them as individuals who are overweight, or have
111 obesity (see Figure 1). Participants were invited via five separate oral recruitment
112 presentations delivered by the second author to the attendees on their first night of
113 attendance. An a priori sample size was calculated using G*POWER (Faul, Erdfelder, Lang,
114 & Buchner., 2007) for a 2x2 ANOVA with a between-within groups interaction and with the
115 pre-defined criteria of medium effect size ($f = 0.25$), $\alpha = 0.05$ and power of 90%. A medium
116 effect size was decided based on the meta-analysis conducted by Bélanger-Gravel et al
117 (2013) showing positive effects of implementation intentions on increasing physical activity.
118 An a priori total sample size of 46 was calculated.

119 Fifty participants agreed to take part providing written consent, and completed data
120 collection on two occasions (week 1 and week 6) in a quiet room on the location the weight
121 loss programme took place in. One control participant dropped out before baseline
122 assessment due to personal reasons. Forty-nine women with a mean age of 39.5 ($SD = 12.4$)

123 and mean Body Mass Index of 31 ($SD = 2.1$) took part in the study. Ethical approval was
124 granted by the leading Institution's Research Ethics Filter Committee.

125 *2c Randomisation*

126 *Sequence generation*

127 In order to have an evenly split number of participants across control and intervention groups
128 individuals were paired in a 1:1 ratio for randomisation, before baseline data collection and
129 intervention starting date.

130 *Implementation*

131 The second author generated the randomisation sequence by selecting shuffled names from a
132 list, and placing the name into an envelope encoded as intervention or control group.

133 *Allocation concealment and blinding*

134 Intervention participants were not blinded to treatment condition pre-baseline data collection,
135 as it was necessary to confirm that they would take part in the augmented programme
136 including the physical activity consultations. However, both intervention and control
137 participants were blinded to the knowledge that they would have their data matched against
138 the other group. The research team were not blinded to group allocations because of the need
139 to participate in the data collection and analyses on site of the weight loss program.

140

141 Insert Figure 1 here

142 *2d Interventions*

143 *Standard Weight Loss Program*

144 Participants in both the intervention and control conditions received a weekly
145 multicomponent weight loss program, delivered in a group setting by a trained professional

146 weight loss practitioner. The sessions mainly focused on healthy eating and weight status.
147 The programme lead provided information on calorie intake, and other alternative low caloric
148 food choices. Participants received an eating plan to promote a healthier life and were
149 encouraged to be more active, however no physical activity plan was provided.

150 *Multi-Component Physical Activity Intervention*

151 In addition to receiving the standardised commercial weight loss programme, participants in
152 the intervention condition attended a 30-minute long group educational physical activity
153 session during week one that was co-delivered by the weight loss practitioner and the second
154 author, who at the time of delivery was a Masters of Science student in Physical Activity and
155 Population Health, and individual physical activity 30-minute long consultations took place
156 in weeks two, three and four, delivered by the second author. The content of the physical
157 activity consultation session was based on a review by Kirk, Barnett, and Mutrie, (2007), and
158 included in-depth discussions about the benefits of physical activity and possible
159 discrepancies between the individual's activity levels (accessed through the data provided
160 from the pedometer device which was visible for the participants, see below for more details)
161 and recommended guidelines; goal setting; and problem solving for overcoming barriers to
162 being active were then formed on the basis of this reflective discussion. Participants in the
163 intervention group completed a physical activity log each day, to enhance self-monitoring, as
164 previous research has shown monitoring to be an effective behavior change technique
165 (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). The log included a section in
166 which participants formed weekly physical activity implementation intentions regarding
167 when, how and where physical activity would take place in the week ahead. These logs were
168 reviewed by the researcher in consultation with the participant one week later, so that the
169 researcher checked the log details matched with what was said to be performed.

170 *2e Outcome measures and procedure*

171 Physical activity was assessed by measuring the mean number of steps taken across 7 days
172 using a Digiwalker DW-200 Yamax pedometer (Yamax, Nottingham, UK). The number of
173 steps was recorded at the end of each day. The number of steps was visible to participants.
174 Approximately 10,000 steps per day are considered to be in line with the physical activity
175 guidelines for health for adults (Tudor-Locke et al 2008). Anthropometric measures of height
176 (centimeters) and weight (kilograms) were recorded to the nearest 0.1 cm and 0.1 kg using a
177 freestanding stadiometer (Holtain Limited, Crymych, Dyfed, UK) and standard scales (Sec,
178 Hamburg, Germany) with the participant wearing indoor clothes but having emptied pockets
179 and removed shoes, jewellery and bulky clothing. Body Mass Index (BMI) was calculated by
180 taking body weight in kilograms and dividing by height in meters squared. Distress was
181 assessed using the General Health Questionnaire-28 (GHQ-28). The GHQ-28 assesses three
182 psychological health factors: anxiety/insomnia, social dysfunction, severe depression, and
183 one physical health factor, namely, somatic symptoms. The GHQ-28 also provides a total
184 score for general health.

