Obesity Surgery
https://doi.org/10.1007/s11695-024-07209-1

ORIGINAL CONTRIBUTIONS

Weight Loss with an AI-Powered Digital Platform for Lifestyle Intervention

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Received: 31 December 2023 / Revised: 28 March 2024 / Accepted: 28 March 2024

Abstract

Background Lifestyle intervention remains the cornerstone of weight loss programs in addition to pharmacological or surgical therapies. Artificial intelligence (AI) and other digital technologies can offer individualized approaches to lifestyle intervention to enable people with obesity to reach successful weight loss.

Methods SureMediks, a digital lifestyle intervention platform using AI, was tested by 391 participants (58% women) with a broad range of BMI (20–78 kg/m^2), with the aim of losing weight over 24 weeks in a multinational field trial. SureMediks consists of a mobile app, an Internet-connected scale, and a discipline of artificial intelligence called Expert system to provide individualized guidance and weight-loss management.

Results All participants lost body weight (average 14%, range 4–22%). Almost all (98.7%) participants lost at least 5% of body weight, 75% lost at least 10%, 43% at least 15%, and 9% at least 20%, suggesting that this AI-powered lifestyle intervention was also effective in reducing the burden of obesity co-morbidities. Weight loss was partially positively correlated with female sex, accountability circle size, and participation in challenges, while it was negatively correlated with sub-goal reassignment. The latter three variables are specific features of the SureMediks weight loss program.

Conclusion An AI-assisted lifestyle intervention allowed people with different body sizes to lose 14% body weight on average, with 99% of them losing more than 5%, over 24 weeks. These results show that digital technologies and AI might provide a successful means to lose weight, before, during, and after pharmacological or surgical therapies.

Keywords Weight loss · Artificial intelligence · Digital platform · Lifestyle intervention

Key Points
- Lifestyle intervention is the cornerstone of weight loss programs and digital technologies can enhance personalization, engagement, and effectiveness.
- An AI-based digital weight loss platform consisting of a mobile app, an Internet-connected scale, and an AI-based system to provide individualized guidance and weight-loss management was tested in a multinational field trial.
- A sample of 391 participants with a broad range of BMI, accomplished 14% (range 4–22%) weight loss over 24 weeks.
- Almost all (99%) participants lost at least 5% of body weight, suggesting that this AI-powered lifestyle intervention can reduce the burden of obesity co-comorbidities.

Introduction

Obesity is a chronic, relapsing, and progressive disease that is now recognized at the same time as the most prevalent chronic disease and, with the cluster of associated co-morbidities, as one of the leading causes of preventable disability and death worldwide [1].

As excess body fat — and, consequently, excess body weight — is the defining characteristic of obesity, weight loss, with all correlated metabolic, cardiovascular, and

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Published online: 04 April 2024

systemic benefits, is the basic metric of success in the treatment of obesity.

Lifestyle intervention, providing a sustained negative energy balance via calorie intake restriction and increased physical activity, is the natural and theoretically obvious approach to the treatment of obesity. However, its impact on the natural history of the disease and the health of people living with obesity is generally limited by compliance challenges and mid- and long-term failure, revealing the existence of powerful counterregulatory mechanisms [2] that make the task of losing weight and keeping it off very difficult [3–5]. Despite these challenges and pitfalls, lifestyle intervention remains the cornerstone of the treatment of obesity and as such is the first line and background treatment of any pharmacological or surgical therapies.

Currently, the armamentarium of therapeutic options available includes effective pharmacological therapies and endoscopic and surgical interventions, besides lifestyle intervention. Lifestyle and pharmacological or surgical therapies are set as complementary approaches that can be customized and combined to enable success for each specific person with obesity.

For example, metabolic and bariatric surgery (MBS) are options for patients that have had their own history of unsuccessful attempts at lifestyle intervention and need prompt and durable weight loss. At the same time, a period of medical management and in many cases pre-operative weight loss are also required to assess patient nutritional status, motivation, and ability to comply with medical directions: all important factors of success for the surgical procedure itself and the post-operative follow-up [6].

The post-operative follow-up, which is truly a lifelong endeavor, leverages lifestyle modifications, not only to improve the tolerability of the side effects of the MBS procedures but also to manage nutrition and energy balance effectively to pursue safe and healthy weight loss. Lifestyle modifications, for example, can correct micronutrient deficiencies, as well as post-prandial reactive hypoglycemia and dumping symptoms that are frequently associated with certain types of MBS [6], and can reduce or eliminate weight regain that often follows the initial MBS-induced weight loss [7].

