

Research

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# Text Messages With Financial Incentives for Men With Obesity A Randomized Clinical Trial

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**IMPORTANCE** Effective weight loss interventions are needed for men with obesity.

**OBJECTIVE** To determine whether an intervention that combined text messaging with financial incentives attained significant weight loss at the 12-month follow-up compared with the control group and whether an intervention of text messaging alone attained significant weight loss at the 12-month follow-up compared with the control group.

**DESIGN, SETTING, AND PARTICIPANTS** An assessor-blinded randomized clinical trial conducted in Belfast, Bristol, and Glasgow areas in the UK. A total of 585 men with body mass index (BMI) of 30 or more were enrolled between July 2021 and May 2022. Final follow-up occurred June 2023.

**INTERVENTIONS** Participants were randomly assigned to 12 months of behavioral focused text messages combined with financial incentives (n = 196), 12 months of behavioral focused text messages alone (n = 194), or a waiting list (control group; n = 195). The financial incentive consisted of a monetary reward that was lost if weight loss targets were not met. All participants received weight management information and a pedometer at baseline.

**MAIN OUTCOMES AND MEASURES** The 2 primary comparisons were the 12-month comparison of within-participant weight change between the text messaging with financial incentive group and the control group and the comparison between the text messaging alone group and the control group (minimum clinically important difference, 3%). The P value defined for statistical significance was  $P < .025$  for each comparison.

**RESULTS** Of the 585 men (mean [SD] age, 50.7 [13.3] years; mean weight, 118.5 [19.9] kg; mean BMI, 37.7 [5.7]; 525 [90%] White), 227 (39%) lived in postal code areas with lower socioeconomic status, and 426 (73%) completed the 12-month follow-up. At the 12-month follow-up, compared with the control group, the mean percent weight change was significantly greater in the text messaging with financial incentive group (mean difference, -3.2%; 97.5% CI, -4.6% to -1.9%;  $P < .001$ ) but was not significantly greater in the text messaging alone group (mean difference, -1.4%; 97.5% CI, -2.9% to 0.0,  $P = .05$ ). The mean (SD) weight changes were -5.7 (7.4) kg for the text messaging with financial incentives group, -3.0 (7.5) kg for the text messaging alone group, and -1.5 (6.6) kg for the control group. The 12-month mean (SD) percentage weight changes from baseline were -4.8% (6.1%) for the text messaging with financial incentives group, -2.7% (6.3%) for text messaging alone group, and -1.3% (5.5%) for the control group. Of 366 adverse events reported, the most common were infections (83 [23%]). Of the 23 serious adverse events (6.3%), 12 (52%) occurred in the text messaging with financial incentives group, 5 (22%) in the text messaging alone group, and 6 (26%) in the control group. None were considered related to participating in a trial group.

**CONCLUSION AND RELEVANCE** Among men with obesity, an intervention with text messaging with financial incentive significantly improved weight loss compared with a control group, whereas text messaging alone was not significantly better than the control condition. These findings support text messaging combined with financial incentives to attain weight loss in men with obesity.

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Obesity increases rates of type 2 diabetes, heart disease, stroke, mobility impairment, and some cancers and affects approximately 800 million people worldwide.<sup>1,2</sup> Approximately 26% of UK adult men have obesity.<sup>3</sup> However, men are less likely than women to participate in weight loss interventions.<sup>4,5</sup> Effective interventions to attain weight loss in men are needed.<sup>6</sup>

Behavior change interventions delivered with text messaging can be effective and scalable components of weight loss programs. A systematic review that included 12 randomized clinical trials reported that text messaging-based weight loss interventions were associated with a mean weight change of  $-2.3$  kg (95% CI,  $-3.2$  to  $-1.4$  kg) compared with control.<sup>7</sup> However, in this systematic review, only 3 clinical trials reported weight loss at 12 months (mean intervention duration 6 months), and no trials included a large proportion of men. Financial incentives can help men with overweight and obesity to lose weight<sup>8,9</sup> and adding behavior change techniques and economic theory may enhance effectiveness.<sup>10-12</sup>

The Game of Stones clinical trial was designed to assess whether text messaging combined with financial incentives could help men with obesity lose weight at 12-month follow-up, compared to a control group. This clinical trial also evaluated whether text messaging alone could attain significant weight loss at 12 months' follow-up compared with a control group.

## Methods

### Trial Design

We conducted a 3-group assessor-blind superiority randomized clinical trial in 3 UK areas around Belfast, Bristol, and Glasgow. Enrollment was between July 2021 and May 2022. Final follow-up occurred June 2023. The trial protocol can be found in Supplement 1<sup>13</sup> and the statistical analysis plan in Supplement 2. Eligible men were randomized to 1 of 3 groups: text messaging with financial incentives for 12 months; text messaging alone for 12 months, or waiting list (control) for 12 months. The control group could receive the first 3 months of text messages at the end of the clinical trial. Ethical approval was provided by North of Scotland Research Ethics Committee 2 [20/NS/0141]. All participants provided written informed consent. This trial is reported using the Consolidated Standards of Reporting Trials Extension (CONSORT Extension) to CONSORT 2010 guidelines for multiarm, parallel-group, randomized trials and the CONSORT harms statement 2022 (<https://www.equator-network.org/>).