185 All participants were recruited for the intervention program meetings over a two week
186 period. Once recruited participants were informed that the study would investigate the effect
187 of a physical activity intervention on physical activity step counts, weight and psychological
188 well-being and that questionnaires would be completed at two time points, in week one and
189 six weeks later. After completion of consent forms, two researchers supervised the data
190 collection and questionnaire completion, that included providing personalised codes to allow
191 researchers to match participants' baseline and follow up data. Height and weight
192 measurements were taken by the researchers and all participants were given a pedometer to
193 wear for seven days. During weeks one, two, three and four, the control group continued with
194 the conventional commercial program while the intervention group received the enhanced

195 intervention. During week six, the same assessment procedure as conducted at baseline was
196 replicated. Following data collection, two researchers manually inputted raw data from the
197 pedometers and questionnaires into SPSS (version 21) software. To ensure consistency and
198 accuracy, the SPSS file was cleaned through randomly selecting and cross-checking 10% of
199 the inputted data with the raw data. A third researcher then conducted data analyses
200 (described below).

201 *2f Statistical Methods*

202 Separate between group (intervention and control) t-tests were calculated as a randomisation
203 check to establish if there were differences between groups in physical activity or weight at
204 baseline. A 2 (Group) x 2 (Time) mixed factors Analysis of Variance (ANOVA) for the
205 physical activity and weight variables was calculated to determine main and interaction
206 effects. To ensure any significant effects were not a result of scores at baseline, separate
207 analysis of covariance (ANCOVA) tests were calculated. The four subscales of the GHQ-28
208 were analysed using a 2 x 2 mixed factors Multivariate Analysis of Variance (MANOVA).
209 Statistically significant effects ($p < .05$) were followed-up using separate 2 x 2 mixed factors
210 ANOVA's. To ensure any significant effects for the GHQ-28 were not a result of scores at
211 baseline, separate ANCOVA tests were calculated for each sub domain. Partial eta squared
212 (η_p^2) as a measure of effect size was calculated, providing an indication of what proportion of
213 the variance in the dependent variable is attributable to the intervention. All calculations were
214 performed using the Statistical Package for the Social Sciences (SPSS) version 21.

215 **3. Results**

216 *3a Participant flow and group randomisation check at baseline*

217 The CONSORT flow diagram for the study design can be found in Figure 1. The
218 characteristics of the sample at baseline are reported in Table 1. There was no significant

219 difference between the groups for age and no difference between the control ($M= 75.43$ kg,
220 $SD= 7.54$) and intervention groups ($M= 75.32$ kg, $SD= 6.67$) for weight $t=.055$, $df=47$,
221 $p=.956$ at baseline. There was no significant difference between the control ($M=30207.67$,
222 $SD= 7833.29$) and the intervention group ($M= 31516.25$, $SD= 9310.17$) on baseline mean
223 weekly pedometer scores $t=-.532$, $df=47$, $p=.597$), and no significant difference between the
224 control and the intervention group on any of the four GHQ-28 sub-scales at baseline
225 $F(5,43)=.464$, $p=.802$, $\eta_p^2 = .051$.

226 *Insert table 1 here*

227 *3b Outcomes, estimation and harms*

228 No negative effects or harms were reported for the standard weight loss programme, and the
229 augmented intervention including physical activity consultations. Effects of the intervention
230 on each of the outcomes are detailed below.

231 *Physical activity*

232 Pre and post intervention data are presented for all variables in Table 2. To investigate if the
233 number of steps per day changed as a result of the intervention, a 2 x 2 mixed factors
234 ANOVA with the independent variables of testing session (time) and for group (intervention
235 versus control) was conducted. There was a significant interaction effect between group and
236 time, $F(1, 47) = 22.41$, $p < .001$, $\eta_p^2 = .32$, with the intervention group exhibiting a greater
237 increase in pedometer scores. While both groups demonstrated an increase in mean steps over
238 time, $F(1, 47) = 244.12$, $p < .001$, $\eta_p^2 = .84$, the intervention group exhibited a larger
239 increase. An ANCOVA was calculated controlling for baseline pedometer scores, the
240 difference between groups at follow up remained statistically significant where in the
241 intervention group performed more steps, $F(1, 46) = 24.10$, $p < .001$, $\eta_p^2 = .35$.

