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Plymfit Study: Feasibility of wrist-worn, commercially available, activity monitor use in perioperative care

Alexander Hunter

alexander.hunter2@nhs.net

University Hospitals Plymouth NHS Trust

Sabrina Stewart

University of Exeter

Charles Coles

University of Plymouth

Charlotte England

University Hospitals Plymouth NHS Trust

Jeremy Fabes

University Hospitals Plymouth NHS Trust

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Abstract

Background

Wrist-worn smartwatches offer a non-invasive, continuous, and scalable means of measuring physical activity throughout the perioperative period.

This prospective observational feasibility study assessed recruitment rate, preoperative smartwatch adherence and completion of a series of validated perioperative outcome assessments against ‘stop, modify and go’ criterion, in a cohort of 50 patients undergoing major abdominopelvic surgery. Participants were recruited through the preoperative clinic and asked to wear a Garmin Vivofit 4 smartwatch for two weeks prior and four weeks after their surgery.

Results

Of 75 eligible patients, 50 were recruited (67%), meeting the go criterion. Overall completion of secondary outcome data collection was 82%, meeting the go criterion. Preoperative smartwatch adherence of at least seven days was achieved in 33 of 50 participants (66%), meeting the modify criterion. The median daily preoperative step count was 5406 (3023) [1084-11679] (n=33). Following surgery, median daily steps rose progressively from 627 (952) [0-8065] (n=23) in the first postoperative week to 3420 (1944) [513-11834] (n=15) by the fourth week. Continuous watch wear declined each week postoperatively (n=23 to n=15) however reported device acceptability was high and 76% of participants felt the watch would help them achieve a target number of steps in the future.

Conclusions

This feasibility study demonstrates that perioperative monitoring using commercially available wearables is achievable and acceptable in patients undergoing major abdominopelvic surgery. These findings should be used to inform the design of future adequately powered studies to evaluate the role of wearables in perioperative care pathways.

Introduction

The increasing volume and complexity of surgical cases presents a significant and growing challenge for perioperative teams. A typical preoperative pathway incorporates a series of structured assessments designed to risk stratify patients presenting for surgery, culminating in a shared decision-making discussion aimed at optimising outcomes for each individual. Over the past two decades, cardiopulmonary exercise testing (CPET) has become a cornerstone of perioperative risk stratification[1] in many centres, and a consistent body of evidence demonstrates that preoperative aerobic capacity predicts adverse perioperative outcomes across a range of surgical settings, particularly adverse cardiopulmonary events and mortality[2]. Preoperative improvement of aerobic capacity through 'prehabilitation'[3] subsequently aims to enhance patient tolerance of the surgical insult and thereby attenuate perioperative risk.

However, these methods of preoperative assessment face several challenges. There is limited association of CPET derived variables and patient-centred outcomes such as postoperative disability-free survival, and health-related quality of life[4] which are especially significant to the surgical patient. Institutional constraints mean that CPET, face-to-face clinics and supervised prehabilitation programmes are a limited resource. All current methods of perioperative assessment are largely time-stamped (unless performed repeatedly) and perform limited means of longitudinal assessment.

Wearable technology remains an understudied and infrequently incorporated adjunct to perioperative care, yet may offer meaningful solutions to these challenges[5]. Wrist-worn monitors have the potential to provide an alternative physiological assessment for perioperative risk stratification[6], potentially triaging the requirement to attend in-person CPET. Early work suggests they may approximate CPET variables in the perioperative setting[7]. They also permit remote assessment of prehabilitation delivery and adherence[8] and may serve as a vehicle for facilitating behavioural change. Uniquely, such devices may offer a combined physiological, psychological, and functional metric with which to characterise patients preparing for surgery. As a result, they are forming a key feature of emerging prehabilitation interventions[9].

Meta-analysis suggests that wearable data, in particular daily step counts, are associated with mortality[10,11], and this incidence of cancer, cardiovascular disease[12,13], type 2 diabetes and dementia[14]. Within the perioperative setting, a series of small cohort studies have suggested an association between step count and postoperative outcomes particularly in hepatobiliary surgery[15,16]. Overall, emerging evidence from both population studies[14] and surgical cohorts[17] suggests a dose-response of daily step count to adverse event may sit at a threshold of approximately 7000 steps per day.

However, before these devices can be meaningfully integrated into perioperative care the precision of consumer wearables in this clinical context must be addressed[18], and several groups are actively working to establish robust methods for validating step count data derived from consumer devices in free-living environments [19]. Consensus on accepted baseline normative values has not been established, missing data remains a consistent limitation in wearable-based studies, and the potential for digital exclusion based on age, digital literacy, and socioeconomic deprivation must be carefully considered. Existing studies are predominantly small, typically enrolling fewer than 100 patients.

Study Rationale

The overarching hypothesis upon which this study is based is that objective measurement of physical activity and step count using wrist-worn wearable devices may have utility across multiple stages of the surgical pathway but requires further investigation to determine whether, and in what capacity, this technology can be effectively and meaningfully applied. This study has been designed to a) evaluate the use of smartwatches in a perioperative cohort to; assess feasibility, test recruitment, compliance and data collection; and b) inform the methodological design of a substantive study capable of answering

questions of direct relevance to improving patient care. Secondary outcomes will help identify which of these are most achievable, help with further hypothesis generation, and data from this feasibility study will inform sample size calculations for these candidate outcome(s) in future studies.

