Original Paper

Feasibility and Preliminary Outcomes of Smartphone-Based Remote Patient Monitoring in Patients With Solid Tumors: Pilot Randomized Controlled Trial

Panot Sainamthip[1], MD; Kittipoom Supamontri[2], PhD; Sirintip Kudtiyakarn[3], MSc; Palita Sakunma[3], BS; Sarunchana Suthanaseriporn[3], BS; Natcha Limtrakun[3], BS

[1]Department of Pharmacology, Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand
[2]School of Business Administration, Bangkok University, Bangkok, Thailand
[3]Invitrace Company Limited, Bangkok, Thailand

Corresponding Author:

Kittipoom Supamontri, PhD
School of Business Administration, Bangkok University
9/1 Phahonyothin Road, Khlong Nueng, Khlong Luang, Pathum Thani
Bangkok 12120
Thailand
Phone: 66 2407 3888
Email: kittipoom.s@bu.ac.th

Abstract

Background: Remote patient monitoring (RPM) using mobile apps and wearable devices may support symptom reporting and communication between patients with cancer and health care professionals. However, evidence regarding sustained engagement, wearable-data completeness, and preliminary clinical outcomes in routine oncology practice remains limited.

Objective: This pilot randomized controlled trial aimed to assess the feasibility of implementing a smartphone-based RPM system integrated with a wearable device among patients with solid tumors and to generate preliminary estimates of between-group differences in quality of life, emergency department (ED) use, and side-effect literacy over 6 months.

Methods: Thirty patients from a single outpatient oncology clinic were randomized 1:1 to receive either the WellHealth RPM intervention plus standard care or standard care alone. The intervention included smartphone-based symptom reporting, medication recording, wearable-device monitoring, and provider-facing alerts. Feasibility outcomes included participant retention, symptom-reporting engagement, wearable-data completeness, and alert generation. The principal exploratory clinical outcome was quality of life measured using the Functional Assessment of Cancer Therapy-General (FACT-G) at baseline and at 1, 3, and 6 months. Secondary exploratory outcomes included cancer- or treatment-related ED visits and side-effect literacy.

Results: Twenty-six of 30 participants (86.7%) completed the 6-month follow-up. All 15 intervention participants generated symptom-monitoring data, although only 6 (40%) continued symptom recording at week 26. Wearable-device integration was substantially less complete: 8 of 15 intervention participants had any successfully synchronized wearable data, 7 never successfully synchronized their device, and wearable data were available for only 27.2% (n=2715) of expected participant-days. The provider system generated 56 alerts. At 6 months, the mean total FACT-G score was numerically higher in the intervention group than in the control group (84.23, SD 12.13 vs 77.15, SD 14.00; Hodges-Lehmann estimate 6.50, 95% CI –0.83 to 16.50; *P*=.07), but no FACT-G total or subscale comparison remained statistically significant after Holm adjustment for multiple comparisons. Cancer- or treatment-related ED visits occurred in 0 of 13 intervention participants and 3 of 13 control participants (*P*=.22). Side-effect literacy did not differ significantly between groups at 3 months (*P*=.46).

Conclusions: This pilot study supports the feasibility of initial smartphone-based symptom reporting among patients with solid tumors but provides less support for sustained engagement and reliable wearable-device integration. Exploratory clinical outcomes did not provide confirmatory evidence of effectiveness. Future studies should improve wearable synchronization, incorporate strategies to sustain patient engagement, standardize clinical alert-response pathways, and evaluate the intervention in a larger, adequately powered multicenter randomized trial.

Trial Registration: Thai Clinical Trials Registry TCTR20230331002; https://www.thaiclinicaltrials.org/show/TCTR20230331002

JMIR Form Res 2026;10:e82041; doi: 10.2196/82041

Keywords: mobile health; mHealth apps; remote patient monitoring; quality of life; cancer care; mobile phone; digital health; health care innovation

Introduction

The management of solid tumors increasingly involves systemic anticancer treatments, including chemotherapy, targeted therapy, immunotherapy, and multimodal treatment. Although these therapies may improve disease control and survival, they can also cause a broad range of treatment-related adverse effects, from fatigue, nausea, and reduced physical functioning to severe infections and organ toxicities [1-3]. Many of these symptoms develop between scheduled outpatient visits and may not be recognized promptly by the clinical team. Delayed identification and management may contribute to deterioration in quality of life (QoL), treatment interruption, and unplanned health care use. Patient education, symptom self-monitoring, and timely communication with health care professionals are therefore important components of supportive cancer care [4,5].

Electronic patient-reported outcome measures and remote patient monitoring (RPM) technologies provide opportunities to monitor patients outside conventional clinical encounters. Smartphone apps can support symptom reporting, medication recording, QoL assessment, and communication between patients and health care professionals [6]. Wearable Internet of Things (IoT) devices can complement patient-reported information by continuously or intermittently collecting objective data such as heart rate, physical activity, and sleep duration [7]. When these data are integrated into a structured clinical monitoring pathway, they may help health care professionals identify changes in patients' conditions and provide timely assessment or supportive management. However, the clinical value of RPM depends not only on data collection but also on sustained patient engagement, data completeness, alert-review processes, and the responsiveness of health care professionals.

Previous studies have evaluated electronic symptom monitoring and patient-reported outcome systems in oncology. Randomized trials have reported improvements in symptom management and selected QoL outcomes among patients receiving cancer treatment [8-10]. Web- and app-based monitoring systems may also facilitate communication between patients and clinical teams and support symptom assessment from home [11,12]. Some studies have reported favorable outcomes associated with remote symptom monitoring, including improvements in selected QoL domains and, in specific populations and intervention models, reductions in health care use or improvements in survival [13-17]. In addition, interventions combining mobile apps with wearable devices have demonstrated potential benefits for physical activity, fatigue, and treatment-related symptoms among patients receiving chemotherapy [18]. Nevertheless, results vary according to cancer type, treatment, intervention components, monitoring duration, and clinical-response model. Evidence regarding sustained engagement, implementation fidelity, and preliminary clinical outcomes in heterogeneous populations with solid tumors remains limited, particularly in routine oncology practice in Thailand.

The WellHealth platform has previously been implemented in a prospective feasibility study of medication management among older adults with osteoporosis. In that study, 32 participants used the system for 1 year, with sustained in-app medication logging and high user acceptability. The authors concluded that implementation was feasible in this small cohort but emphasized that larger studies were needed to determine clinical effectiveness [19]. Although these findings provide preliminary evidence that the platform can support longitudinal digital engagement in chronic disease management, they cannot be directly generalized to oncology, where symptom burden, treatment trajectories, monitoring requirements, and risks of clinical deterioration differ substantially.

Accordingly, this single-center pilot randomized controlled trial aimed to assess the feasibility of implementing a smartphone-based RPM system integrated with a wearable device among patients with solid tumors and to generate preliminary estimates of between-group differences in QoL, emergency department (ED) use, and side-effect literacy over 6 months. Feasibility was examined through participant retention and app engagement. Given the pilot sample size, the study was not designed or powered to establish clinical effectiveness; therefore, the clinical outcome analyses were considered exploratory and hypothesis-generating.

Methods

Study Design

This was a single-center, parallel-group pilot randomized controlled trial with a 1:1 allocation ratio and a 6-month follow-up period, reported in accordance with the CONSORT (Consolidated Standards of Reporting Trials) guidelines (Checklist 1). The study was conducted at the outpatient oncology clinic of Mongkutwattana Hospital, Bangkok, Thailand. The trial was designed to assess the feasibility of implementing smartphone-based RPM with wearable-device integration and to generate preliminary estimates of clinical outcomes. It was not designed or powered to establish clinical effectiveness.

The study was conducted in accordance with the Declaration of Helsinki, the Belmont Report, the Council for International Organizations of Medical Sciences guidelines, and the International Council for Harmonisation Good Clinical Practice guidelines. The study protocol was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand (approval number 537/65). All participants provided written informed consent before enrollment and baseline assessment. The trial

was registered with the Thai Clinical Trials Registry under registration number TCTR20230331002.

Sample Size

No formal efficacy-based sample size calculation was performed because this was a pilot trial and was not intended to test a definitive clinical-effectiveness hypothesis. The target sample of 30 participants was selected pragmatically based on the expected number of eligible patients during the recruitment period, available study resources, and the objective of estimating recruitment, retention, intervention engagement, outcome variability, and preliminary between-group effect estimates to inform the design of a future adequately powered trial.

Participants and Setting

Participants were recruited during routine visits to the outpatient oncology clinic at Mongkutwattana Hospital between January 23 and March 24, 2023. All participants were recruited from and clinically managed by one certified oncologist. Eligible participants were aged 18 to 60 years, had a pathologically or radiologically confirmed solid tumor, and had an Eastern Cooperative Oncology Group (ECOG) performance status of 0 to 2. Participants were required to have received systemic anticancer treatment, including chemotherapy alone or in combination with targeted therapy or radiotherapy, within the 3 months preceding enrollment, to be able to read and understand Thai, and to be able to use a smartphone independently or with assistance from a family member or caregiver. Patients were excluded if they had an end-stage chronic condition and were receiving palliative or end-of-life care, or if they were concurrently participating in another interventional research study.

