



ORIGINAL ARTICLE

Clinical Trials and Investigations

Early outcomes of referrals to the English National Health Service Digital Weight Management Programme

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Abstract

Objective: The study objective was to assess participant weight change for the English National Health Service (NHS) Digital Weight Management Programme, the first such digital intervention to achieve population coverage.

Methods: A service evaluation was used to assess intervention effectiveness for adults with obesity and a diagnosis of hypertension and/or diabetes, between April 2021 and March 2022, using prospectively collected, national service-level data in England.

Results: Of the 63,937 referrals made from general practices, within the time period, 31,861 (50%) chose to take up the 12-week Programme. There were 31,718 participants who had time to finish the Programme; of those, 14,268 completed the Programme (defined as attending $\geq 60\%$), a 45% completion rate. The mean weight change for those who had time to finish the Programme was -2.2 kg (95% CI: -2.25 to -2.16), for those who completed it was -3.9 kg (95% CI: -3.99 to -3.84), and for those who had time to finish the Programme but did not complete it was -0.74 kg (95% CI: -0.79 to -0.70).

Conclusions: The NHS Digital Weight Management Programme is effective at achieving clinically meaningful weight loss. The outcomes compare favorably to web-based weight management interventions tested in randomized trials and those delivered as face-to-face interventions, and results suggest that the approach may, with increased participation, bring population-level benefits.

INTRODUCTION

Obesity is recognized as a multifaceted global health concern and a modifiable risk factor for a range of chronic diseases, including type 2 diabetes, many common cancers, cardiovascular disease, and musculoskeletal disorders [1].

In England, 25.9% of adults are living with obesity, with prevalence increasing and estimated annual costs to the National Health Service (NHS) in England of £6.1 billion in 2019 [2] and £9.7 billion by 2050 [3].

In 2020, influenced by the SARS-CoV-2 global pandemic [4] and associated social distancing guidelines in the UK [5], NHS England initiated a process to commission a nationally available digitally delivered

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weight management intervention, accessible via software applications and web-based platforms. The intervention, delivered over 12 consecutive weeks, consists of four core areas: managing mind-set; understanding weight change, nutrition, and diet advice; aiming to encourage healthy habits through a guided syllabus of behavioral support, nutrition, and diet guidance; and peer support.

Launched in April 2021, the NHS Digital Weight Management Programme is the first nationally available NHS England-commissioned, -led, and -funded service supporting adults living with obesity to manage their weight, and it is the only weight management intervention of its kind internationally, delivered digitally across differing levels of intensity and at scale. To be eligible for referral into the Programme, adults must be registered with a general practice in England, have a body mass index (BMI) of ≥ 30 kg/m² (adjusted to 27.5 kg/m² for people from Black, Asian, and minority ethnic groups), and have a diagnosis of diabetes or hypertension or both.

The Programme is accessible via direct referral from any general practice in England, and those referred are triaged to one of three intervention intensities: Level 1 provides self-guided digital content, alongside optional participation in group peer-support sessions; Level 2 additionally offers up to 50 min of one-on-one human coaching; and Level 3 further increases provision of one-on-one human coaching to 100 min.

Results from the NHS Diabetes Prevention Programme (DPP) suggest that specific participant demographic characteristics may influence the likelihood of successful completion of a behavioral intervention of this nature; being of younger age, living in more socioeconomically deprived areas, and being of Asian, mixed, and other minority ethnicities were associated with lower rates of NHS DPP completion [6]. Applying this learning, the NHS Digital Weight Management Programme developed a bespoke triage system, based on regression models using NHS DPP data (with age, sex, ethnicity, and deprivation as independent variables and Programme completion as the dependent variable), to allocate to intensity of intervention according to the modeled likelihood of completion, with the rationale that additional human coaching may support improved retention.

We aimed to analyze data related to the Programme referrals during the first year of launch, between April 11, 2021 and March 31, 2022, to address the following questions:

1. What proportion of those referred take up the Programme?
2. Do the characteristics of those who take up the Programme suggest equitable access according to dimensions of age, sex, ethnicity, and socioeconomic deprivation?
3. What is the weight change achieved, and does it vary by participant characteristics?

METHODS

Study design

This is a service evaluation in England evaluating the effectiveness of the NHS Digital Weight Management Programme, using prospectively

Study Importance

What is already known?

- Obesity is a global health concern and a modifiable risk factor for a range of chronic diseases.
- There are existing guidelines for the management of obesity and overweight; however, there is uncertainty about which interventions and delivery methods comprise effective services and practice.
- Recent reviews have provided some evidence that digitally delivered weight management interventions can be successful; however, little is known about the effectiveness of these in real-world populations.