Methods

This study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

This prospective observational cohort study recruited participants scheduled for major abdominopelvic surgery at a single tertiary referral centre. The full study protocol has been published previously[20]. Participants were identified from the preoperative anaesthetic clinic list and were considered eligible if they met the following inclusion criteria: age > 18 years; elective major abdominopelvic surgery, defined as requiring an overnight hospital stay, an operative duration > 90 minutes, and including upper or lower gastrointestinal, hepatobiliary, vascular, urological or gynaecological surgery; completion of cardiopulmonary exercise testing (CPET) within three months of the date of surgery; and surgery scheduled more than two weeks after the date of consent.

The published protocol specified that participants would be excluded if they did not have access to a smartphone within the household however these participants were not excluded and were accommodated via a centralised research device.

Participants were introduced to the trial by a member of their usual clinical team, who provided a written patient information sheet and obtained consent for research contact. A member of the trial team subsequently discussed the study, and consent was obtained either following the clinic appointment or by telephone in the days thereafter. For participants consented by telephone, written confirmation was recorded by a member of the research team in accordance with local practice.

A quota sampling strategy was used with target quotas set by age and ASA grade (Table S1, Supplementary Appendix). A purposeful quota was used to reduce bias associated with two factors: expected event rate of post-operative complications according to comorbidity and age; and to account for older adults who may have lower activity levels and be less likely to consent to a technology-based study.

At the time of consent, baseline demographic and comorbidity data (Charlson Comorbidity Index[21]), CPET data, and preoperative quality-of-life assessments (EuroQol EQ-5D-5L[22]; Duke Activity Status Index, DASI[23]) were recorded in the study REDCap[24] database. Participants were asked to wear a Garmin Vivofit 4[25] smartwatch during waking hours for two weeks before surgery and for four weeks afterwards. Commercially available watches were specifically chosen as, although research-specific devices exist, these are likely to represent an easily applicable tool to generalise to prehabilitation and routine perioperative care. These Vivofit 4 is a long battery life device that have been validated in relevant settings[26]. The devices captured step-count data and were linked to a third-party, GDPR-compliant

platform (*Fitrockr[27]*) via the participant's smartphone, which periodically synchronised with the device. As described above, smartwatches could also be set up without a smartphone using a centralised version of the *Fitrockr* platform on a research device. All smartwatch data were pseudonymised before entry. Watches were either set up in person after the preoperative clinic or sent by post with setup instructions. Telephone calls were used to troubleshoot participants who were not uploading smartwatch data.

Surgery received, length of hospital stay and ICU admission data were collected from hospital electronic health records. Post operative morbidity scores (POMS)[28] were collected by notes review at day 7, and participants were followed up until 30 days postoperatively. At day 30, repeat EQ-5D-5L and DASI assessments were performed via telephone along with a smartwatch user questionnaire. This was a locally-designed questionnaire co-developed with patients to assess user interaction with, and experience of, the smartwatch devices (supplied in Supplementary Appendix). Watches were then returned via post.

Primary outcomes were feasibility focused. Feasibility was defined according to 'stop' (not feasible in the current format), 'modify' (feasible with modification), and 'go' (feasible in the current format) criteria. These comprised: the proportion of eligible patients recruited (< 20%, 20–30%, > 30%); the proportion of patients compliant with preoperative smartwatch use (minimum of 7 consecutive days; < 60%, 60–75%, > 75%); and completion of secondary outcome data collection (< 60%, 60–75%, > 75%). Secondary outcomes included CPET data, smartwatch step count data, length of hospital stay, days alive-and-at-home at 30-days (DAH30), Post-Operative Morbidity Survey (POMS) at post-operative day 7, health related quality of life assessments (EQ-5D-5L, DASI) and device acceptability via the locally designed Smartwatch User Experience Questionnaire. Detailed secondary outcomes are provided in the Supplementary Appendix S2.

Cross-sectional data indicate that six days of monitoring are required to reliably characterise habitual physical activity across all activity intensities[29]. Accordingly, a minimum of seven days of preoperative smartwatch data was prespecified as the feasibility threshold. Participants were included in the postoperative smartwatch analysis if they contributed at least seven days of step-count data both preoperatively and postoperatively. Weekly wear was defined as providing seven days of data for that week. The day of surgery was excluded from the step-count analysis, as participants were instructed to remove the device for the day of surgery itself.

As a feasibility study, a formal sample size calculation has not been performed. Fifty patients were recruited, providing sufficient data to answer our primary questions. A sample size of fifty participants allowed a recruitment rate of 30% to be estimated with an 95% confidence interval of ± 10%.