After written informed consent was obtained, demographic information, clinical characteristics, cancer diagnosis and stage, treatment information, and baseline Functional Assessment of Cancer Therapy–General (FACT-G) scores were collected before the randomization and initiation of the intervention.

Follow-up assessments were conducted at approximately 1, 3, and 6 months after enrollment. The final 1-month, 3-month, and 6-month assessment periods were completed by April 30, June 30, and September 30, 2023, respectively.

Randomization and Allocation

Thirty participants were randomly assigned in a 1:1 ratio to either the intervention group, which received the WellHealth RPM intervention in addition to standard care, or the control group, which received standard care alone.

A computer-generated blocked randomization sequence with a fixed block size of 4 was used to maintain approximate balance between the 2 study groups throughout enrollment. The sequence was generated using the Sealed Envelope online randomization-list generator. The randomization sequence was prepared by a study nurse, and participants were enrolled and assigned to study groups by the investigator.

The randomization sequence was not stratified by cancer type, cancer stage, treatment modality, or performance status because of the small pilot sample. Consequently, clinically relevant imbalances between the study groups could not be excluded. Allocation concealment was not formally implemented, which was considered when evaluating the risk of selection bias.

Blinding

Because of the nature of the intervention, participants, the treating oncologist, and research personnel involved in follow-up could not be blinded to group allocation. FACT-G outcomes were self-reported. Participants in the intervention group completed FACT-G assessments electronically, whereas participants in the control group completed the same FACT-G questionnaire on paper according to the same assessment schedule and scoring procedures. In contrast, the side-effect literacy questionnaire was administered electronically via Google Forms to participants in both randomized groups. Outcome-data extraction and statistical analysis were not performed blinded to group allocation. The study was therefore considered open-label.

Standard Care

Both groups continued to receive routine oncology care at Mongkutwattana Hospital throughout the study. Standard care included scheduled outpatient oncology consultations approximately every 2 to 3 weeks according to treatment schedules and clinical condition; laboratory and imaging monitoring according to the treating oncologist's clinical plan; medication and treatment-related symptom counseling; instructions regarding when and how to contact the clinic; telephone follow-up when clinically indicated, although routine scheduled telephone monitoring was not provided; and advice to attend the ED for severe or concerning symptoms.

Participants in the control group did not receive app-based symptom monitoring, wearable-device monitoring, automated alerts, or access to the WellHealth communication functions.

Digital Intervention (WellHealth)

Participants assigned to the intervention group received the WellHealth smartphone-based RPM system in addition to standard oncology care. The platform was developed by Invitrace Company Limited and adapted for use in Thailand.

The intervention was intended to support remote symptom reporting, medication tracking, quality-of-life assessment, wearable-data collection, communication with health care professionals, and review of potentially concerning patient-reported or physiological data. It functioned as an adjunct to routine cancer care and did not replace scheduled consultations, diagnostic examinations, or emergency services.

At enrollment, a nurse conducted an individual onboarding session lasting approximately 15 to 20 minutes. The session included app installation, account activation, navigation instructions, symptom and medication entry, wearable-device synchronization, and guidance on contacting the clinical team. Participants received written instructions and could

obtain technical assistance through the research assistance phone.

The WellHealth intervention comprised 3 components: the patient app, provider dashboard, and wearable device (Figure 1).

The patient app enabled participants to record symptoms and symptom severity, document medication use, complete scheduled quality-of-life assessments, manually enter selected health measurements, review health information collected through compatible devices, receive medication or assessment reminders, and communicate with health care professionals through the in-app chat function. Participants were instructed to record symptoms daily. The app's to-do list displayed scheduled symptom reports and assessments, and submitted information was transferred to the provider dashboard (Figure 2).

Figure 1. Illustrative interface of the WellHealth patient app. From left to right: home and task-list screen, medication-recording screen, and health-tracking screen.

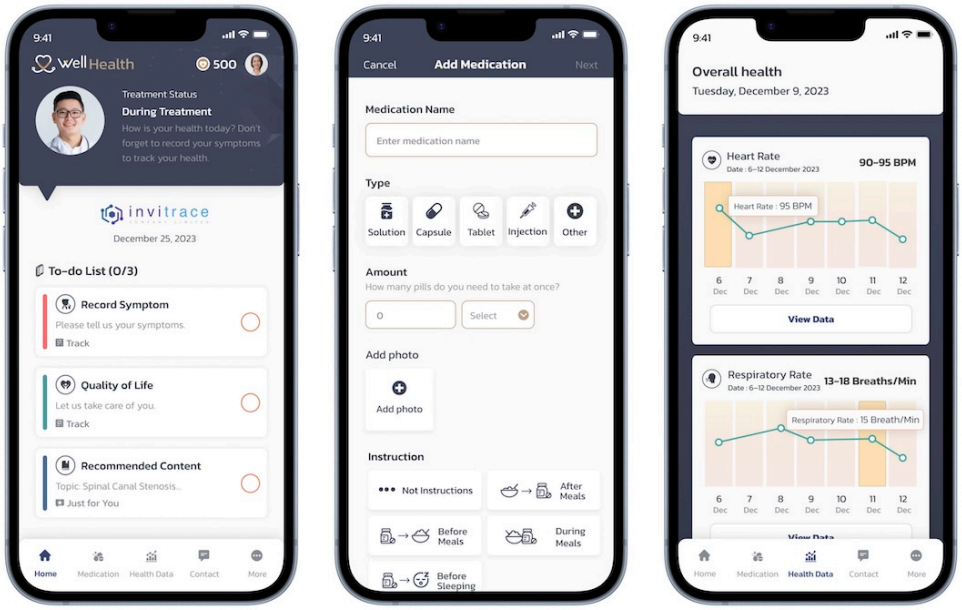
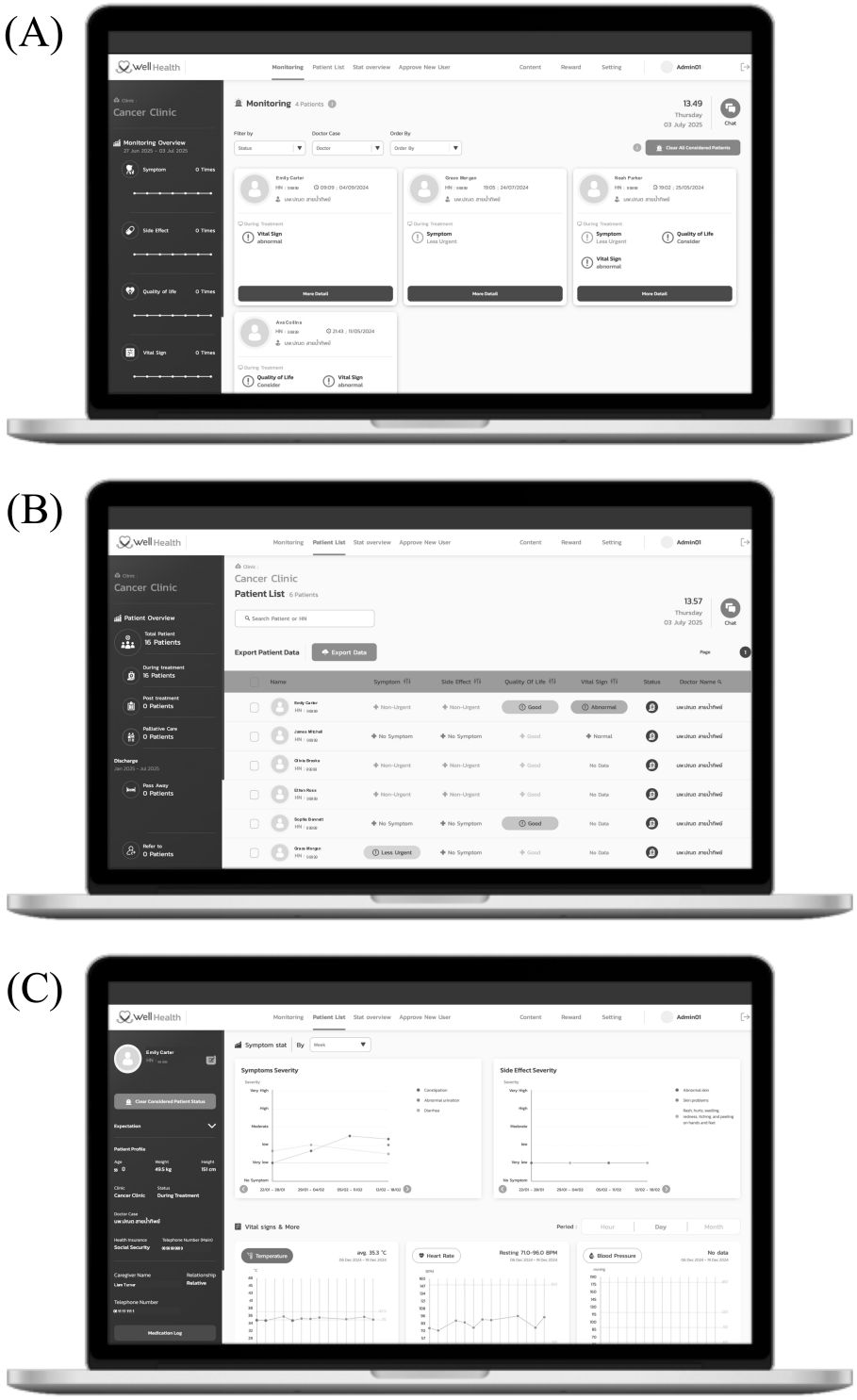


Figure 2. WellHealth provider dashboard interface. Panel A presents the monitoring-alert screen, panel B presents the patient-list screen, and panel C presents the individual patient-profile and monitoring screen.



