Assessing functional recovery in burn patients: A retrospective study using digital activity monitoring

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Laidlaw Scholar - Imperial College 2025 Cohort

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Laidlaw Scholars Programme - Research Report

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Abstract

Background:

Long-term burn recovery remains poorly quantified. Current follow-up relies on clinic visits and subjective assessments, often missing day-to-day fluctuations in function. Digital health technologies such as smartphones offer a novel means of continuous, objective recovery monitoring.

Aim:

To assess whether smartphone-derived physical activity (PA) data can objectively reflect functional recovery after burn injury and to explore how recovery varies by burn severity and other clinical factors.

Methods:

A retrospective cohort study was conducted using anonymised data from the StepHome App at Chelsea and Westminster Hospital. Adults (≥18 years) with burn injuries sustained after 2021 and at least three months of pre-injury Apple Health data were included. Walking distance data were collected from three months pre-injury to 12 months post-injury. Clinical information included demographics, burn size (Total Body Surface Area or TBSA), depth, treatment, and rehabilitation use.

Results:

Physical activity recovery correlated inversely with burn severity. Minor burns (0–5% TBSA) regained baseline activity rapidly and often exceeded pre-injury levels, whereas moderate (5–30%) and severe (>30%) burns demonstrated slower and more variable recovery. These trends mirrored expected clinical outcomes, supporting the validity of smartphone-derived data as an objective recovery marker.

Conclusions:

Smartphone-based PA monitoring offers a powerful and scalable tool for tracking recovery trajectories in burn patients. Integration of such data with clinical measures could enable development of a digital recovery model capable of predicting outcomes, detecting setbacks early, and supporting personalised rehabilitation strategies.

Background

Challenges in burn recovery tracking

Functional recovery following burn injuries remains poorly quantified in real-world settings. Current follow-up methods rely heavily on clinic visits, subjective assessments, and therapist input, which may fail to capture meaningful day-to-day variations in a patient's recovery. There is a growing need for tools that can track recovery remotely, objectively, and continuously.

With the widespread use of smartphones and embedded sensors, digital health technologies now offer the potential to revolutionise postoperative care. Among these is the StepHome App, a mobile platform that passively collects physical activity (PA) data using in-built accelerometers, providing an unobtrusive and quantifiable insight into functional recovery trajectories.

This study aims to validate the use of the StepHome App in burn patients - a novel application for this technology. Building on its use in reconstructive and orthopaedic surgery, we aim to assess whether smartphone-derived PA data correlates with traditional recovery markers in burns, thus offering a new standard for rehabilitation monitoring.

The opportunity for smartphone-based tech

Burns are among the most severe forms of trauma, often causing long-term physical and psychological harm. In the UK alone, the majority of burn injuries lead to emergency department visits, with a smaller proportion requiring specialist care (1). These injuries result from various energy transfers - thermal, chemical, electrical, or frictional (2) - triggering complex physiological responses and prolonged recovery (3).
Yet despite their seriousness, recovery tracking post-discharge remains fragmented and subjective. Smartphone-based technology offers a scalable solution: using built-in sensors to passively monitor physical activity, it enables real-time, objective insight into functional recovery. This approach has shown success in other surgical fields and could transform burn rehabilitation by providing continuous, accessible, and personalised follow-up.

Success of StepHome Trial

The StepHome Trial application has previously been used to track functional recovery in patients undergoing macromastia (breast reduction) surgery (MSc), Deep Inferior Epigastric Perforator (DIEP) flap reconstruction for breast cancer (BSc) and is currently being trialled in abdominoplasty and orthopaedic surgery patients. These studies have demonstrated the potential of smartphone-based PA tracking to provide an objective measure of patient recovery. Applying this methodology to burn patients offers an opportunity to develop a more comprehensive understanding of long-term functional outcomes in burn injury rehabilitation.

To date, no studies have examined the application of smartphone-based activity monitoring in burn recovery. Burn rehabilitation presents unique challenges due to scarring, contractures, pain, and psychological burden, all of which can impact functional mobility. As such, validating this technology in burns could allow clinicians to remotely monitor recovery, detect deviations early, and tailor interventions more effectively.

Gaps in burn recovery tracking

The classification of burns is based on several factors, primarily wound depth, and informs decisions around management and prognosis. Current guidelines categorise burns into superficial I°, superficial partial IIa°, deep partial

IIb°, deep III°, and full-thickness IV°, each differing in severity, healing time, and required interventions (4-5). Early acute management - such as timely cooling with water and escalation based on depth - plays a critical role in reducing complications, improving healing, and preventing long-term morbidity (6-9).

However, while acute care is well protocolised, the monitoring of functional recovery after discharge remains fragmented. Clinical decisions are guided by classification and immediate outcomes, but do not always capture the patient's day-to-day functional progress or setbacks during rehabilitation. There is a significant gap in structured, long-term recovery tracking, particularly for patients recovering at home. This disconnect between initial treatment and post-recovery outcomes, highlights the need for scalable, objective tools that can provide ongoing insight into patient recovery. Digital health technologies, such as smartphone-based activity monitoring, present an opportunity to bridge this gap.

Despite advances in acute burn care, long-term recovery monitoring remains fragmented and inconsistent. One study found that 25.5% of patients failed to attend any follow-up appointments, and over half missed at least one within the first year (10). Attendance was lowest among patients who were homeless, substance-dependent, or had smaller burns - highlighting disparities in post-discharge care.

International data echo similar concerns. In Belgium, most burn centres lacked written discharge protocols, leading to wide variation in aftercare. Respondents, including clinicians and patients, raised concerns about the absence of structured rehabilitation planning across specialised centres (11).