### Participants

We recruited participants through letters sent by general family practices and through the community, such as information stands in supermarkets, leaflets, posters, social media, and word of mouth.<sup>14,15</sup>

Men 18 years or older with a body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) of 30 or higher were eligible. Men were excluded if they did not have a mobile phone, were unable to understand

### Key Points

**Question** Do text messages with or without financial incentives promote weight loss in men with obesity?

**Findings** In this randomized trial that included 585 men with obesity, text messaging with behavioral messages combined with a financial incentive resulted in a 5% weight loss at 12 months, compared with weight loss of 3% for text messaging alone, and 1% for the control group. The difference in weight loss was statistically significant for the comparison between text messaging with financial incentives and the control group but not between the text messaging alone and the control group.

**Meaning** In men with obesity, a 12-month intervention consisting of text messaging with financial incentives resulted in modest but statistically significant weight loss compared with control.

English, planned to move from the area or have bariatric surgery within 12 months, had participated in a weight loss intervention less than 6 months ago, or had a terminal or severe psychiatric illness.

Men were randomly allocated 1:1:1 by researchers within each area using a secure remote web-based system to 12 months of automated text messages with financial incentives, text messages alone, or a control group. Randomization was stratified by area using permuted blocks of random sizes of 3, 6, or 9.

### Interventions

Text messages and financial incentives were developed with feedback from potentially eligible men and health care clinicians and were designed to promote inclusivity, sustainability, minimal effort from participants and clinical staff, and to have a low risk of harm.<sup>16,17</sup>

### Text Messages

Daily text messages were identical for the 2 intervention groups and did not mention financial incentives. They incorporated weight management evidence, website links to information resources, and theory-based behavior change techniques based on the Health Action Process Approach,<sup>18</sup> self-determination theory,<sup>19</sup> and the behavior change maintenance model.<sup>20</sup> Examples are provided in the **Box** and eTable 1 in Supplement 3. Text messages commenced within a week of randomization, with options for participants to pause, restart, or reduce frequency. The total number of text messages that a participant could receive was 370, of which 364 were behavioral, 3 were weight appointment reminders, and 3 were notifications of weight goal attainment. Participants could respond to text messages but were advised that they would usually not receive a reply unless a participant safety issue was identified.

### Financial Incentives

Participants allocated to the text messaging with the financial incentives group were told that £400 (US \$490) had been placed in a study account for them that they could access at the end of the clinical trial, but that money would be lost if weight loss goals were not attained. The goals were 5% weight loss from baseline at 3 months (£50 [\$64] secured),

**Box. Example Text Messages<sup>a</sup>**

**Baseline:** "OK, here's the deal. Some texts will be useful and others maybe won't. Just pick whatever works for you and ignore the rest. If you want to reply to any of the texts please do. We read every text but usually we won't be able to write back. Sorry."

**3 months:** "Rick says that when he's got a special occasion coming up, he prepares for it and makes sure he has a period where you are doing well before making loads of sensible eating choices—this way you will have earned it even more."

**6 months:** "That's the 6 months mark! Two things are important now: Keep off any weight lost and have your 1-year goal in mind. How confident are you that you can manage this?"

**9 months:** "Weekend coming up, finally! Remember Gavin's tip: the power of meal prep. Helps you stay ahead. Time for another batch prep session?"

**Automated incentive calculation text with {algorithm}:<sup>a</sup>**

**12 months:**

"Thanks for attending the weigh-in. You lost {0} kg ({1} st {2} lb), or {3}% of your starting weight. You have secured £{4} and lost £{5}. Well done! Your total Game of Stones payment is £{3m + 6m + 12m} Look forward to seeing you in 12 months' time."

<sup>a</sup> eTable 1 in Supplement 3 provides more examples of daily text messages and the embedded behavior change techniques; eTable 2 in Supplement 3 provides more examples of the automated texts with {algorithms} for the money secured and lost following each weight assessment.

10% from baseline at 6 months (£150 [\$191] secured), and maintaining 10% weight loss at 12 months (£200 [\$254] secured) (eMethods in Supplement 3). If all goals were met, participants could retain £400 [\$490] if they were weighed in person at community venues of family practices within 23 days of their follow-up due date on the study scales. For each 1% of weight lost between 5% and 10% at 6 and 12 months, additional money was secured. Information about the amount of money due was automatically calculated from the weight data and sent to participants by text after each weight assessment (Box and eTable 2 in Supplement 3) and participants were paid after the 12-month follow-up through bank transfer.

**Interventions Received by All 3 Groups**

All participants received a pedometer and access to a study website with evidence-based information about weight management (eMethods in Supplement 3). Participants in intervention groups had personal login accounts that allowed them to track their weight and step count and access information about local weight management and physical activity services. Study staff directed participants to study materials rather than giving weight management advice.

**Primary Outcome**

The 2 primary outcomes are within-participant weight change expressed as a percentage of baseline weight at 12 months comparing the text messaging with financial incentives vs the control group and comparing the text messaging alone vs the control group.

**Secondary Outcomes**

Secondary outcomes at the 12-month follow-up compared with baseline were as follows: absolute weight change in kilograms; the percent of participants with any weight loss, the percent of participants achieving weight loss of 5% or more, or achieving weight loss of 10% or more; categories of weight loss were defined as 0 to less than 5%, 5% or more to less than 10%, 10% or more; percent of participants gaining weight; the EuroQol 5-Dimension 5-level (EQ-5D-5L); Warwick-Edinburgh Mental Well-Being Score (WEMWBS); and Weight Self-Stigma Questionnaire (WSSQ). The following secondary outcomes were added after the trial start: EQ-5D-5L Anxiety/Depression Dimension (EQ-5D-5L-AD), Patient Health Questionnaire (PHQ-4), and all possible categories for percent weight change from baseline were specified. Baseline data collection for PHQ-4 began November 2021 during enrollment and before collection of 12-month follow-up data. No outcome data were reviewed prior to adding these secondary outcomes.

