

## Research Article

# Greater Attendance at a Community Weight Loss Programme over the First 12 Weeks Predicts Weight Loss at 2 Years

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## Keywords

Attendance · Community programme · Weight loss · Behavioural support

## Abstract

**Background:** There is considerable heterogeneity in long-term weight loss among people referred to obesity treatment programmes. It is unclear whether attendance at face-to-face sessions in the early weeks of the programme is an independent predictor of long-term success. **Objective:** To investigate whether frequency of attendance at a community weight loss programme over the first 12 weeks is associated with long-term weight change. **Methods:** Participants were randomised to receive brief support only (control,  $n = 211$ ), or a weight loss programme for 12 weeks ( $n = 530$ ) or 52 weeks ( $n = 528$ ). This study included participants with data on session attendance over the first 12 weeks ( $n = 889$ ) compared to the control group. The association between attendance (continuously) and weight loss was explored using a linear model. A multi-level mixed-effects linear model was used to investigate whether attendance (categorised as 0, 1, 2–5, 6–9, and 10–12 sessions) was associated with weight loss at 3, 12, and 24 months compared to the control. **Results:** For every session attended in the first 12 weeks, the average weight loss was  $-0.259$  kg/session at 24 months ( $p = 0.005$ ). Analysis by attendance group found only those attending 10–12 sessions had significantly greater weight loss ( $-7.5$  kg [95% CI  $-8.1$  to  $-6.9$ ] at 12 months;  $-4.7$  kg [95% CI  $-5.3$  to  $-4.1$ ] at 24 months) compared to the control group ( $-3.4$  [95% CI  $-4.5$  to  $-2.4$ ] at 12 months,  $-2.5$  [95% CI  $-3.5$  to  $-1.5$ ] at 24 months). Early attendance was higher for people  $\geq 70$  years, but there was no evidence of a difference by gender, ethnicity, education, or income. **Conclusions:** Greater attendance at a community weight loss programme in the

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first 12 weeks is associated with enhanced weight loss up to 24 months. Regular attendance at a programme could be used as a criterion for continued provision of weight loss services to maximise the cost-effectiveness of interventions.

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## Introduction

Behavioural weight management programmes are recommended for the treatment of overweight and obesity [1, 2]. There is good evidence that referral from a primary care practitioner to a community-based weight loss programme produces greater weight loss than self-guided efforts and that this is a cost-effective use of public finance [3–6]. However, there is significant inter-individual variation in outcome. Understanding the factors associated with long-term success may help to inform decisions about continued provision of weight loss support, facilitating more cost-effective treatments.

Many studies have examined participant characteristics associated with weight loss, frequently identifying positive associations with older age, male gender, white ethnicity, higher body mass index (BMI) at baseline, and higher levels of physical activity at baseline, but differences between groups are modest [7–11]. Greater overall attendance has also been reported to be associated with greater weight loss [8, 9, 11–14]. A recent study reported that attendance at one third of weekly meetings over 6 months was associated with 5–10% weight loss, and attendance at two thirds of weekly meetings was associated with  $\geq 10\%$  weight loss at 6 months. In an intervention trial comprising face-to-face and digital support, attendance at the group was more strongly associated with weight loss than use of the website or mobile app [11].

There is also evidence that greater weight loss early in the programme predicts long-term weight loss [7, 10, 15–17], and it is likely that weight loss and attendance are mutually reinforcing. However, it is not clear whether attendance at face-to-face sessions in the early weeks of the programme is an independent predictor of long-term success. If so, providers could use regular attendance as a criterion for continued provision of weight loss services.

The Weight loss Referrals for Adults in Primary care (WRAP) trial showed that extending treatment duration from 12 to 52 weeks led to significantly greater weight loss at 24 months [6]. However, only 42% of participants randomised to receive treatment for 52 weeks were continuing to attend the programme in the last 12 weeks of their referral [6]. Here we report an exploratory observational analysis of the WRAP trial to examine the association between attendance at a community-based weight loss programme over the first 12 weeks of an intervention study (“early attendance”) and weight change at 3, 12, and 24 months. Our hypothesis was that higher attendance at the programme was associated with greater weight loss at 1 year. We also examined whether any effect is independent of weight loss achieved at 3 months. For comparison with previous studies, we also examined whether baseline characteristics predict attendance in the first 12 weeks of the programme.