The web-based provider dashboard displayed patient-reported symptoms and their severity, FACT-G responses or scores, medication records, available wearable and physiological data, patient lists and profiles, and system-generated monitoring alerts. The dashboard was reviewed by the oncology care team on working days and when alerts were generated.

Alerts were generated when a participant reported a symptom categorized as severe, when a recorded physiological value exceeded a predefined threshold, or when a clinically concerning quality-of-life response was submitted. Following an alert, the responsible health care professional could review the patient's submitted data, contact the patient through the app, provide self-management advice, arrange an earlier outpatient assessment, or advise the participant to

attend the ED, as clinically appropriate. Clinical responses to alerts were determined by the treating oncologist based on clinical judgment; no standardized response-time target or escalation protocol was prespecified.

Wearable Device

Participants in the intervention group received a Xiaomi Smart Band 7, which recorded heart rate, step count, and sleep duration. Data from the device were synchronized with the WellHealth app through Apple Health or Google Fit, depending on the participant's smartphone operating system. Participants were instructed to wear the device daily, except during charging or activities for which the manufacturer did not recommend use.

Outcome Measures

Feasibility Outcomes

App engagement was assessed from symptom-log records. A participant was considered active within a specified follow-up interval if at least 1 symptom-log entry was recorded during that interval. Engagement outcomes included the total number of symptom entries, symptom entries per participant, the number of months with at least 1 symptom entry, and the proportion of participants active during months 1-6.

Wearable-data completeness was assessed as the number of participant-days with successfully synchronized wearable data relative to the total number of planned participant-days during the 6-month monitoring period. Planned participant-days represented the full monitoring duration originally scheduled for all participants allocated to the intervention group, irrespective of subsequent death or loss to follow-up. The proportion of intervention participants with at least 1 day of successfully synchronized wearable data was also calculated.

QoL

The principal exploratory clinical outcome was QoL, assessed using the FACT-G [20]. The FACT-G consists of 27 items across 4 subscales: physical well-being, social/family well-being, emotional well-being, and functional well-being. Total scores range from 0 to 108, with higher scores indicating better QoL. The FACT-G was administered at baseline and at 1, 3, and 6 months.

The 1-, 3-, and 6-month assessments were selected to capture early changes after intervention initiation, intermediate changes across several treatment cycles, and longer-term quality-of-life patterns during continued monitoring.

ED Use

Cancer- or treatment-related ED use during the 6-month follow-up was an exploratory secondary outcome. Qualifying events were defined as unscheduled ED visits considered related to the participant's malignancy, anticancer treatment, or treatment-related symptoms. Visits clearly attributable to unrelated causes, such as accidental trauma, were excluded. ED visits were identified from Mongkutwattana Hospital electronic medical records, and the treating oncologist reviewed the relevant medical records to determine whether each event was cancer- or treatment-related based on clinical judgment. Visits occurring at other health care facilities were not systematically captured. The primary ED-use measure was the proportion of participants experiencing at least 1 qualifying ED visit during follow-up.

Side-Effect Literacy

Side-effect literacy was assessed at 3 months using a 20-item investigator-developed Thai-language questionnaire informed by previous studies of patient knowledge regarding adverse effects of cancer treatment [21,22]. Each correct response was assigned 1 point, producing a total score ranging from 0 to 20, with higher scores indicating greater knowledge. The questionnaire assessed general treatment-related adverse-effect knowledge and was administered electronically via Google Forms to participants in both groups and was separate from the routine symptom-reporting method assigned by study arm. The instrument had not undergone formal psychometric validation in the study population; therefore, this outcome was considered exploratory.

Data Collection and Follow-Up

Baseline assessments were completed after informed consent and before randomization. Follow-up outcome assessments were conducted at 1, 3, and 6 months. Side-effect literacy was assessed at 3 months.

FACT-G assessments were completed electronically by participants in the intervention group and on paper by participants in the control group. In contrast, the side-effect literacy questionnaire was administered electronically via Google Forms to participants in both groups.

Research personnel contacted participants using the same schedule in both groups to request the completion of follow-up assessments. Clinical follow-up, treatment decisions, and emergency referrals remained under the responsibility of the treating oncologist.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics (version 29.0.2.0). Baseline demographic and clinical characteristics were summarized descriptively and were not subjected to significance testing between randomized groups. Continuous variables were summarized using means and SDs or medians and IQRs, as appropriate, and categorical variables were summarized using frequencies and percentages.

Because of the small pilot sample and the distribution of the clinical outcome data, nonparametric methods were used for exploratory between-group comparisons. FACT-G total and subscale scores were compared between randomized groups at 1, 3, and 6 months using the Mann-Whitney *U* test. Between-group effects were summarized using Hodges-Lehmann estimates of the intervention-minus-control location difference with 95% CIs. To account for multiplicity across the 15 post-baseline FACT-G comparisons (5 outcomes × 3 follow-up assessments), Holm-adjusted *P* values were

calculated. Baseline FACT-G comparisons were descriptive and were not included in the multiplicity adjustment.

Within-group changes in FACT-G scores were evaluated using the Wilcoxon signed-rank test and were reported as supplementary exploratory analyses. These analyses were not used to infer an intervention effect, and their *P* values were not adjusted for multiple comparisons.

Cancer- or treatment-related ED use was analyzed as the proportion of participants experiencing at least 1 qualifying ED visit. Groups were compared using a 2-sided Fisher exact test, and the intervention-minus-control absolute risk difference with a 95% CI was reported. Side-effect literacy scores were compared using the exact Mann-Whitney *U* test, with a Hodges-Lehmann estimate and 95% CI.

FACT-G analyses used an available-case approach. All participants with an observed FACT-G assessment at a given time point were included in the corresponding between-group analysis according to randomized allocation, regardless of whether they completed subsequent follow-up assessments. Thus, earlier observations were not excluded on the basis of subsequent mortality or loss to follow-up. No missing FACT-G values were imputed, and no last-observation-carried-forward procedure was used.

Ethical Considerations

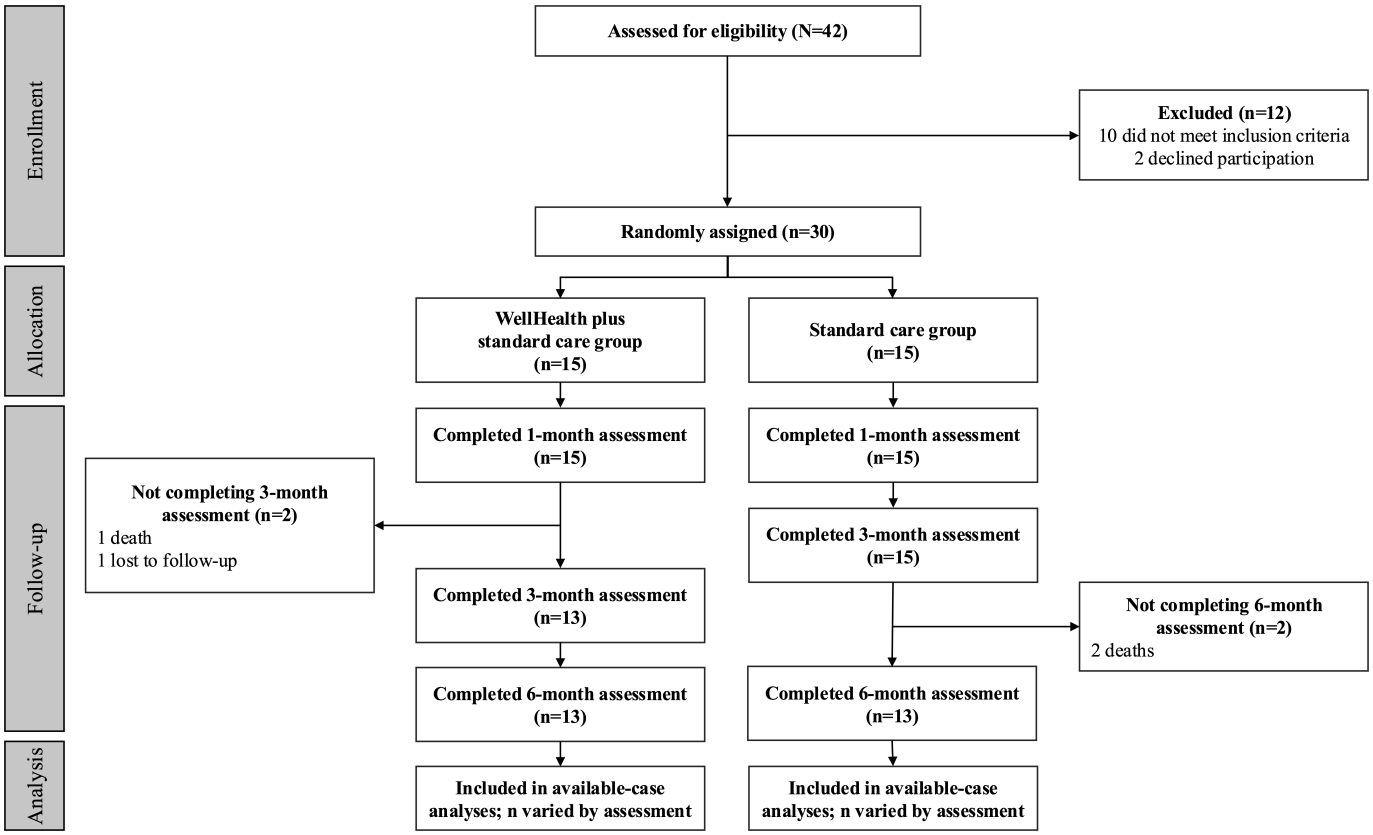
Ethical approval for this study was obtained from the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University (approval number 537/65). The study was conducted in accordance with the Declaration of Helsinki and relevant international guidelines for human research protection. All participants provided written informed consent prior to enrollment. This trial was registered with the Thai Clinical Trials Registry (TCTR20230331002).