On the other hand, to be effective, lifestyle intervention requires frequent monitoring and interactions with people with obesity that are not feasible at the level of primary care settings and at the scale that the prevalence of obesity demands. Digitally assisted lifestyle intervention or modification programs are now becoming more available to fill this gap, but also to offer more comprehensive management of the individuals trying to lose weight by leveraging and interpreting information from a wide array of sources. AI, along with complementing digital health technologies, offers a promising approach to obesity management. Here, we report the results of a field trial to assess the effectiveness of using a digital platform called SureMediks to lose weight over 24 weeks by a sample of individuals with a broad range of BMI. SureMediks consists of a mobile app to allow easy access to the platform, an Internet-connected scale for an automatic report of the participant's body weight, a cloud server to store and analyze accrued data, an AI-based system to provide tailored guidance, and dashboards for the trial managers (i.e., coaches) to manage participants' progress during the trial.

Methods

Participant Enrollment and Trial Setup

Initially, 1137 participants from the USA, Canada, UK, and Australia accepted the invitation to participate. They were asked screening questions to determine their commitment to losing weight and their readiness to follow a low-calorie diet and track their physical activity. Participants' consent was registered online during screening. The trial was set for 24 weeks, with a benchmark weight loss goal of 10%. Participants were requested to complete the trial even if the goal of 10% weight loss was achieved in less than 24 weeks.

Procedure and Measures

SureMediks platform consists of (1) a mobile app to allow participants to access the platform and communicate with the system for motivation [8–10], guidance, accountability, support [11–14], gamification [15], and progress tracking [16–19]; (2) a digital scale connected via WiFi to a cloud server for an automatic report of the body weight; (3) a cloud server to store and organize the data for easy interrogation and use; (4) an AI-expert system (ES) to provide tailored guidance to the participants (Fig. 1) [20–22]; (5) dashboards for the trial managers (i.e., coaches: four in total, one per country) to assist with the management of participants during the trial. The field trial setup is depicted in Fig. 2.

To ensure continuous engagement and enable success, SureMediks divided the overall weight loss goal into weekly sub-goals (short-term goals) [23] based on the Khokhar WL formula: (US Patent number 11,353,358), $W_{loss} = \frac{\Delta W}{1-e^{-\frac{r\tau}{10}}}\left(e^{-\frac{rn}{10}} - e^{-\frac{r\tau}{10}}\right)$, where W_{loss} is the total weight loss, ΔW is the target weight loss during each week, τ is the time to lose weight, and r is the curve tension, which defines the weight loss curve bending (Fig. 3).

SureMediks provided individualized feedback and guidance, based on the participants' current and previous weight loss, and self-reported food consumption and physical activity. The knowledge base used by the AI system included

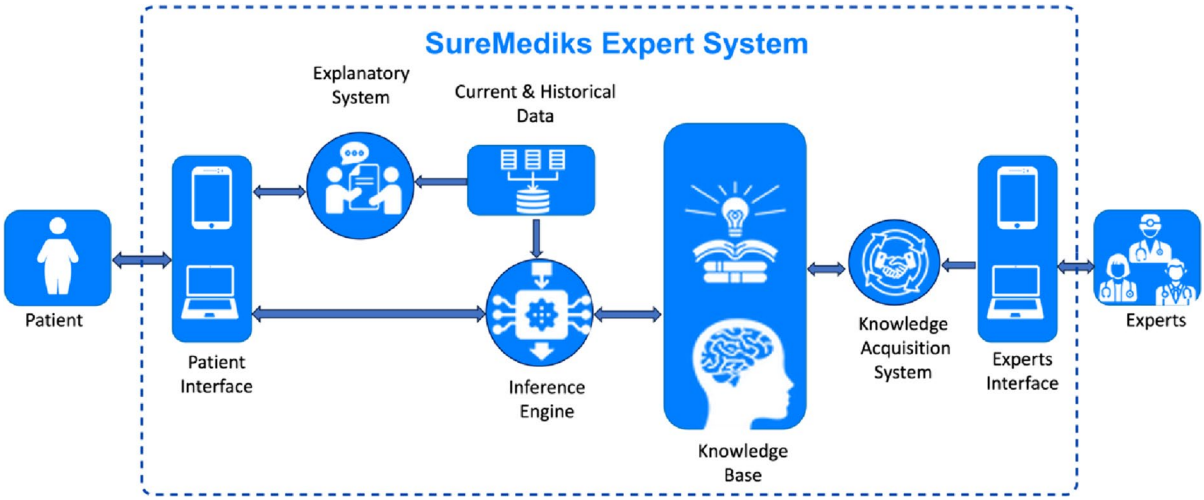

Fig. 1 Tailored guidance, education, and explanations delivery of SureMediks Expert System (ES). The knowledge acquisition system of the ES extracts the expert knowledge and translates it into rules in the knowledge base (KB). Inference engine (IE) activates these rules based on current and historical patient data, such as body weight, body composition, macronutrient composition of the diet, and physical activity level, and provides guidance and education. IE also updates the rules in KB dynamically as it learns new knowledge about the participant. The explanatory system interprets participant's data and explains their significance to the participants via text, charts, and graphs in the mobile app