## Subjects and Methods

### *Study Design*

The trial design, participants, and interventions have been described previously [18]. In summary, WRAP was a multicentre, non-blinded, three-arm randomised controlled trial to examine weight loss after referral from a general practitioner to a commercial provider (CP; WW, formerly Weight Watchers) [6]. Participants received brief support comprising written

information to encourage self-help (control), or either 12-week or 52-week referrals to a community-based weight loss programme.

A final population of 1,269 eligible participants provided informed consent and were randomised ( $n = 530$  to 12-week referral,  $n = 528$  to 52-week referral,  $n = 211$  to control). Participants referred to the CP were asked to attend a local WW meeting once a week for the duration of their treatment (12 or 52 weeks). Participants were given either 1 voucher booklet for 12 weekly sessions (3 months) or 4 voucher booklets given quarterly (to be used once a week over 1 year). In addition, all CP participants were able to access WW digital tools (web- and app-based) for the duration of their treatment.

Participants were booked to attend trial measurement appointments at baseline and 3, 12, and 24 months. Height was measured at baseline only with a stadiometer to the nearest 0.1 cm; weight was measured to the nearest 0.1 kg wearing light clothing and without shoes or socks (Tanita, Amsterdam, The Netherlands). Self-reported age, gender, ethnic group, education level, employment status, and household income were also collected at baseline and follow-up study visits.

#### *Attendance at the Programme in the First 12 Weeks*

Attendance in the first 12 weeks of the programme was recorded by the CP because the vouchers handed in were registered electronically. Due to a computer system error, for a short time period vouchers were not recorded. For participants who were scheduled to attend during this period, attendance data from self-reported questionnaires was used and a sensitivity analysis conducted excluding self-reported data. Where objective attendance data was missing we considered this to be missing at random, as the only difference between those who had objective attendance data or not was the referral date.

Attendance at the CP was scheduled to be weekly, and early attendance was recorded as a continuous variable (0–12 sessions). All participants referred to the CP (12 or 52 weeks) with available attendance data were categorised into one of 5 groups according to the number of sessions they attended in the first 12 weeks of their referral: 0 sessions, people who had no exposure whatsoever to the programme; 1, 2–5, and 6–9 sessions, people who attended a variable number of sessions sporadically or continuously; or 10–12 sessions, those who strongly engaged and attended most of the sessions (10–12).

#### *Sociodemographic Characteristics*

Ethnicity was self-reported and grouped into White, other, and not stated. Education level data was grouped into: up to General Certificate of Secondary Education (GCSE, usually around 16 years) or equivalent, A Level (around 18 years) or equivalent, university degree or equivalent, and higher degree or equivalent. Employment status was grouped into: “not employed” for those identifying as unemployed, student, or unable to work, “employed” for those who were self-employed or employed by another, and “retired”. Household income data was divided into tertiles of GBP <20,000, 20,000–39,999, and  $\geq 40,000$  per annum.

Baseline observations were used for the following variables: age, employment, ethnicity, household income, and level of education. If baseline data was missing but present at subsequent visits (3, 12, or 24-month follow-up), this information was used with priority given to the earliest recorded measure.

#### *Statistical Analysis*

All statistical analyses were conducted using STATA 14. Baseline characteristics were described by profile of attendance data, and differences were tested using ANOVA for age; Kruskal-Wallis for BMI;  $\chi^2$  test for sex, intervention group, education level, and household income; and Fisher’s exact test for ethnic group and employment status.

To investigate the association between weight loss and early attendance at the CP, we used a multivariable linear model treating attendance as a continuous exposure (0–12 sessions). For the main analysis, a multi-level mixed-effects linear regression model with unstructured dependence variance-covariance structure was used treating attendance as a categorical exposure (0, 1, 2–5, 6–9, and 10–12 sessions). Each categorical attendance group was compared to the control group of the trial given that these participants did not receive a referral to a CP. To determine whether weight change for each attendance group was significantly different from the control group at each time point (3, 12, and 24 months), an interaction term (attendance group  $\times$  visit) was included in the model. Potential confounders identified by the literature and available in the dataset were baseline age, sex, BMI, ethnicity, education level, employment status, and household income. All were included in the models, in addition to the allocated intervention group (referral for 12 or 52 weeks or control) and attendance data source (CP-reported or self-reported). A separate model was conducted to analyse the association between early attendance and weight loss at 12 and 24 months while controlling for the amount of weight lost at 3 months. In exploratory analyses we ran those models within each of the intervention groups separately (12-week vs. 52-week referral). A sensitivity analysis was conducted to exclude those with only self-reported attendance data.