Descriptive statistics are presented for feasibility and secondary outcomes. Continuous variables, including step count data, were not normally distributed and are therefore summarised as median (interquartile range). Categorical data are reported as number (proportion). A limited exploratory analysis was conducted to assess the associated between preoperative step count and CPET variables

and used Spearman's rank for correlation and Mann-Whitney U tests to compare groups. All analyses were conducted using R (version 4.5.2; R Core Team, 2025) and the 'ggstatsplot' [30] and 'ggstats'[31]packages were used for figures.

Results

50 patients were recruited to wear smartwatches before and after major elective abdominopelvic surgery between March and October 2025. We report observed demographic characteristics, cardiopulmonary exercise testing (CPET), smartwatch-derived metrics, and clinical outcomes.

In total, 109 patients were assessed for eligibility. Thirty-four did not meet the inclusion criteria, leaving 75 eligible patients. Five eligible patients declined to provide consent. Figure 1.

Table 1 summarises the demographic characteristics of the cohort. The median age was 67 years (IQR 15), BMI 29.8 $kg \cdot m^{-2}$ (IQR 8.1). Participants were predominantly male (62%) and non-smokers (92%). All patients were classified as ASA 2 or 3, with a median Charleson Comorbidity Index of 2 (IQR 1). The median Index of Multiple Deprivation rank was 14737, corresponding to the fourth or fifth decile, where 1 represents the most deprived 10% derived using participant postcodes from 2019 UK government data[32].

Table 1
Characteristics and pre-operative CPET data of patients. Values are median (IQR) [range] or number (proportion).

Demographic variable	**n = 50**
Age; y	67 (15) [35–89]
18–64	19 (38%)
≥65	31 (62%)
Sex	
Male	31 (62%)
Ethnicity	
White	50 (100%)
Weight; kg	85 (24) [56–127]
BMI	29.8 (8.1) [18.7–44.5]
Current smoker	5 (10%)
Unknown	1 (2%)
ASA physical status	34 (68%)
2	16 (32%)
3	
Charleson Comorbidity Index	2 (1) [0–11]
Clinical Frailty Score	
1	2 (4%)
2	18 (36%)
3	28 (56%)
4	2 (4%)
Index of Multiple Deprivation Rank*	14,737 (13,093) [1,821–29,291]
CPET variable	
Anaerobic threshold; $ml.kg^{-1}.min^{-1}$	12.1 (3.0) [6.5–24.0]
Not achieved	1 (2%)
VO2 Peak; $ml.kg^{-1}.min^{-1}$	17.7 (5.7) [11.2–37.6]
*where rank 1 = most deprived, rank 32,844 = least deprived.	

Demographic variable	n = 50
Ventilatory equivalent (VE/VCO2) at AT	34.0 (5.0) [26.0–58.0]
Peak Power; W	106 (48) [55–237]
Heart rate maximum; beats per minute	129 (21) [85–175]
Time under load; minutes	7.0 (2) [4.48–9.47]
*where rank 1 = most deprived, rank 32,844 = least deprived.	

47 patients underwent surgery; three planned procedures were not completed for surgical reasons. Surgical specialities were lower gastrointestinal, hepatobiliary or upper gastrointestinal in 86% of cases, with liver resection, Ivor Lewis oesophagectomy and Whipple's procedure being the three most frequent procedures in the data, totalling 45% of surgical procedures. Surgical complexity was complex in 60% of cases (AXA Specialist Procedure Code grading). Table 2.

Table 2
Surgical and outcome data. Values are number (proportion), or median (IQR) [range]. n = 47, 3 patients did not receive an operation.

Surgical specialty	**n = 47**
Lower GI	18 (38%)
Hepatobiliary	16 (34%)
Upper GI	9 (19%)
Urology	4 (9%)
Most frequent procedures	
Resection of lesion(s) of the liver	9 (19%)
Ivor Lewis Oesophagectomy	6 (13%)
Pancreatoduodenectomy and excision of surrounding tissue (Whipple's procedure)	6 (13%)
Anterior Resection	5 (11%)
Right Hemicolectomy	5 (11%)
Surgical complexity	
Complex	30 (60%)
Complex Major	6 (12%)
Extra Major	6 (12%)
Major	4 (8%)
Intermediate	1 (2%)
Length of Stay; days	7 (6.5) [0–30]
Upper GI	9 (6) [0–23]
Lower GI	7 (5) [2–30]
Hepatobiliary	6 (2.75) [1–21]
Urology	2.5 (1.5) [2–5]
Admitted to ICU	3 (6%)
Length of ICU stay; days	1 (3) [1–7]
*Days alive-and-at-home at 30-days	

Surgical specialty	**n = 47**
DAH30*	21 (8) [4–28]
*Days alive-and-at-home at 30-days	

Primary (feasibility) outcomes

Of 75 eligible patients, 50 were recruited (67%, 95% CI 55%-76%), meeting the prespecified 'go' criterion for recruitment. Of the 20 not recruited and not declining consent, 12 were due to a lack of study team capacity to approach, 5 did not have the trial appropriated introduced by a member of the clinical team such that they could be approached, 3 were not able to be contacted by phone. Preoperative smartwatch adherence of at least seven days was achieved in 33 of 50 participants (66%, 95% CI 52%-78%), meeting the 'modify' criterion. Overall completion of secondary outcome data collection was 82%, meeting the 'go' criterion. This was calculated with 47/50 having complete CPET, perioperative outcome and health related quality of life data, 43/50 had completed smartwatch user experience questionnaire, and 33/50 had complete smartwatch data.