Results

Participant Flow and Retention

A total of 42 patients were assessed for eligibility. Twelve were excluded, including 10 who did not meet the inclusion criteria and 2 who declined participation. The remaining 30 participants were randomized in a 1:1 ratio to the intervention group receiving WellHealth RPM plus standard care (n=15) or the control group receiving standard care alone (n=15). All participants in both groups completed the 1-month assessment. By the 3-month assessment, 13 participants remained in the intervention group after 1 death and 1 loss to follow-up, whereas all 15 participants in the control group completed the assessment. Between the 3- and 6-month assessments, 2 participants in the control group died. Consequently, 13 participants in each group completed the 6-month follow-up, corresponding to an overall retention rate of 86.7% (Figure 3). Outcome analyses used available observations at each assessment as described below.

Figure 3. CONSORT (Consolidated Standards of Reporting Trials) flow diagram of participant enrollment, allocation, follow-up, and analysis.



Baseline Characteristics

Baseline demographic and clinical characteristics of all 30 randomized participants are summarized in Table 1. The mean age was 51.17 years (SD 8.06), and 23 of 30 (76.7%) participants were female; breast cancer was the most common cancer type (n=17, 56.7%), followed by colon cancer (n=6, 20%) and lung cancer (n=4, 13.3%). Eighteen (60%) participants had stage IV disease at baseline.

Table 1. Baseline demographic and clinical characteristics of randomized participants[a].

Characteristic	Total (N=30)	Intervention group (n=15)	Control group (n=15)
Sex, n (%)			
Female	23 (76.7)	12 (80.0)	11 (73.3)
Male	7 (23.3)	3 (20.0)	4 (26.7)
Age (y), mean (SD)	51.17 (8.06)	48.20 (8.74)	54.13 (6.27)
Cancer subtype, n (%)			
Breast	17 (56.7)	9 (60)	8 (53.3)
Lung	4 (13.3)	3 (20)	1 (6.7)
Colon	6 (20)	3 (20)	3 (20)
Pancreas	2 (6.7)	0 (0)	2 (13.3)
Head and neck	1 (3.3)	0 (0)	1 (6.7)
Cancer stage, n (%)			
Stage I	4 (13.3)	2 (13.3)	2 (13.3)
Stage II	4 (13.3)	3 (20)	1 (6.7)
Stage III	4 (13.3)	3 (20)	1 (6.7)
Stage IV	18 (60)	7 (46.7)	11 (73.3)
FACT-G[b] at baseline, mean (SD)	78.93 (13.24)	78.92 (12.95)	78.94 (13.98)
Physical well-being	21.43 (4.90)	22.40 (4.32)	20.47 (5.40)
Social/family well-being	20.77 (4.15)	20.46 (3.55)	21.08 (4.79)
Emotional well-being	17.93 (4.78)	18.20 (4.48)	17.67 (5.21)
Functional well-being	18.80 (4.54)	17.87 (4.19)	19.73 (4.83)

[a]Baseline characteristics are presented descriptively; no hypothesis tests were performed for baseline between-group comparisons because participants were randomly allocated.
[b]FACT-G: Functional Assessment of Cancer Therapy–General.

Although participants were randomly allocated, some clinically relevant baseline imbalances were observed because of the small pilot sample. Participants in the intervention group were younger on average than those in the control group (mean 48.20, SD 8.74, y vs mean 54.13, SD 6.28 y). In addition, stage IV disease was less frequent in the intervention group than in the control group (n=7, 46.7% vs n=11, 73.3%). These imbalances were considered when interpreting the exploratory clinical outcomes.

Baseline quality-of-life scores were generally comparable between the groups. Mean total FACT-G scores were 78.92 (SD 12.95) in the intervention group and 78.94 (SD 13.98) in the control group. Given the randomized pilot design, baseline characteristics were summarized descriptively rather than subjected to hypothesis testing.

Feasibility and Intervention Engagement

All 15 participants allocated to the intervention group used the WellHealth app and generated symptom-monitoring data during the study period (Table 2). Across the 6-month observation period, participants recorded a total of 1834 symptom entries. The number of symptom entries varied substantially between participants, with a median of 34 entries per participant (IQR 13-237; range 6-421). Participants recorded symptoms during a median of 2.5 of the 6 follow-up months (IQR 1.3-5.0 mo; range 0.5-6 mo), indicating considerable heterogeneity in longitudinal application engagement.

Table 2. Feasibility and engagement outcomes in the intervention group (n=15).

Domain and measure	Result
App engagement	
Participants with ≥1 symptom-log entry, n/N (%)	15/15 (100)
Total symptom-log entries, n	1834
Symptom-log entries per participant, median (IQR)	34 (13-237)

Domain and measure	Result
Symptom-log entries per participant, range	6-421
Months with ≥1 symptom entry per participant, median (IQR)	2.5 (1.3-5.0)
Longitudinal symptom logging	
Active during month 1, n/N (%)	13/15 (86.7)
Active during month 2, n/N (%)	11/15 (73.3)
Active during month 3, n/N (%)	12/15 (80)
Active during months 4-5, n/N (%)	10/15 (66.7)
Active at month 6, n/N (%)	6/15 (40)
IoT[a] synchronization	
Participants with ≥1 synchronized day, n/N (%)	8/15 (53.3)
Participant-days with synchronized IoT data, n/N (%)	738/2715 (27.2)
IoT data completeness among participants with ≥1 synchronized day, median (IQR)	53.1% (39.9%-70.6%)
Provider alerts	
Total alerts, n	56
Vital-sign alerts, n (%)	29 (51.8)
Side-effect alerts, n (%)	14 (25.0)
Quality-of-life alerts, n (%)	10 (17.9)
Symptom alerts, n (%)	3 (5.4)

[a]IoT: Internet of Things.

During the first 1 month after enrollment, 13 of 15 (86.7%) participants recorded at least 1 symptom entry. Eleven (73.3%) participants recorded symptoms during month 2, 12 (80%) participants during month 3, and 10 (66.7%) participants during months 4 to 5. At month 6, 6 of 15 (40%) participants continued to record symptoms. These findings indicate that app use was sustained in a subset of participants throughout the 6 months, although engagement decreased and varied considerably between individuals.

Wearable-device synchronization was less complete than symptom-reporting engagement. Across the intervention group, wearable data were synchronized on 738 of 2715 (27.2%) expected participant-days. Eight of 15 (53.3%) participants had at least 1 day of synchronized wearable data, whereas 7 participants had no recorded wearable synchronization. Among participants with any synchronized wearable data, the median proportion of expected days with available data was 53.1% (IQR 39.9%-70.6%). These findings suggest that wearable-device integration was technically achievable for some participants, but that data completeness was limited and inconsistent across the intervention group.

During the study period, the provider-facing monitoring system generated 56 alerts. Of these, 29 (51.8%) were triggered by vital-sign measurements, 14 (25.0%) by treatment side effects, 10 (17.9%) by quality-of-life assessments, and 3 (5.4%) by symptom reports. These alerts show that the remote monitoring platform could identify and transmit potentially clinically relevant patient-reported and physiological information to the provider dashboard.

One participant in the intervention group died during follow-up and one was lost to follow-up. No study discontinuation was documented as being specifically attributable to an app- or wearable-device technical problem.

Exploratory Quality-of-Life Outcomes

Table 3 and Figure 4 present FACT-G outcomes using an available-case approach. All available observations at each assessment were included according to randomized group, irrespective of the completion of subsequent follow-up assessments. FACT-G data were available for all 30 randomized participants at month 1 (n=15 intervention and n=15 control), 28 participants at month 3 (n=13 intervention and n=15 control), and 26 participants at month 6 (n=13 per group). Missing observations were not imputed.

Figure 4. Mean Functional Assessment of Cancer Therapy–General (FACT-G) total and subscale scores at baseline and at 1, 3, and 6 months by randomized group using available observations at each assessment. Error bars represent 95% CIs. Data were available for 15 intervention and 15 control participants at baseline and month 1; 13 intervention and 15 control participants at month 3; and 13 participants in each group at month 6. Between-group clinical outcome analyses were exploratory; no comparison remained statistically significant after Holm adjustment for multiple comparisons.