The association between baseline characteristics and early attendance was analysed using a multivariable linear regression model with attendance treated as a continuous variable (e.g., number of sessions attended over the first 12 weeks).

## Results

The final sample analysed in this study ( $n = 1,100$ ) included participants with objectively recorded attendance data ( $n = 632$ ) or self-reported attendance data ( $n = 257$ ), as well as those in the control group ( $n = 211$ ) who were not referred to CP (online suppl. Appendix 1; see [www.karger.com/doi/10.1159/000509131](http://www.karger.com/doi/10.1159/000509131)). We excluded 169 participants who had missing information on attendance (objective and/or self-reported). Compared to the final study sample, those with missing attendance data were younger ( $49.9 \pm 13.9$  vs.  $54.1 \pm 13.5$  years,  $p < 0.001$ ); more likely to have been referred for 12 weeks (61 vs. 48%,  $p < 0.01$ ), and less likely to be retired from work (19 vs. 32%,  $p < 0.05$ ).

Table 1 shows the baseline characteristics of participants referred to CP with available attendance data. Of those with early attendance data ( $n = 889$ ), the mean age at baseline was  $54.1 \pm 13.5$  years, the median BMI was  $33.3 \text{ kg/m}^2$  (IQR 30.6–37.1), 69% were female, and 92% reported their ethnicity as White.

Among those referred to a CP the median number of early sessions attended was 11 (IQR 6–12) from a possible 12. Of these, 76 (9%) participants did not attend any sessions in the first 12 weeks, 36 (4%) only attended 1 session, 90 (10%) attended between 2 and 5 sessions, 131 (15%) attended between 6 and 9 sessions, and 556 (63%) attended 10 or more sessions. This pattern of attendance in the first 12 weeks was not different between the intervention groups (Table 1; CP 12 vs. 52 weeks,  $p = 0.323$ ), but the mean age was significantly different across the attendance groups ( $p < 0.001$ ). Although all participants had access to web- and app-based tools, participants mostly reported they “never or almost never” used web-based tools at 3 months (67, 75, 62, 53, and 49%) or app-based support (81, 75, 68, 79 and 76%) among participants attending 0, 1, 2–5, 6–9, or 10–12 sessions, respectively.

### *Early Attendance and Weight Change*

In the continuous analysis (Table 2), for every session attended in the first 12 weeks, average weight loss was  $-0.297 \text{ kg}$  per session at 3 months ( $p < 0.001$ ),  $-0.404 \text{ kg}$  per session