In low-resource settings such as New Delhi, the gap is even more stark: up to 100% of burn patients were lost to follow-up within three weeks of discharge (12). Across surveyed public hospitals, none used standardised rehabilitation assessments or prescribed formal recovery programmes. Socioeconomic factors like poverty and low health literacy further limit access to essential rehabilitation.

Together, these findings reveal an urgent need for more accessible, standardised, and technology-enabled systems to support and monitor long-term burn recovery across diverse healthcare settings.

Methods

Study Design and Setting

This study was a single-centre retrospective observational cohort study conducted at Chelsea and Westminster Hospital (Imperial College Healthcare NHS Trust, London). The objective was to evaluate functional recovery following burn injury using objectively measured smartphone-derived physical activity (PA) data, alongside clinical burn characteristics and patient-reported outcome measures. PA data were collected for three months prior to injury to establish an individualised baseline and for up to twelve months following injury to characterise long-term recovery trajectories. Ethical approval was granted by the National Research Ethics Committee (15/LO/1038), and the study was registered on ClinicalTrials.gov (NCT03635723). All participants provided informed electronic consent, and all researchers involved completed NIHR Good Clinical Practice certification.

Participant Identification and Recruitment

Adults admitted with burn injuries to Chelsea and Westminster Hospital from 2021 onwards were screened for eligibility. Recruitment was conducted retrospectively between 8 June 2025 and 8 September 2025 using contact details obtained from the Cerner® electronic health record system. These details were accessed solely for recruitment purposes and were not retained following initial contact. Eligible patients were contacted via telephone and secure NHS email, with voicemail messages, email follow-ups, and WhatsApp Business messaging used where initial contact attempts were unsuccessful. Participants were enrolled following electronic consent through the StepHome Trial application, which integrated the participant information sheet, consent documentation (see Appendix B) and data capture processes. Each participant was assigned a unique trial identifier upon enrolment.

Eligibility Criteria

Inclusion criteria were adults aged 18 years or older at the time of data collection, admission with a burn injury to Chelsea and Westminster Hospital from 2021 onwards, and ownership and use of an Apple iPhone (Apple Inc., Cupertino, California) for a minimum of three months prior to injury, enabling the collection of pre-injury physical activity data. Exclusion criteria included use of an Android smartphone due to the absence of a compatible data collection application, inability to use an iPhone for physical activity data collection, or lack of capacity to provide informed consent, including due to cognitive impairment or pre-existing conditions. No additional exclusion criteria were applied.

Physical Activity Data Collection

Physical activity data were collected using the StepHome Trial application, which integrates with Apple Health and utilises iPhone accelerometer and GPS sensors (see Appendix A). Hourly walking and running distance data were extracted as comma-separated value (CSV) files spanning three months pre-injury to twelve months post-injury and were securely transmitted to Google Firebase storage. Each CSV file contained time-stamped, hourly walking and running distance data (kilometres) for individual participants (see Appendix C), spanning three months pre-injury to twelve months post-injury. Files were linked to participants using a unique trial identifier and did not contain directly identifiable personal information.

CSV files were securely transmitted and stored within a protected Google Firebase environment prior to analysis. Data was imported into Microsoft Excel for initial processing, including aggregation of hourly values into daily activity measures and verification of data completeness. Processed datasets were then exported for statistical analysis.

Clinical and Patient-Reported Data

Demographic, injury-specific and clinical outcome data were extracted from Cerner® electronic medical records. Recorded burn characteristics included burn depth, anatomical location, laterality, referral total body surface area (TBSA), Baux score, and injury type, source and category. Functional status was assessed using pre-injury mobility and

post-injury functional assessment scores (Independent = 1, Dependent = 2). Pain was evaluated using pain scores recorded before and during change of dressing, and infection risk was documented where applicable. Clinical outcomes included total length of hospital stay, intensive therapy unit referral, return to theatre, post-operative complications, documented infection and receipt of post-operative therapy. Surgical variables recorded included requirement for surgical intervention, type of intervention, operative time, time from injury to first operation, estimated blood loss, number of operations and/or need for surgical reintervention, donor site, prosthesis or implant use and anaesthetic type.

Outcome Definitions

The primary outcome was daily physical activity, defined as walking plus running distance in kilometres derived from Apple Health data. To account for inter-individual variability, post-injury PA was normalised to each participant's own pre-injury mean daily activity and expressed as a percentage of baseline recovery. Functional recovery was defined as achieving at least 100% of pre-injury baseline physical activity. Secondary outcomes included burn severity measures, functional status, pain scores, infection risk, surgical interventions, clinical outcomes.

Statistical Analysis

Data processing was performed using Microsoft Excel (Version 2504; Microsoft, Redmond, USA), and statistical analyses were conducted using GraphPad Prism (Version 10.4.2; GraphPad, La Jolla, USA).. Post-injury recovery was analysed across predefined intervals of 0–3 months, 3–6 months and 6–12 months post-injury. Univariable linear regression was used to explore associations between recovery and burn severity, functional status and clinical variables. Multivariable modelling was not performed due to sample size limitations. Statistical significance was defined as $p < 0.05$.

Data Quality and Confidentiality

Data quality checks ensured inclusion of participants with adequate pre-injury baseline data and completed post-injury follow-up. Days with recorded physical activity of 0.00 kilometres beyond the early recovery period were assumed to reflect iPhone non-use rather than true inactivity and were excluded from analysis. Participants were initially identified using medical record numbers during recruitment. Upon enrolment, all data were anonymised using a unique trial identifier linking physical activity data to clinical and outcome variables. All data collected via the StepHome Trial application were securely transmitted and stored within Google Firebase infrastructure. All data handling complied with the UK General Data Protection Regulation and the Data Protection Act 2018.

