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Original Research

Patient-led walking program before lung resection: a pilot study on feasibility and impact on quality of life

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Abstract

Background: The role of preoperative conditioning on postoperative outcomes in thoracic surgery is of growing interest. There is a paucity of data on understanding compliance with a patient-led walking program and its impact on quality of life.

Objectives: To understand the feasibility of patient-driven data collection of daily steps via pedometers and to understand the impact of preoperative conditioning on quality of life.

Design: A prospective single-institution quality improvement study.

Methods: The study included patients who underwent thoracic surgery between 2020 and 2022 who were and were selected to receive a pedometer at their preoperative clinic appointment. A daily step goal was determined, and patients were instructed to record their daily steps. Quality of life was assessed at baseline and at presentation for surgery. Clinical data and postoperative outcomes were derived from the institutional Society of Thoracic Surgery General Thoracic Surgery Database.

Results: There were 167 patients provided with pedometers at their presurgical clinic appointment, of whom 43 returned pedometer data (utilization rate 26%). Of the 104 who underwent lung resection, 74 (44.3%) did not record step data, 15 had <6000 median daily steps, and 15 had >6000 median daily steps. Pre-intervention self-perceived outcomes were similar. Post-pedometer data demonstrated higher scores in the domains of general health ($p = 0.016$), quality of life ($p = 0.03$), general physical health ($p = 0.002$), physical performance ($p = 0.03$), social health ($p = 0.009$), social performance (p=0.01), and fatigue level ($p = 0.01$) for patients with higher median step counts. There were no significant differences in postoperative outcomes based on survival, length of stay ($p = 0.77$), or respiratory complications ($p = 0.52$).

Conclusion: A patient-led walking program using pedometers is feasible for a minority of patients. Higher recorded daily step counts are associated with improved self-perceived quality of life in patients prior to lung surgery.

Plain language summary

Patient-led walking program for patients undergoing lung surgery

In this study, patients undergoing lung surgery were provided with a pedometer and a personalized daily step goal to keep track of their walking prior to their operation. Only a quarter of patients participated in this program. However, patients who participated and recorded high daily step counts also reported better quality of life when presenting for surgery.

Keywords: lung cancer, lung resection, pedometer, surgical conditioning, thoracic surgery

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Introduction

Early mobility following thoracic surgery is a well-established determinant of patient recovery, directly affecting length of stay as well as cardiopulmonary complications.[1] An area of interest is to assess preoperative physical conditioning. Physical activity may impact patients' surgical experience and play a part in modified risk reduction prior to lung cancer surgery.[2]

Preconditioning patients before surgery is becoming more significant for reducing surgical risks and enhancing postoperative recovery. Prehabilitation at large incorporates exercise-based therapy, nutritional supplementation, psychological support, and smoking cessation.[3] Preoperative conditioning is thus a heterogeneous and interdisciplinary approach ranging from physiotherapy to psychotherapy, with a focus on respiratory and musculoskeletal systems to improve surgical outcomes. Patients who are physically prepared before surgery demonstrate improved mobility less postoperative fatigue, and faster return to baseline function.[4] Tools such as the six-minute walk test (6MWT) and hand-grip strength have been used to assess baseline function.[5,6]

Traditional metrics such as the 6MWT may not accurately reflect patients' day-to-day activities or compliance with mobility recommendations. In contrast, wearable pedometer devices offer a more practical and objective method of monitoring activity levels. Pedometers provide continuous data on daily step counts, allowing for a more granular assessment of patient engagement in physical activity. This data can offer insights into how well patients are adhering to their step goals outside of the clinical setting.

Pedometers have been used in previous literature to foster and keep track of activity. Among patients undergoing general surgery, a preoperative activity level of less than 7500 daily steps was associated with increased odds of postoperative complications.[7]

There is a current research gap in the utilization rates of pedometers to quantify preconditioning prior to surgery. The purpose of this study is to understand (1) the feasibility of patient use of self-controlled pedometers and (2) to assess the impact on quality of life (QOL) and postoperative outcomes.

Figure 1. Wearable pedometer provided to patients.