**Table 1.** Summary of baseline characteristics by category of attendance among participants of the WRAP trial

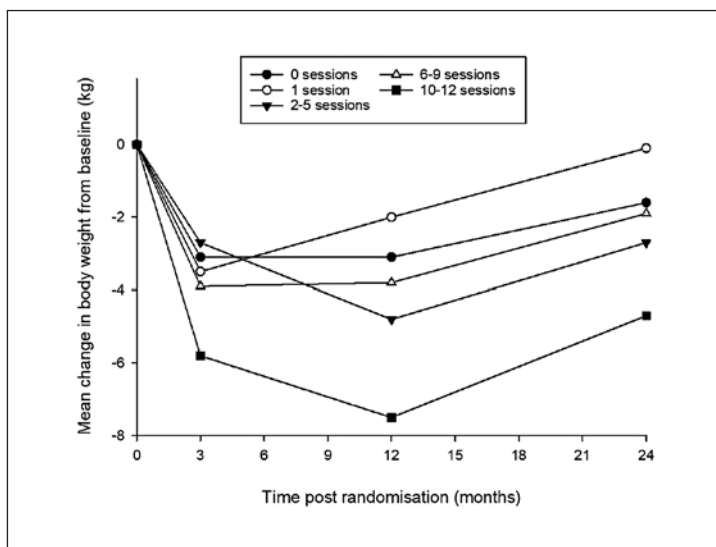
	Total	Number of sessions attended					Between-group differences <sup>3</sup>
		0	1	2–5	6–9	10–12	
Participants <sup>1</sup>	889	76 (8.6)	36 (4.1)	90 (10.1)	131 (14.7)	556 (62.5)	
Age, years	889	53.1±12.9	51.5±11.4	50.1±14.8	54.0±12.0	55.1±13.7	F = 5.11; p < 0.001
BMI	889	33.4 (30.5–36.5)	33.3 (31.3–36.9)	33.4 (31.0–37.2)	33.0 (30.3–37.1)	33.3 (30.6–37.1)	χ <sup>2</sup> = 1.351 p = 0.853
Sex							
Female	612	45 (7.3)	23 (3.8)	69 (11.3)	92 (15.0)	383 (62.6)	χ <sup>2</sup> = 6.385
Male	277	31 (11.2)	13 (4.7)	21 (7.6)	39 (14.1)	173 (62.5)	p = 0.172
Intervention group							
Referral for 12 weeks of treatment	427	39 (9.1)	20 (4.7)	37 (8.7)	70 (16.4)	261 (61.1)	χ <sup>2</sup> = 4.668
Referral for 52 weeks of treatment	462	37 (8.0)	16 (3.5)	53 (11.5)	61 (13.2)	295 (63.9)	p = 0.323
Ethnic group							
White	818	73 (8.9)	30 (3.7)	80 (9.8)	125 (15.3)	510 (62.4)	p = 0.07
Other	55	2 (3.6)	5 (9.1)	9 (16.4)	5 (9.1)	34 (61.8)	
Education							
≤GCSE	325	32 (9.9)	15 (4.6)	24 (7.4)	48 (14.8)	206 (63.4)	χ <sup>2</sup> = 9.897
A Level/post-secondary study	201	15 (7.5)	8 (4.0)	29 (14.4)	24 (11.9)	125 (62.2)	p = 0.625
University degree	191	15 (7.9)	9 (4.7)	18 (9.4)	28 (14.7)	121 (63.4)	
Higher degree	128	10 (7.8)	4 (3.1)	16 (12.5)	21 (16.4)	77 (60.2)	
Employment status							
Not employed <sup>2</sup>	85	8 (9.2)	4 (4.6)	13 (14.9)	11 (12.6)	51 (58.6)	χ <sup>2</sup> = 9.801
Employed	493	45 (8.9)	22 (4.4)	54 (10.7)	80 (15.8)	304 (60.2)	p = 0.633
Retired	281	23 (8.1)	9 (3.2)	21 (7.4)	38 (13.4)	192 (67.8)	
Household income (GBP per annum)							
<20,000	242	29 (10.9)	14 (5.3)	24 (9.0)	25 (9.4)	174 (65.4)	χ <sup>2</sup> = 15.978
<20,000–39,999	238	22 (8.7)	8 (3.2)	24 (9.5)	43 (17.1)	155 (61.5)	p = 0.192
≥40,000	221	18 (7.8)	8 (3.5)	23 (10.0)	37 (16.1)	144 (62.6)	

Data are presented as n (%), mean ± SD, or median (IQR), as appropriate. <sup>1</sup> Percentages total by row. <sup>2</sup> Unemployed, unable to work, student. <sup>3</sup> p values for differences between groups were determined using ANOVA for parametric data (age), Kruskal-Wallis test for non-parametric data (BMI), and χ<sup>2</sup> for all categorical variables except for ethnic group, for which Fisher's exact test was used due to small sample sizes in some of the attendance groups.

**Table 2.** Weight change at each time point for every extra session attended during the first 12 weeks among participants of the WRAP trial

	Weight change, kg	95% CI	p value
Unadjusted model <sup>1</sup>			
3 months	-0.306	-0.369 to -0.242	<0.001
12 months	-0.499	-0.645 to -0.352	<0.001
24 months	-0.404	-0.557 to -0.251	<0.001
Multivariable model <sup>2</sup>			
3 months	-0.297	-0.365 to -0.230	<0.001
12 months	-0.404	-0.558 to -0.251	<0.001
24 months	-0.259	-0.422 to -0.097	0.002

<sup>1</sup> Unadjusted linear regression model. <sup>2</sup> Adjusted for baseline covariates: age, intervention group, BMI, employment status, ethnic group, household income, sex, and education.