242

243

Insert Table 2 here

244 *Weight*

245 There was a slightly greater increase in weight loss for the intervention group. However,
246 there was no significant main effect of group and no significant interaction between time and
247 group. There were significant main effects of time for weight, $F(1, 47) = 144, p < .001, \eta_p^2$
248 $=.75$, with weight significantly decreasing by 3.74 kg for the intervention and 3.39 kg for the
249 control groups from the first to second testing session. An ANCOVA was calculated
250 controlling for baseline weight levels. No statistically significant differences between groups
251 were shown.

252 *GHQ-28*

253 A 2 x 2 mixed MANOVA was conducted with the four subscales of the GHQ-28 as the
254 dependent variables. There was a significant multivariate main effect for group,
255 Wilks' $\Lambda = 3.67, F(4, 44) = 5.42, p < .001, \eta_p^2 = .33$; time, Wilks' $\Lambda = .303, F(4, 44) = 25.29, p$
256 $< .001, \eta_p^2 = .33$, and a significant group x time interaction, Wilks' $\Lambda = .712, F(4, 44) = 4.44,$
257 $p = .004, \eta_p^2 = .28$. Separate analysis for each domain of the GHQ-28 is presented below.

258 *Anxiety*

259 A 2x2 mixed design ANOVA revealed a significant interaction between group and time for
260 anxiety, $F(1, 47) = 8.16, p < .001, \eta_p^2 = .15$, the intervention group exhibited a greater
261 decrease in scores compared to the control. When an ANCOVA was calculated controlling
262 for baseline anxiety scores, the statistically significant difference between groups remained
263 where in the intervention group scored lower $F(1,46) = 51.95, p < .001, \eta_p^2 = .53$.

264 *Social Dysfunction*

265 A 2x2 mixed design ANOVA revealed a significant interaction effect between group and
266 time for social dysfunction $F(1,47) = 8.91; p < .001, \eta_p^2 = .16$. The intervention group
267 exhibited a greater decrease in scores compared to the control. To control for baseline social
268 dysfunction scores an ANCOVA was calculated, the significant main effect remained $F(1,46)$
269 $= 33.62, p < .001, \eta_p^2 = .42$.

270 *Depression*

271 A 2x2 mixed design ANOVA revealed a significant interaction effect between group and
272 time for depression $F(1,47) = 4.22; p < .001; \eta_p^2 = .08$. The intervention group exhibited a
273 greater decrease in depression scores compared to the control. An ANCOVA was calculated.
274 After controlling for baseline depression scores a significant main effect remained $F(1,46) =$
275 $10.58, p < .01, \eta_p^2 = .19$.

276 *Somatic*

277 A 2x2 mixed design ANOVA revealed no significant interaction effect between group and
278 time $F(1, 47) = .03, p = .87, \eta_p^2 = .001$.

279 **4. Discussion**

280 *4a Interpretation*

281 Commercial weight loss programs represent culturally significant resources for individuals
282 aiming to achieve weight loss, yet most programs do not include physical activity and
283 research is inconclusive regarding program's effects on mental health. As such, the aims of
284 the present study were to test whether: (a) the physical activity levels of women with
285 overweight or obesity enrolled in a commercial weight loss program could be boosted with a
286 theory-based physical activity consultation, and (b) whether participants randomized to
287 receive the physical activity intervention reported better emotional health during dieting
288 compared to those who received a standard version of a weight loss program. The findings

289 show that for women who participated in a weight loss program receiving an enhanced multi-
290 component tailored one-to-one physical activity consultation, number of steps per-day
291 increased and distress was decreased compared with people who received the standard
292 commercial weight loss program. Participants who received the intervention demonstrated
293 lower anxiety, social-dysfunction and depression at follow-up compared to the control group.
294 In addition, a larger reduction in weight was found for the intervention group. Collectively,
295 the findings support evidence showing the effects of physical activity interventions for
296 increasing physical activity behaviour and reducing body weight (WHO, 2010; Biddle,
297 Mutrie, & Gorely, 2015), and extends the evidence that in populations with obesity,
298 enhancing physical activity levels can improve emotional health (Baker et al., 2016). We now
299 discuss the findings offering recommendations to advance research and practice.