Methods

A prospective quality improvement project involved consecutive patients undergoing thoracic surgery at The Ohio State University Wexner Medical Center between June 2020 and July 2022. Patients were included irrespective of performance status and use of assist devices such as canes or walkers. Patients who were unable to ambulate at baseline were excluded. Patients were provided with an Easy Read Large Screen Pedometer (Ariel Premium Supply Inc., Overland, MO, USA) wearable pedometer device (Figure 1) at the time of their preoperative clinic appointment. Patients were instructed on how to use the pedometer and how to reset the step count and provided a user manual. To determine a step goal, the surgeon inquired about patients' personal goals for the functional status they are aiming for. Via shared decision making between the patient and surgeon, a final daily step goal ranging from 2,500 to 10,000 steps was established. Patients were instructed to record their step counts in a daily logbook provided by the surgical team. A date of operation was scheduled within an approximately one-month time frame from the initial clinic visit. The step log was collected on the day of the surgery and scanned into the electronic medical record.

Quality of life assessment

Quality of life was measured using the Patient Reported Outcomes Measurement Information System (PROMIS) Global Health Scale (Supplemental Table 1).[8] The baseline survey was administered at the initial preoperative clinic visit. A second survey was administered to patients on the day of their surgery, after the perioperative use of the pedometer, and before surgery to assess the impact on QOL.

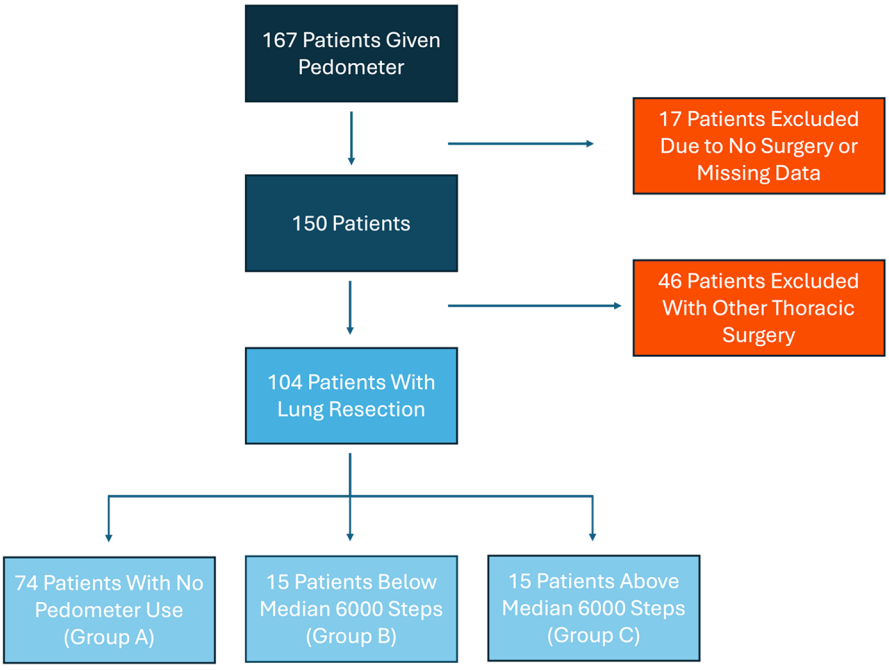

Figure 2. Flow diagram outlining patient selection and grouping for the analysis.

Clinical data

Patient demographics and medical history pertaining to surgical risk, operative characteristics, and postoperative outcomes were retrieved from the institutional Society of Thoracic Surgery General Thoracic Surgery Database (STS-GTSDB). The STS-GTSDB is a quality database prospectively maintained by professional data abstractors. Postoperative physical functioning and mobility during the inpatient recovery were routinely assessed by the physical therapists using the Activity Measure for Post-Acute Care (AM-PAC).[9,10] The AM-PAC score closest to the time of discharge from the hospital was recorded.

