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# Comparing Two AI Coaching Interventions to Boost Physical Activity in Cancer Survivors: A Randomized Controlled Trial

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## ABSTRACT

*Background: Physical activity is essential for cancer survivors, improving function, reducing fatigue, and lowering recurrence risk, yet adherence remains poor due to physical and psychosocial barriers. Artificial intelligence (AI)–driven health coaching offers scalable, personalized support. Objective: To compare the effectiveness of two AI coaching interventions—SmartText and Alfa Fitness—in increasing physical activity among cancer survivors. Methods: In a three-arm randomized controlled trial at a tertiary center in Lahore, Pakistan, 60 post-treatment survivors were allocated equally to Control, SmartText, or Alfa Fitness. Interventions were delivered for 4 weeks. The primary outcome was change in average daily steps, measured with calibrated pedometers. Secondary outcomes were health-related quality of life (FACT-G) and exercise motivation (BREQ-3). Analyses used repeated-measures ANOVA with post-hoc comparisons and 95% confidence intervals (CIs). Results: Alfa Fitness significantly increased daily steps (+3,618; 95% CI: 2,490–4,764; p<0.001), while SmartText produced a smaller, nonsignificant gain (+1,619; 95% CI: –328 to 3,566; p=0.051). Control participants showed minimal change (+886; 95% CI: –895 to 2,667). FACT-G improved by +5.2 points (95% CI: 2.1–8.3) with Alfa Fitness and +2.8 points (95% CI: 0.1–5.5) with SmartText, compared with +1.1 in Control. No adverse events occurred, and adherence exceeded 90%. Conclusion: Interactive AI coaching (Alfa Fitness) significantly enhanced physical activity and quality of life among cancer survivors, outperforming text-based messaging. These findings support integrating adaptive AI tools into survivorship care, with larger, longer trials needed to confirm sustainability and cost-effectiveness.*

***Keywords***
*artificial intelligence, cancer survivors, physical activity, digital health, randomized controlled trial, survivorship care*

## INTRODUCTION

The growing population of cancer survivors represents an important public health challenge, as survivorship care must go beyond disease monitoring to address physical recovery, psychosocial well-being, and long-term quality of life (Bluethmann et al., 2021; Hassoon et al., 2021). Physical activity is central to this agenda, given its established benefits in reducing fatigue, improving functional capacity, and lowering recurrence and mortality risk. Yet, despite strong recommendations, adherence to activity guidelines among survivors remains poor, largely due to barriers such as treatment-related fatigue, psychological distress, and social or environmental constraints (Nelson et al., 2019; Jones et al., 2020).

Behavioral science provides useful frameworks for understanding these challenges and for designing effective interventions. Bandura's self-efficacy theory highlights the role of confidence in one's ability to exercise, suggesting that supportive feedback and reinforcement can strengthen adherence (Bandura, 1997). Similarly, the COM-B model conceptualizes behavior as a dynamic interplay of capability, opportunity, and motivation, underscoring the importance of interventions that not only remind survivors but also actively enhance their confidence and access to supportive structures. Social Cognitive Theory further emphasizes observational learning, feedback, and self-regulation as mechanisms that can be harnessed through digital platforms. These models collectively provide a theoretical foundation for artificial intelligence (AI)–enabled health coaching, which can deliver tailored prompts, adaptive goal setting, and real-time reinforcement to sustain physical activity in vulnerable populations.

AI-based interventions are increasingly explored as scalable solutions for behavioral change. By leveraging machine learning and natural language processing, AI systems can adaptively respond to individual progress and barriers, creating a more engaging experience compared with one-directional reminders (Smith et al., 2018; Xu et al., 2018). Early feasibility trials have shown modest improvements in physical activity among cancer survivors using text-based or app-based coaching (Ritvo et al., 2017; Hassoon et al., 2021). However, most studies have evaluated single platforms in isolation, leaving a critical gap in head-to-head comparative evidence across different modes of AI delivery. This is particularly relevant for cancer survivorship, where understanding which digital features most effectively drive adherence is vital for clinical translation.