**Exploratory Outcomes**

The exploratory outcomes (no minimally important clinical difference defined) consisted of program satisfaction assessed using a 0- to 100-point scale, (100 was most satisfied); satisfaction with weight loss progress assessed using 7 categories 1 (very unhappy) to 7 (very happy); and publicly funded weight management services including "yes" or "no" for medication and meal replacements used. Behavioral exploratory outcomes will be reported separately and consist of weight management strategies; self-monitoring weight; self-monitoring steps; physical activity; alcohol use; smoking status; confidence in ability to lose weight; and confidence in ability to maintain weight loss long term.

**Assessments**

Staff measuring weight and analyzing outcomes, harms and benefits data were unaware of group allocations. Weight was measured in-person within 3 weeks of the target date for follow-up using study scales and verified independently by another researcher. If the participant was not able to return for measurement of weight in person, participants were offered a video call to measure weight on study scales delivered to their home. If participants declined or did not respond to this option, they were mailed a letter requesting email or postal return of a questionnaire with self-reported weight on their own scale. Weights were measured at baseline and 12 months for all 3 groups, and the 2 intervention groups at 3 and 6 months. Staff asked participants at each assessment about helpful or harmful consequences of taking part in the study and about adverse events including serious adverse events (eMethods in Supplement 3).

Self-report questionnaires at baseline included socioeconomic measures consistent across UK countries obtained from the UK Office for National Statistics.<sup>21</sup> Data on racial and ethnic group were collected to assess the potential generalizability of results to UK regions with different populations. Participants were asked to select one of the following 6 options: African; Asian or Asian British; Black, Black British,

or Caribbean; White; mixed or multiple ethnic groups; and other ethnic group or prefer not to say.

#### Power Calculation

The sample size calculation was based on detecting a target difference in weight between the intervention groups and the control group of at least 3.3 kg, assuming an SD of 8 kg.<sup>7,14</sup> The 3.3 kg was based on 3% of the mean baseline weight of 109 kg in the feasibility study and the National Institute of Health and Care Excellence guidance.<sup>22</sup> We required outcome data on 146 participants per group for 90% power with a 2-sided  $\alpha$  of 2.5% (to account for 2 comparisons). We increased this to 169 per group (total sample size, 585 participants) to allow for 25% loss to follow-up.

#### Statistical Analyses

All participants (including those with missing primary outcome data) were included in the primary analysis according to treatment group allocation, regardless of adherence to their assigned group. For the primary outcome, 2 analyses estimated the mean differences in percentage weight change at 12 months between groups (text messaging with financial incentives group vs control group; and text messaging alone group vs control group) using a linear regression model adjusted for the recruitment areas and recruitment route (general practice or community), with missing data accounted for using multiple imputation under a missing at random assumption. The *P* value for statistical significance was defined as  $P < .025$ . The imputation model used baseline weight, recruitment method, area deprivation quintile using country-specific Index of Multiple Deprivation (eMethods in Supplement 3), recruitment area, height, and age to impute missing weights at 12 months for each group. In sensitivity analyses, analyses were repeated among people with 12-month weight values obtained in person (including video) if on study scales within 23 days of the target date, with missing data imputed using the model above. Additional sensitivity analyses used the same analysis model on all observed data (a missing-completely-at-random assumption) and 2 missing-not-at-random models with either baseline observations carried forward or last observation carried forward (for the intervention groups only). Stata statistical software version 16 was used for all analyses (StataCorp).

#### Secondary and Exploratory Analyses

Secondary and exploratory outcomes were analyzed in a similar manner as the primary outcome, using a generalized linear model suitable for the outcome distribution and effect sizes presented with 97.5% CIs. Statistical significance was  $P < .025$ .

#### Post Hoc Analyses

An exploratory post hoc analysis repeated the primary analyses after excluding participants who reported taking weight loss medications or meal replacements at any point during the trial.

## Results

Between July 2021 and May 2022, 1073 men expressed interest in enrolling, of whom 93 were ineligible, 304 declined par-