What does this study add?

- This is the first evaluation of a digital intervention for weight management delivered on a national footprint.
- In the English National Health Service Digital Weight Management Programme, a clinically meaningful weight change at 12 weeks (−2.2 kg for those who had time to finish the Programme and −3.9 kg for those who completed the Programme) was observed.
- Weight reductions were not associated with participants' socioeconomic status, which may relate to the bespoke triage system that proactively allocated the participants to the different intensities of support.

How might these results change the direction of research or the focus of clinical practice?

- Early analyses demonstrate clinically meaningful weight loss for participants and provide a platform for ongoing learning.
- The outcomes of the intervention compare favorably to other similar interventions, and adopting it might bring population-level benefits.
- Incorporating digital delivery into clinical practice could enhance the overall effectiveness and reach of weight management services while maintaining patient-centered care.

collected national service-level data for participants referred during the time period.

Intervention

The intervention was delivered according to a national service specification by one of six service providers selected through a national competitive procurement process (Table S1). The specification (Table S2) was developed by an expert group based on evidence for

clinical effectiveness and cost-effectiveness, government recommendations for diet and physical activity [7–10], and suggested mechanisms for achieving behavior change described in the National Institute for Health and Care Excellence (NICE) Public Health and Clinical Guidance [11, 12]. These include the provision of information to raise awareness of the benefits and types of lifestyle changes needed to achieve and maintain a healthy weight, exploration and reinforcement of participants' reasons for wanting to change and their confidence about making changes, goal setting, action planning, coping plans, and relapse prevention.

Individuals were triaged into one of the three intervention levels, informed by likelihood of Programme completion according to demographics, with the proportion triaged to each level designed to ensure that total delivery costs fell within the Programme financial limits.

Following triage, individuals were invited to select their preferred service provider at their allocated intervention level.

Data collection

The NHS Digital Weight Management Programme minimum dataset was used to identify those referred to the Programme. The dataset included participant characteristics, demographics, and relevant comorbidities at point of referral. Providers populated a minimum dataset that included individual participants' self-reported weight measurements, sessional engagement, and coaching uptake. Data from the minimum dataset were used for these analyses.

Data were collected in accordance with UK General Data Protection Regulation (GDPR) article 35 [13]. The associated Data Protection Impact Assessment, approved through the NHS England Corporate Information Governance framework, sets out the valid lawful basis for collection and processing of the associated data by NHS England. Analysis of anonymized data for evaluation purposes is in accordance with the Programme data usage information provided at the point of intervention access. As such, this evaluation did not require ethics committee approval.

Covariates

Demographic variables (age, sex, ethnicity, quintile of deprivation, and intervention variables including the intervention level, provider, and number of weeks the participant engaged with the intervention) were identified as potential factors influencing the outcome(s), based on NHS Digital Weight Management Programme implementation and what was learned from the NHS DPP.

Sex was recorded as male or female. Date of birth at referral was used to derive participants' age, shared in the minimum dataset and grouped into 5-year age bands other than age groups 18 to 24 and ≥ 75 years, for analytical purposes. Self-reported ethnicity was categorized as Asian, Black, Mixed, Other, or White. Deprivation was derived

using Lower Layer Super Output Area (derived from participant postcode), linked to the deprivation quintile from the English Index of Multiple Deprivation [14].

Outcomes

The primary outcome was change in weight for those who had enough time to finish the Programme by September 30, 2022, and for whom there were no missing data for age, sex, ethnicity, deprivation, or weight. In the secondary analyses, data from participants who completed the Programme, defined as participants who engaged with $\geq 60\%$ of the Programme (a minimum of 7 weeks of the 12-week duration), were assessed separately. The proportion who achieved weight loss of $\geq 5\%$ was calculated for both, those who finished the Programme and those who completed it. Programme uptake was calculated as the proportion of referrals who engaged in at least 1 week of the 12-week intervention.

Weight change was calculated as the difference between weight measurements recorded in the last and the first week of intervention engagement. When no valid weight measurements were recorded in a week in which the participant engaged in the intervention, the previous or subsequent recorded weight was used. Weight measurements outside of 35 kg to 300 kg were considered erroneous and were excluded. Weight changes >5 SD from the mean were also deemed erroneous and excluded from analysis.

Programme engagement in a given week was defined as at least one of the following forms of engagement: self-recording a weight measurement, receipt of human coaching, and/or engagement with the provider, all recorded digitally.