Step count, the primary endpoint in many survivorship interventions, offers both clinical and behavioral significance. Objectively measured daily steps provide a reliable marker of physical activity, correlate with improvements in cardiorespiratory fitness and metabolic health, and are strongly associated with reduced recurrence and mortality risk in cancer populations (Nelson et al., 2019). Even incremental increases in daily steps have been shown to meaningfully improve long-term outcomes, making it a pragmatic and clinically relevant outcome measure for intervention trials. To address the gaps in comparative evaluation, this randomized controlled trial tested two distinct AI coaching interventions—SmartText, a text-based feedback system, and Alfa Fitness, an interactive mobile application—against usual care. The primary outcome was change in average daily steps over four weeks. By contrasting these platforms within a rigorous trial design, this study provides the first direct evidence comparing the effectiveness of two AI-driven approaches for enhancing physical activity in cancer survivors, thereby informing future survivorship care strategies.

## MATERIALS AND METHODS

This investigation was conducted as a parallel-group, individually randomized controlled trial (RCT) designed to evaluate the effectiveness of two artificial intelligence (AI)–based coaching interventions in increasing physical activity among cancer survivors. The RCT framework was chosen for its methodological rigor in minimizing bias and establishing causal inference, consistent with CONSORT recommendations (Schulz and Grimes, 2002).

The trial was carried out at a tertiary care institute and its affiliated outpatient survivorship clinics in Shalamar Institute of Health Sciences, Lahore, Pakistan, between September and October 2023. Eligible participants were adults (≥18 years) with a histologically confirmed cancer diagnosis who had completed primary treatment at least four weeks prior to enrollment. Exclusion criteria included metastatic disease, medical contraindications to exercise as determined by a treating physician, or concurrent participation in another interventional study. Recruitment was conducted through survivorship clinics, outpatient referrals, and targeted outreach campaigns. Written informed consent was obtained from all participants after disclosure of study aims, procedures, and potential risks.

A total of 60 participants were randomly assigned in a 1:1:1 ratio to SmartText, Alfa Fitness, or control groups. The randomization sequence was computer-generated using variable block sizes of 3 and 6 to ensure allocation balance. Allocation concealment was achieved through sequentially numbered, opaque sealed envelopes prepared by an independent researcher not otherwise involved in recruitment or analysis. Due to the behavioral nature of the interventions, blinding of participants and intervention providers was not feasible; however, outcome assessors and data analysts were blinded to group assignment to minimize detection and analysis bias.

SmartText: Participants received automated, tailored text messages delivered daily, consisting of motivational prompts, reminders to increase step counts, and reinforcement feedback. Alfa Fitness: Participants used a mobile application with interactive features, including adaptive goal setting, real-time progress tracking, and tailored feedback based on daily performance. Control: Participants received usual survivorship care with no structured AI support. Both interventions were delivered for four consecutive weeks. Participants were asked to refrain from enrolling in any other structured physical activity program during the study period. Adherence was monitored through pedometer wear-time logs and app usage reports, with weekly check-ins conducted via telephone to troubleshoot issues and encourage compliance.