Secondary outcomes

CPET data

Cardiopulmonary exercise testing demonstrated a median (IQR) anaerobic threshold of 12.1ml.kg^{-1}.min^{-1} (3.0), oxygen uptake at anaerobic threshold of 17.7 ml.kg-1.min-1 (5.7), and ventilatory equivalent for CO_2 at anaerobic threshold of 34.0 (5.0). Median peak power output of 106W (48) achieved on the cycle ergometer.

Smartwatch data

Individual participant smartwatch data are summarised in Supplementary Table S4, with cohort-level data presented in Table 3 and Fig. 2. Baseline demographic and surgical characteristics of the 33 participants who met the preoperative threshold of at least 7 days of step-count data, are detailed in Supplementary Table S3. Of these, 23 had sufficient paired postoperative data and were included in the postoperative analysis.

Table 3

Smartwatch derived step count data, cohort summary. Each presented is the median (IQR) [range] of each individual median daily step count contained within Supplementary Table S4. Each presented value is the percentage change referenced to that individual's median preoperative daily step count.

Daily step count, median (IQR) [range]				
Preop	**Postop**			
(n = 33)	Week 1	Week 2	Week 3	Week 4
	(n = 23)	(n = 21)	(n = 17)	(n = 15)
5406 (3023) [1084–11679]	627 (952) [0-8065]	1696 (2014) [0-9735]	2310 (1719) [94-12473]	3420 (1944) [513-11834]
Post operative step count change percentage, median (IQR) [range]				
	-83% (26)	-70% (67)	-41% (65)	-28% (50)
	[-100 - +126]	[-100 - +56]	[-99 - +113]	[-92 - +68]

Preoperatively, the median daily step count across the cohort was 5406 (3023) [1084–11679] (n = 33). Following surgery, median daily steps rose progressively from 627 (952) [0-8065] (n = 23) in the first postoperative week to 3420 (1944) [513-11834] (n = 15) by the fourth week (Table 3, Fig. 2). This corresponds to reductions from preoperative baseline of 83%, 70%, 41%, and 28% in weeks one through four respectively. Among the 15 participants with four complete weeks of postoperative data, 4 (27%) had returned to within 10% of their preoperative step count by week four.

Exploratory analysis showed preoperative daily step count demonstrated weak, non-significant positive correlations with both anaerobic threshold ($\rho = 0.22$, $p = 0.24$) and VO_2 peak ($\rho = 0.16$, $p = 0.37$). When dichotomising by median preoperative daily step count threshold of 4000 steps.day^{-1} (used as the lower limit of healthy adults from normative data[33]), participants below this threshold (n = 10) had a lower anaerobic threshold compared with those above it (n = 22), though this did not reach statistical significance [11.4ml.kg-1.min-1 (IQR 1.67) vs 13.3 (IQR 3.8); p = 0.13]. A similar pattern was observed with VO_2 peak, with participants below 4000 steps.day^{-1} threshold demonstrating a lower median than those above it [15.0ml.kg-1.min-1 (IQR 2.8) vs 18.9 (IQR 5.0); p = 0.02].

17 participants did not meet the preoperative minimum of 7 consecutive days of smartwatch data required for inclusion in step-count analysis. Sociodemographic characteristics did not differ significantly between those who met and did not meet this threshold (Supplementary Table S3). Of these 17, two wore the watch but accumulated insufficient days of data. Among the remaining 15, non-compliance occurred due to: failure to wear the device (n = 7), difficulty with initial setup (n = 4), and failure of the third-party API following watch reset and reuse (n = 4).

Of the 33 participants with adequate preoperative data, a further 10 were excluded from subsequent postoperative analysis due to insufficient postoperative step-count data; four accumulated some

postoperative data but fell below the 7-day threshold, whilst six did not wear the device following surgery. An additional four participants collected adequate postoperative data but were excluded owing to insufficient preoperative data.

Peri-operative outcome data

Median length of hospital stay was 7 days (IQR 6.5) and 3 participants were admitted to ICU. Participants had a median of 21 days (IQR 8) alive and at home at 30 days after their procedure. POMS-defined morbidity was present in 40.4% (19/47) 7 days after the surgical procedure. Infective (23.4%), Gastrointestinal (14.9%), Haematological and Renal (both 6.4%) were the most frequently occurring causes of morbidity.

Health related quality of life data

At baseline, the most frequently reported impairments on the EQ-5D-5L were anxiety or depression (35.4%, 17/48), impaired mobility (22.9%, 11/48) and pain or discomfort (18.8%, 9/48). At 30 days postoperatively, 68.2% (30/44) of participants demonstrated new or worsening scores in one or more EQ-5D-5L domains, with declines most commonly observed in usual activities, pain or discomfort, and mobility. Improvement in health-related quality of life was seen in 15.9% (7/44) of participants. Paired DASI scores were available for 44 participants, with a median preoperative score of 37.5 (IQR 17.6 [16–53]) falling to 23.4 (IQR 16.8 [7.2–53]) at 30 days postoperatively ($p = 0.0001$). These median values correspond to 5.79 and 4.05 METs (metabolic equivalent of task) respectively.