Statistical analyses

A χ^2 test was used to evaluate whether uptake and completion differed according to demographic characteristics (age, sex, ethnicity, deprivation) and intervention level. A multiple logistic regression model was used to assess uptake and completion, adjusting for demographic characteristics and with baseline weight added to the regression model to assess its influence.

Weight change was analyzed for all those who had time to finish the Programme and then separately for all those who completed the Programme, for whom there were no missing data for demographic characteristics or weight. ANOVA was used to assess differences in the mean weight change within subgroups. A multiple linear regression model was used to assess whether changes in outcomes were associated with demographic variables, participants' weekly engagements with the Programme, and participants' baseline weight. Due to intervention level being assigned based on demographic characteristics, it could not be included in any regression models because of high collinearity with the demographic variables. Therefore, separate logistic and linear regression models were run by intervention level.

TABLE 1 Characteristics of participants as they progress through the various stages of the NHS Digital Weight Management Programme.

	Referrals		Uptake				Finish the Programme		Complete the Programme			
	n	n	%	95% lower CI	95% upper CI	χ^2 p value	n	n	%	95% lower CI	95% lower CI	χ^2 p value
Total	63,937	31,861	49.8%	49.6%	50.0%		31,718	14,268	45.0%	44.7%	45.3%	
IMD1 (most deprived)	16,925	7480	44.2%	43.8%	44.6%	<0.001	7438	3336	44.9%	44.3%	45.4%	0.330
IMD2	14,701	7016	47.7%	47.3%	48.1%		6989	3047	43.6%	43.0%	44.2%	
IMD3	12,387	6367	51.4%	51.0%	51.8%		6334	2878	45.4%	44.8%	46.1%	
IMD4	11,130	5940	53.4%	52.9%	53.8%		5916	2712	45.8%	45.2%	46.5%	
IMD5 (least deprived)	8794	5058	57.5%	57.0%	58.0%		5041	2295	45.5%	44.8%	46.2%	
Asian	8328	3407	40.9%	40.4%	41.4%	<0.001	3389	1884	55.6%	54.7%	56.4%	<0.001
Black	6559	3059	46.6%	46.0%	47.3%		3042	1276	41.9%	41.1%	42.8%	
Mixed	980	502	51.2%	49.6%	52.8%		497	283	56.9%	54.7%	59.2%	
Other	4932	1491	30.2%	29.6%	30.9%		1471	825	56.1%	54.8%	57.4%	
White	42,763	23,402	54.7%	54.5%	55.0%		23,319	10,000	42.9%	42.6%	43.2%	
Unknown	375	—	—	—	—		—	—	—	—	—	
Female	36,477	19,603	53.7%	53.5%	54.0%	<0.001	19,522	9157	46.9%	46.5%	47.3%	<0.001
Male	27,460	12,258	44.6%	44.3%	44.9%		12,196	5111	41.9%	41.5%	42.4%	
18–24	192	124	64.6%	61.1%	68.0%	<0.001	124	84	67.7%	63.5%	71.9%	<0.001
25–29	522	321	61.5%	59.4%	63.6%		320	227	70.9%	68.4%	73.5%	
30–34	1323	817	61.8%	60.4%	63.1%		813	574	70.6%	69.0%	72.2%	
35–39	2626	1515	57.7%	56.7%	58.7%		1510	1053	69.7%	68.6%	70.9%	
40–44	4263	2321	54.4%	53.7%	55.2%		2312	1199	51.9%	50.8%	52.9%	
45–49	6199	3179	51.3%	50.6%	51.9%		3153	1633	51.8%	50.9%	52.7%	
50–54	9372	4683	50.0%	49.5%	50.5%		4660	2148	46.1%	45.4%	46.8%	
55–59	10,918	5572	51.0%	50.6%	51.5%		5549	2237	40.3%	39.7%	41.0%	
60–64	10,386	5203	50.1%	49.6%	50.6%		5177	2029	39.2%	38.5%	39.9%	
65–69	8392	4107	48.9%	48.4%	49.5%		4094	1553	37.9%	37.2%	38.7%	
70–74	5567	2490	44.7%	44.1%	45.4%		2482	1002	40.4%	39.4%	41.4%	
≥75	4177	1529	36.6%	35.9%	37.4%		1524	529	34.7%	33.5%	35.9%	
Level 1	34,021	17,276	50.8%	50.5%	51.1%	<0.001	17,191	6523	37.9%	37.6%	38.3%	<0.001
Level 2	20,266	9686	47.8%	47.4%	48.1%		9651	4342	45.0%	44.5%	45.5%	
Level 3	9650	4899	50.8%	50.3%	51.3%		4876	3403	69.8%	69.1%	70.4%	

Note: Numbers of participants who chose to uptake and finish the Programme do not match because the latter refers to a cohort who had enough time to finish the 12-week Programme by September 30, 2022. Please see the “Outcomes” section for more details.