Results

Study Population and Recruitment

A total of 1,211 patients admitted with burn injuries to Chelsea and Westminster Hospital were initially identified from electronic health records. Following preliminary screening, 727 patients were excluded due to age under 18 years (n = 464), death prior to recruitment (n = 78), duplicate records (n = 6), incorrect contact details (n = 38), or injury sustained less than 12 months before the study period (n = 141).

Of the remaining 484 eligible patients, 311 did not respond despite repeated follow-up attempts, 31 were unable to participate due to illness, and 41 declined participation. A further 58 patients were excluded due to lack of a compatible smartphone (Android device or no smartphone). This resulted in 43 patients successfully recruited.

Following data completeness checks, 11 patients were excluded due to incomplete physical activity datasets, leaving 32 patients included in the final analysis. A flow diagram of the recruitment process is shown in figure 1.

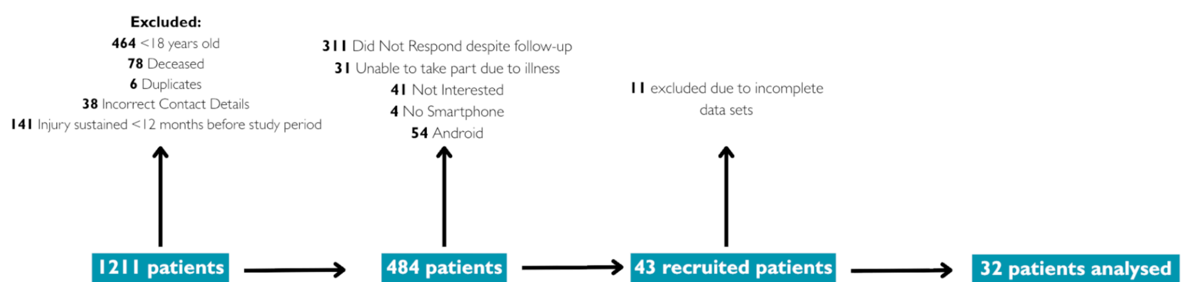

Figure 1: *Flowchart of patient recruitment, screening, and exclusion process*

Temporal Recovery Dynamics

Across all TBSA categories, physical activity recovery followed a non-linear trajectory, characterised by an initial period of markedly reduced activity followed by gradual improvement over time. However, the rate, consistency, and extent of recovery differed substantially by burn severity, with clear separation between groups throughout the 100-day post-injury period - this is illustrated in figure 1.

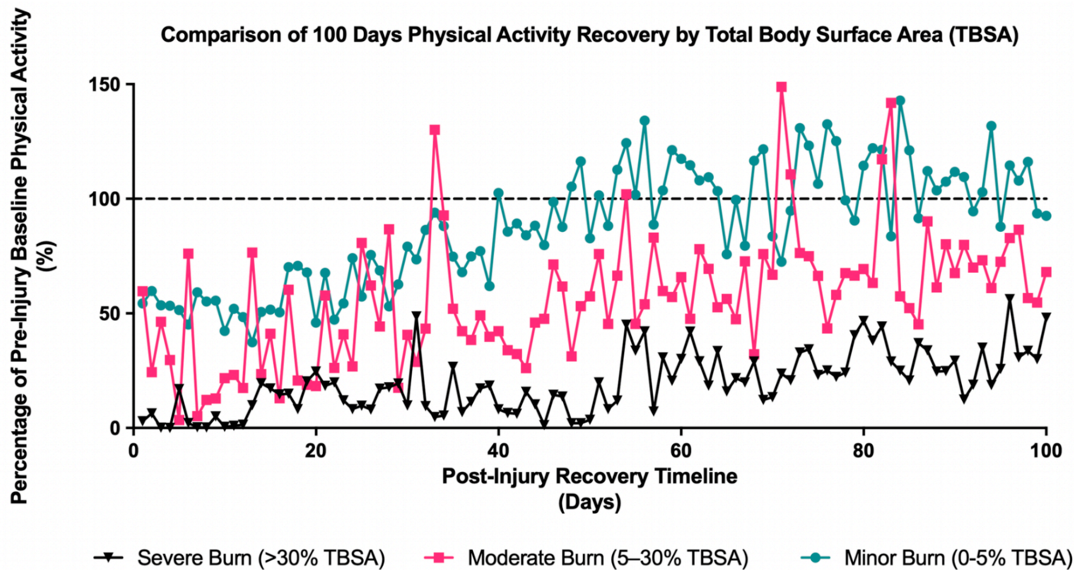

Figure 2: *Physical activity recovery over 100 days post-burn injury by severity*

In patients with minor burns (0–5% TBSA), recovery was rapid and progressive. Following an initial reduction in activity during the early post-injury phase, physical activity increased steadily, reaching pre-injury baseline by approximately 50–60 days. Beyond this point, activity frequently exceeded baseline, consistent with the group mean recovery of 109.6%, indicating that, on average, patients regained and surpassed their pre-injury activity levels within the 100-day period. While day-to-day variability was present, it did not obscure the overall upward trend, indicating a relatively consistent return to premorbid functional capacity.

Early reductions in activity were observed, with a minimum value of 37.4%, followed by a steady and sustained increase over time. Activity levels approached baseline by mid follow-up and remained predominantly at or above baseline thereafter, with limited secondary decline. Compared with other groups, recovery was more consistent and less variable.

In contrast, patients with moderate burns (5–30% TBSA) demonstrated a more protracted and unstable recovery pattern. Although mean activity increased over time, recovery was characterised by frequent fluctuations, with intermittent peaks and troughs rather than a smooth trajectory. While some individuals achieved or exceeded baseline activity at isolated time points, recovery was not sustained at the group level, reflected by a mean activity of 81.4% (SD 32.9) at 100 days. This pattern highlights substantial heterogeneity within this group, with recovery trajectories varying widely between individuals with a range of recovery values (3.46%–196.7%). Longitudinal analysis showed frequent fluctuations in daily activity, with intermittent peaks approaching or exceeding baseline that were often not sustained. These findings suggest variable recovery patterns within this TBSA category rather than a uniform trajectory.