300 The intervention was shown to increase the number of steps performed by the
301 participants in the intervention group compared to the control group at follow up. The change
302 in step count behavior can be interpreted to be a result of the physical activity consultation.
303 According to Wolf (1986), when Cohen's $d = .5$, (or the equivalent $\eta_p^2 = .06$ as included
304 above) this magnitude reflects a practical/clinical change. The behaviour change techniques
305 were operationalised through one-to-one consultations which entailed goal-setting and
306 problem solving based on IIP's for overcoming barriers to being active each day, and the
307 keeping of physical activity logs for self-monitoring reflection and boosting the educational
308 content of the consultations. The positive effects on physical activity behaviour supports the
309 efficacy of self-monitoring and IIP's for improving daily physical activity (Michie, Abraham,
310 Whittington, McAteer, & Gupta, 2009; Bélanger-Gravel, Godin, and Amireault (2013) and
311 may be considered when integrating physical activity into current commercial weight loss
312 programs (Balliot et al., 2017).

313 A more thorough research design would have allowed us to determine the direct and
314 indirect effects of the intervention's effects on physical activity behaviour as it is not clear
315 how much of the behaviour change can be accounted for by implementation intentions alone.
316 For example, integrated behaviour change frameworks (Hagger & Chatzarakis, 2014) along
317 with extant evidence (Bélanger-Gravel, Godin, and Amireault (2013) suggest that physical
318 activity enhancements may be realised to a combination of conscious and non-conscious
319 processes, in which IIP's exert unique effects. Further research entailing the measurement of
320 IIP's is required to determine the actual mediated or unmediated effect that the addition of
321 IIP's may have added.

322 For the intervention group on all psychosocial outcome variables (anxiety, social
323 dysfunction and depression) except somatic, the effect size (η_p^2) was above .06. This finding
324 contradicts the majority of studies that indicate that physical activity is not as effective at
325 reducing distress in populations with obesity (Baker et al., 2016). Therefore, due
326 consideration should be given to how physical activity consultations could be included to
327 enhance the health benefits of weight loss programmes (Balliot et al., 2017). It would also be
328 useful to identify how the physical activity consultation could be incorporated within current
329 healthy lifestyle programmes that do not only focus on weight loss, but the wellbeing of the
330 person in general (Breslin et al, 2013; Biddle, Mutrie & Gorely, 2014; Balliot et al., 2017).

331 There were no negative effects or harms reported for either the intervention or control
332 group. Furthermore, the cost of augmenting the weight loss intervention with physical
333 activity consultations was low, given a volunteer from the research team conducted the
334 meetings. Feedback from the commercial weight loss practitioner revealed a willingness to be
335 trained in the application of physical activity consultation techniques for bolstering the
336 weight loss intervention within their program. The design of such training could be client
337 centred, and cost-efficient through delivery over one day, and bolstered by further top-up

338 sessions (Ntoumanis, Quested, Reeve & Cheon, 2017). A thorough process evaluation would
339 have helped gain understanding of the overall cost, precise number of sessions, and
340 consultations the participants engaged in, and acceptability of the intervention from the
341 perspective of the participants (Jean-Naylor et al., 2002), and should be considered for further
342 work.

343 *4b Limitations and generalisability*

344 Some potential limitations of this study should be considered. First, the favorable response to
345 the intervention came from women who were already motivated to lose weight and able to
346 afford a commercial weight loss program and so caution should be adopted before
347 generalizing the findings. Second, the length of follow-up was relatively short and it would
348 be valuable to see whether the effects can be sustained in the longer term. Third, because of
349 human resource constraints, some of the research team were required to conduct
350 randomisation, whilst also participating in intervention delivery and data collection, meaning
351 it was not possible to blind outcome assessors to group allocations. Fourth, the physical
352 activity logs were used to enhance the educational messages of the consultations, however,
353 the qualitative content of the logs were not analysed by the researchers. On reflection a log or
354 diary may have provided important additional information on the context of the types of
355 physical activity engaged in. Future research may consider screening physical activity logs or
356 using a self-report physical activity instrument alongside validated wearable devices (e.g.
357 pedometers, accelerometers) for better contextualising the physical activity. Nevertheless, it
358 is encouraging that physical activity habits have been shown to develop in as few as five
359 weeks (Armitage, 2005) and so there are grounds for cautious optimism in conducting further
360 research with longer term follow-ups.

361 *4c Conclusion and implications*

362 This study demonstrated that the inclusion of a multi-component physical activity
363 consultation for women enrolled in a commercial weight loss program were more likely to
364 increase their physical activity, and improve their emotional health than those who attended a
365 standard version of the commercial weight loss program. These findings provide evidence to
366 support the inclusion of face-to-face physical activity consultations that comprises self-
367 monitoring, goal-setting and implementation intentions. Future developments of such
368 commercial weight loss programs may consider a more holistic programme aim beyond
369 weight loss, such as improving multiple aspects of wellbeing through a healthy lifestyle.

370

371 ***Conflict of interest***

372 All authors declare that we have no conflict of interest to declare.

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375

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