Abbreviation: IMD, Index of Multiple Deprivation.

Sensitivity analyses were conducted using multiple imputation using multivariate chained equations to impute missing data, and then results were compared to the primary and secondary outcomes.

RESULTS

Between April 11, 2021 and March 31, 2022, 63,937 people were referred from general practices into the Programme; 53% (34,021) were triaged to Level 1, 32% (20,266) to Level 2, and 15% (9650) to

Level 3. Of 6522 general practices in England, 3312 (51%) made at least one referral during this time [15].

Of those referred, 31,861 (50%) took up the Programme; 51% (17,276) took up for Level 1, 48% (9686) for Level 2, and 51% (4899) for Level 3 (Table 1). There were 31,718 participants who had time to finish the Programme during the reporting period, of whom 14,268 completed the Programme, giving a completion rate of 45%. Figure 1 demonstrates participant flow at each stage.

Participant characteristics at each stage are shown in Table 1: 57% of those referred were women, the mean (SD) age was 57.4 (11.6)

years, and 77% of those referred were aged 40 to 69 years. One-third of those referred (33%) were people of Asian (13%), Black (10%), Mixed (2%), or Other (8%) ethnicity. There was a higher proportion of participants from the most deprived quintile compared with the least deprived quintile (26% vs. 14%). The largest decreases in proportions of participants between referral and take-up of the intervention involved those from the most deprived quintiles, older age groups, men, and those of Asian, Black, and Other ethnicity (Tables S3 and S4). Table S5 shows characteristics of people who did not take up the intervention.

Characteristics of participants at each stage in the Programme by the three intervention levels are shown in Table S6, where differences are by design and relate to the regression models used to support triage: the mean (SD) ages for Level 1, Level 2, and Level 3 participants were 65.2 (7.2) years, 52.2 (7.1) years and 41.0 (7.7) years, respectively. Variation was seen in the ethnic distribution for all three intervention levels; at Level 1, 17% of referrals were people of Asian, Black, Mixed, and Other ethnicity compared to 39% and 73%, respectively, at Levels 2 and 3. A higher proportion of referrals for Level 2 and 3 were from the most deprived quintile compared to the least

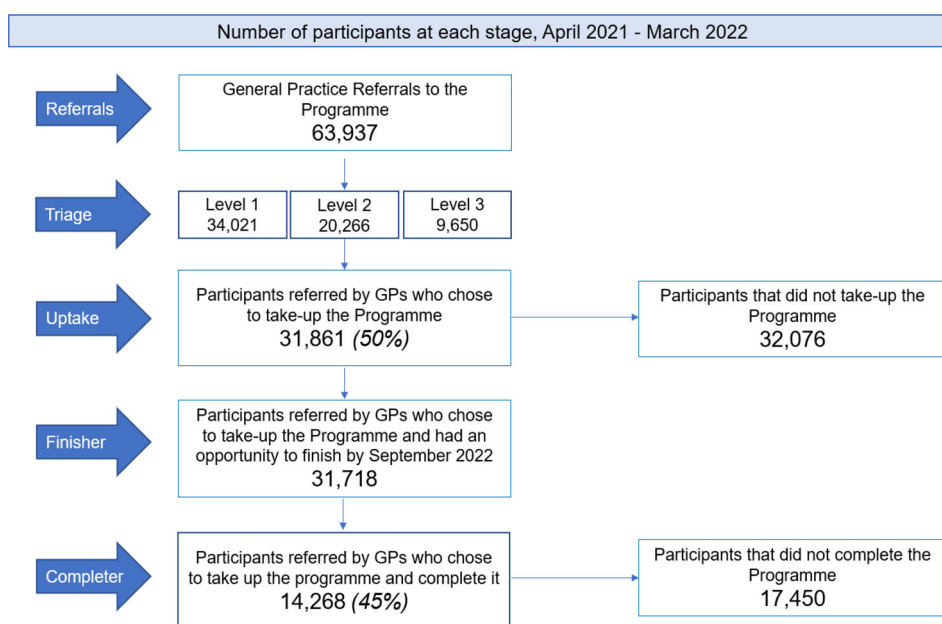


FIGURE 1 Flow of participants at each stage in the NHS Digital Weight Management Programme. GP, general practice. [Color figure can be viewed at wileyonlinelibrary.com]