Patients with severe burns (>30% TBSA) exhibited the slowest and most limited recovery. Physical activity remained profoundly suppressed throughout the early and mid-recovery periods, with only modest improvement over time. Even by 100 days post-injury, activity levels remained substantially below baseline for most patients, consistent with a low mean recovery of 35.9%. Activity values ranged from a minimum of 0.04%, reflecting near-complete immobility during early recovery for some patients, to a maximum of 118.4%, indicating that a small number of observations exceeded baseline activity. However, recovery remained limited overall, with the majority of activity values remaining well below

baseline throughout follow-up. Although gradual improvement was observed over time, activity levels did not consistently approach baseline within the study period.

Magnitude and Variability of Recovery

Descriptive statistics demonstrated a progressive increase in variability with increasing burn severity. Minor burns showed relatively tight clustering of activity values around the group mean, reflecting more uniform recovery. In contrast, moderate and severe burns displayed progressively wider dispersion, with broad ranges of activity values observed across the recovery period.

This widening variability suggests that TBSA alone does not fully account for functional recovery, particularly in higher severity burns. Within moderate and severe groups, recovery outcomes likely reflect the cumulative influence of additional factors such as surgical burden, donor site morbidity, infection, prolonged hospitalisation, and rehabilitation intensity. Importantly, despite severe burns having the lowest mean activity, the wide observed range indicates that meaningful functional recovery remains possible in selected individuals, underscoring the importance of longitudinal, patient-level assessment rather than reliance on single summary measures.

Baseline-Normalised Physical Activity as a Discriminatory Outcome

Normalising physical activity to each participant's pre-injury baseline enabled direct comparison across individuals with differing premorbid activity levels and revealed clear stratification by TBSA severity. Recovery trajectories for minor and severe burns showed minimal overlap across much of the follow-up period, while moderate burns occupied an intermediate position, overlapping with both groups at different time points and reinforcing their heterogeneous nature.
The persistence of suppressed activity in severe burns despite gradual improvement suggests the presence of early recovery plateaus, during which functional gains are limited. Conversely, the early return to baseline activity observed in minor burns aligns with clinical expectations of rapid functional recovery following low-TBSA injury.

Integrated Interpretation of Recovery Patterns

Taken together, these findings demonstrate that burn severity, as measured by TBSA, is strongly associated with both the rate and extent of functional recovery during the first 100 days following injury. Increasing TBSA was associated with slower recovery, lower absolute activity levels, and greater inter-individual variability.

The continuous nature of smartphone-derived physical activity measurement captured day-to-day fluctuations and recovery inflection points that would not be detectable using traditional episodic clinical assessments. This highlights physical activity as a sensitive and objective marker of functional recovery and supports its utility for discriminating between clinically meaningful burn severity groups.

Discussion

This study demonstrates that burn severity, measured by total body surface area (TBSA), is strongly associated with both the rate and extent of functional recovery during the first 100 days following injury, as quantified using smartphone-derived physical activity data. A clear severity-dependent gradient in recovery was observed, with minor burns showing rapid return to baseline activity, moderate burns exhibiting delayed and heterogeneous recovery, and severe burns characterised by persistent functional impairment.

Interpretation of Key Findings

Patients with minor burns (0–5% TBSA) showed rapid and largely complete recovery, with group-level activity returning to baseline by approximately 50–60 days and exceeding pre-injury levels thereafter. This pattern aligns with clinical expectations that low-TBSA burns, while acutely painful and disruptive, are typically associated with limited long-term functional impairment. The sustained activity above baseline observed in some individuals may reflect behavioural or rehabilitative overcompensation, return to employment, or increased health awareness following injury, although these factors were not directly measured in this study.

In contrast, patients with moderate burns (5–30% TBSA) demonstrated substantial heterogeneity in recovery trajectories. Although mean physical activity improved over time, recovery remained incomplete at the group level, with frequent fluctuations and intermittent attainment of baseline activity. This variability likely reflects the wide spectrum of injury characteristics encompassed within this TBSA category, including differences in burn depth, anatomical distribution, need for surgical intervention, donor site morbidity, and post-injury complications. These findings highlight that TBSA alone incompletely captures the complexity of recovery in moderate burns and underscore the importance of longitudinal, patient-level outcome measures.

Patients with severe burns (>30% TBSA) experienced profound and sustained reductions in physical activity throughout the observation period. Despite gradual improvement over time, activity levels remained substantially below baseline even at 100 days post-injury, indicating persistent functional limitation during early recovery. Occasional late improvements were observed in individual patients, suggesting that meaningful recovery is possible; however, these instances were insufficient to alter the overall group trajectory. This finding is consistent with the known burden of severe burns, which are associated with prolonged hospitalisation, repeated surgical interventions, systemic inflammatory responses, and extended rehabilitation requirements.

Value of Smartphone-Derived Physical Activity as an Outcome Measure

A key strength of this study is the use of baseline-normalised, continuously captured physical activity as a marker of functional recovery. Traditional burn outcomes often focus on mortality, length of stay, or complication rates, which, while important, provide limited insight into day-to-day functional recovery from the patient perspective. By contrast, physical activity integrates multiple dimensions of recovery, including mobility, endurance, pain, psychological readiness, and rehabilitation progress.

Normalising activity to each participant's pre-injury baseline allowed meaningful comparison across individuals with differing premorbid activity levels and revealed clear separation between TBSA severity groups. Importantly, the continuous nature of the data captured recovery inflection points and fluctuations that would not be detected using

episodic clinical assessments or single time-point outcome measures. This suggests that smartphone-derived activity metrics may represent a sensitive and scalable tool for monitoring functional recovery following burn injury.