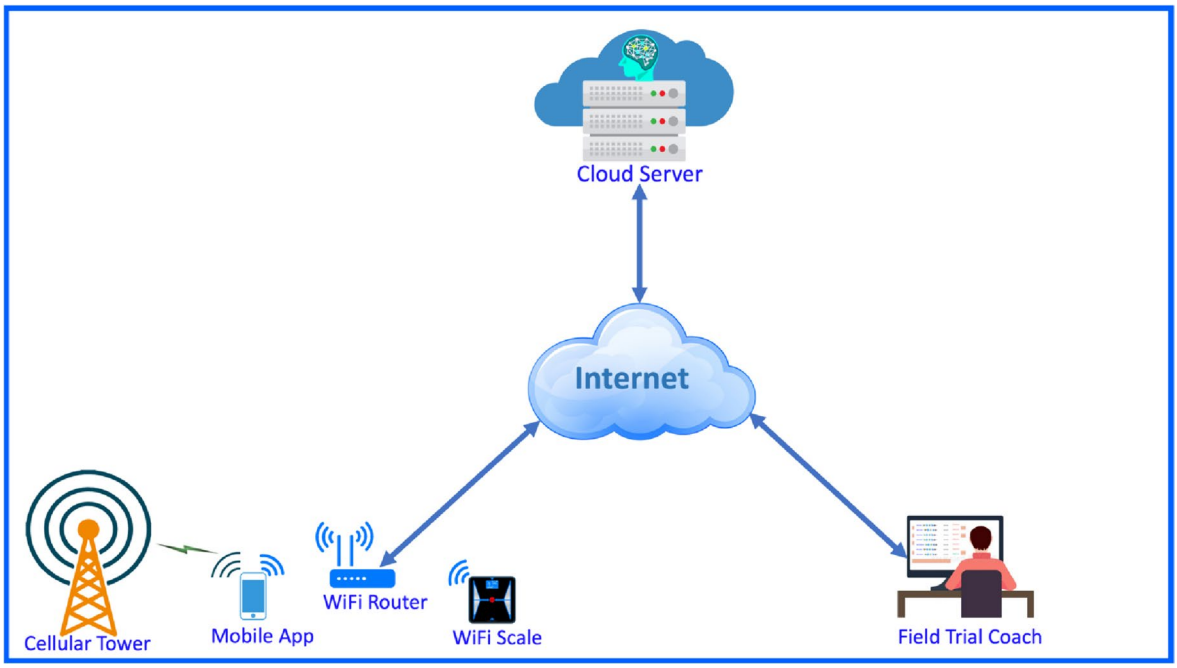

Fig. 2 The field trial setup: participants have a WiFi-enabled scale and mobile app, the field trial coach has the dashboard, and the AI system is in the cloud

scientific societies' guidelines, position papers, original papers, and dietary recommendations.

The initial 10% weight loss goal was generated and translated into an estimated target curve at the start of the trial. For those participants who achieved 10% before the end of the trial (24 weeks), additional subgoals were added, and the new target curve was concatenated with the previous one, resulting in one adaptive target curve.

Participants could add other participants into their accountability circle to share experiences, support each

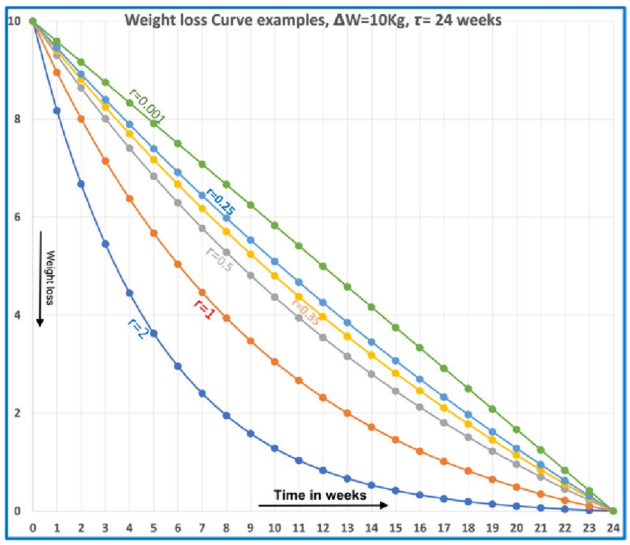

Fig. 3 Various paths of weight loss described by different values of the curve tension, i.e., *r*

other, engage in challenges (so-called, gamification), and have interactive discussions with other participants. Every 4 weeks, there was the possibility to launch a new challenge to lose additional body weight.