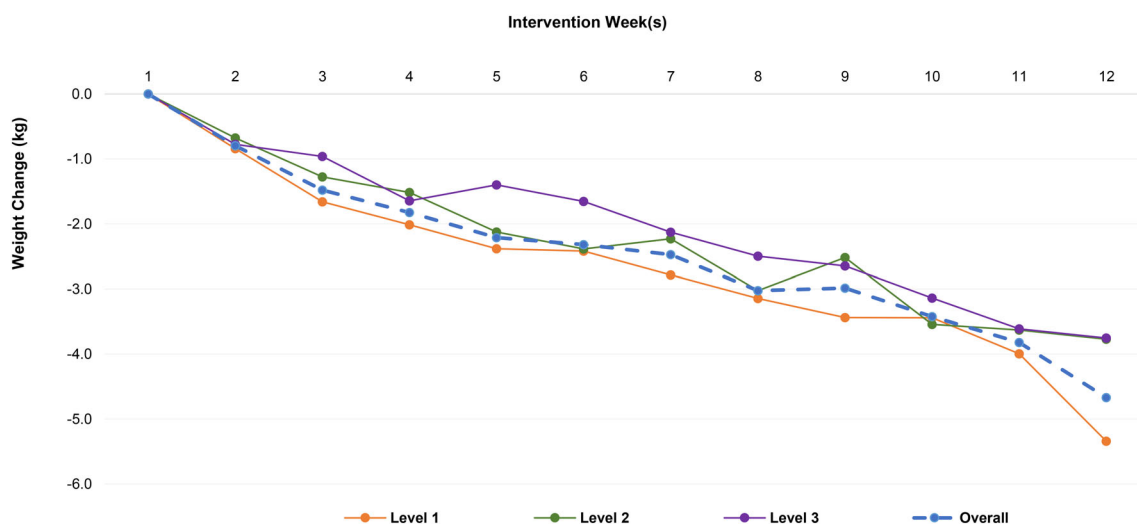


FIGURE 2 Mean weight change (kilograms) by number of weeks that a participant engaged with the NHS Digital Weight Management Programme; analyses include those for whom all data fields were complete ($N = 22,189$). CIs are not shown in this chart. This is because the chart shows a 12-week trajectory for all three levels of intervention and the overall intervention. Addition of CIs could obscure the weight change details that this chart provides. [Color figure can be viewed at wileyonlinelibrary.com]

TABLE 2 Weight change for participants who had an opportunity to finish the NHS Digital Weight Management Programme (primary outcome) and for those who completed it (secondary outcome; the analyses include those for whom all data fields are complete [$N = 22,189$ and $N = 10,228$, respectively], univariate analysis).