**Fig. 1.** Weight change (kg) by category of attendance among participants in the WRAP trial.

at 12 months ( $p < 0.001$ ), and  $-0.259$  kg per session at 24 months ( $p = 0.005$ ) in the fully adjusted model.

Mean weight change in each attendance group at each time point is shown in Figure 1. Only participants who attended 10–12 sessions lost significantly more weight ( $-7.5$  [95% CI  $-8.1$  to  $-6.9$ ] at 12 months;  $-4.7$  [95% CI  $-5.3$  to  $-4.1$ ] at 24 months) compared to the control group ( $-3.4$  [95% CI  $-4.5$  to  $-2.4$ ] at 12 months,  $-2.5$  [95% CI  $-3.5$  to  $-1.5$ ] at 24 months) (Table 3). We also investigated the association between each attendance group and weight loss at 12 and 24 months after adjusting for the amount of weight lost at 3 months (Table 3). Participants attending 10–12 sessions lost significantly more weight than the control group at 12 months ( $-7.5$  kg [95% CI  $-8.2$  to  $-6.8$ ] vs.  $-3.8$  kg [95% CI  $-5.0$  to  $-2.7$ ],  $p < 0.001$ ) and 24 months ( $-4.7$  kg [95% CI  $-5.4$  to  $-4.0$ ] vs.  $-3.1$  kg [95% CI  $-4.3$  to  $-1.9$ ],  $p = 0.034$ ).

Additional exploratory analyses investigated the associations within each of the active intervention groups separately (12-week and 52-week referral) and found results consistent with those presented in the main analysis described above.

In a sensitivity analysis excluding those with only self-reported attendance data, the conclusions from the main model as well as for the second model adjusted for weight loss at 3 months were unchanged.

**Table 3.** Weight change by category of attendance among participants of the WRAP trial

Attendance group	Mean weight at baseline, kg	Mean weight change from baseline, kg <sup>1</sup>			p values within attendance group comparing each visit to baseline <sup>2</sup>		p values between attendance groups comparing weight change at each time point to control <sup>3</sup>			
		3 months	12 months	24 months	baseline to 3 m	baseline to 12 m	baseline to 24 m	3 m	12 m	24 m
Control, n = 211	96.1 (1.1)	-2.0 (-3.0 to -1.0)	-3.4 (-4.5 to -2.4)	-2.5 (-3.5 to -1.5)	<0.001	<0.001	<0.001	-	-	-
<sup>4</sup> Adjusted for 3 m WL		- (-)	-3.8 (-5.0 to -2.7)	-3.1 (-4.3 to -1.9)	-	<0.001	<0.001	-	-	-
0 Sessions, n = 76	97.8 (2.1)	-3.1 (-4.6 to -1.7)	-3.1 (-4.6 to -1.6)	-1.6 (-3.1 to 0.0)	<0.001	<0.001	0.047	0.193	0.724	0.317
<sup>4</sup> Adjusted for 3 m WL		- (-)	-2.6 (-4.3 to -1.0)	-1.2 (-2.9 to 0.5)	-	0.002	0.167	0.255	0.255	0.070
1 Session, n = 36	93.9 (3.5)	-3.5 (-6.2 to -0.9)	-2.0 (-4.8 to 0.8)	-0.1 (-2.9 to 2.6)	0.009	0.159	0.924	0.294	0.338	0.103
<sup>4</sup> Adjusted for 3 m WL		- (-)	-1.9 (-5.4 to 1.5)	0.2 (-3.4 to 3.8)	-	0.271	0.912	0.302	0.302	0.083
2-5 Sessions, n = 90	95.2 (1.5)	-2.7 (-4.5 to -1.0)	-4.8 (-6.7 to -2.8)	-2.7 (-4.6 to -0.8)	0.002	<0.001	0.005	0.489	0.252	0.860
<sup>4</sup> Adjusted for 3 m WL		- (-)	-4.6 (-6.9 to -2.3)	-2.7 (-5.0 to -0.4)	-	<0.001	0.019	0.573	0.573	0.763
6-9 Sessions, n = 131	95.3 (1.6)	-3.9 (-5.0 to -2.7)	-3.8 (-5.1 to -2.6)	-1.9 (-3.1 to -0.7)	<0.001	<0.001	0.003	0.015	0.636	0.417
<sup>4</sup> Adjusted for 3 m WL		- (-)	-4.0 (-5.4 to -2.5)	-2.2 (-3.6 to -0.8)	-	<0.001	0.002	0.876	0.876	0.340
10-12 Sessions, n = 556	96.0 (0.7)	-5.8 (-6.4 to -5.2)	-7.5 (-8.1 to -6.9)	-4.7 (-5.3 to -4.1)	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
<sup>4</sup> Adjusted for 3 m WL		- (-)	-7.5 (-8.2 to -6.8)	-4.7 (-5.4 to -4.0)	-	<0.001	<0.001	<0.001	<0.001	0.034