The participants' body weight was auto-reported to the field study managers and the cloud server for analysis; no human intervention was needed. The app allowed participants to communicate with their coaches as needed through text messages and video calls.

Baseline weight was measured at the start of the trial, and participants were encouraged to step on the scale at least twice a week.

Statistical Analysis

Parametric (such as paired *t*-test, ANOVA, multivariate regression) and non-parametric (such as chi-square) statistical tests were used for the assessment of comparison and distribution of continuous and categorical variables, respectively. Statistical analysis was performed using the EXCEL software (Microsoft, Redmond, USA). A *P*-value of less or equal to 0.05 was considered statistically significant.

Results

Three hundred ninety-one participants (age 21–77 years) completed the 6-month trial. This population included participants with a broad BMI range (19.8–77.5 kg/m^2), encompassing all BMI categories, from normal weight to the most severe degrees of obesity (Table 1). Three hundred forty-eight participants were classified as individuals with

Table 1 Demographic and clinical characteristics of the participants at baseline

Characteristic	All participants, $N=391$
Age, yrs.—M ± SD [range]	47.3 ± 16.5 [21–77]
Female sex—*n* (%)	227 (58.1)
Body weight, kg—M ± SD [range]	120.8 ± 31.6 [64.6–180]
BMI, kg/m^2—M ± SD [range]	45.9 ± 13.0 [19.8–77.5]

obesity (BMI ≥ 30 kg/ m^2). The most represented BMI subgroups were in the obesity range, specifically the O-III and O-IV categories, with 29% and 17% of the total population, respectively (Table 2). Gender representation was balanced overall and across subgroups, with no statistical differences observed ($P > 0.05$). Age was also not significantly different across subgroups ($P > 0.05$; data not shown).

All participants had body weight loss (average 13.9%), from a minimum of 3.8% to a maximum of 22% of the baseline weight. Within the obesity range subpopulation, weight loss was 13.7% on average, from a minimum of 3.8% to a maximum of 22% of the baseline weight.

Weight loss was highly significant ($p < < 0.05$) overall and at the subgroup level. There were no significant ($p > 0.05$) differences in body weight loss across subgroups (Table 3). Weight loss was not different between female and male participants, both overall and within subgroups ($p > 0.05$; data not shown).

Almost all (98.7%) participants lost at least 5% of body weight, 75% lost at least 10%, 43% at least 15%, and 9% at least 20% (Fig. 4). The distribution of standard weight loss categories by subgroups was not significantly different.

As the time course of weight loss was guided according to the target weight loss curve established for each participant at the beginning of the trial, actual goal achievement was checked on a weekly basis, and, if necessary, feedback aiming to correct the trajectory was delivered by SureMediks to the participant. Figure 5 shows an example of an individual time course of weight loss, illustrating the accuracy of weight loss management accomplished with SureMediks.

The characteristic features of SureMediks (sub-goal reassignments, accountability circle, and participation in challenges) were variably used by the participants (Table 4). Together with demographic and clinical variables (age, sex, baseline BMI), these variables were evaluated in a multivariate regression to identify possible contributing factors to weight loss in the trial. As shown in Table 5, female sex, accountability-circle size, and participation in challenges were positively correlated, whereas sub-goal reassignments were negatively correlated with the achieved weight loss. Age and BMI were not significantly associated with weight loss in the multivariate model. Results were similar in the all-population and in the all-obesity group (Table 5).

Table 2 Distribution of participants in BMI-defined subgroups

Subgroup	*n* (%)	Female sex—*n* (%)	BMI, kg/ m^2—M ± SD
Normal weight—NW (19–24.9 kg/ m^2)	12 (3.1)	6 (50.0)	22.8 ± 1.5
Overweight—OW (25–29.9 kg/ m^2)	31 (7.9)	17 (54.8)	27.9 ± 1.5
Obesity I—O I (30 – 34.9 kg/ m^2)	50 (12.8)	32 (64.0)	32.6 ± 1.5
Obesity II—O II (35- 39.9 kg/ m^2)	48 (12.3)	22 (45.8)	37.3 ± 1.5
Obesity III—O III (40 – 49.9 kg/ m^2)	112 (28.6)	67 (59.8)	44.9 ± 2.8
Obesity IV—O IV (50 – 59.9 kg/ m^2)	68 (17.4)	46 (67.6)	54.5 ± 4.5
Obesity V—O V (60 – 69.9 kg/ m^2)	56 (14.3)	29 (51.8)	64.5 ± 2.9
Obesity VI—O VI (≥ 70 kg/ m^2)	14 (3.6)	8 (57.1)	72.9 ± 2.4