	Finish the Programme						Complete the Programme					
	Weight change analysis cohort	Mean baseline weight	Weight change	95% lower CI	95% upper CI	<i>p</i> value	Weight change analysis cohort	Mean baseline weight	Weight change	95% lower CI	95% upper CI	<i>p</i> value
	<i>n</i>	kg	kg				<i>n</i>	kg	kg			
Total	22,189	104.80	-2.21	-2.25	-2.16	—	10,228	104.68	-3.92	-3.99	-3.84	—
Deprivation												
IMD1 (most deprived)	4841	106.24	-2.16	-2.26	-2.05	<0.001	2176	106.26	-3.77	-3.94	-3.59	0.008
IMD2	4851	104.59	-2.04	-2.14	-1.94		2123	104.52	-3.75	-3.92	-3.58	
IMD3	4476	104.60	-2.25	-2.36	-2.15		2089	105.05	-4.04	-4.20	-3.87	
IMD4	4272	104.42	-2.26	-2.37	-2.16		2012	103.50	-3.96	-4.13	-3.80	
IMD5 (least deprived)	3749	103.82	-2.36	-2.48	-2.25		1828	103.87	-4.11	-4.28	-3.93	
Ethnicity												
Asian	1855	91.14	-1.60	-1.75	-1.45	<0.001	969	91.73	-2.55	-2.78	-2.31	<0.001
Black	1934	100.75	-1.90	-2.07	-1.74		834	100.76	-3.50	-3.80	-3.21	
Mixed	310	103.45	-2.50	-2.93	-2.07		183	103.39	-3.47	-4.02	-2.91	
Other	824	99.64	-2.11	-2.38	-1.84		462	99.54	-3.19	-3.58	-2.80	
White	17,266	106.98	-2.30	-2.36	-2.25		7780	107.05	-4.19	-4.27	-4.10	
Sex												
Female	13,561	99.74	-2.18	-2.24	-2.12	0.161	6549	100.10	-3.72	-3.81	-3.63	<0.001
Male	8628	112.73	-2.25	-2.33	-2.17		3679	112.84	-4.27	-4.41	-4.13	
Age group												
18–24	54	116.21	-1.89	-2.73	-1.05	<0.001	34	116.04	-2.25	-3.45	-1.05	<0.001
25–29	168	115.49	-1.99	-2.56	-1.42		108	116.46	-2.89	-3.67	-2.11	
30–34	445	115.76	-2.82	-3.23	-2.41		289	115.03	-3.78	-4.35	-3.22	
35–39	843	111.44	-2.79	-3.06	-2.52		542	111.35	-3.84	-4.19	-3.48	
40–44	1293	107.00	-2.04	-2.23	-1.84		686	105.51	-3.01	-3.29	-2.73	
45–49	1850	108.14	-2.19	-2.35	-2.03		1020	108.01	-3.33	-3.57	-3.09	
50–54	2918	107.27	-2.25	-2.38	-2.11		1504	106.50	-3.62	-3.83	-3.41	
55–59	4081	105.78	-2.20	-2.31	-2.08		1745	105.10	-4.10	-4.30	-3.90	
60–64	4020	104.11	-2.21	-2.32	-2.10		1658	102.93	-4.26	-4.44	-4.07	
65–69	3244	101.68	-2.08	-2.20	-1.97		1308	101.00	-4.35	-4.54	-4.15	
70–74	2031	99.76	-2.24	-2.38	-2.09		872	99.28	-4.25	-4.48	-4.03	
≥75	1242	96.56	-2.03	-2.21	-1.86		462	97.65	-4.32	-4.64	-3.99	
Level												
Level 1	13,700	103.42	-2.18	-2.24	-2.12	<0.001	5466	102.91	-4.41	-4.52	-4.31	<0.001
Level 2	5985	107.23	-2.15	-2.24	-2.06		3122	106.81	-3.31	-3.45	-3.18	
Level 3	2504	106.46	-2.50	-2.66	-2.34		1640	106.53	-3.41	-3.62	-3.20	
Provider level 1												
Morelife UK	2618	104.52	-1.13	-1.22	-1.03	<0.001	510	103.70	-3.95	-4.25	-3.65	<0.001
Second Nature	1721	103.01	-4.93	-5.11	-4.74		1569	103.35	-5.39	-5.57	-5.20	
Slimming World	5833	102.88	-2.27	-2.36	-2.18		2419	102.42	-4.32	-4.47	-4.17	
Xyla Health and Wellbeing	3528	103.69	-1.47	-1.57	-1.36		968	103.03	-3.32	-3.56	-3.08	

TABLE 2 (Continued)

	Finish the Programme						Complete the Programme					
	Weight change analysis cohort	Mean baseline weight	Weight change	95% lower CI	95% upper CI	p value	Weight change analysis cohort	Mean baseline weight	Weight change	95% lower CI	95% upper CI	p value
		n	kg					kg	kg			
Provider level 2												
Morelife UK	918	110.47	-2.51	-2.76	-2.27	<0.001	617	109.45	-3.19	-3.51	-2.87	0.245
Oviva	1477	105.94	-2.34	-2.52	-2.16		1019	106.05	-3.21	-3.44	-2.99	
Xyla Health and Wellbeing	3590	106.93	-1.97	-2.09	-1.86		1486	106.23	-3.44	-3.63	-3.24	
Provider level 3												
Liva	418	104.24	-2.52	-2.96	-2.07	<0.001	387	104.95	-2.73	-3.20	-2.25	<0.001
Second Nature	792	108.06	-3.79	-4.09	-3.49		741	108.15	-4.03	-4.34	-3.72	
Xyla Health and Wellbeing	1294	106.20	-1.70	-1.89	-1.52		512	105.38	-3.02	-3.36	-2.68	

Abbreviation: IMD, Index of Multiple Deprivation.

deprived quintile, 36% versus 11% and 41% versus 2%, respectively, compared to 16% versus 19% for Level 1.

Completion and weight change were assessed for 22,189 (70%) participants who had time to finish the Programme and had no missing data for demographic characteristics and weight. Of those, 46% (10,228) completed the Programme. By level of intensity, 39.9%, 52.2%, and 65.5% of participants completed the Programme for Level 1, Level 2, and Level 3, respectively. A multiple logistic regression analysis (Table S7) showed that participants who were living in less deprived quintiles, those who were of Asian, Other, or Mixed ethnicity, and those who were of younger ages were associated with greater likelihood of completion, whereas those of Black ethnicity and male sex were associated with a lower likelihood of completion. A separate regression analysis (Table S8) for each intervention level showed there was no clear relationship between age and completion within any level. Participants' baseline weight and sex did not influence completion.