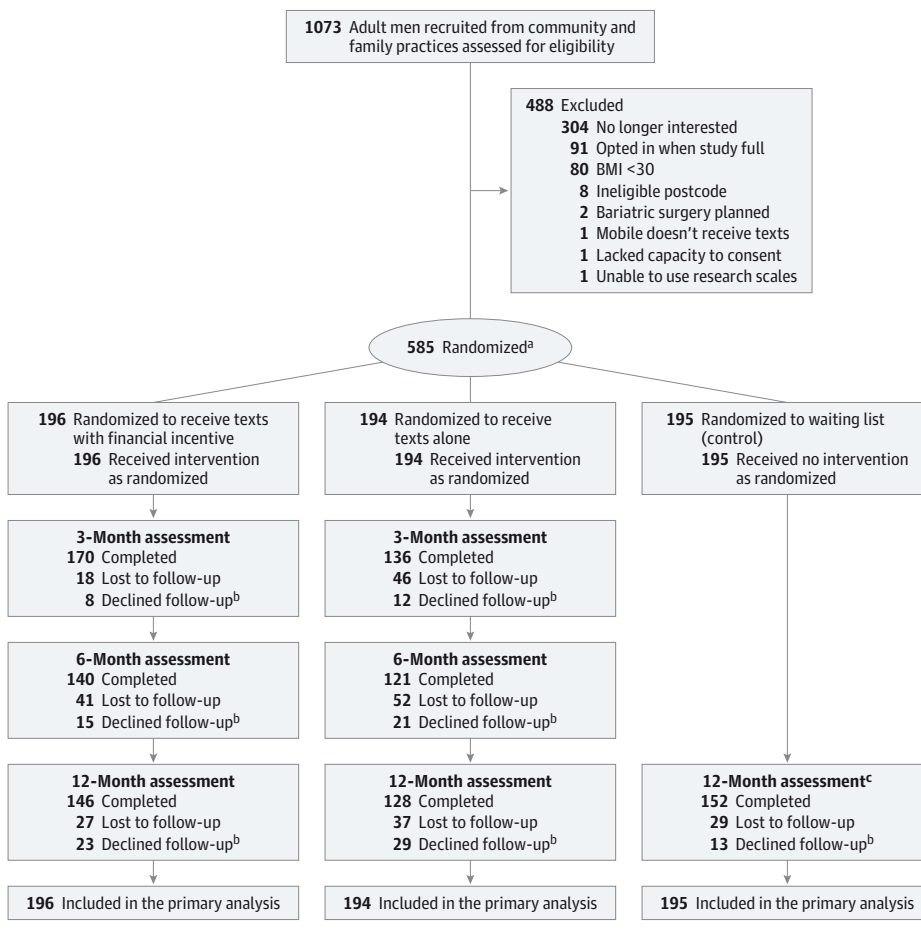
ticipation, 91 expressed interest after enrollment was completed, and 585 were randomized: 196 to text messaging with financial incentives group, 194 to text messaging alone group, and 195 to the control group (Figure 1). Weight at 12 months was completed by 426 participants (73%): 146 (75%) in the text messaging with financial incentives group, 128 (66%) in the text messaging alone group, and 152 (78%) in the control group. Overall, 397 (68%) completed the 12-month weight measurement on study scales within 23 days of the target date, consisting of 137 participants (70%) in the text messaging with financial incentives group, including 1 participant who followed up by video; 118 (61%) in the text messaging alone group; and 142 (73%) in the control group (eTable 3 in Supplement 3). Nineteen participants (3%) provided written weight by questionnaire, consisting of 4 in the text messaging with incentives group, 8 in the text messages alone group, and 7 in the control group. Weight assessments at 3 months were completed by 170 men (87%) in the text messaging with financial incentives group and 136 (70%) in the text messaging alone group. Weight assessments at 6 months were completed by 140 men (71%) in the text messages with incentives group compared with 121 (63%) in the text messaging alone group (eTable 4 in Supplement 3). The reasons for the 66 men (11%) declining follow-up were comparable across groups (eTable 5 in Supplement 3).

Baseline characteristics were similar across trial groups (mean age, 50.7 [SD, 13.3] years; 525 White (90%) (Table 1; eTables 6 and 7 in Supplement 3). Overall, 227 (39%) lived in the 2 more disadvantaged quintile areas, 416 (71%) self-reported an obesity-related health condition, 104 (18%) had diabetes, 235 (40%) had multiple long-term conditions, and 165 (29%) reported a physical or mental health disability (Office for National Statistics definition). The mean body weight was 118.5 (SD, 19.9) kg and the mean BMI was 37.7 (SD, 5.7). More participants were recruited through community strategies (368 [63%]) than through general practices (217 [37%]).

Of a maximum of 370 texts over 12 months, the mean number sent to participants was 332.4 (SD, 80.9) in the text messaging with financial incentives group and 317.3 (SD, 100.8) in the text messaging alone group. The mean number of responses to the text messages received was 8.8 (SD, 18.9) in the text messaging with financial incentives group and 8.6 (SD, 33.8) in the text messaging alone group (eTable 8 in Supplement 3). The number of participants who visited the trial website are listed in eTables 9 and 10 in Supplement 3.

A mean of £128 (\$159) was paid per participant randomized to text messaging with financial incentives for meeting weight loss goals (eTable 4 in Supplement 3). Of 146 participants who provided a 12-month weight, 90 men (62%) adhering to the payment protocol received payments (eMethods in Supplement 3), with 5 men missing either 3- or 6-month targets but paid for attaining 5% or more weight loss at 12 months. Six participants met 3- and/or 6-month targets of 5% or more but received no money because their 12-month weight was greater than at baseline. Twenty-seven of 196 men (14%) randomized to the text messaging with incentives group received the full £400 (\$490).

Figure 1. Participant Flow Through the Game of Stones Study



<sup>a</sup>Randomization was stratified by area using permuted blocks of random sizes of 3, 6, or 9.

<sup>b</sup>eTable 5 reports reasons for declining follow-up.

<sup>c</sup>There were no 3- or 6-month follow-up sessions for the control group.