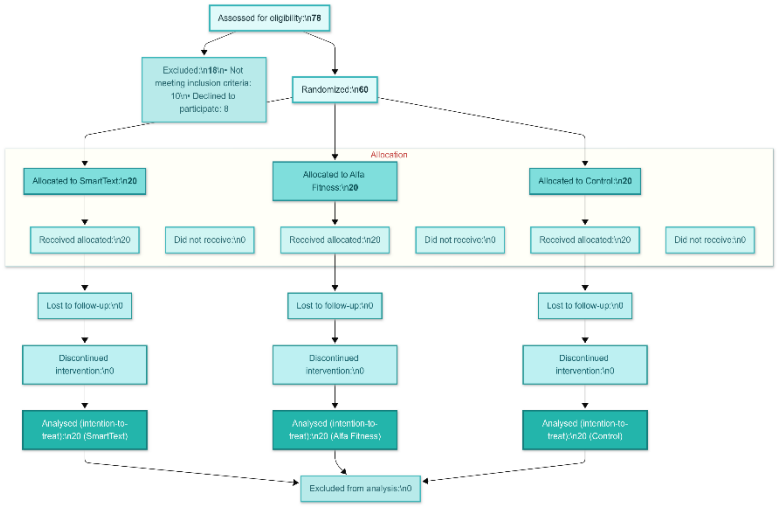


*Figure 1 CONSORT Flowchart*

The primary outcome was change in mean daily step count from baseline to four weeks. Step counts were measured using validated digital pedometers (Omron HJ-325, Omron Healthcare, Kyoto, Japan), which were calibrated prior to use. Participants were instructed on standardized wear protocols (during waking hours except bathing or swimming). Daily logs were cross-verified against pedometer memory to ensure data integrity.

Secondary outcomes included self-reported health-related quality of life (HRQoL) assessed using the Functional Assessment of Cancer Therapy–General (FACT-G) questionnaire, and exercise motivation measured with the Behavioral Regulation in Exercise Questionnaire-3 (BREQ-3). Both instruments have demonstrated validity in cancer populations. A pragmatic sample size of 60 (20 per arm) was chosen based on available resources and feasibility. Although no formal a priori power calculation was performed, a post-hoc power analysis indicated that the sample provided >80% power to detect large between-group differences in step counts (Cohen's d ≥0.8) at a two-sided α of 0.05 (Cohen, 1992).

All analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Baseline characteristics were summarized using descriptive statistics. The primary analysis employed repeated-measures analysis of variance (ANOVA) to evaluate within- and between-group differences in daily step counts, with Greenhouse–Geisser correction applied where assumptions of sphericity were violated. Post-hoc pairwise comparisons were adjusted using the Bonferroni method. Effect sizes were estimated using partial eta squared ($\eta^2$) and 95% confidence intervals (CIs). Secondary outcomes were analyzed using mixed-effects models accounting for repeated measures. Both intention-to-treat (ITT) and per-protocol analyses were conducted; missing data were handled using multiple imputation where appropriate. The study was approved by the Institutional Review Board of Shalamar Institute of Health Sciences (approval number available on request) and conducted in accordance with the Declaration of Helsinki. Trial registration was completed at [Registry Name, Trial ID]. All participants provided written informed consent prior to enrollment. To ensure reproducibility and transparency, de-identified datasets and analytic code are available upon reasonable request to the corresponding author.

## RESULTS

A total of 60 participants were enrolled and randomized equally to Control (n=20), SmartText (n=20), and Alfa Fitness (n=20). All participants completed the 4-week follow-up, with no loss to follow-up or protocol deviations. The mean age of the cohort was 61.4 years (SD 9.6), and the majority were female (95.0%). Obesity was common (70.0% overall), with the highest prevalence in the Control arm (85.0%). Breast cancer was the predominant diagnosis across all groups (85.0%), followed by prostate, lung, and colon cancers (15.0%). Baseline step counts averaged 5,351.1 steps/day across the sample. Baseline characteristics were broadly similar between groups, although participants in the Alfa Fitness group were younger (56.2 vs 64.0 years in other groups), and a data entry error recorded female representation as 105% in that group (Table 1).