Table 3 Weight loss for all participants and by subgroup

Participants	Weight loss, kg	Weight loss, % of baseline
All—M ± SD [range]	16.8 ± 7.1 [3.5–37.2]	13.9 ± 4.4 [3.8–22.0]
NW—M ± SD [range]	10.7 ± 4.5 [3.6–19.4]	14.6 ± 5.1 [5.6–20.4]
OW—M ± SD [range]	12.9 ± 4.2 [5.3–19.6]	15.6 ± 3.9 [7.2–21.3]
All obesity subgroups (*n* = 348)—M ± SD [range]	17.3 ± 7.2 [3.5–37.2]	13.7 ± 4.4 [3.8–22.0]
O I—M ± SD [range]	12.3 ± 4.1 [5.2–20.0]	14.0 ± 4.0 [6.5–21.4]
O II—M ± SD [range]	14.3 ± 5.2 [3.5–25.9]	13.9 ± 4.4 [3.8–20.9]
O III—M ± SD [range]	17.6 ± 6.8 [5.5–33.1]	14.3 ± 4.4 [5.4–22.0]
O IV—M ± SD [range]	19.3 ± 7.2 [5.3–36.4]	13.2 ± 4.4 [4.2–21.2]
O V—M ± SD [range]	20.6 ± 7.9 [9.1–37.2]	12.8 ± 4.6 [6.1–21.7]
O VI—M ± SD [range]	21.4 ± 9.6 [6.8–36.5]	12.5 ± 5.3 [4.1–20.8]

Discussion

In this field trial, we found that participants with obesity had a mean weight loss of 13.7% from baseline using an AI-assisted lifestyle intervention only. This outcome is greater than typically reported with sustained lifestyle interventions and is nominally comparable with results reported with the most effective GLP-1 RA [24, 25], although the absence of a control group in our trial does not endorse extrapolation of the results.

More importantly, all participants lost body weight, with a staggering 98.7% and 98.6% losing at least 5%, overall and among the participants with obesity, respectively. As known, this weight loss threshold is generally accepted as the qualifier for clinically meaningful weight loss and as such is used by the FDA as a benchmark for the evaluation of efficacy (hence the benefit/risk) of new treatments for obesity or overweight with co-morbidities under review for market authorization.

While we cannot show the associated improvement in metabolic and cardiovascular variables—as these data were not collected—the achievement of 5% or greater weight loss is an indicator of improvement in metabolic health [26] and as such is generally adopted as a marker of the success of weight loss treatments. From this point of view, people with and without obesity using the lifestyle intervention used in this trial achieved the highest percentage of success of any non-surgical treatment for obesity, thus far reported, to the best of our knowledge.

Furthermore, large proportions of participants with and without obesity were able to obtain more desirable targets of weight loss: at least 10 or 15% from baseline levels that are typically associated with major benefits in obesity-related co-morbidities [26].

Our search for potential baseline characteristics and specific SureMediks variables contributing to weight loss identified female sex, accountability-circle size and participation in challenges as positively associated, and sub-goal reassignments as negatively associated, with the outcome. Altogether these variables, and—non-significant per se—BMI and age, explained two-thirds of the achieved weight loss. Not surprisingly, the size (i.e., number of members) of the accountability circle was a success factor as it is a proxy for the amount of support and encouragement that participants received from friends, family, and acquaintances [12, 27]. Similarly, a greater participation in challenges indicates a higher level of engagement and motivation that are natural success factors in lifestyle intervention programs. On the other hand, a greater number of sub-goal reassignments,