**Primary Outcome**

At the 12-month follow-up, the mean (SD) percent weight change was -4.8% (6.1%) for the text messaging with financial incentives group, -2.7% (6.3%) for the text messaging alone group, and -1.3% (5.5%) for the control group. Compared with the control group, the text messaging with incentive group had significantly greater weight loss (mean difference in percentage change from baseline, -3.2%; 97.5% CI, -4.6 to -1.9;  $P < .001$ ), but the text messaging alone group did not have significantly greater weight loss (mean difference in percentage change from baseline, -1.4%; 97.5% CI, -2.9 to -0.0;  $P = .05$ ; Figure 2; eTable 11 in Supplement 3).

**Secondary Outcomes**

Participants lost a mean (SD) of 5.7 (7.4) kg in the text messaging with financial incentives group, 3.0 (7.5) kg in the text messaging alone group, and 1.5 (6.5) kg in the control group (eTable 12 in Supplement 3). At the 12-month follow-up, 114 of 146 participants (78%) in the text messaging with financial incentives group lost some weight compared with 86 of 128 (67%) in the text messaging alone group, and 92 of 152 (61%) in the control group (Table 2). At least 5% weight loss was attained by 65 of 146 participants (45%) in the text messaging with financial incentives group compared with 32 of 128 (25%)

in the text messaging alone group and 28 of 152 (18%) in the control group. Compared with the control group, the odds ratio (OR) for weight loss of at least 5% in the text messaging with incentive group was 3.6 (97.5% CI, 2.0-6.6;  $P < .001$ ). For the text messaging alone group compared with the control group, the OR was 1.5 (97.5% CI, 0.8-2.9;  $P = .2$ ). At least 10% weight loss was attained by 40 of 146 (27%) in the text messaging with financial incentives group, 8 of 128 (6%) in the text messaging alone group, and 11 of 152 (7%) in the control group. Figure 3 shows weight loss over time with weight outcomes at 3 and 6 months (eTable 13 in Supplement 3). There were no statistically significant differences in EQ-5D-5L; EQ-5D-5L-AD; WEMWBS; PHQ-4; WSSQ scores between the text messaging with financial incentives group and the control group or between the text messaging alone group and the control group (eTable 14 in Supplement 3). Data for the PHQ-4 scores were missing for 291 participants, 163 of whom did not receive the question at baseline. Those in the text messaging with financial incentives group significantly improved the EQ-5D visual analogue scale score by 5.00 (97.5% CI, 0.76 to 9.25;  $P = .008$ ) compared with the control group. The text messaging alone group improved the EQ-5D visual analogue scale score by 3.71 (97.5% CI, -0.75 to 8.16,  $P = .06$ ) compared with the control group, but the difference was not statistically significant.

Table 1. Baseline Characteristics

	Text messages with financial incentives (n = 196)	Text messages alone (n = 194)	Control group (n = 195)
Recruitment strategy <sup>a</sup>			
General practice, No. (%)	74 (38)	79 (41)	64 (33)
Community, No. (%)	122 (62)	115 (59)	131 (67)
Age, mean (SD) [No., y] <sup>b</sup>	50.0 (12.7) [195]	51.7 (13.3) [194]	50.2 (13.9) [195]
Deprivation category, No. (%) <sup>c</sup>	n = 195	n = 192	n = 194
Most deprived	48 (25)	36 (19)	50 (26)
More deprived	28 (14)	37 (19)	28 (14)
Deprived	25 (13)	33 (17)	29 (15)
Less deprived	39 (20)	40 (21)	31 (16)
Least deprived	55 (28)	46 (24)	56 (29)
Ethnic group, No. (%) <sup>b</sup>	n = 190	n = 186	n = 188
Asian/Asian British	2 (1.1)	3 (1.6)	6 (3.2)
Black/African/Caribbean/Black British	3 (1.6)	3 (1.6)	3 (1.6)
White	179 (94)	174 (94)	172 (92)
Mixed or multiple ethnic groups	2 (1.1)		4 (2.1)
Other	3 (1.6)	3 (1.6)	2 (1.1)
Prefer not to say	1 (0.5)	3 (1.6)	1 (0.5)
Relationship status, No. (%) <sup>b</sup>	n = 193	n = 191	n = 190
Married or civil partnership	126 (64)	116 (60)	113 (56)
Cohabiting	25 (13)	34 (18)	37 (19)
Single (never married; never in a civil partnership)	30 (16)	19 (9.8)	27 (14)
Divorced	5 (2.6)	8 (4.1)	6 (3.1)
Separated	5 (2.6)	6 (3.1)	3 (1.5)
Widowed	0	3 (1.5)	3 (1.5)
Prefer not to say	2 (1.0)	5 (2.6)	1 (0.5)
Comorbidities, No. (%) <sup>b,d</sup>	n = 196	n = 193	n = 194
High blood pressure	93 (47)	83 (43)	86 (44)
Mental health condition	51 (26)	46 (24)	49 (25)
Arthritis	40 (20)	55 (28)	47 (24)
Possible latent mental health condition	50 (26)	48 (25)	44 (23)
Diabetes	37 (19)	38 (20)	29 (15)
Heart condition	29 (15)	34 (18)	28 (14)
Stroke (including ministroke)	9 (4.6)	3 (1.5)	8 (4.1)
Cancer	6 (3.1)	8 (4.1)	5 (2.6)
≥1 Comorbidity	136 (69)	136 (70)	144 (74)
Multiple long-term condition <sup>b</sup>	82 (42)	82 (42)	71 (36)
Including self-reported diabetes <sup>b</sup>	33 (17)	34 (18)	23 (12)
Physical or mental disability <sup>a,e</sup>	n = 193	n = 193	n = 192
Disability, No. (%)	60 (31)	47 (24)	58 (30)
Measured weight	n = 196	n = 194	n = 195
Weight, mean (SD), kg	120.3 (20.1)	117.2 (17.9)	118.1 (21.6)
BMI, mean (SD)	38.2 (5.9)	37.3 (4.7)	37.8 (6.4)

Abbreviation: BMI, body mass index, calculated as weight in kilograms divided by height in meters squared.