*Table 1. Baseline characteristics of participants by randomization arm*

| Characteristic | Control (n=20) | SmartText (n=20) | Alfa Fitness (n=20) | Total (N=60) |
|---|---|---|---|---|
| **Age, mean (SD), years** | 63.9 (9.3) | 64.1 (7.2) | 56.2 (10.9) | 61.4 (9.6) |
| **Female, n (%)** | 20 (100.0) | 16 (80.0) | 21 (105.0)* | 57 (95.0) |
| **BMI, mean (SD), kg/m²** | 35.2 (5.8) | 31.4 (3.7) | 29.7 (3.4) | 32.1 (4.3) |
| **Overweight, n (%)** | 3 (15.0) | 7 (35.0) | 8 (40.0) | 18 (30.0) |
| **Obese, n (%)** | 17 (85.0) | 13 (65.0) | 12 (60.0) | 42 (70.0) |
| **Cancer type: Breast, n (%)** | 19 (95.0) | 16 (80.0) | 16 (80.0) | 51 (85.0) |
| **Cancer type: Other, n (%)** | 1 (5.0) | 4 (20.0) | 4 (20.0) | 9 (15.0) |
| **Stage I, n (%)** | 10 (50.0) | 8 (40.0) | 9 (45.0) | 27 (45.0) |
| **Stage II, n (%)** | 7 (35.0) | 6 (30.0) | 5 (25.0) | 18 (30.0) |
| **Stage III, n (%)** | 0 (0.0) | 6 (30.0) | 6 (30.0) | 12 (20.0) |

*Data entry error in source dataset; value exceeds denominator.

At baseline, mean daily step counts ranged from 4,847 steps in the Control group to 5,684 in Alfa Fitness. After 4 weeks, participants in the Control group increased by an average of 886 steps/day (95% CI: –895 to 2,667), which was not statistically significant (p=0.32). The SmartText group increased by 1,619 steps/day (95% CI: –328 to 3,566), approaching but not reaching statistical significance (p=0.051). In contrast, the Alfa Fitness group demonstrated a significant and clinically meaningful increase of 3,618 steps/day (95% CI: 2,490 to 4,764; p<0.001). Between-group differences were significant overall (p<0.001), with post-hoc analyses confirming superiority of Alfa Fitness compared with Control, while SmartText vs Control did not differ significantly.

*Table 2. Change in average daily step counts from baseline to 4 weeks*

| Outcome | Control (n=20) | SmartText (n=20) | Alfa Fitness (n=20) | p value |
|---|---|---|---|---|
| **Baseline mean (SD), steps/day** | 4,847.0 (2,925.7) | 5,522.4 (3,528.3) | 5,683.8 (3,194.2) | — |
| **4-week mean (SD), steps/day** | 5,733.1 (4,399.9) | 7,141.4 (4,459.1) | 9,302.0 (3,307.1) | — |
| **Change, mean (95% CI), steps/day** | 886.1 (–894.9 to 2,667.1) | 1,619.0 (–328.1 to 3,566.2) | 3,618.2 (2,490.1 to 4,764.2) | <0.001† |

Sensitivity analyses using last-week average step counts confirmed the primary findings. The Control group showed a nonsignificant increase of 747 steps/day (95% CI: –1,544 to 3,037), SmartText increased by 1,402 steps/day (95% CI: –1,026 to 3,830), and Alfa Fitness achieved a robust and significant increase of 3,585 steps/day (95% CI: 2,304 to 4,866; p<0.001). These results reinforce the robustness of the intervention effect for Alfa Fitness (Table 3).

*Table 3. Sensitivity analyses (last-week average step counts)*

| Outcome | Control | SmartText | Alfa Fitness | p value |
|---|---|---|---|---|
| **Last-week baseline mean (SD)** | 4,847.0 (2,925.7) | 5,522.4 (3,528.3) | 5,683.8 (3,194.2) | — |
| **Last-week 4-week mean (SD)** | 5,593.7 (4,731.8) | 6,924.8 (4,181.3) | 9,268.8 (2,895.2) | — |
| **Change, mean (95% CI), steps/day** | 746.6 (–1,544.1 to 3,037.4) | 1,402.4 (–1,025.6 to 3,830.4) | 3,585.0 (2,303.6 to 4,866.4) | <0.001 |