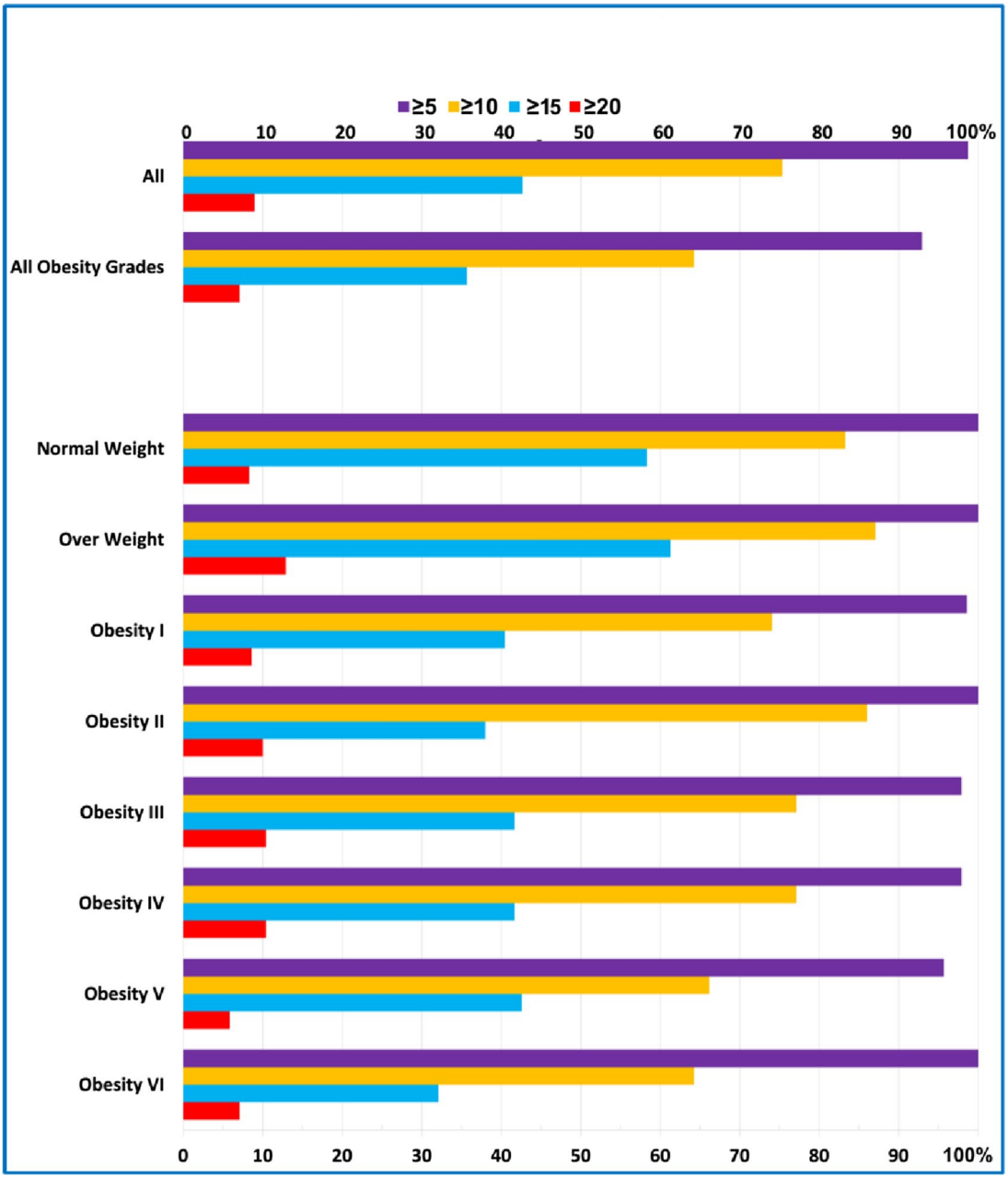

Fig. 4 Proportions of participants achieving body weight reduction targets overall and by subgroups

while instrumental to the attainment of the overall weight loss goals, indicate that participants struggled somewhat with keeping a constant pace of weekly results, suggesting a certain level of difficulty in achieving the assigned goals. In terms of baseline characteristics, while we did not observe significant differences in the outcome between women and men, women seemed to have a slight advantage in using the SureMediks platform efficiently, possibly because of a greater degree of compliance and motivation. Interestingly, in the multivariate analysis, BMI and age did not show a significant correlation with weight loss, indicating that this AI-aided lifestyle intervention is equally effective at all ranges of body size and all ages represented in the enrolled sample. We can speculate that this might be explained by the personalization of procedures, management, and goal attainment, making the path to success more reliable and feasible than commonly experienced in lifestyle intervention programs.

Although clearly smaller than the weight loss achievable with bariatric surgery procedures [28], this methodology of lifestyle intervention can be very instrumental during the "run-in" period to elect candidates for bariatric surgery as

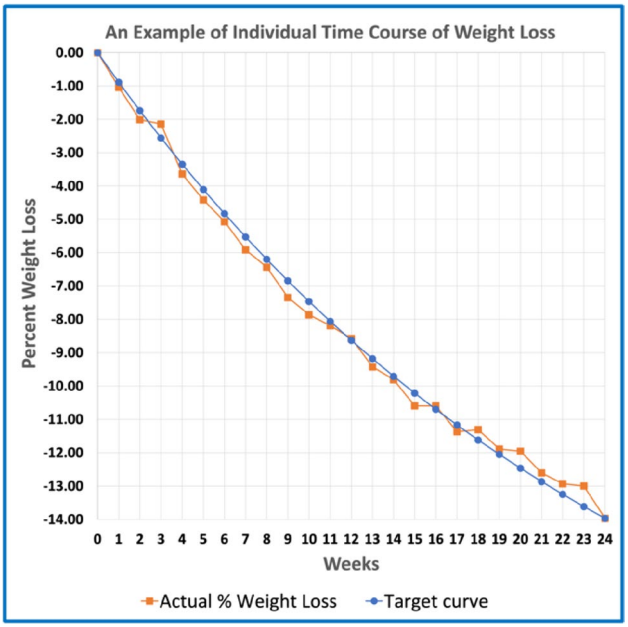

Fig. 5 Example of individual time course of weight loss

well as, and maybe more importantly, for managing the weight loss effects and overall regained health and lifestyle after surgery. In their essence, lifestyle interventions and modifications provide the critical benefit of building or strengthening the behavioral and cognitive skills necessary to manage energy intake and energy expenditure according to individual health goals [25, 29]. This effect of lifestyle modifications is fundamental for the long-term success of both pharmacological and surgical therapies for obesity: this is the reason why lifestyle modifications remain the first line and background therapy of any treatment for obesity.