Methodological Considerations and Surgical Burden

Burn care is inherently staged, with many patients undergoing multiple operative interventions over time, while others are managed conservatively. In this context, analysing outcomes at the level of individual procedures risks overrepresenting patients with more complex injuries and introduces dependency between repeated measures. Accordingly, this study adopted a patient-level analytical approach, summarising surgical burden using binary and cumulative measures rather than per-procedure outcomes. This approach allowed inclusion of both operative and non-operative patients and enabled meaningful comparison across the cohort.

Similarly, anatomical burn involvement and donor site utilisation were recorded using standardised, patient-level variables rather than free-text descriptions. This ensured consistency and reduced analytic noise, while still capturing clinically relevant indicators of injury severity and treatment burden.

Clinical Implications

These findings have several potential clinical implications. First, early post-injury physical activity trajectories may help identify patients at risk of delayed or incomplete recovery, particularly within the moderate burn group where outcomes were highly variable. Second, the persistence of suppressed activity in severe burns suggests a potential window for targeted early rehabilitation interventions, with the aim of mitigating prolonged functional impairment. Finally, objective activity monitoring may complement existing clinical assessments, providing clinicians with real-time insights into recovery outside the hospital setting.

Limitations

This study has several limitations. The sample size was modest, reflecting the challenges of retrospective recruitment and reliance on smartphone-derived data. Physical activity was measured only in patients owning and using an iPhone, introducing potential selection bias. Additionally, activity data may be influenced by factors unrelated to burn recovery, such as occupational demands, psychosocial factors, or device non-carry, although data quality checks were applied to minimise these effects.

TBSA, while widely used, does not capture burn depth, anatomical complexity, or associated injuries, which likely contribute to recovery variability, particularly in moderate and severe burns. Finally, although physical activity is a meaningful proxy for function, it does not capture all dimensions of recovery, such as scar quality, pain severity, or psychological wellbeing.

Future Directions

Future studies should explore integration of smartphone-derived physical activity with additional patient-reported outcomes, such as pain and quality-of-life measures, and examine its predictive value for longer-term recovery milestones. Larger, multicentre studies may help refine severity stratification and identify modifiable factors associated

with improved functional outcomes. Prospective use of continuous activity monitoring could also inform personalised rehabilitation strategies and early intervention pathways.

Personal Reflections

Conducting telephone-based recruitment for this study highlighted the importance of sensitivity and adaptability when engaging with patients recovering from burn injury. Many individuals were at different stages of physical and emotional recovery, which influenced their ability and willingness to participate. This reinforced the need to prioritise patient autonomy and to recognise that research engagement must be balanced against ongoing health and recovery challenges.

Engaging directly with members of the burns community provided valuable context for interpreting the study findings. Conversations with patients emphasised that recovery extends well beyond measurable clinical milestones, shaping my understanding of functional recovery as a deeply individual and prolonged process. This experience strengthened my appreciation of patient-centred research and the value of clear, empathetic communication when conducting research involving vulnerable populations.

Conclusion

In summary, this study demonstrates that functional recovery following burn injury is strongly associated with burn severity, with increasing TBSA linked to slower, more limited recovery of physical activity. Smartphone-derived, baseline-normalised physical activity provides a novel, objective, and sensitive measure of recovery that captures clinically meaningful differences between severity groups. These findings support the role of digital health tools in enhancing outcome assessment and guiding recovery-focused care in burn patients.

Acknowledgments

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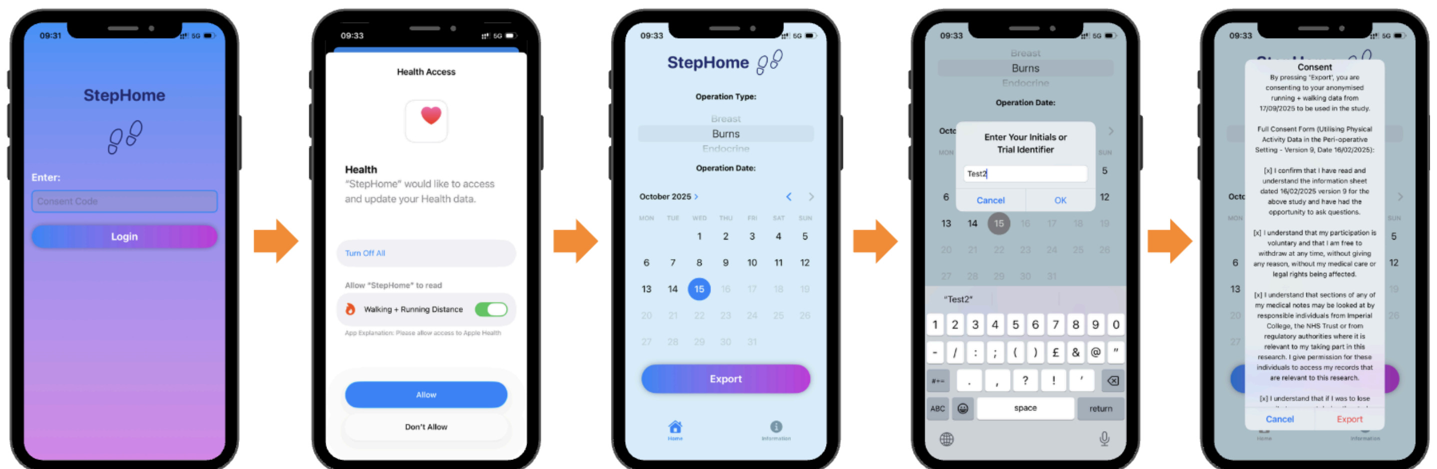
Appendix

Appendix A: User Interface Design of the StepHome Trial Application

Apple Health on iOS devices continuously passively records PA data from setup. This data can be securely exported to the StepHome Trial app, available on the Apple App Store. The app enables efficient extraction of detailed activity data and complies with UK data protection laws (GDPR, Data Protection Act 2018) via encrypted HTTPS.