Smartwatch User Experience Questionnaire

User experience is summarised in Fig. 3, 44 users responded to the questionnaire. Device acceptability was high with respondents reporting the watch was comfortable to wear (90%), easy to use (83%) and functioned across the duration of the study. 60% felt they could set up the watch independently, however 17% felt they could not. There was one question investigated behavioural influence of wearing the watch asking if the ‘watch made me exercise more’. 52% agreed or strongly agreed with this statement, 29% disagreed and 19% were neutral. Questions targeting future acceptability revealed that 76% of participants felt the watch would help them achieve a target number of steps and 64% would be motivated by a team reviewing their steps. 52% of participants felt having the healthcare team reviewing their activity would make them feel safer about doing more, 36% were neutral and 12% disagreed with this statement.

Discussion

We found that collecting perioperative smartwatch data alongside outcome data in patients undergoing major abdominopelvic surgery is feasible. This is important because consumer wearable technology

represents an accessible, low-cost tool that may capture meaningful information about habitual physical activity, cardiorespiratory fitness, and perioperative recovery potentially augmenting existing assessment tools such as CPET. Further work is required in a larger cohort to explore the relationship between habitual activity and cardiorespiratory fitness in surgical populations and determine whether wearable-derived step count predicts perioperative outcomes. The data presented here may be of use to inform future studies.

Recruitment and secondary outcome data collection both met 'go' criteria, supporting progression without modification. Preoperative smartwatch adherence met the 'modify' criterion at 66%, falling short of the > 75% 'go' threshold, and strategies to improve this should be incorporated into future study design and are discussed below. The median preoperative daily step count was 5406 steps, and exploratory analysis provided preliminary evidence that wearable-derived step count may differentiate patients with higher cardiorespiratory fitness on CPET. Postoperative recovery trajectory was reflected in progressively rising daily step counts, from a median of 627 steps in week one to 3420 by week four. Smartwatch acceptability was high, suggesting consumer wearable devices are likely to be acceptable to future perioperative populations.

The feasibility metrics observed in this study are consistent with existing perioperative wearable studies, which have demonstrated comparable participation and completion rates in surgical populations[15,34,35]. The preoperative median daily step count of 5406 steps is lower than values reported in large-scale accelerometry studies, where median daily step counts in healthy populations frequently exceed 7000 steps per day[13,33]. This step count is, however, consistent with data from older, comorbid surgical populations[15,36] and likely a strength of the purposive sampling strategy used. Very few studies have reported progressive changes in postoperative step counts [37], however, our wearable data, POMS and health related quality of life data is consistent with recovery trajectories described in existing colorectal and major abdominal surgery literature[38–40], supporting the plausibility of consumer wearable step count as a meaningful marker of functional recovery that could be used in conjunction with other methods of assessment [41].

While a high burden of postoperative morbidity and health-related quality of life impairment was observed in this cohort, considerable heterogeneity in recovery trajectories was apparent within the step count data. Although this almost certainly reflects the heterogeneity of surgical procedures and sample size included, it supports the hypothesis that inter-individual differences in functional recovery or “recovery phenotypes” may exist[42]. This is a hypothesis that a larger procedure-specific study may be able to test. Identifying recovery phenotypes through continuous wearable monitoring could ultimately facilitate earlier recognition of patients with delayed recovery, enabling targeted postoperative intervention.

The 30-day follow-up period here, appears insufficient to capture full functional recovery in this population; only 27% of participants with complete postoperative data had returned to within 10% of their preoperative step count by week four, and neither DASI nor EQ-5D-5L scores had returned to baseline

levels, consistent with current literature demonstrating that recovery extends well beyond 30 days [39,40,42] and again should be considered in future study design.

Whilst larger accelerometry-based studies report higher absolute step counts, the applicability of population-derived normative values to a surgical cohort remains uncertain. Establishing disease and procedure-specific normative step count data will be a requirement for future studies seeking to design intervention thresholds or make absolute comparisons between wearable-derived data and for example CPET-derived cardiorespiratory variables. In the absence of these normative values, study designs in which each participant serves as their own internal control, for example by targeting a proportional weekly increase from individual preoperative baseline step counts during prehabilitation, may circumvent the need for population normative data and represent a pragmatic approach to personalised, wearable-guided prehabilitation.

The weak and non-significant correlations observed between preoperative step count and CPET variables in this study are discordant with several other studies where stronger relationships are reported with similar participant numbers [43,44]. However the significant difference in VO_2 peak observed when dichotomising by 4000 steps/day preoperatively [15.0 vs 18.9 steps; p = 0.02] provides preliminary evidence that wearable-derived step count may approximate formal exercise testing, and raises the possibility that consumer wearables could serve as an accessible screening tool to identify patients who might benefit from targeted prehabilitation or formal CPET referral.