Taken together, results from this field trial support the use of AI-assisted methodologies for lifestyle interventions offering the added benefit of highly customizable, multidimensional, and user-friendly features. We believe that the combination of all these positive characteristics has allowed people to use this methodology to achieve the great results that we report here.

This field trial had several limitations: the absence of a control group and lack of measurement of obesity-associated phenotypes are the major ones. Furthermore, we have not followed up on these participants after the weight loss phase reported here: SureMediks or a similar platform could be used for weight loss maintenance, as the same principles leading to success in weight loss can be applied adaptively for successful weight loss maintenance. However, this hypothesis needs to be tested in a dedicated study that we are currently planning. Considering these limitations, the results reported here warrant further confirmation as related to the magnitude of the weight loss effect and of the implied, associated metabolic, cardiovascular, respiratory, and quality of life benefits.

Conclusion

Using an AI-assisted lifestyle intervention, with user-friendly and personalized features, people with obesity, overweight, and normal weight achieved a remarkable 14%

Table 4 SureMediks characteristic features measured cumulatively during the trial

Feature	All participants ($N=391$)
Sub goals reassignment—M ± SD [range]	4.03 ± 1.95 [1–10]
Accountability circle members—M ± SD [range]	4.03 ± 1.43 [1–6]
Participation in challenges—M ± SD [range]	2.18 ± 1.34 [0–6]

Table 5 Multiple regression model for weight loss results

Independent variable	All participants, $N=391$ R square = 0.66			All participants with obesity $N=348$ R square = 0.67		
	Regression coefficient	t Stat	p-value	Regression coefficient	t Stat	p-value
Intercept	14.27	14.4	6.1 E-38	13.82	12.5	6.2 E-30
BMI	−0.02	−1.9	0.06	−0.01	−1.0	0.3
Age	−0.01	−1.3	0.2	−0.01	−0.9	0.4
Female sex	0.79	3.2	0.002	0.70	2.7	0.006
Sub-goals reassignment	−1.01	−12.0	2.2 E-28	−1.03	−11.5	4.7 E-26
Accountability circle members	0.41	3.6	0.0003	0.4	3.4	0.0008
Participation in challenges	1.35	12.3	1.22 E-29	1.37	11.9	1.4 E-27

weight loss on average after 24 weeks. All participants lost weight, with more than 98% losing 5% or more, suggesting that this lifestyle intervention is associated with extensive benefits in reducing obesity and related co-morbidities.

Acknowledgements We would like to thank our participants and their commitment to their dedicated time. Their compliance and dedication to our field trial were commendable. We would also like to thank Mr. Kannan Palaniswami for his efficient technical support and Ms. Helga Andersen for her moral support in completing the field trial and organizing the database.

Data Availability The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics Statement All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Consent to Participate Consent from all the participants was taken after they had read the details of the trial, understood, and voluntarily consented to participate in the field trial.

Conflict of Interest Sarfraz Khokhar is a scientific officer at Rasimo Systems where SureMediks is a research and development project. Angelo Del Parigi is a senior advisor for Rasimo System. Catherine Toomer is a medical advisor for Rasimo System. John Holden has no conflict of interest.