Users select their surgery type and date, then tap “export” to begin. After consenting digitally, they enter initials or a trial ID to label the file, facilitating data matching. The app generates a Comma-Separated Values file (CSV), named with this identifier, and is automatically uploaded to a secure server via Google Firebase.



Appendix B: Integrated Patient Information and Consent Process

The StepHome Trial application integrates the patient information leaflet, consent form and data collection steps into a streamlined workflow, reducing burden and complexity for participants. All participants provided informed electronic consent (a = Patient Consent Form; b = Patient Information Sheet).

a)

Version 9, Date 16/02/2025

Title of Project:
Utilising Physical Activity Data in the Peri-operative Setting

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Please initial box

1. I confirm that I have read and understand the information sheet dated 16/02/2025 version 9 for the above study and have had the opportunity to ask questions. ☐
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason, without my medical care or legal rights being affected. ☐
3. I understand that sections of any of my medical notes may be looked at by responsible individuals from Imperial College, the NHS Trust or from regulatory authorities where it is relevant to my taking part in this research. I give permission for these individuals to access my records that are relevant to this research. ☐
4. I understand that if I was to lose capacity to consent during the study, although no further data would be collected, the data already collected may still be used in the study. ☐
5. I agree to take part in the above study. ☐
6. I agree to take part in an interview after I complete the study if I am invited. ☐
7. I agree for my smartphone health data to be used anonymously for the study. (Optional for those using wearable sensors) ☐
8. I agree for my anonymised data to be submitted to open access repositories to promote scientific advances. ☐

Name of Participant	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

b)

PARTICIPANT INFORMATION SHEET

Research Study Title: Utilising Physical Activity data in the Peri-operative setting

Version 9 16/02/2025

Contact
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REC reference: 15/LO/1038
IRAS project ID: 177761

You are being invited to take part in a research study. Before you decide it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take your time to decide whether or not you wish to take part.

Thank you

Summary

Why?
We are researching how peoples' activity levels change before and after healthcare episodes.
This is important to help us understand how people recover from operations and to help doctors make decisions about these patients in the future.

What?
We are asking participants to wear a light wrist-worn activity monitor/sensor and/or Smartphone activity data to measure how much movement and activity they undergo daily both before and after their healthcare episodes. The activity monitor will be worn for two weeks at home before the event, and in the hospital. Smartphone activity data would be sent via a secure application.

Who?
Anyone undergoing a healthcare episode is eligible to take part in this study.

Where?
This study is being conducted at Imperial College Healthcare NHS Trust.

Appendix C: Export and Secure Storage of Walking and Running Distances

Hourly walking and running distances (km) over 24 hours were exported as CSV files. Data was collected from 28-days before surgery up to patient contact. Files were securely uploaded and stored via Google Firebase

A	B	C	D	E	F	G	H	I	J	K	L	M
Day	12am - 1an	1am - 2am	2am - 3am	3am - 4am	4am - 5am	5am - 6am	6am - 7am	7am - 8am	8am - 9am	9am - 10an	10am - 11a	11am - 12p
-82	0	0	0	0	0	0	0	0	0	0	0	0
-80	0	0	0	0	0	0	0	0	0.17	0	0.14	0
-79	0	0	0	0	0	0	0	0	1.5	0.42	0.04	0.34
-78	0	0	0	0	0	0	0	0	0	0	0	0
-77	0.08	0	0	0	0	0	0	0	0	0	0.01	0.01
-76	0.07	0.03	0	0	0	0	0	0	0	0.49	0.47	0.18
-75	0.01	0	0.03	0	0	0	0	0	0	0	0	0.01
-74	0	0	0	0	0	0	0	0	0	0	0.12	0.01
-73	0.15	0	0	0	0	0	0	0	0.05	0.18	1.94	1.83
-72	0	0	0	0	0	0	0.31	0.01	0.02	0.01	0	0
-71	0	0	0	0	0	0	0	0	0	0	0	0
-70	0	0	0	0	0	0	0	0	0	0.01	0	0
-69	0	0	0	0	0	0	0	0	0	0	0.11	0.18
-68	0	0	0	0	0	0	0	0	0	0	0	0.01
-67	0	0	0	0	0	0	0	0	0	0	0	0
-66	0	0	0	0	0	0	0	0	0	0	0	0
-65	0	0	0	0	0	0	0	0	0.12	0.5	0	0.12
-64	0	0	0	0	0	0	0	0	0	0	0	0
-63	0	0	0	0	0	0	0	0	0	0	0	0
-62	0.01	0	0	0	0	0	0	0	0	0	0.15	0.01
-61	0	0	0	0	0	0	0	0	0.31	0.38	0.77	0
-59	0.02	0	0	0	0	0	0	0	0	0	0	0
-58	0	0	0	0	0	0	0	0	0.66	0.74	0	0.2
-55	0	0	0	0	0	0	0	0	0	0.01	0	0
-54	0	0	0	0	0	0	0	0	0	0	0	0
-53	0	0	0	0	0	0	0	0	0	0	0	0
-52	0	0	0	0	0	0	0	0	0	0	0	0
-51	0	0	0	0	0	0	0	0	0	0	0	0
-50	0	0	0	0	0	0	0	0	0.86	1.1	0.85	0.07
-49	0	0	0	0	0	0	0	0	0	0	0	0.2
-48	0	0	0	0	0	0	0	0	0	0.01	0	0.18
-47	0.32	0	0	0	0	0	0	0	0	0	0	0.14
-46	0.61	1.06	0	0	0	0	0	0	0	0	0	0
-45	0	0	0	0	0	0	0	0	0	0.88	0.22	0.53
-44	0	0	0	0	0	0	0	0	0.36	0.3	0.01	0.57
-43	0.16	0.11	0.19	0.71	0.59	0.65	0	0	0	0	0	0
-42	0	0	0	0	0	0	0	0	0	0	0.44	0.13
-41	0	0	0	0	0	0	0	0	0	0	0.28	0.5
-40	0	0	0	0	0	0	0	0	0	0	0.3	0.34
-39	0	0	0	0	0	0	0	0	0	0	0	0.32
-38	0.36	0.21	0.38	0	0	0	0	0	0	0	0	0.53
-37	0.03	0.44	0.06	0	0	0	0	0	0	0	0	0.53
-36	0	0	0	0	0	0	0	0	0	0	0	0
-35	0	0	0	0	0	0	0	0	0	0	0.44	0.84
-34	0	0	0	0.41	0	0	0	0	0	0	0	0
-33	0	0	0	0	0	0	0	0	0	0	0	0
-32	0	0	0	0	0	0	0	0	0	0	0	0
-31	0.18	0	0	0	0	0	0	0	0.12	1.29	0.7	0.02
-30	0.35	0	0	0	0	0	0	0.25	0.1	0	0.25	0.02
-29	0	0	0	0	0	0	0	0	0	0	0	0
-28	0	0	0	0	0	0	0	0	0	0.53	0.61	0.52
-27	0	0	0	0	0	0	0.93	1.01	0.45	0.83	0.39	0.54
-26	0.24	0	0	0	0	0	0	0	0	0	0.07	0.77
-25	0.32	0.32	0	0	0	0	0	0	0	0	0	0.53
-24	0.48	0.02	0	0	0	0	0	0	0	0.21	0.24	0.65
-23	0.93	1.1	0.17	0	0	0	0	0	0	0	0	0.38
-22	0.36	0	0	0	0	0	0	0	0	0	0	0.51
-21	0.63	0.01	0	0	0	0	0	0	0	0.01	0.02	0.71
-20	0.82	0	0	0	0	0	0	0	0	0	0	0.23
-19	0	0	0	0	0	0	0	0	0	0	0	0.3
-18	0	0	0	0	0	0	0	0	0	0	0	0.25
-17	0.15	0.13	0.37	0	0	0	0	0	0	0	0	0.09