<sup>a</sup> See eTables 6 and 7 in Supplement 3 for more detail.

<sup>b</sup> Self-reported.

<sup>c</sup> To measure disadvantage participant postcodes of residence were looked up in the following country-specific databases and assigned an index of multiple deprivation-2020v2- postcode-look-up; England: <https://imd-by-postcode.opendatacommunities.org/imd/> 2019; Northern Ireland: <https://www.nisra.gov.uk/publications/central-postcode-directory-jul-2023-downloads>.

<sup>d</sup> In the questionnaire, participants were asked, "Has a doctor ever told you that you have/had? (Please tick all that apply)" followed by the following list of obesity-related conditions: a stroke or ministroke, high blood pressure, a heart condition such as angina or atrial fibrillation, diabetes, cancer, arthritis, a mental health condition, or none of the above. Multiple long-term conditions were defined as ticking 2 or more of the conditions listed above. Derivation of the category a possible latent mental health condition is described in the statistical analysis plan (Supplement 2).

<sup>e</sup> Disability was measured using the Harmonised standards and guidance, Government Statistical Service, Office for National Statistics, 2021. In the questionnaire, participants were asked: "Do you have any physical or mental health conditions or illnesses lasting or expected to last 12 months or more? If you answered, 'Yes' to the question above, do any of your conditions or illnesses reduce your ability to carry out day-to-day activities? (Please tick one)." The choices were yes, a lot; yes, a little; or not at all. To be categorized as disabled, participants must have answered yes to the first question and yes to the second question.