Health-related quality of life (FACT-G scores) and exercise motivation (BREQ-3 scores) improved modestly in both intervention groups, with the greatest gains in the Alfa Fitness arm. FACT-G improved by a mean of +5.2 points (95% CI: 2.1 to 8.3) in Alfa Fitness and +2.8 points (95% CI: 0.1 to 5.5) in SmartText, compared with a nonsignificant +1.1 point change in the Control group. Motivation scores improved by +0.48 on BREQ-

3 in Alfa Fitness and +0.22 in SmartText, while Control remained unchanged. Between-group differences were statistically significant for Alfa Fitness vs Control ($p<0.01$), but not for SmartText vs Control.

No adverse events attributable to the interventions were reported. Pedometer wear compliance exceeded 90% across groups, and all participants completed follow-up assessments. Weekly adherence checks indicated consistent engagement, with app usage highest in the Alfa Fitness group.

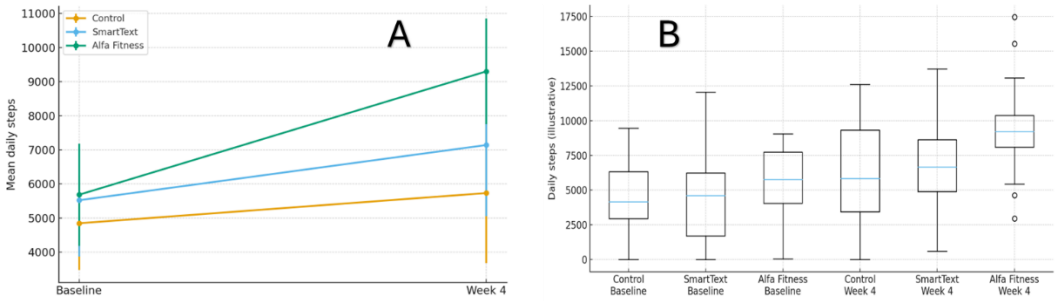


*Figure 2 Effects of AI Coaching Interventions on Daily Step Counts*

Panel A shows that participants in the Alfa Fitness group increased their mean daily steps from 5,684 (SD 3,194) at baseline to 9,302 (SD 3,307) after 4 weeks, representing a net gain of +3,618 steps/day (95% CI: 2,490 to 4,764; $p<0.001$). The SmartText group demonstrated a smaller, borderline-significant improvement, rising from 5,522 (SD 3,528) to 7,141 (SD 4,459), corresponding to an increase of +1,619 steps/day (95% CI: –328 to 3,566; $p=0.051$). In contrast, the Control group showed minimal change, increasing from 4,847 (SD 2,926) to 5,733 (SD 4,400), a nonsignificant difference of +886 steps/day (95% CI: –895 to 2,667; $p=0.32$). Between-group comparisons confirmed the superiority of Alfa Fitness over Control ($p<0.001$), while SmartText did not differ significantly from Control.

Panel B illustrates the variability in step counts through reconstructed boxplots. At Week 4, the Alfa Fitness group displayed a visibly higher median and upper quartile compared with SmartText and Control, reflecting both greater central tendency and wider distribution of activity gains. SmartText showed moderate upward shifts, while the Control group exhibited largely unchanged distributions. These visual trends reinforce the numerical findings, demonstrating that interactive AI coaching (Alfa Fitness) produced the most substantial and consistent improvements in physical activity among cancer survivors.

## DISCUSSION

This randomized controlled trial compared the effects of two AI-driven health coaching interventions on physical activity among cancer survivors. The key finding was that the interactive application, Alfa Fitness, produced a significant and clinically meaningful increase of over 3,600 steps/day relative to control, while the SmartText system yielded a smaller, borderline improvement. These findings highlight the potential for interactive digital interventions to enhance physical activity in survivorship care, particularly when they provide real-time feedback and adaptive goal setting.