A	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
Day	12pm - 1pr	1pm - 2pm	2pm - 3pm	3pm - 4pm	4pm - 5pm	5pm - 6pm	6pm - 7pm	7pm - 8pm	8pm - 9pm	9pm - 10pr	10pm - 11p	11pm - 12a	Total	Baseline	Percenta
-82	0.4	0.91	0.25	0.92	1.55	1.68	0.65	0.66	0.77	0.39	0	0	8.18	6.12670732	133.5
-80	0.36	0	0	0	0	0	0	0	0	0	0	0	0.67	6.12670732	10.93
-79	1.03	0.76	0.39	0.01	0.48	1.5	1.5	0.95	1.17	1.3	0.66	0	12.05	6.12670732	196.
-78	0	0	0	0.24	0.09	0	0.01	0.01	0.01	0.01	0.06	0.1	0.53	6.12670732	8.650
-77	0	0	0.01	0.26	0.1	2.6	0.31	0.01	0.05	0.29	0.03	0.67	4.43	6.12670732	72.30
-76	0.22	0.06	0.06	1.42	2.63	1.51	0.02	0.02	0.01	0	0	0.01	7.2	6.12670732	117.5
-75	0.02	0.26	1.72	0.65	0.27	0.25	1.35	0.46	0.02	0.05	0.15	0.17	5.42	6.12670732	88.46
-74	0.12	0.01	0.17	0.14	0.01	0.04	0.08	0.14	0.08	0.15	0.03	0.18	1.28	6.12670732	20.89
-73	0.22	0.14	0.55	0.38	0.65	0.25	0.13	0	0.36	0	0.41	0.02	7.26	6.12670732	118.4
-72	0.14	0	0	0.01	0	0.06	0.09	0.23	0	0	0	0	0.88	6.12670732	14.36
-71	0	0	0	0	0	0	0	0	0	0	0	0.03	0.03	6.12670732	0.489
-70	0	0	0	0	0	0	0	0	0	0	0	0	0.01	6.12670732	0.163
-69	0.89	0.19	0	0	0	0	0	0	0	0	0	0	1.37	6.12670732	22.36
-68	0	0	0	0	0	0	0	0	0	0	0	0	0.01	6.12670732	0.163
-67	0	0	0	0.19	0	0.27	0.31	0.27	0	0.26	0	0	1.3	6.12670732	21.21
-66	0	0	0	0	0	0	0	0.3	0.66	0.55	0.38	0.25	2.14	6.12670732	34.92
-65	0.69	0.06	1.38	0.02	0.2	1.36	0.32	0	0	0	0	0	4.77	6.12670732	77.8
-64	0	0	0	0	0	0	0	0	0	0.02	0	0	0.02	6.12670732	0.326
-63	0	0	0	0	0	0.13	0.12	0.53	1.05	0.15	0.29	0	2.27	6.12670732	37.05
-62	1.56	2.16	1.48	1.14	0.61	1.03	0.66	0	0.92	0	0.84	0.01	10.58	6.12670732	172.6
-61	0	0.25	0.34	0.63	0.7	0.28	0.46	0.37	0.09	0	0	0	4.58	6.12670732	74.75
-59	0	0.01	0	0	0	0	0	0	0	0	0	0	0.03	6.12670732	0.489
-58	0.49	1.14	0.6	0	0	0	0.85	0.02	0	0	0	0	4.7	6.12670732	76.71
-55	0	0	0	0	0	0	0	0	0	0	0	0	0.01	6.12670732	0.163
-54	0	0	0.19	0.42	0.42	0.75	0.66	0.46	0.34	1.31	0.3	0	4.85	6.12670732	79.16
-53	0.01	0	0	0	0	0	0	0	0	0	0	0.01	0.02	6.12670732	0.326
-52	0	0	0	0	0	0	0	0	0	0	0.01	0.01	0.02	6.12670732	0.326
-51	0	0.01	0	0	0	0	0	0	0	0	0	0	0.01	6.12670732	0.163
-50	0	0.16	0.1	0.06	0.13	0	0	0	0	0	0	0	3.33	6.12670732	54.35
-49	0.79	0.98	0.06	0.31	0.14	0.64	0.91	0.3	0.35	0	0	0	4.68	6.12670732	76.38
-48	0.75	0.08	0.35	0.21	0.11	0.56	0.12	0.76	0.46	0	0	0	3.59	6.12670732	58.59
-47	0.19	0.86	0.51	0.28	0.49	0.68	0.67	0.06	1.22	0.87	0.66	0.65	7.6	6.12670732	124.0
-46	0.12	0.97	0.66	0.61	0.54	0.73	0.86	0.34	0.49	0.22	0.38	0	7.59	6.12670732	123.8