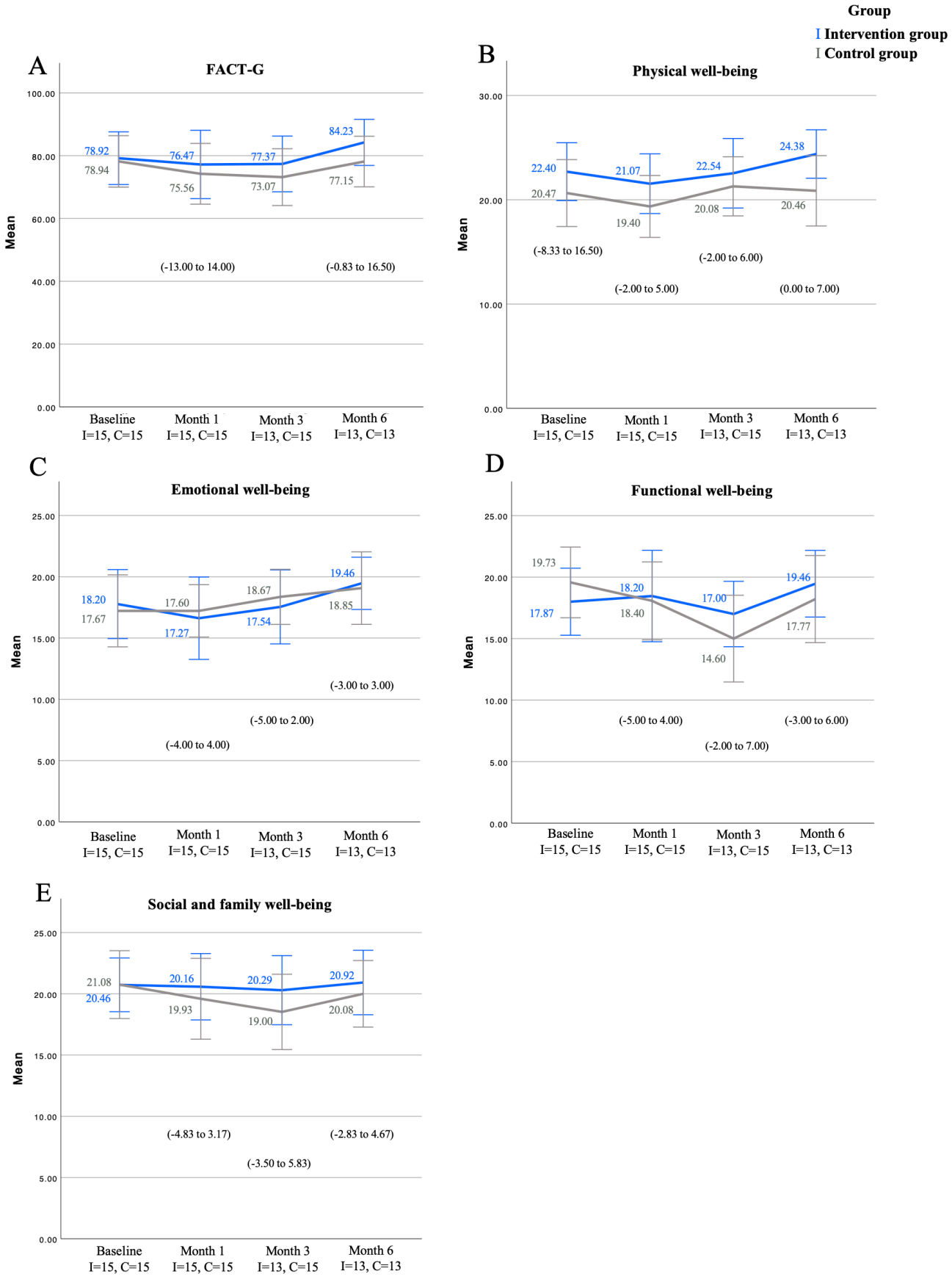


Table 3. Exploratory Functional Assessment of Cancer Therapy-General (FACT-G) outcomes using available-case analysis[a].

Outcome/timepoint	Control group, mean (SD)	Intervention group, mean (SD)	Hodges-Lehmann estimate, intervention-control (95% CI)	Unadjusted *P* value[b]	Holm-adjusted *P* value[c]
Total FACT-G					
Baseline (n=30)	78.94 (13.98; n=15)	78.92 (12.95; n=15)	—[d]	—	—
Month 1 (n=30)	75.56 (16.94; n=15)	76.47 (16.97; n=15)	1.00 (–13.00 to 14.00)	.79	≥.99
Month 3 (n=28)	73.07 (15.11; n=15)	77.37 (14.69; n=13)	3.50 (–8.33 to 16.50)	.46	≥.99
Month 6 (n=26)	77.15 (14.00; n=13)	84.23 (12.13; n=13)	6.50 (–0.83 to 16.50)	.07	≥.99
Physical well-being					
Baseline	20.47 (5.40)	22.40 (4.32)	—	—	—
Month 1	19.40 (4.95)	21.07 (4.70)	2.00 (–2.00 to 5.00)	.48	≥.99
Month 3	20.80 (5.09)	22.54 (5.52)	2.00 (–2.00 to 6.00)	.29	≥.99
Month 6	20.46 (5.88)	24.38 (3.84)	3.00 (0.00 to 7.00)	.048	.73
Social/family well-being					
Baseline	21.08 (4.79)	20.46 (3.55)	—	—	—
Month 1	20.16 (5.92)	19.93 (4.49)	–0.83 (–4.83 to 3.17)	.71	≥.99
Month 3	19.00 (5.45)	20.29 (4.67)	1.00 (–3.50 to 5.83)	.68	≥.99
Month 6	20.08 (4.89)	20.92 (4.35)	1.16 (–2.83 to 4.67)	.59	≥.99
Emotional well-being					
Baseline	17.67 (5.21)	18.20 (4.48)	—	—	—
Month 1	17.60 (3.87)	17.27 (5.43)	0.00 (–4.00 to 4.00)	.98	≥.99
Month 3	18.67 (3.94)	17.54 (4.99)	–1.00 (–5.00 to 2.00)	.59	≥.99
Month 6	18.85 (5.26)	19.46 (3.53)	0.00 (–3.00 to 3.00)	.98	≥.99
Functional well-being					
Baseline	19.73 (4.83)	17.87 (4.19)	—	—	—
Month 1	18.40 (5.44)	18.20 (5.81)	0.00 (–5.00 to 4.00)	.72	≥.99
Month 3	14.60 (6.08)	17.00 (4.40)	1.00 (–2.00 to 7.00)	.33	≥.99
Month 6	17.77 (6.14)	19.46 (4.48)	2.00 (–3.00 to 6.00)	.34	≥.99

[a]Analyses included all available observations at each assessment according to randomized group. Missing values were not imputed; therefore, sample sizes varied across follow-up assessments.
[b]Unadjusted *P* values were obtained using 2-sided Mann-Whitney *U* tests for between-group comparisons.
[c]Holm adjustment was applied across the 15 postbaseline FACT-G comparisons (5 outcomes × 3 follow-up assessments). Baseline comparisons were descriptive and were not included in the multiplicity adjustment.
[d]Not applicable.

FACT-G total and subscale scores were assessed at baseline and at 1, 3, and 6 months, with higher scores indicating better QoL. Between-group comparisons at the postbaseline assessments were considered exploratory. To account for multiple testing across the 15 post-baseline FACT-G comparisons (5 outcomes × 3 follow-up assessments), Holm-adjusted *P* values were calculated in addition to the unadjusted *P* values.

At 6 months, the intervention group had a numerically higher mean total FACT-G score than the control group (mean 84.23, SD 12.13 vs mean 77.15, SD 14.00). The Hodges-Lehmann estimate of the between-group location difference was 6.50 points (95% CI –0.83 to 16.50); however, the difference was not statistically significant (unadjusted *P*=.07; Holm-adjusted *P*≥.99).

For physical well-being, the intervention group had a higher mean score than the control group at 6 months (mean 24.38, SD 3.84 vs mean 20.46, SD 5.88). The estimated between-group difference was 3.00 points (95% CI 0.00-7.00), with an unadjusted *P* value of .048. This finding did not remain statistically significant after adjustment for multiple comparisons (Holm-adjusted *P*=.73).

No statistically significant unadjusted between-group differences were observed for social/family well-being, emotional well-being, or functional well-being at any postbaseline assessment. After adjustment for multiple comparisons, none of the 15 post-baseline FACT-G total or subscale comparisons met the threshold for statistical significance.

Within-group changes over time are presented in Tables S1 and S2 in Multimedia Appendix 1 as supplementary exploratory analyses. These comparisons were not used to infer an intervention effect because statistical significance within 1 randomized group does not establish a statistically significant difference between randomized groups. Given the pilot sample size and variation in outcome availability across follow-up assessments, these quality-of-life findings should be interpreted as preliminary estimates intended to inform the design and sample-size planning of a future adequately powered trial.