The motivational potential of consumer wearables was explored within the smartwatch user experience questionnaire. In this cohort, 76% of participants felt they would be able to achieve a target number of steps and 64% reported they would be motivated by a clinical team reviewing their step count data. This is promising amongst participants with a median age of 67, however it is important that any future invention will need to be carefully tailored to the subject population.

Strengths of this study include the methods for digital inclusivity such as a centralised device that could include participants without a smartphone. Telephone consent and paid postage of devices allowed time for study consideration as well as ease of study participation and completion. The use of commercially available, long battery-life consumer devices rather than research-specific accelerometers enhances translational applicability, as such devices are widely accessible and increasingly familiar to patients. However, ongoing work is required to determine accuracy and validity of consumer wearables and a protocol for such has been suggested [19].

A significant limitation of this study is the non-adherence with smartwatch wear. The reasons for this broadly fell into two categories. Either participants decided not to wear the watch pre or postoperatively, or participants had intention of wearing the watch but were unable to setup the device with their smartphone or the device failed to work once reset with the *Fitrockr* application programming interface. This warrants consideration of the merits of a research specific device to be used for certain applications. While the user interface and real time feedback is typically lost, some of these technical errors are overcome.

The single-centre design and small non-random sample are also important limitations when considering the predominantly white and relatively affluent demographics. Future work should aim to ensure underrepresented groups are targeted for recruitment. Exploratory analyses, particularly those examining the relationship between step count and CPET variables, should be interpreted cautiously given subgroup sizes. It is also worth noting overall that comparison with the existing perioperative wearable literature is itself limited by small sample sizes and considerable heterogeneity of surgical populations, devices, and outcome metrics employed [6].

Conclusion

In conclusion, this feasibility study demonstrates that perioperative consumer wearable monitoring is achievable and acceptable in this patient cohort undergoing major abdominopelvic surgery. These feasibility data support the design of adequately powered studies to determine whether wearable-derived activity metrics predict perioperative outcomes or can guide prehabilitation.

Declarations

Ethics approval and consent to participate

The trial was conduction in accordance with the World Medical Association's Declaration of Helsinki and was authorised by South Central - Berkshire B Research Ethics Committee (REC Reference: 24/SC/0364) on 12/11/2024. This trial was sponsored by the University Hospitals Plymouth NHS Trust. Written consent was obtained from participants using the REC approved Informed Consent Form either in person or via the telephone.

Consent for publication

N/A

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Author Contribution

AH, JF; were involved in all stages of the work; conception and design, methodology, investigation, analysis and writing, SS, CC, CE; substantially contributed to the acquisition of data, investigation and writing.

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Data Availability

Daily wearable data are available upon reasonable request to the corresponding author. Requesters will be asked to complete an application form detailing specific requirements, rationale, and proposed usage. The corresponding author and study sponsor (including the sponsor's Research Governance Manager (or deputy), the Information Governance Team, Caldicott Guardian, IM&T Security Officer and the researcher funder, as appropriate) will review all requests within 90 days. Where access to requested data is granted, requesters organisation must sign a data sharing agreement before they can access any data. Under similar circumstances to the data sharing stipulations above, all R code can be made available to allow transparent reproduction of analysis.