-45	0.14	0.09	0.49	0.61	0.34	0.65	0.59	0.77	0.41	0.81	0	0	6.53	6.12670732	106.5
-44	0.26	0	0	0.4	0	0	0.5	0.97	0.88	0	0	0.27	4.52	6.12670732	73.77
-43	0	0	0	0	0	0	0	0	0.28	0.42	0	0	3.11	6.12670732	50.76
-42	0.41	0.03	0.13	0.72	0.89	0.01	0.03	0.09	0.02	0.02	1.01	0.33	4.26	6.12670732	69.53
-41	0.84	0.41	0.37	0.75	0.86	0.77	0.7	0.7	0.91	0.47	0.08	0	7.64	6.12670732	124.6
-40	0.2	0.11	0.49	0.6	1.16	0.44	0.55	0.08	0.05	0	0.03	0.23	4.58	6.12670732	74.75
-39	0	0.11	0.83	0.71	0.14	0	0	0	0	0.23	0.22	0.03	2.59	6.12670732	42.27
-38	0.44	0.63	0.54	1.05	0.56	0.53	0.86	0.95	0.46	0.85	0.6	0.03	8.98	6.12670732	146.5
-37	0.7	0.65	0.08	1.23	0.98	0.66	0.42	0.22	0.98	0.78	0.74	0.05	8.55	6.12670732	139.5
-36	0.01	0.73	0.44	0.44	0.42	0.5	0.7	1.05	1.11	0.37	0	0	5.77	6.12670732	94.
-35	0.58	0.61	0.83	0.88	0.41	0.56	0.52	0.67	1.27	0.15	0.01	0.14	7.91	6.12670732	129.1
-34	0.01	0	0	0.17	0.08	0.47	0.06	0.89	1	0.41	0.22	0	3.72	6.12670732	60.71
-33	0.14	0.45	0.05	0.47	0.52	0.14	0.71	0.39	1.05	0.27	0.02	0	4.21	6.12670732	68.71
-32	0.37	0.06	0.01	0.03	0.15	0.04	0.54	0.09	0.15	0.28	0.1	0.13	1.95	6.12670732	31.82
-31	0.37	0.27	0.2	0.01	0.19	0.01	0.02	0.16	0.07	0.52	0.25	0.4	4.78	6.12670732	78.01
-30	0.14	0.13	0.16	0.66	0	0.17	0.3	0.27	0	0.07	0.98	0.13	3.98	6.12670732	64.96
-29	0	0.44	0.6	0.63	0.65	0.66	0.61	0.28	0.48	0.56	0.38	0.38	5.67	6.12670732	92.54
-28	0.59	0.6	0.37	0.54	0.37	0.86	0.6	0.79	0.41	0.37	0.01	0	7.17	6.12670732	117.0
-27	0.72	0.54	0.51	0.55	0.49	1.56	1.36	2.12	0.77	1.43	0.63	0.98	15.81	6.12670732	258.0
-26	0.84	1.48	1.18	0.6	1.09	1.31	1.64	2.15	1.45	0.5	1.06	1.04	15.42	6.12670732	251.6
-25	0.46	1.41	0.79	0.4	0.7	0.89	1.12	0.9	1.46	0.64	1.54	1.04	12.52	6.12670732	204.3
-24	1.07	0.74	0.8	0.82	1.65	1.95	1.18	1.13	1.28	0.46	0.64	1.02	14.34	6.12670732	234.0
-23	0.52	1.08	1.43	1.91	0.78	0.83	1.04	1.51	1.04	0.89	1.17	0.93	15.71	6.12670732	256.
-22	0.94	1.46	0.88	0.58	0.6	0.78	0.05	1.08	2.15	1.31	1.25	0.62	12.57	6.12670732	205
-21	1.26	1.23	0.89	0.78	1.51	1.02	1.31	1.11	1.33	1.72	0.64	0.68	14.86	6.12670732	242.5
-20	1	1.04	1.09	0.57	0.69	0.71	0.85	1.11	0.98	1.44	0.97	0.35	11.85	6.12670732	193.4
-19	0.43	1.18	1.18	0.85	0.67	0.61	0.74	1.06	1.31	1.24	0.75	0.77	11.09	6.12670732	181.0
-18	0.54	0.23	0.64	1.02	0.53	0.79	0.59	0.21	0.64	0.45	0.57	0.13	6.59	6.12670732	107.5
-17	0.33	0	0	0.01	0	0	0.42	0	0.66	0.36	0.01	0.44	2.97	6.12670732	48.47

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