ED Use

During the 6-month follow-up, 3 of 13 participants (23.1%) in the control group and none of the 13 participants in the intervention group experienced at least one cancer- or treatment-related ED visit (Table 4). The absolute risk difference was −23.1 percentage points (95% CI −50.3 to 4.2; intervention minus control). The difference was not statistically significant (Fisher exact *P*=.22). Given the small number of events and pilot sample size, this finding was considered exploratory and does not establish that the intervention reduced ED use.

Table 4. Exploratory secondary outcomes using available-case analysis[a].

Outcome	Control group	Intervention group	Effect estimate, intervention-control (95% CI)	*P* value
Participants with ≥1 cancer/treatment-related ED[b] visit, n/N (%)	3/13 (23.1)	0/13 (0)	Risk difference: −23.1 percentage points (−50.3 to 4.2)	.22[c]
Side-effect literacy score, mean (SD)	14.09 (2.51; n=11)	14.77 (2.68; n=13)	1.00 (−2.00 to 3.00)	.42[d]

[a]Higher side-effect literacy scores indicate greater knowledge of treatment-related adverse effects. Analyses were based on all available observations for each outcome; missing values were not imputed.
[b]ED: emergency department.
[c]Two-sided Fisher exact test.
[d]Exact Mann-Whitney *U* test. The Hodges-Lehmann estimate represents the intervention-minus-control location difference.

Side-Effect Literacy

Side-effect literacy data at the 3-month assessment were available for 24 participants, including 13 participants in the intervention group and 11 in the control group; data were missing for 2 intervention participants and 4 control participants. The mean literacy score was 14.77 (SD 2.68) in the intervention group and 14.09 (SD 2.51) in the control group. The Hodges-Lehmann estimate of the between-group difference was 1.00 point (95% CI −2.00 to 3.00). There was no statistically significant difference between groups (Mann-Whitney *U*=86.0; two-sided *P*=.42).

Mortality and Missing Data

Four of the 30 randomized participants did not complete the 6-month follow-up. In the intervention group, 1 participant died and 1 was lost to follow-up before the 3-month assessment. In the control group, 2 participants completed the 3-month assessment but died before the 6-month assessment. Overall, 3 deaths occurred during follow-up: 1 in the intervention group and 2 in the control group. All 3 participants who died had stage IV disease at baseline. No death was considered related to study participation or use of the RPM intervention.

For the longitudinal FACT-G analyses, missing values after death or loss to follow-up were not imputed, and no last-observation-carried-forward procedure was used. Instead, an available-case approach was applied, whereby all participants with an observed FACT-G assessment at a given time point were included in the corresponding analysis according to their randomized group, irrespective of the completion of subsequent follow-up assessments. FACT-G data were therefore available for all 30 randomized participants at the 1-month assessment (n=15 intervention and n=15 control), 28 participants at the 3-month assessment (n=13 intervention and n=15 control), and 26 participants at the 6-month assessment (n=13 per group). This approach avoided excluding earlier observations solely on the basis of subsequent mortality or loss to follow-up.

Side-effect literacy was assessed separately at 3 months and was analyzed using all available observations at that assessment. Literacy data were available for 24 participants, including 13 participants in the intervention group and 11 in the control group. Data were missing for 2 intervention participants and 4 control participants. No missing literacy scores were imputed.

Given the small sample size, the study had limited ability to assess whether missing outcome data were associated with clinical deterioration or other participant characteristics. In particular, mortality in this oncology population may have been related to underlying disease severity and therefore may not represent completely random missingness. Although the available-case approach retained observations collected before subsequent death or loss to follow-up, estimates at later follow-up assessments may still be subject to attrition-related bias and should be interpreted cautiously.

Discussion

Principal Findings

This pilot randomized controlled trial evaluated the feasibility of a smartphone-based RPM system integrated with a wearable device in patients with solid tumors and generated preliminary estimates of quality of life, ED use, and side-effect literacy outcomes. Overall study retention was high, with 26 of 30 randomized participants (86.7%) completing the 6-month follow-up. However, the feasibility findings differed substantially across intervention components. All 15 intervention participants successfully generated symptom-monitoring data, supporting the feasibility of initial app adoption and active symptom reporting. In contrast, engagement declined over time, with only 6 of 15 participants continuing to record symptoms at week 26. Wearable-device integration was substantially less successful: 7 of 15 intervention participants never successfully synchronized their wearable device, and synchronized wearable data were available for only 27.2% (n=738) of expected

participant-days. Therefore, the present study provides stronger evidence for the feasibility of initial smartphone-based symptom reporting than for sustained remote monitoring or reliable wearable-device integration.

The clinical outcome findings should be interpreted as exploratory. FACT-G analyses were revised to include all available observations at each assessment rather than restricting earlier assessments to participants who subsequently completed the 6-month follow-up. All 30 randomized participants contributed to the 1-month analysis, 28 contributed to the 3-month analysis, and 26 contributed to the 6-month analysis. At 6 months, the intervention group had a numerically higher total FACT-G score than the control group. The Hodges-Lehmann estimate of the between-group location difference was 6.50 points (95% CI –0.83 to 16.50), but the between-group comparison was not statistically significant. Physical well-being was also higher in the intervention group at 6 months in the unadjusted analysis, but this finding did not remain statistically significant after adjustment for multiple comparisons. None of the FACT-G total or subscale comparisons remained statistically significant after Holm adjustment. These findings therefore do not establish an intervention effect on QoL but provide preliminary effect estimates for the design of a future adequately powered trial.

ED use was uncommon. Three of 13 participants in the control group and none of the 13 participants in the intervention group experienced at least 1 cancer- or treatment-related ED visit during follow-up. Although the absolute risk difference favored the intervention group, the CI was wide and included no difference, and the Fisher exact test was not statistically significant. The small number of events prevents conclusions regarding whether remote monitoring reduced ED use. Side-effect literacy also did not differ significantly between groups, suggesting that monitoring alone, without a structured cancer-specific educational component, may be insufficient to improve knowledge regarding treatment-related adverse effects.

Feasibility and Engagement

The feasibility findings provide important information beyond participant retention. Although all 15 intervention participants generated symptom-monitoring data, the intensity and persistence of application use varied considerably. Participants recorded symptoms during a median of 2.5 (IQR 1.3-5.0) of the 6 follow-up months, and only 6 of 15 participants remained active at month 6. Engagement was not uniformly progressive over time, but activity was generally lower during later follow-up. These findings suggest that initial adoption of smartphone-based symptom reporting may be achievable, while maintaining engagement over several months remains a challenge.

The distinction between study retention and digital engagement is important. An 86.7% (n=26) study-completion rate indicates that participants could remain enrolled for 6 months, but it does not imply continuous use of all intervention components. For future trials, engagement should therefore be evaluated separately from study retention, using predefined measures such as active months, reporting frequency, completion of scheduled symptom assessments, and duration of sustained use.

Retention in the present study was broadly comparable with that reported by Soto-Perez-De-Celis et al [23], who observed a 93% completion rate in a pilot study using smartphone-based activity monitoring among older adults receiving chemotherapy in Mexico. However, that study monitored participants over a substantially shorter period of approximately 1 chemotherapy cycle. The longer 6-month follow-up in the present study may partly explain the greater variation in longitudinal engagement. More importantly, the present findings indicate that feasibility should not be evaluated solely by retention; sustained digital participation and completeness of remotely collected data are also important considerations.

Wearable-device integration presented a greater implementation challenge. Only 8 of 15 intervention participants had at least 1 day of synchronized IoT data, and synchronized data were available for 27.2% (n=738) of expected participant-days overall. Among participants with any synchronized data, completeness was substantially higher but remained variable. This suggests that the technical feasibility of passive or semipassive wearable monitoring may differ from the feasibility of active smartphone symptom reporting. Potential explanations include device pairing, synchronization through Apple Health or Google Fit, participant charging and wearing behavior, operating-system restrictions, and differences in digital literacy. Because the study did not systematically record the causes of unsuccessful synchronization, these explanations remain speculative and should be evaluated prospectively in future studies.

The provider-facing system generated 56 alerts during the intervention period, including alerts related to vital signs, treatment side effects, quality-of-life responses, and symptoms. This demonstrates that the platform was capable of transforming remotely collected information into notifications that could be reviewed by the clinical team. However, the study did not systematically capture alert-review time, provider responses, clinical actions, or whether individual alerts resulted in earlier assessment or modification of care. Consequently, the present study establishes the technical generation of alerts but cannot determine whether the alert pathway itself improved clinical outcomes. Future studies should prospectively capture alert-to-review time, alert-to-contact time, actions taken, escalation decisions, and clinical resolution.

Exploratory Quality-of-Life Findings

The available-case FACT-G analyses retained observations from participants at each assessment regardless of whether they subsequently died or were lost to follow-up. This approach avoided excluding valid earlier observations solely on the basis of later survival or retention status, which is particularly important in a small oncology sample in which mortality may be associated with disease severity. Neverthe-

less, available-case analyses do not eliminate the possibility of attrition-related bias at later assessments.