Data are presented as mean (SE) or mean (95% CI), as appropriate. m, months; WL, weight loss. <sup>1</sup> Results are mean change in weight from baseline at each follow-up visit for each attendance group. <sup>2</sup> p values within attendance group comparing weight loss between each time point and baseline, from multivariable multilevel mixed-effects linear regression models with categorical attendance groups adjusted for baseline covariates: age, intervention group, BMI, employment status, ethnic group, household income, sex, and education. <sup>3</sup> p values between attendance groups comparing weight change in each attendance group to the brief intervention group at each time point (interaction attendance group × visit), from multivariable multilevel mixed-effects linear regression models with categorical attendance groups adjusted for baseline covariates: age, intervention group, BMI, employment status, ethnic group, household income, sex, and education. <sup>4</sup> Further adjustment for weight loss at 3 months was introduced to the main model specified above.

**Table 4.** Baseline predictors of early attendance at the programme among participants of the WRAP trial

	$\beta$	95% CI	p value
Sex			
Male	-0.15	-0.83 to 0.53	0.673
Age group			
30–39 years	-0.34	-2.06 to 1.38	0.701
40–49 years	0.30	-1.30 to 1.90	0.712
50–59 years	0.08	-1.53 to 1.68	0.925
60–69 years	0.83	-0.92 to 2.58	0.353
70+ years	2.42	0.37 to 4.47	0.021
BMI (kg/m <sup>2</sup> )			
30–34.99	0.09	-0.81 to 1.00	0.837
35–39.99	0.37	-0.63 to 1.37	0.471
>40	0.58	-0.64 to 1.79	0.351
Education			
A-Level, post-secondary study	0.52	-0.35 to 1.38	0.240
University degree	0.53	-0.35 to 1.40	0.239
Higher degree	0.24	-0.79 to 1.27	0.645
Household income (GBP per annum)			
20,000–39,999	0.01	-0.80 to 0.82	0.982
40,000+	0.21	-0.70 to 1.13	0.647
Ethnic group			
Other	-0.44	-1.70 to 0.81	0.491
Allocated intervention group			
Referral for 52 weeks of treatment	0.21	-0.42 to 0.84	0.510
Employment			
Employed	0.74	-0.53 to 2.00	0.251
Retired	0.30	-1.26 to 1.86	0.707
Constant	7.09	5.01 to 9.16	<0.001

Results are  $\beta$  (95% CI) from multivariable linear regression models, with the following reference groups: female, <30 years of age, BMI <30, White, education level up to GCSE, household income GBP <20,000 per annum, referral for 12 weeks of treatment, and not employed.

#### Baseline Correlates of Attendance

In multivariable linear models, sex, BMI, education, income, employment, ethnicity, and intervention group were not significantly associated with attendance (Table 4). Participants aged  $\geq 70$  years of age attended an average of 2.38 (95% CI 0.29–4.48) more sessions than the reference group aged <30 years. This difference was still significant at the 5% level after Bonferroni corrections to account for multiple testing.

## Discussion

Greater attendance at a community weight loss group in the first 12 weeks of the programme is associated with greater weight loss at 24 months. Weight loss among participants attending  $\geq 10$  of the first 12 sessions was greater than for all other attendance groups at 12 and 24 months. The association between early attendance and long-term weight loss is independent of the planned duration of the programme. The only significant sociodemographic predictor of greater attendance was age, with the older age group attending significantly more sessions than the younger age group.