References

1. Powell-Wiley TM, Poirier P, Burke LE, et al. Obesity and cardiovascular disease: a scientific statement from the American Heart Association. Circulation. 2021;143(21):e984–1010.
2. Schwartz MW, Seeley RJ, Zeltser LM, et al. Obesity Pathogenesis: an endocrine society scientific statement. Endocr Rev. 2017;38(4):267–96.
3. Jensen MD, Ryan DH, Donato KA, et al. Guidelines (2013) for managing overweight and obesity in adults. Obesity. 2014;22(S2):S1-410.
4. Butryn ML, Webb V, Wadden TA. Behavioral treatment of obesity. Psychiatr Clin North Am. 2011;34(4):841–59.
5. Guidelines (2013) for managing overweight and obesity in adults. Preface to the executive summary. Obesity (Silver Spring). 2014;22 Suppl 2:S4.
6. Bettini S, Belligoli A, Fabris R, et al. Diet approach before and after bariatric surgery. Rev Endocr Metab Disord. 2020;21(3):297–306.
7. Kow L, Sharaiha RZ, O'Kane M, et al. Methodology and results of a joint IFSO-WGO Delphi survey of 94 intercontinental, interdisciplinary experts in obesity management. Obes Surg. 2023;33(11):3337–52.
8. Williams GC, Grow VM, Freedman ZR, et al. Motivational predictors of weight loss and weight-loss maintenance. J Pers Soc Psychol. 1996;70(1):115–26.
9. Soini S, Mustajoki P, Eriksson JG. Long-term weight maintenance after successful weight loss: motivational factors, support, difficulties, and success factors. Am J Health Behav. 2018;42(1):77–84.
10. West DS, Gorin AA, Subak LL, et al. A motivation-focused weight loss maintenance program is an effective alternative to a skill-based approach. Int J Obes (Lond). 2011;35(2):259–69.
11. Bradford TW, Grier SA, Henderson GR. Weight loss through virtual support communities: a role for identity-based motivation in public commitment. J Interact Mark. 2017;40(1):9–23.
12. Hwang KO, Ottenbacher AJ, Green AP, et al. Social support in an Internet weight loss community. Int J Med Inform. 2010;79(1):5–13.
13. Islam MM, Poly TN, Walther BA, et al. Use of mobile phone app interventions to promote weight loss: meta-analysis. JMIR Mhealth Uhealth. 2020;8(7):e17039.
14. Antoun J, Itani H, Alarab N, et al. The effectiveness of combining nonmobile interventions with the use of smartphone apps with various features for weight loss: systematic review and meta-analysis. JMIR Mhealth Uhealth. 2022;10(4):e35479.
15. Timpel P, Cesena FHY, da Silva CC, et al. Efficacy of gamification-based smartphone application for weight loss in overweight and obese adolescents: study protocol for a phase II randomized controlled trial. Ther Adv Endocrinol Metab. 2018;9(6):167–76.
16. Winpenny EM, Smith M, Penney T, et al. Changes in physical activity, diet, and body weight across the education and employment transitions of early adulthood: a systematic review and meta-analysis. Obes Rev. 2020;21(4):e12962.
17. Hollis JF, Gullion CM, Stevens VJ, et al. Weight loss during the intensive intervention phase of the weight-loss maintenance trial. Am J Prev Med. 2008;35(2):118–26.
18. McTiernan A, Sorensen B, Irwin ML, et al. Exercise effect on weight and body fat in men and women. Obesity (Silver Spring). 2007;15(6):1496–512.
19. Frie K, Hartmann-Boyce J, Jebb S, et al. Patterns in weight and physical activity tracking data preceding a stop in weight monitoring: observational analysis. J Med Internet Res. 2020;22(3):e15790.
20. Stein N, Brooks K. A Fully Automated conversational artificial intelligence for weight loss: longitudinal observational study among overweight and obese adults. JMIR Diabetes. 2017;2(2):e28.
21. Forman EM, Berry MP, Butryn ML, et al. Using artificial intelligence to optimize delivery of weight loss treatment: protocol for an efficacy and cost-effectiveness trial. Contemp Clin Trials. 2023;124:107029.
22. Turner-McGrievy G, Tate D. Tweets, apps, and pods: results of the 6-month mobile pounds off digitally (mobile POD) randomized weight-loss intervention among adults. J Med Internet Res. 2011;13(4):e120.
23. Jeffery RW, Wing RR, Mayer RR. Are smaller weight losses or more achievable weight loss goals better in the long term for obese patients? J Consult Clin Psychol. 1998;66(4):641–5.
24. Wilding JPH, Batterham RL, Calanna S, et al. Once-weekly semaglutide in adults with overweight or obesity. N Engl J Med. 2021;384(11):989–1002.
25. Wadden TA, Chao AM, Moore M, et al. The role of lifestyle modification with second-generation anti-obesity medications: comparisons, questions, and clinical opportunities. Curr Obes Rep. 2023;12(4):453–73.
26. Ryan DH, Yockey SR. Weight loss and improvement in comorbidity: differences at 5%, 10%, 15%, and over. Curr Obes Rep. 2017;6(2):187–94.
27. Chhabria K, Ross KM, Sacco SJ, et al. The assessment of supportive accountability in adults seeking obesity treatment: psychometric validation study. J Med Internet Res. 2020;22(7):e17967.

28. O'Brien PE, Hindle A, Brennan L, et al. Long-term outcomes after bariatric surgery: a systematic review and meta-analysis of weight loss at 10 or more years for all bariatric procedures and a single-centre review of 20-year outcomes after adjustable gastric banding. Obes Surg. 2019;29(1):3–14.
29. Wadden TA, Tronieri JS, Butryn ML. Lifestyle modification approaches for the treatment of obesity in adults. Am Psychol. 2020;75(2):235–51.