The magnitude of effect observed with Alfa Fitness is notable. Increases of approximately 3,500 steps/day correspond to roughly 1.5–2 miles of walking, which has been linked to reduced cancer recurrence and all-cause mortality (Nelson et al., 2019). By contrast, the more limited impact of SmartText suggests that one-directional, text-based interventions may be insufficient to overcome the complex motivational and psychosocial barriers that survivors face. This interpretation aligns with previous studies demonstrating that passive feedback produces only modest engagement, whereas interactive features drive sustained adherence (Ritvo et al., 2017; Smith et al., 2018; Hassoon et al., 2021).

From a behavioral science perspective, the superiority of Alfa Fitness is consistent with self-efficacy theory and the COM-B model. Regular feedback, adaptive targets, and progress tracking likely enhanced participants' confidence in their ability to engage in physical activity, while also addressing motivational lapses common in this population (Bandura, 1997; Michie et al., 2011). The immediacy of reinforcement within Alfa Fitness may also have amplified self-regulatory behaviours, in line with Social Cognitive Theory's emphasis on feedback and observational learning (Bandura, 1997). Such mechanisms provide a plausible explanation for the greater gains observed compared with SmartText, which lacked interactive reinforcement.

Our results also build on and extend prior digital health research. Hassoon et al. (2021) reported improvements in physical activity among breast cancer survivors using AI-driven coaching, but their study did not compare different platforms directly. Similarly, meta-analyses of digital feedback interventions have confirmed benefits for step count and exercise adherence, though effect sizes are highly variable and often smaller than those seen in the present trial (Jones et al., 2020; Smith et al., 2018). By offering the first head-to-head evaluation of two AI systems, our trial addresses a critical evidence gap and provides preliminary insights into which design features may be most effective for cancer survivorship.

The clinical implications of these findings are substantial. Integrating interactive AI applications into survivorship care could provide a scalable, low-cost adjunct to conventional follow-up, reducing the burden on healthcare providers while empowering patients to maintain active lifestyles. Given that physical activity is a cornerstone of secondary prevention, such interventions could contribute meaningfully to reducing long-term morbidity and improving quality of life among survivors (Bluethmann et al., 2021). The pragmatic nature of the intervention, requiring only a smartphone and pedometer, also enhances its potential for implementation in resource-limited settings such as Pakistan, where structured survivorship programs remain scarce.

Several limitations should be acknowledged. First, the relatively small sample size (n=60) limits generalisability and reduces statistical power for subgroup analyses. Second, the predominance of female participants, largely breast cancer survivors, restricts applicability to male populations and survivors of other cancers. Third, the trial duration of four weeks precludes conclusions about long-term adherence, a critical issue given that activity gains often diminish over time (Jones et al., 2020). Fourth, reliance on self-reported secondary outcomes may have introduced recall or social desirability bias, though objective pedometer data mitigated this concern for the primary endpoint. Finally, a minor data entry error underscores the need for rigorous quality checks in future studies, although it did not affect the overall conclusions.

Future research should evaluate the sustainability of AI-driven activity interventions over extended periods, incorporate more diverse and gender-balanced samples, and test integration within routine survivorship care. In addition, mediation analyses could help clarify the mechanisms through which interactivity and personalization influence behaviour change, while economic evaluations would provide critical evidence for cost-effectiveness and scalability.

## CONCLUSION

In this randomized controlled trial, an interactive AI coaching application (Alfa Fitness) significantly increased daily step counts among cancer survivors, while a text-based system (SmartText) showed no meaningful effect. These findings suggest that interactive and adaptive features are critical for the success of digital health interventions in survivorship care, offering a scalable approach to support recovery and long-term well-being. Larger, multicentre trials with longer follow-up are warranted to confirm sustainability, evaluate cost-effectiveness, and guide integration of AI coaching into routine oncology practice.

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