The mean baseline weight for those who had time to finish the Programme and had no missing data was 104.8 kg; the mean weight change was -2.2 kg (95% confidence interval [CI]: -2.25 to -2.16), and 16% of participants lost $\geq 5\%$ of their baseline weight. The magnitude of weight change increased as the number of weeks of engagement increased (Figure 2). Univariate analyses of mean weight change for participants who finished and completed the Programme are shown in Table 2. The mean baseline weight for Level 1 participants was 103.4 kg, significantly lower than the mean baseline weight for Level 2 (107.2 kg) and Level 3 (106.5 kg) participants. Greater weight change was observed for Level 3 (-2.5 kg [95% CI: -2.66 to -2.34]) participants compared to Level 1 (-2.2 kg [95% CI: -2.24 to -2.12]) and Level 2 (-2.1 kg [95% CI: -2.24 to -2.05]).

The regression analysis (Table S9) indicated that, for each additional week a participant engaged in the Programme, there was a 0.41-kg greater weight loss, and for each 1-kg higher baseline weight, there was an additional 0.026 kg of weight loss. Participants from

older age groups lost more weight than younger age groups whereas participants of Asian and Other ethnicity lost less weight than those of White ethnicity. No significant differences by sex or deprivation were observed. A separate regression analysis (Table S10) for each intervention level showed that the significant association between older age and increased weight loss was apparent within Level 1 and Level 3 participants, but not Level 2. For each additional week of participant engagement, weight loss was greatest for Level 1 (0.43 kg), followed by Level 2 (0.36 kg) and Level 3 (0.34 kg). There were no significant differences by deprivation or ethnicity within any analyses by intervention level.

The mean baseline weight for those who completed the Programme and had no missing data was 104.7 kg, with a mean weight change of -3.9 kg (95% CI: -3.99 to -3.84). Of those, 31% lost $\geq 5\%$ of baseline weight. The mean baseline weight for Level 1 participants was 102.9 kg, significantly lower than the mean baseline weight for Level 2 (106.8 kg) and Level 3 (106.5 kg) participants. Greater weight change was observed for Level 1 (-4.4 kg [95% CI: -4.51 to -4.31]) participants compared to Level 2 (-3.3 kg [95% CI: -3.45 to -3.18]) and Level 3 (-3.4 kg [95% CI: -3.62 to -3.20]). The regression analysis (Table S11) indicated that, for each additional week the participant engaged, there was a 0.44-kg greater weight loss, and for each 1-kg higher baseline weight, there was an additional 0.04 kg of weight loss. Older age was associated with increased weight loss compared to younger age, and Asian and Other ethnicity was associated with smaller weight loss compared to White ethnicity. There were no significant differences by sex or quintiles of deprivation. A separate regression analysis (Table S12) for each intervention level showed that the significant association between older age and increased weight loss was apparent within Level 1 and Level 3 participants. For each additional week participants engaged, weight loss was greatest for Level 1 (0.48 kg), followed by Level 2 (0.40 kg) and Level 3 (0.26 kg). There were no significant differences by quintile of

deprivation, and only Level 3 saw significant differences by ethnicity. Table S13 shows the proportion of weight change by demographics for participants who have had an opportunity to finish the Programme and for those who completed it.

Programme uptake, programme completion, and weight change demonstrated significant differences between providers at each intervention level (Tables S4, S8, S10, and S12).

Sensitivity analysis using imputed data showed no substantive changes in the direction and magnitude of the associations (Table S14).

DISCUSSION

This is the first evaluation, to our knowledge, of a digital intervention for weight management delivered on a national footprint, at scale, anywhere internationally. The results suggest this digital behavioral intervention was associated with clinically meaningful weight change at 12 weeks, of a magnitude of -2.2 kg for those who had time to finish the Programme and -3.9 kg for those who completed it. The analyses indicate that these weight reductions are not dependent on participants' quintile of deprivation or sex, and this may be influenced by proactive triage of participants to the different levels of support. However, greater weight loss was associated with older age and White ethnicity, consistent with findings in other national weight management interventions [7].