At 6 months, the intervention group had a mean total FACT-G score of 84.23 (SD 12.13) compared with 77.15 (SD 14.00) in the control group, corresponding to a Hodges-Lehmann estimate of 6.50 points (95% CI –0.83 to 16.50). Although the direction of the estimate favored the intervention, the CI included no between-group difference, and the unadjusted comparison was not statistically significant. Physical well-being was also numerically higher in the intervention group at 6 months, with an estimated between-group difference of 3.00 points (95% CI 0.00-7.00). Although the unadjusted *P* value was below .05, this finding did not remain statistically significant after adjustment for multiple comparisons. Accordingly, neither finding should be interpreted as evidence of intervention efficacy.

Within-group changes in selected FACT-G domains were observed at some follow-up assessments and are reported as supplementary exploratory analyses using available paired observations. However, a statistically significant change within 1 randomized group does not establish that the change differs significantly from that observed in the other randomized group. Furthermore, the supplementary within-group comparisons were not adjusted for multiplicity. These findings were therefore not used to support conclusions regarding intervention effectiveness.

Previous studies have demonstrated that electronic symptom monitoring can improve selected patient-reported outcomes when remote reporting is integrated into structured clinical-response pathways. Basch et al [8] reported benefits of systematic patient-reported symptom monitoring during routine cancer treatment, while the multicenter eSMART trial by Maguire et al [24] evaluated real-time remote symptom monitoring during chemotherapy. The present pilot differs substantially from these larger studies in sample size, cancer-type heterogeneity, intervention maturity, and clinical-response processes. Therefore, the current findings should be viewed as complementary feasibility evidence rather than confirmation of previously demonstrated clinical effects.

Similarly, Galiano-Castillo et al [25] reported quality-of-life benefits from an internet-based exercise intervention among breast cancer survivors. However, the intervention mechanism and population differ considerably from those in the present study. Direct comparison of individual FACT-G domains across these studies should therefore be made cautiously.

The lack of a detectable difference in social/family well-being may also reflect the intervention design. The app primarily focused on symptom monitoring, medication recording, physiological monitoring, and communication with health care professionals rather than interventions specifically intended to increase family or social support. Nevertheless, because the pilot trial was small, the absence of a between-group difference should not be interpreted as evidence that social-support functionality would necessarily improve this outcome.

ED Use

The difference in ED use warrants further investigation but should not be interpreted as evidence that the intervention prevented emergency visits. No intervention participant experienced a qualifying cancer- or treatment-related ED visit compared with 3 of 13 control participants. However, the absolute risk difference of –23.1 percentage points had a wide 95% CI that included no difference, and the Fisher exact test was not statistically significant.

The low event frequency substantially limited statistical precision. A larger trial with a longer observation period would be required to determine whether remote symptom monitoring can influence unscheduled acute care use. Future studies should also prospectively define whether the outcome includes all-cause, cancer-related, or treatment-related emergency visits and should capture reasons for each visit using standardized adjudication procedures.

Previous studies have suggested that RPM may be associated with reduced acute health care use in selected oncology populations. For example, Pritchett et al [26] reported lower hospitalization rates among patients with cancer and COVID-19 enrolled in an interdisciplinary RPM program. However, that study involved a different clinical condition and care model and therefore cannot be used to infer that the present intervention reduces emergency use. Rather, these findings support continued investigation of whether structured RPM pathways can influence acute-care use in specific oncology contexts.

Side-Effect Literacy

No significant between-group difference in side-effect literacy was observed at 3 months. One possible explanation is that the intervention primarily supported monitoring and communication and did not contain a comprehensive, structured educational program tailored to individual anticancer treatments. In addition, the literacy questionnaire was investigator-developed and was not formally validated in the study population, which limits the interpretation of this outcome.

Future versions of the intervention could incorporate treatment-specific educational content linked to reported symptoms, medications, and treatment phases. However, whether such functionality improves patient knowledge should be evaluated using a validated or appropriately developed outcome instrument rather than assumed from the present findings.

Strengths and Limitations

This study has several strengths. The randomized pilot design allowed preliminary comparison with standard care while simultaneously evaluating implementation over a 6-month period. The study incorporated multiple sources of remote information, including patient-reported symptoms, wearable-device data, and provider-facing alerts. Participant-level engagement and data-completeness measures also provide practical information for refining the intervention and planning a larger trial.

Several limitations should be considered. First, the small sample size and pilot design limited statistical power and precision; consequently, the study was not designed to establish clinical efficacy. Second, the study was conducted at a single center and involved care overseen by a single oncologist, which may limit generalizability to other oncology settings and workflows. Participants also had heterogeneous solid tumors and treatment regimens, introducing clinical variability that could not be adequately addressed in this small sample.

Third, wearable-device synchronization represented a major technical limitation. Sustained app engagement was also limited. Although all intervention participants generated symptom-monitoring data during the study, only 6 of 15 participants remained active at month 6. Thus, successful initial adoption should not be interpreted as evidence of sustained engagement throughout the monitoring period. Seven of the 15 intervention participants never successfully synchronized their wearable device, and wearable data were captured for only 27.2% (n=738) of expected participant-days. Therefore, the findings should not be interpreted as demonstrating the feasibility of sustained wearable-integrated remote monitoring. The study also did not systematically document the reasons for synchronization failure, preventing determination of whether missing wearable data were primarily attributable to technical, behavioral, device-related, or user-level factors.

Fourth, missing clinical outcome data may not have occurred completely at random. Three participants died during follow-up, all of whom had stage IV disease at baseline, and 1 participant was lost to follow-up. Although the available-case analysis retained observations collected before subsequent death or loss to follow-up, participants contributing data at later assessments may differ systematically from those who did not. Later follow-up estimates may therefore remain susceptible to attrition-related bias.

Finally, ED use was based on events documented at Mongkutwattana Hospital, and visits to other health care facilities were not systematically captured. In addition, only 3 qualifying events occurred, substantially limiting statistical precision.

Implications for Future Research

The findings provide several practical directions for a future definitive trial. First, the smartphone symptom-reporting component appears more feasible than the wearable synchronization component, suggesting that the technical optimization of device connectivity should occur before scaling the intervention. Automated synchronization monitoring, device troubleshooting workflows, and targeted onboarding may improve wearable-data completeness.

Second, a larger multicenter randomized trial should consider stratified or minimization-based randomization for important prognostic factors such as cancer stage, cancer type, and treatment modality. A larger sample would also allow adjusted analyses and more precise estimation of quality-of-life and health care use outcomes.

Finally, future studies could incorporate cancer- and treatment-specific educational content and consider disease-specific patient-reported outcome measures in addition to FACT-G when greater sensitivity to treatment-related changes is required.

Conclusions

This pilot randomized controlled trial suggests that initial adoption of smartphone-based symptom monitoring was feasible among patients with solid tumors, with high study retention and successful symptom reporting across the intervention group. However, sustained engagement declined over time, and wearable-device integration was substantially limited, with incomplete synchronization across much of the follow-up period. Therefore, the study provides stronger support for the feasibility of initial app-based symptom reporting than for sustained wearable-enabled remote monitoring.

The exploratory clinical outcomes did not provide confirmatory evidence of effectiveness. Although the intervention group had numerically higher total FACT-G and physical well-being scores at 6 months, none of the quality-of-life comparisons remained statistically significant after adjustment for multiple comparisons. Cancer- or treatment-related ED visits were observed only in the control group, but the number of events was small, and the between-group difference was not statistically significant. Side-effect literacy also did not differ significantly between groups.

These findings highlight the need to improve wearable-device synchronization, support sustained patient engagement, standardize alert-response workflows, and strengthen cancer-specific educational content before larger-scale evaluation. A larger, adequately powered, multicenter randomized trial with predefined feasibility criteria, prospective assessment of intervention fidelity, and stratification for important prognostic factors is warranted to determine whether this remote monitoring approach can improve patient-reported outcomes and reduce acute health care use.

Acknowledgments

The authors would like to thank the patients who participated in this study and the clinical staff of the outpatient oncology clinic at Mongkutwattana Hospital for their support during recruitment, follow-up, and data collection. The authors also acknowledge the support of the research and implementation teams involved in onboarding participants and maintaining the remote patient monitoring system used in this study.

Generative AI Use

ChatGPT (OpenAI) was used on a limited basis to assist with manuscript organization and language editing. It was not used for data generation, statistical analysis, or independent scientific decision-making. All AI-assisted text was reviewed and edited by the authors, who take full responsibility for the accuracy and scientific content of the manuscript.

Funding

This study received no external financial funding. Invitrace Company Limited provided the WellHealth app used in the intervention as an in-kind contribution. The roles of Invitrace-affiliated authors in the study are described in the Authors' Contributions and Conflicts of Interest sections.