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Figures

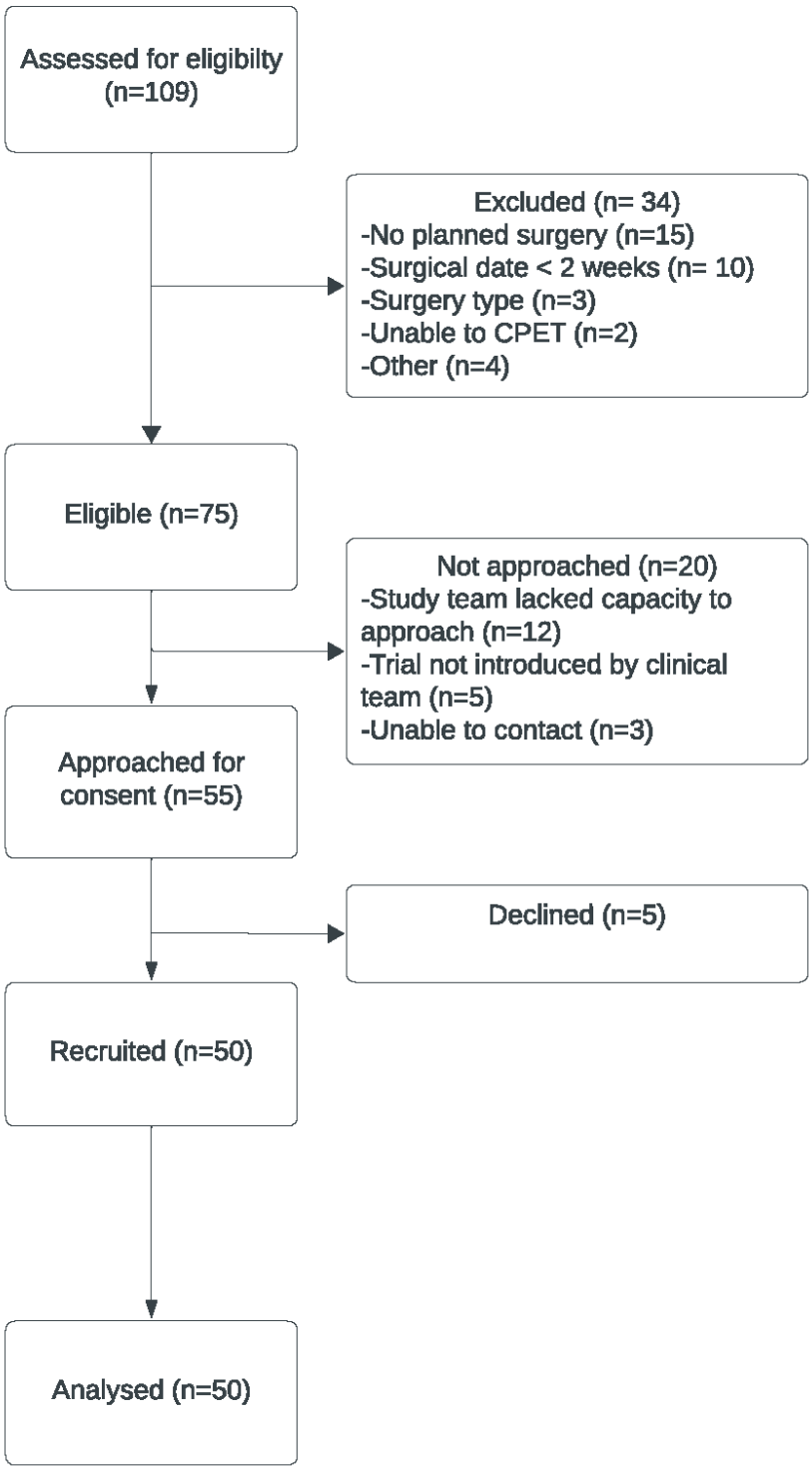


Figure 1

STROBE flow diagram of patient recruitment

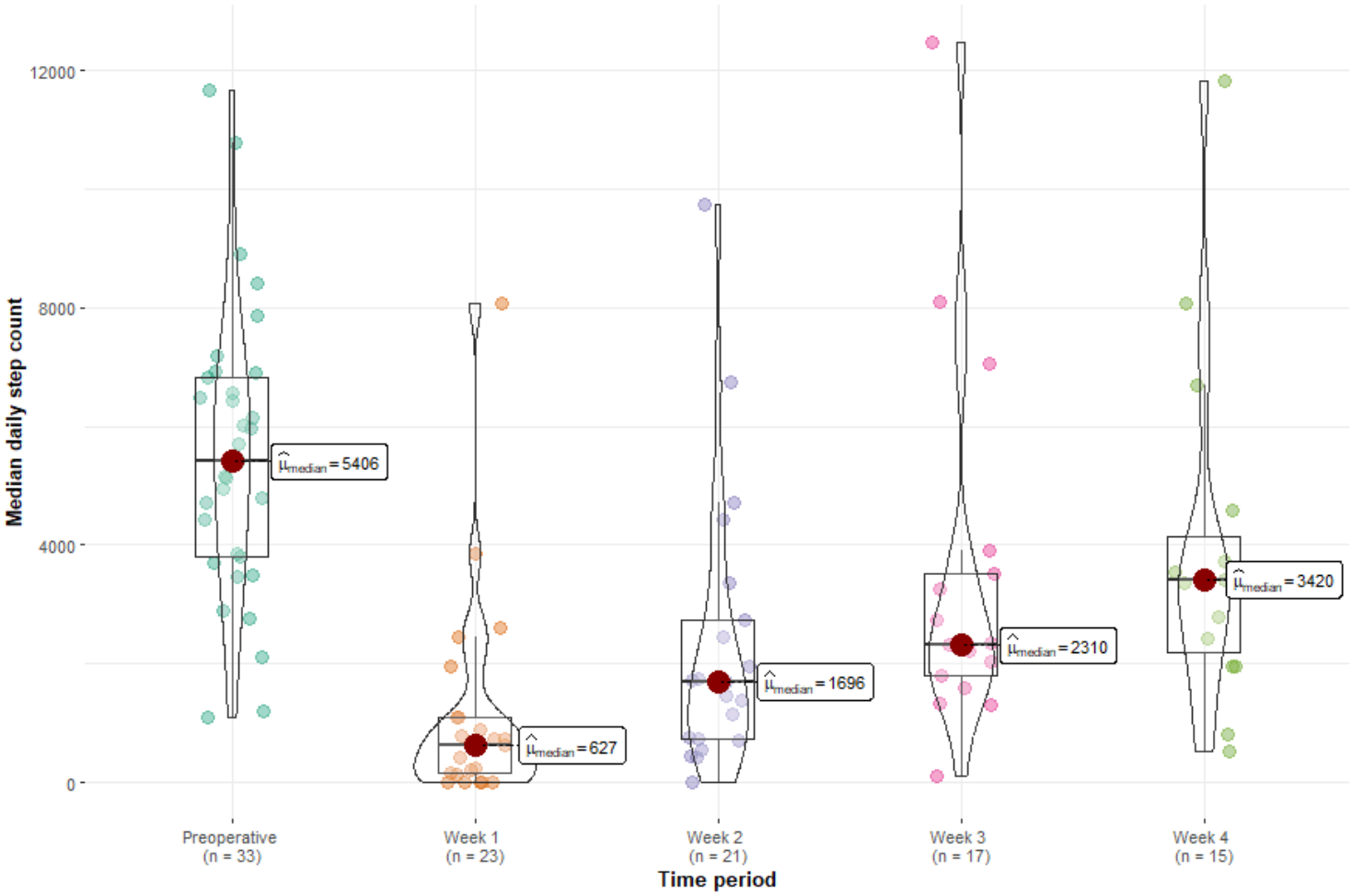


Figure 2

Pre and postoperative step counts. Each point represents the raw data for median daily step count per participant, with a distribution (violin plot) and boxplot of this data overlaid.

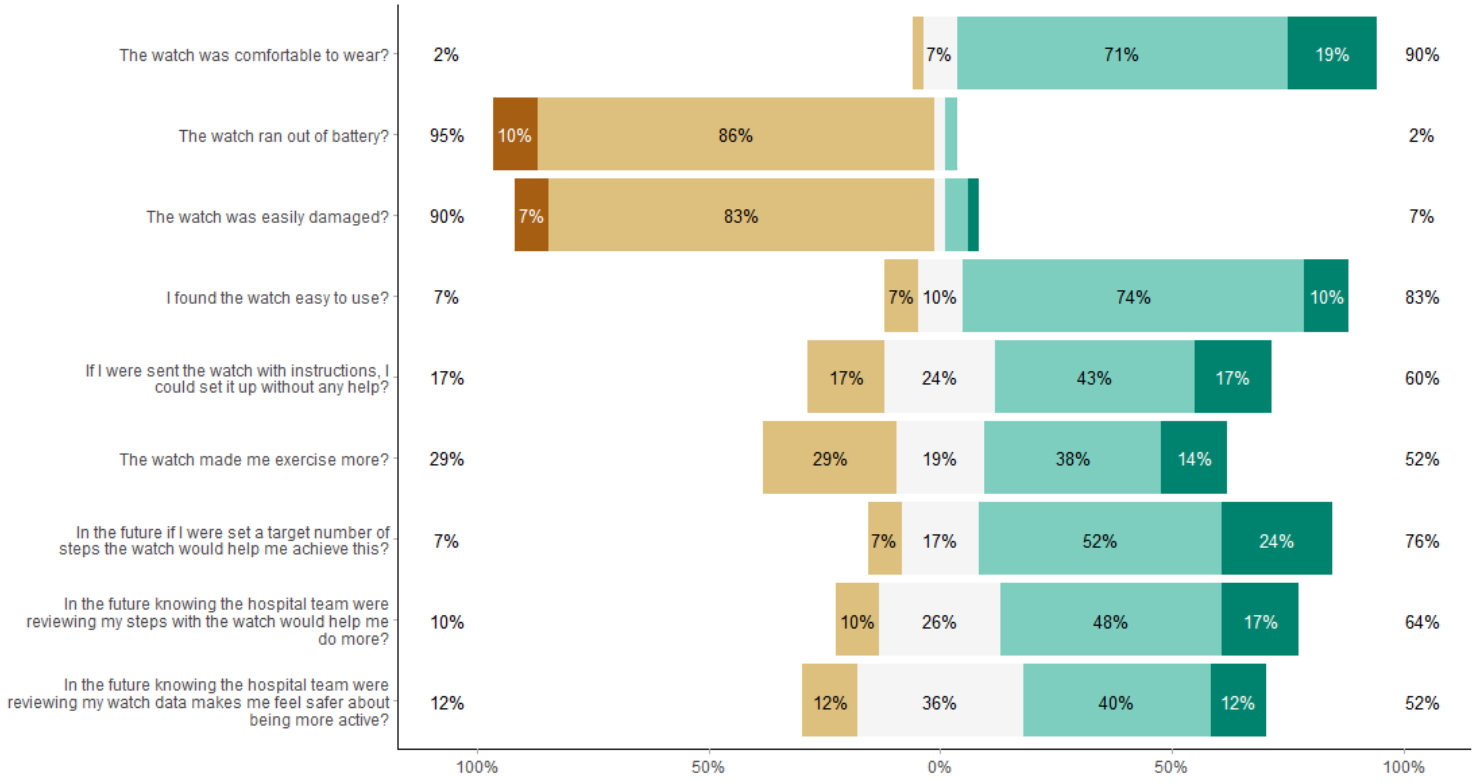


Figure 3

Responses to smartwatch user experience questions (n=44). Positive responses and their percentage of overall responses are represented to the right of the centre percentage; light green “agree”, dark green “strongly agree”. Similarly leftwards; light brown “disagree”, dark brown “strongly disagree”. “Neither agree nor disagree” is represented in white. The percentage of positive or negative response (excluding neutral responses) is presented at each end of the centred bars.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- SupplementaryMaterial.docx
- Smartwatchquestionnaire.docx