Despite emerging evidence suggesting that weight loss interventions could be delivered effectively using digital technologies [16–18], to date there has been little evidence of their effectiveness in routine care settings [19]. This study provides evidence supporting continuation of the national implementation of a digital weight management intervention by the NHS, with findings suggesting that a digitally delivered weight loss intervention can be operationalized nationally, can achieve weight change comparable to that seen with web-based weight management interventions tested in randomized trials [20], and performs favorably compared to face-to-face group-based interventions [20].

Significant reductions in weight at the population level could catalyze population health benefits, as digitally delivered interventions can be delivered at scale. Digital interventions may be more acceptable than group-based weight management services for some people, potentially being easier to fit into busy lifestyles and working patterns and possibly overcoming the detrimental impact from perceived stigma associated with attending such sessions. Indeed, digital delivery of the NHS DPP has attracted those with significantly greater baseline weight than seen in face-to-face delivery [21], which may relate to the stigma felt in group-based environments [22]. Additionally, increased engagement by those of younger age groups with the NHS Digital Weight Management Programme suggests that digital interventions are effective in reaching a younger cohort of working-age people.


Comparison of the effectiveness of each intervention level suggests that the addition of personal coaching is positively

associated with participant engagement and completion rates. A higher completion rate and greater weight loss for those who had time to finish the Programme were observed in participants triaged to Level 3 (Tables 1 and 2). The role of health coaching in engaging patients to take an active role in managing their health and empowering them to make change is known to be effective [23–26] and is the core differentiating service characteristic across the Programme's three intervention levels, purposefully designed to improve retention rates in those less likely to complete the Programme. However, with allocation to a higher intervention level weighted toward specific ethnicities, age groups, and more deprived socioeconomic statuses, substantial differences in these characteristics of participants at each intervention level were observed. Although no clear exhibited pattern of weight loss by level has been observed, those least likely to engage and lose weight were triaged to intervention levels involving greater human support, likely attenuating any potential differential effects on weight loss between levels. Potential differences in weight change outcomes by level may also be influenced by each provider not delivering services at every level, which merits further exploration.

This study's findings provide supporting evidence that the Programme has a positive influence on weight change in adults living with obesity and associated comorbidities and provides an effective and acceptable delivery method to support weight management on a national scale for individuals of different demographic characteristics. However, for potential population-level benefits of the Programme to be realized, increased access, participation, and take-up are required.

This is the largest cohort of people, to our knowledge, to be offered a 12-week intervention for weight management, delivered digitally, to include measures of weight, engagement, and assessment of impact on health inequalities. There was equitable intervention access across different groups, evidenced by the referred population's demographic diversity. The principles for the acquisition of ongoing data collection to determine longer-term outcomes, including participant weight change trajectories over time, are established within the NHS National Obesity Audit [27].

The uncontrolled nature of this analysis means that external confounders cannot be excluded and there may have been other factors influencing weight change. A measured approach to consider effects on data interpretation for missing data in terms of covariates including weight measurement has been taken. Analysis showed missing weight measurements were associated with certain demographic characteristics, but not baseline weight. It was not possible to assess whether missing final weights were associated with a particular magnitude of weight change or were missing at random. Nevertheless, a multiple imputation analysis was conducted under the assumption that the missing covariates data were missing at random and findings do not vary in terms of direction and broad magnitude compared to the primary analyses, providing some reassurance that missing data have not appreciably biased the conclusions.

To conclude, this report contains early analyses of the Programme that demonstrate clinically meaningful weight loss for participants, not impacted significantly by participants' socioeconomic status, and provides a platform for ongoing learning and improvements. 

CONFLICT OF INTEREST STATEMENT

Jonathan Valabhji was the National Clinical Director for Diabetes and Obesity at National Health Service (NHS) England from 2013 to September 2023 and is funded by the Imperial National Institute for Health Research (NIHR) Biomedical Research Centre and North-West London NIHR Applied Research Collaboration. Chirag Bakhai is an adviser to the NHS England NHS Diabetes Programme. Susan Jebb is funded by the NIHR Oxford Biomedical Research Centre and Oxford NIHR Collaboration and Leadership in Applied Health Research. Paul Aveyard is an NIHR Senior investigator and is funded by NIHR Oxford Biomedical Research Centre, NIHR Oxford Health Biomedical Research Centre, and NIHR Oxford and Thames Valley Applied Research Collaboration. Nita Gandhi Forouhi acknowledges support by the Medical Research Council (MRC) (grant number MC_UU_00006/3) and by NIHR Cambridge Biomedical Research Centre theme on Nutrition, Obesity, Metabolism and Endocrinology (NIHR203312), and she is an NIHR Senior Investigator. The other authors declared no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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