Authors' Contributions

Conceptualization: P Sainamthip, KS
Data curation: SK, P Sakunma, SS, NL
Investigation: SK, P Sakunma, SS, NL, P Sainamthip
Methodology: P Sainamthip, KS
Project administration: KS, SK
Resources: P Sainamthip
Supervision: P Sainamthip, KS
Validation: NL
Writing – review and editing: KS, NL, P Sakunma, P Sainamthip, SK, SS
All authors reviewed and approved the final version of the manuscript and agree to be accountable for the accuracy and integrity of the work.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Supplementary Tables S1 and S2 presenting exploratory within-group changes in Functional Assessment of Cancer Therapy–General (FACT-G) total and subscale scores from baseline to 1, 3, and 6 months in the intervention and control groups.
[DOCX File (Microsoft Word File), 18 KB-Multimedia Appendix 1]

Checklist 1 CONSORT-eHEALTH checklist (V 1.6.1)

[PDF File (Adobe File), 1155 KB-Checklist 1 CONSORT-eHEALTH checklist (V 1.6.1)]

References

1. DeVita Jr VT, Chu E. A history of cancer chemotherapy. Cancer Res. Nov 1, 2008;68(21):8643-8653. [doi: 10.1158/0008-5472.CAN-07-6611] [Medline: 18974103]
2. Hesketh PJ. Chemotherapy-induced nausea and vomiting. N Engl J Med. Jun 5, 2008;358(23):2482-2494. [doi: 10.1056/NEJMra0706547] [Medline: 18525044]
3. Chabner BA, Roberts Jr TG. Timeline: chemotherapy and the war on cancer. Nat Rev Cancer. Jan 2005;5(1):65-72. [doi: 10.1038/nrc1529] [Medline: 15630416]
4. Given BA, Given CW, Sherwood P. The challenge of quality cancer care for family caregivers. Semin Oncol Nurs. Nov 2012;28(4):205-212. [doi: 10.1016/j.soncn.2012.09.002] [Medline: 23107177]
5. Mackintosh NJ, Davis RE, Easter A, et al. Interventions to increase patient and family involvement in escalation of care for acute life-threatening illness in community health and hospital settings. Cochrane Database Syst Rev. Dec 8, 2020;12(12):CD012829. [doi: 10.1002/14651858.CD012829.pub2] [Medline: 33285618]
6. He P, Huang D, Wu D, et al. A survey of Internet of medical things: technology, application and future directions. Digit Commun Netw. May 2026;12(5):717-742. [doi: 10.1016/j.dcan.2024.11.013]
7. Dunn J, Runge R, Snyder M. Wearables and the medical revolution. Per Med. Sep 2018;15(5):429-448. [doi: 10.2217/pme-2018-0044] [Medline: 30259801]
8. Basch E, Deal AM, Kris MG, et al. Symptom monitoring with patient-reported outcomes during routine cancer treatment: a randomized controlled trial. J Clin Oncol. Feb 20, 2016;34(6):557-565. [doi: 10.1200/JCO.2015.63.0830] [Medline: 26644527]
9. Basch E, Artz D, Dulko D, et al. Patient online self-reporting of toxicity symptoms during chemotherapy. J Clin Oncol. May 20, 2005;23(15):3552-3561. [doi: 10.1200/JCO.2005.04.275] [Medline: 15908666]
10. Basch E. Patient-reported outcomes—harnessing patients' voices to improve clinical care. N Engl J Med. Jan 12, 2017;376(2):105-108. [doi: 10.1056/NEJMp1611252] [Medline: 28076708]

11. Jensen RE, Snyder CF, Abernethy AP, et al. Review of electronic patient-reported outcomes systems used in cancer clinical care. J Oncol Pract. Jul 2014;10(4):e215-22. [doi: 10.1200/JOP.2013.001067] [Medline: 24301843]
12. Bennett AV, Jensen RE, Basch E. Electronic patient-reported outcome systems in oncology clinical practice. CA Cancer J Clin. 2012;62(5):337-347. [doi: 10.3322/caac.21150] [Medline: 22811342]
13. Bakitas MA, Tosteson TD, Li Z, et al. Early versus delayed initiation of concurrent palliative oncology care: patient outcomes in the ENABLE III randomized controlled trial. J Clin Oncol. May 1, 2015;33(13):1438-1445. [doi: 10.1200/JCO.2014.58.6362] [Medline: 25800768]
14. Denis F, Lethrosne C, Pourel N, et al. Randomized trial comparing a web-mediated follow-up with routine surveillance in lung cancer patients. J Natl Cancer Inst. Sep 1, 2017;109(9):djx029. [doi: 10.1093/jnci/djx029] [Medline: 28423407]
15. Denis F, Lethrosne C, Pourel N, et al. Overall survival in patients with lung cancer using a web-application-guided follow-up compared to standard modalities: results of phase III randomized trial. J Clin Oncol. Jun 20, 2016;34(18_suppl):LBA9006-LBA9006. [doi: 10.1200/JCO.2016.34.18_suppl.LBA9006]
16. Paul CL, Boyes AW, O'Brien L, et al. Protocol for a randomized controlled trial of proactive web-based versus telephone-based information and support: can electronic platforms deliver effective care for lung cancer patients? JMIR Res Protoc. Oct 26, 2016;5(4):e202. [doi: 10.2196/resprot.6248] [Medline: 27784648]
17. Zhu J, Ebert L, Liu X, Chan SWC. A mobile application of breast cancer e-support program versus routine care in the treatment of Chinese women with breast cancer undergoing chemotherapy: study protocol for a randomized controlled trial. BMC Cancer. Apr 26, 2017;17(1):291. [doi: 10.1186/s12885-017-3276-7] [Medline: 28446141]
18. Cheong IY, An SY, Cha WC, et al. Efficacy of mobile health care application and wearable device in improvement of physical performance in colorectal cancer patients undergoing chemotherapy. Clin Colorectal Cancer. Jun 2018;17(2):e353-e362. [doi: 10.1016/j.clcc.2018.02.002] [Medline: 29551558]
19. Mahaisavariya C, Supamontri K, Limtrakun N, Fuangfoo A, Sakunma P. Implementation of a web-based application (Wellhealth) for osteoporosis medication management in older adults: prospective feasibility study. JMIR Form Res. Jun 10, 2026;10:e86067. [doi: 10.2196/86067] [Medline: 42269168]
20. Cella DF, Tulsky DS, Gray G, et al. The Functional Assessment of Cancer Therapy scale: development and validation of the general measure. J Clin Oncol. Mar 1993;11(3):570-579. [doi: 10.1200/JCO.1993.11.3.570] [Medline: 8445433]
21. Berger O, Grønberg BH, Loge JH, Kaasa S, Sand K. Cancer patients' knowledge about their disease and treatment before, during and after treatment: a prospective, longitudinal study. BMC Cancer. Apr 3, 2018;18(1):381. [doi: 10.1186/s12885-018-4164-5] [Medline: 29614997]
22. Almohammadi A, Alqarni A, Alraddadi R, Alzahrani F. Assessment of patients' knowledge in managing side effects of chemotherapy: case of King Abdul-Aziz University Hospital. J Cancer Educ. Apr 2020;35(2):334-338. [doi: 10.1007/s13187-019-1469-2] [Medline: 30637532]
23. Soto-Perez-De-Celis E, Kim H, Rojo-Castillo MP, et al. A pilot study of an accelerometer-equipped smartphone to monitor older adults with cancer receiving chemotherapy in Mexico. J Geriatr Oncol. Mar 2018;9(2):145-151. [doi: 10.1016/j.jgo.2017.09.008] [Medline: 29017891]
24. Maguire R, McCann L, Kotronoulas G, et al. Real time remote symptom monitoring during chemotherapy for cancer: European multicentre randomised controlled trial (eSMART). BMJ. Jul 21, 2021;374:n1647. [doi: 10.1136/bmj.n1647] [Medline: 34289996]
25. Galiano-Castillo N, Cantarero-Villanueva I, Fernández-Lao C, et al. Telehealth system: a randomized controlled trial evaluating the impact of an internet-based exercise intervention on quality of life, pain, muscle strength, and fatigue in breast cancer survivors. Cancer. Oct 15, 2016;122(20):3166-3174. [doi: 10.1002/cncr.30172] [Medline: 27332968]
26. Pritchett JC, Borah BJ, Desai AP, et al. Association of a remote patient monitoring (RPM) program with reduced hospitalizations in cancer patients with COVID-19. JCO Oncol Pract. Sep 2021;17(9):e1293-e1302. [doi: 10.1200/OP.21.00307] [Medline: 34085535]

Abbreviations

CONSORT: Consolidated Standards of Reporting Trials
ECOG: Eastern Cooperative Oncology Group
ED: emergency department
FACT-G: Functional Assessment of Cancer Therapy–General
IoT: Internet of Things
QoL: quality of life
RPM: remote patient monitoring

Edited by Javad Sarvestan; peer-reviewed by Haonan Yin, Kwabena Aninkora, Zhao Liu; submitted 08.Aug.2025; final revised version received 13.Sep.2026; accepted 22.Sep.2026; published 17.Nov.2026

Please cite as:
Sainamthip P, Supamontri K, Kudtiyakarn S, Sakunma P, Suthanaseriporn S, Limtrakun N
Feasibility and Preliminary Outcomes of Smartphone-Based Remote Patient Monitoring in Patients With Solid Tumors: Pilot Randomized Controlled Trial
JMIR Form Res 2026;10:e82041
URL: https://formative.jmir.org/2026/1/e82041
doi: 10.2196/82041

© Panot Sainamthip, Kittipoom Supamontri, Sirintip Kudtiyakarn, Palita Sakunma, Sarunchana Suthanaseriporn, Natcha Limtrakun. Originally published in JMIR Formative Research (https://formative.jmir.org), 17.Nov.2026. This is an open-access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in JMIR Formative Research, is properly cited. The complete bibliographic information, a link to the original publication on https://formative.jmir.org, as well as this copyright and license information must be included.