The main strength of this study is that it is based on a large randomised controlled trial with 24-month follow-up data. Including body weight for participants in the control group in



the model allows us to isolate the effect of programme attendance from participation in a research study. This is important because evidence suggests that participation in a trial positively impacts on outcomes regardless of the intervention itself, leading to inflated estimates of the treatment effect in the absence of a control group [19]. Attendance at a programme is often self-reported, whereas here we use objectively collected attendance data for 60% of participants, which provides confidence that the associations found are not caused by reporting bias. Unfortunately, the study is limited by a computer system error which meant that attendance data was missing for 40% of participants and we had to rely on self-reported information on attendance. However, in a sensitivity analysis the exclusion of self-reported data did not change the observed associations. Another limitation was the small sample sizes in some of the attendance groups which limited the power of the exploratory and sensitivity analyses, although these were consistent with the main analysis. This analysis was also constrained by the data collected in the main randomised controlled trial, and hence this observational analysis may still be affected by residual confounding related to factors such as prior history of weight loss or motivation to lose weight.

Early attendance at the programme was very high, with over 60% of participants attending 10 or more sessions in the first 12 weeks (based on objectively recorded attendance data). This is similar to an independent analysis of 29,326 NHS referrals to the same programme which found that 54% of those referred attended all 12 sessions [20]. Another external audit of a different provider reported that approximately 58% of those referred attended  $\geq 10$  out of 12 sessions [21]. There was no difference in weight loss for groups of people attending for  $< 10$  weeks compared to the control group. However, the relatively small proportion of people attending  $< 10$  sessions makes it difficult to establish whether there is a threshold level of attendance or a specific pattern of attendance (e.g., attending once or twice a month but regularly) which is associated with positive outcomes. The proportion of participants self-reporting use of web- or app-based tools was low, particularly among those attending very few face-to-face sessions.

The finding that early weight loss is a strong predictor of long-term weight loss confirms previous findings [16, 17], and the positive association between attendance and weight loss is also consistent with the existing literature across a range of different behavioural weight loss programmes [9, 12, 22, 23]. However, additionally we have shown that early attendance predicted weight loss independent of the amount of weight lost over the first 12 weeks and independent of the length of treatment programme that participants were offered.

Most of the sociodemographic characteristics measured in our study were not associated with attendance, except age. Other studies have also identified older age as being associated with higher attendance [8, 15, 22] and in some cases White ethnicity and education [24]. Other studies have shown that psychosocial factors, such as self-efficacy or being in the “action” stage of change, high perceived risk of cardiovascular disease, or a diagnosis of diabetes, are positively associated with greater overall attendance [25]. But the differences between groups are small.

In routine practice it is not appropriate for practitioners to use sociodemographic factors as predictors of the likelihood of success in order to select people for referral to a weight loss programme [7, 23, 26, 27]. Instead, a more pragmatic approach would be to offer short-term interventions routinely to people who are overweight, which we have previously shown to be effective [5], and to base decisions on continued provision based on attendance at the programme. In the WRAP trial we observed that less than half of participants who received free vouchers to attend the programme for 1 year continued to do so over the last 12 weeks of the 1-year treatment [6], and providers could use regular attendance as a criterion for continued provision of services to improve the cost-effectiveness of these interventions. Future research should address how practitioners can support ongoing attendance, perhaps

learning from prior research on communication practices to deliver health behaviour change [28].

In conclusion, this study provides evidence that consistent attendance at a community-based weight loss programme during the first 12 weeks is significantly associated with greater weight loss at 24 months, independent of the magnitude of early weight loss. Regular attendance at a programme could be used as a criterion for continued provision of weight loss services to maximise the cost-effectiveness of interventions.

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### Statement of Ethics

Ethical approval was obtained from the NRES Committee East of England Cambridge East and local approvals from NRES Committee North West Liverpool Central and NRES Committee South Central Oxford. This trial was registered with Current Controlled Trials (No. ISRCTN 82857232). All eligible participants provided informed consent.

### Conflict of Interest Statement

P.A. and S.A.J. are principal investigators of a trial funded by a grant to the University of Oxford from Cambridge Weight Plan. A.L.A. is principal investigator of an NIHR PGfAR-funded trial in which the intervention is delivered by WW at no cost. J.C.G.H. has a trial funded by the American Beverage Association. All other authors declare no competing interests.

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### Author Contributions

C.P., F.M., S.A.J., and P.A.: conceptualization. C.P. and F.M.: data curation and formal analysis. A.L.A., J.W., E.J.B., J.C.G.H., S.A.J., and P.A.: project administration, funding, and resources. All authors: roles/writing – original draft. All authors gave final approval of the submitted and published versions.

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