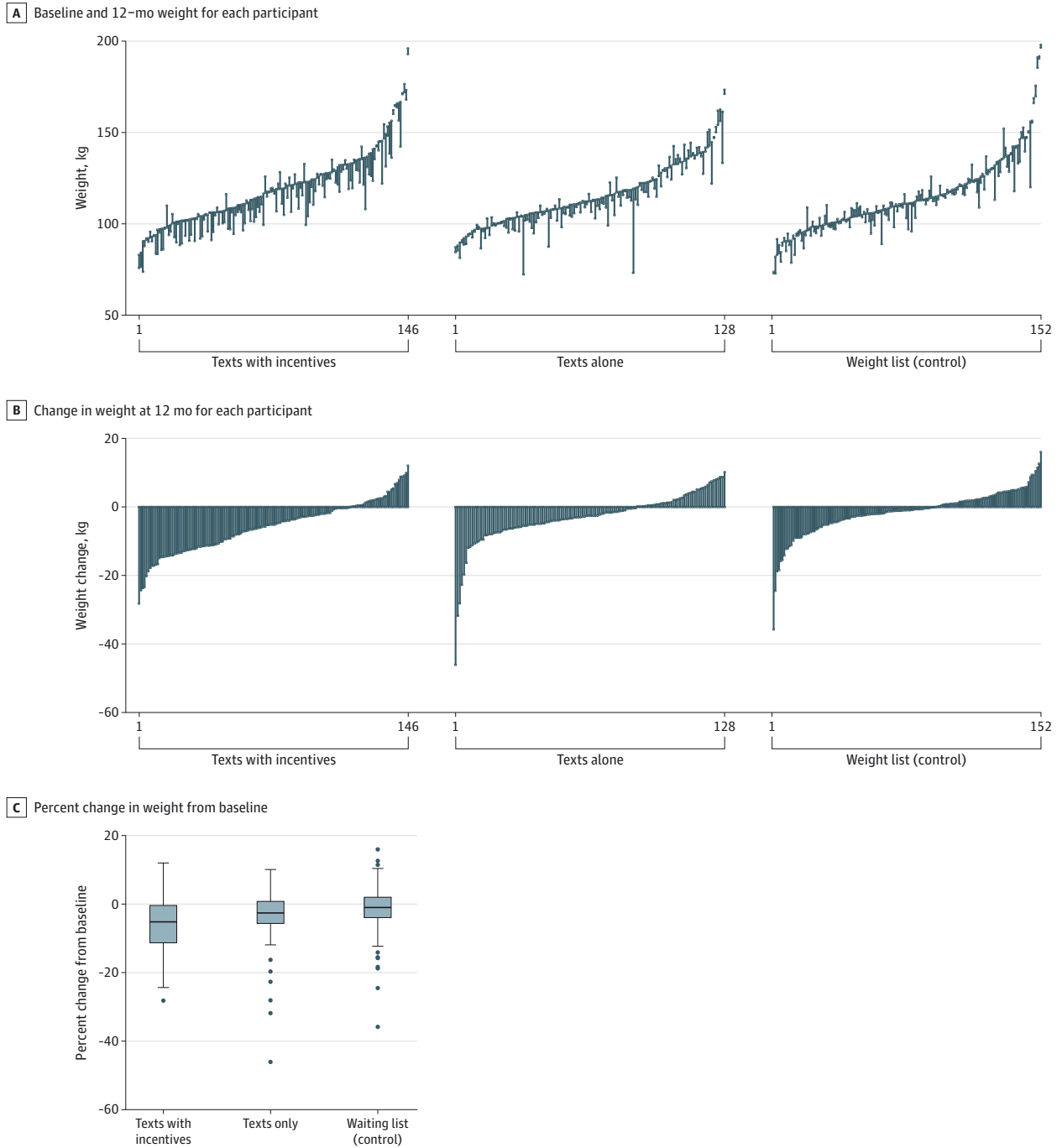
**Number Needed to Treat**

For the outcome of weight loss of 5% or more, the number needed to treat for the text messaging with financial incentives group at 12 months was 4 (97.5% CI, 3-8), for a weight loss of 10% or more, 5 (97.5% CI, 4-10). The number needed to treat with text messaging alone for a weight loss of 5% or more at 12 months was 15 (97.5% CI, NNT[harm] 33 to ∞ to NNT[benefit] 6) and for ≥10% weight loss it was NNT[harm] 102 (97.5% CI, NNT[harm] 15 to ∞ to NNT[benefit] 18).

**Exploratory Outcomes**

Compared with the control group, the text messaging with financial incentives group significantly improved the satisfaction scale by 18.6 (97.5% CI, 11.4-25.8; *P* < .001) and the text messaging alone group improved the satisfaction scale by 10.3 points (97.5% CI, 2.7-17.8; *P* = .002; eTable 15 in Supplement 3). Compared with the control group, the text messaging with financial incentives group significantly improved satisfaction with weight loss by 1.7 (97.5% CI, 1.0-2.6;

Figure 2. Weight Change and Percent Weight Change From Baseline to 12 Months



The thick lines in the boxes represent the median; the bottom and top of the box, the first and third quartiles, respectively; whiskers, an additional 1.5 times the IQR lower than the first quartile and higher than the third quartile; and dots, more extreme values that lie outside 1.5 times the IQR.

$P = .02$ ) and the text messaging alone group improved the satisfaction scale for weight loss by 1.3 points (97.5% CI, 0.8-2.1;  $P = .18$ ).

**Sensitivity Analyses**

All sensitivity analyses for missing data are reported in eTable 16 in Supplement 3. In analyses limited to partici-

pants weighed on study scales within 23 days of the target date (in person or video) compared with the control group, the text messaging with financial incentives group changed percentage weight by  $-3.6\%$  (97.5% CI,  $-5.2\%$  to  $-2.0\%$ ;  $P < .001$ ) and the text messaging alone group changed percentage weight by  $-1.5\%$  (97.5% CI,  $-3.2\%$  to  $0.2\%$ ;  $P = .05$ ).

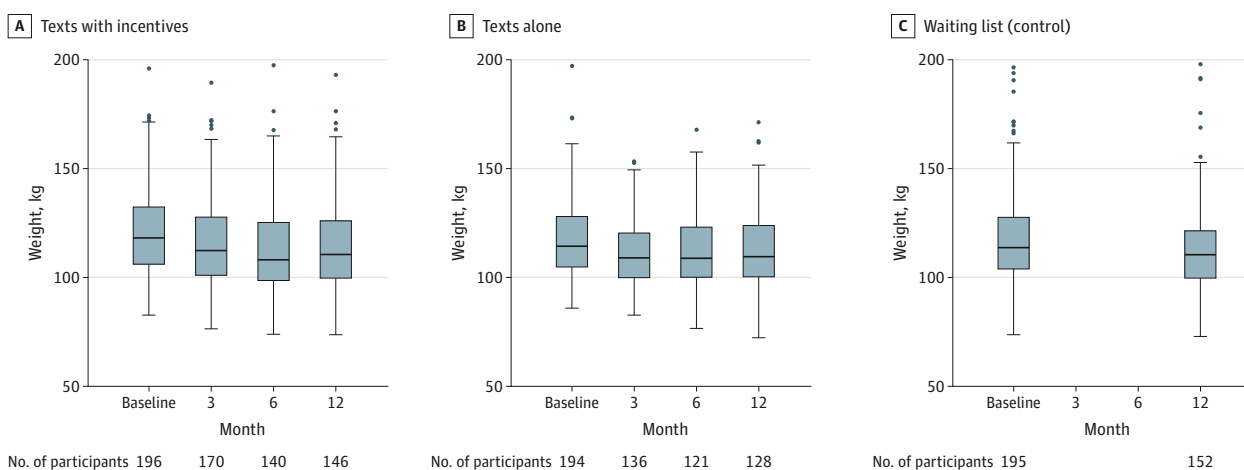
Table 2. Secondary Outcomes at 12 Months

Weight at 12 mo	Texts with incentives (n = 146)	Texts alone (n = 128)	Waiting list control (n = 152)	Risk differences (97.5% CI)		Odds ratios (97.5% CI) [P value]			
				Texts with incentives vs control	Texts alone vs control	Texts with incentives vs control	P value	Texts alone vs control	P value
<b>Weight loss</b>									
Any weight loss, %	114 (78)	86 (67)	92 (61)	17 (5.6 to 29) <sup>a</sup>	6.2 (6.6 to 19) <sup>a</sup>	2.3 (1.3 to 4.2) <sup>a</sup>	.001	1.3 (0.7 to 2.3) <sup>a</sup>	.28
≥5	65 (45)	32 (25)	28 (18)	26 (15 to 38) <sup>a</sup>	6.9 (4.2 to 18) <sup>a</sup>	3.6 (2.0 to 6.6) <sup>a</sup>	<.001	1.5 (0.8 to 2.9) <sup>a</sup>	.16
≥10	40 (27)	8 (6.3)	11 (7.2)	20 (11 to 30) <sup>a</sup>	-0.8 (-5.9 to 7.6) <sup>a</sup>	4.9 (2.2 to 11.1) <sup>a</sup>	<.001	0.9 (0.3 to 2.6) <sup>a</sup>	.78
<b>Weight change categories, No. (%)</b>									
Gain	32 (22)	42 (33)	60 (39)			3.2 (2.0 to 5.3) <sup>b</sup>	<.001	1.3 (0.8 to 2.2) <sup>b</sup>	.20
<b>Loss, %</b>									
0 to 5	49 (34)	54 (42)	64 (42)						
≥5 to <10	25 (17)	24 (19)	17 (11)						
≥10	40 (27)	8 (6.3)	11 (7.2)						

<sup>a</sup> Odds ratio from a binary logistic regression, adjusting for area and method of recruitment and using all observed outcome data, the absolute risk difference and confidence intervals were also estimated from this model and presented as a percentage.

<sup>b</sup> Odds ratio from an ordered categories logistic regression adjusting for area and method of recruitment and using all observed outcome data.

Figure 3. Weight Change in Kilograms Over Time



The thick lines in the boxes represent the median; the bottom and top of the box, the first and third quartiles, respectively; whiskers, an additional 1.5 times the IQR lower than the first quartile and higher than the third quartile; and dots, more extreme values that lie outside 1.5 times the IQR.

**Post Hoc Analyses**

Fifty-one participants reported taking weight-loss medications, including injectable therapies or meal replacements (eTable 17 in Supplement 3). In a post hoc exploratory analysis for which the observed 12-month follow-up data for these 51 participants were removed and then imputed, text messaging with financial incentives significantly improved weight loss compared with the control group (mean difference, -2.7%; 97.5% CI, -4.2% to -1.1%; *P* = .001), whereas the text messaging alone group was not significantly different compared with the control group (mean difference, -1.1%; 97.5% CI, -2.7% to 0.5%; *P* = .19; eFigure 1 and eTable 18 in Supplement 3).

**Adverse Events**

Overall, 366 adverse events were reported including 83 infections (23%), 58 social harms (17%, eg, bereavement, employ-

ment problems, illness of a family member, relationship problems); and 39 musculoskeletal and connective tissue adverse events (11%); 160 adverse events (44%) were in the text messaging with financial incentives group, 137 (37%) in the text messaging alone group, and 69 (19%) in the control group. Of the 366 adverse events, 23 (6.3%) were classified as serious adverse events, including 12 (52%) in the texts messaging with incentives group; 5 (22%) in the texts messaging alone group, and 6 (26%) in the control group. None were considered associated with participation in the clinical trial (eTables 19-22 in Supplement 3).

**Discussion**

In this randomized clinical trial involving 585 men with obesity, behavioral text messages combined with financial



incentives reduced weight by 3.2% compared with a control group. Text messaging alone did not significantly reduce weight compared with the control group. This study included 39% of men from lower socioeconomic backgrounds who have typically been under represented in clinical trials of weight loss in people with obesity.<sup>23</sup>

Although 5% weight loss is typically considered clinically meaningful, some evidence has suggested that weight loss of less than 5% may be clinically important.<sup>24,25</sup> Providing participants with cash that they could retain if they met study goals may have facilitated enrollment of participants with lower incomes, in contrast to deposit contract financial incentives where participants risk losing their own money.<sup>10,11</sup> Including men with obesity living in disadvantaged areas in making decisions about the design of the incentives, number of assessments, goals, and text messages<sup>16,17</sup> may have contributed to the effectiveness of the text messaging with the financial incentives intervention. A meta-analysis recommended 12 in-person contacts for individual or group behavioral weight-management interventions.<sup>26</sup> In addition, NICE (National Institute for Health and Care Excellence)<sup>27</sup> recommends weekly or fortnightly sessions, including a weigh-in at each weight management session, for at least 3 months. In contrast, interventions for the current study included 4 weight assessments, which could reduce costs and burden for participants and staff.

### Limitations

This study had several limitations. First, generalizability to women, diverse ethnic groups, people without mobile phone access, and people with low literacy, poor vision, or inability to attend weight assessments is uncertain. Second, the drop-out rate was higher among men in the group with text messaging alone compared with the other 2 groups. Third, weight regain is common following weight loss trials and may be greater for financial incentive interventions.<sup>28</sup> Follow-up weight beyond 12 months is not yet available for this study. Fourth, because the clinical trial did not include a 2 × 2 factorial design, it is not possible to know whether text messaging with financial incentives was more effective than financial incentives alone in this population. Fifth, harms were collected more frequently in the intervention groups than in the control group and might have influenced rates of adverse events.

### Conclusions

Among men with obesity, a text-messaging with an endowment financial incentive intervention significantly improved weight loss compared with a control group; however, text messaging alone was not significantly better than the control condition. These findings support text messaging combined with financial incentives to attain weight loss in men with obesity.

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