Statistical analysis

A descriptive analysis was performed for the entire cohort. The use of a pedometer, the number of days recording step counts, days exceeding goal step counts, and median step counts were analyzed. A detailed analysis of the impact on QOL and postoperative outcomes was limited to patients undergoing lung resections (Figure 2).[11] Patients with lung resection were further stratified into three cohorts: no pedometer usage (Group A), pedometer usage with <6000 median daily steps (Group B), and pedometer usage with >6000 median daily steps (Group C). The threshold of 6000 steps was retroactively set based on the median number of daily steps recorded among patients. Ordinal and categorical variables were tested for statistical significance using Kruskal-Wallis and Chi-Squared tests, respectively. All statistical analyses were performed by a senior biostatistician (MAR) using SAS version 9.4 (SAS Institute, Cary, NC, USA). A p-value <0.05 was used to determine statistical significance. This study is in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (Supplemental File 1).[12]

Results

Feasibility of patient-controlled pedometer use

A total of 167 patients who were seen in the clinic for a preoperative appointment were provided with a pedometer (Figure 1). The median step goal for the entire cohort was 7500 (IQR 5000-10,000). A minority of patients ($n=43$) used the pedometer and returned the step log prior to surgery for an overall utilization rate of 26%. The median number of days patients used the pedometer was 16 (IQR 11–20) days, and the median number of daily steps recorded was 6295 (IQR 4224–7979). Patients met or exceeded their daily

Table 1. Baseline characteristics of patients undergoing lung resection based on preoperative pedometer use.

Variable	No pedometer use ($n=74$)	Pedometer use with <6000 steps ($n=15$)	Pedometer use with ≥ 6000 steps ($n=15$)	p-Value
Age (years)	65.5 (58.0–72.0)	63.0 (56.0–76.0)	64.0 (59.0–68.0)	0.81
Female sex	37 (50%)	8 (53%)	8 (53%)	0.95
Race				0.96
Caucasian	62 (84%)	13 (87%)	14 (93%)	
Black	10 (14%)	2 (13%)	1 (7%)	
Asian Chinese	1 (1%)	0 (0%)	0 (0%)	
Multiracial	1 (1%)	0 (0%)	0 (0%)	
DLCO Low (% Predicted)	83.5 (66.0–99.0)	98.0 (98.0–98.0)	105.5 (99.0–112.0)	0.30
FEV (% Predicted)	81.5 (64.0–95.0)	82.0 (64.0–98.0)	98.5 (82.0–106.0)	0.06
Days pedometer used	0 (0–0)	15.0 (11.0–20.0)	11.0 (8.0–17.0)	<0.0001
Daily step goal				0.005
2500	4 (6%)	1 (7%)	0 (0%)	
5000	25 (39%)	13 (86%)	2 (13%)	
7500	8 (12%)	0 (0%)	4 (27%)	
10,000	28 (43%)	1 (7%)	9 (60%)	
Procedure				0.73
Lobectomy	54 (73%)	9 (60%)	12 (80%)	
Wedge Resection	14 (19%)	3 (20%)	2 (13%)	
Segmentectomy	5 (7%)	2 (13%)	1 (7%)	
Pneumonectomy	1 (1%)	1 (7%)	0 (0%)	

DLCO, diffusing capacity of the lungs; FEV, forced expiratory volume.

step goals on a median of 6 days (IQR 2–12) prior to surgery.

Impact on quality of life assessment

The impact of pedometer use on QOL and outcomes was compared for the subgroup of 104 patients undergoing lung resection (Figure 2). Baseline demographics were similar between patients not using the pedometer (Group A), patients recording <6,000 median daily steps (Group B), and those recording >6000 median daily steps (Group C; Table 1). There were also no significant differences in preoperative lung function or extent of lung resection (Table 1).

Based on survey results at the time the pedometer was provided, the PROMIS Global Health Scale responses were fairly equally distributed between groups. Statistically significant differences at baseline were limited to the domains of overall QOL (Median 4.0 (IQR 3–4), 3.5 (3.0–4.0), and 4.0 (4.0–5.0), $p=0.034$) and fatigue level (3.0 (3.0–4.0), 3.0 (3.0–4.0), and 4.0 (4.0–4.0), $p=0.020$) for Groups A, B, and C, respectively (Figure 3).

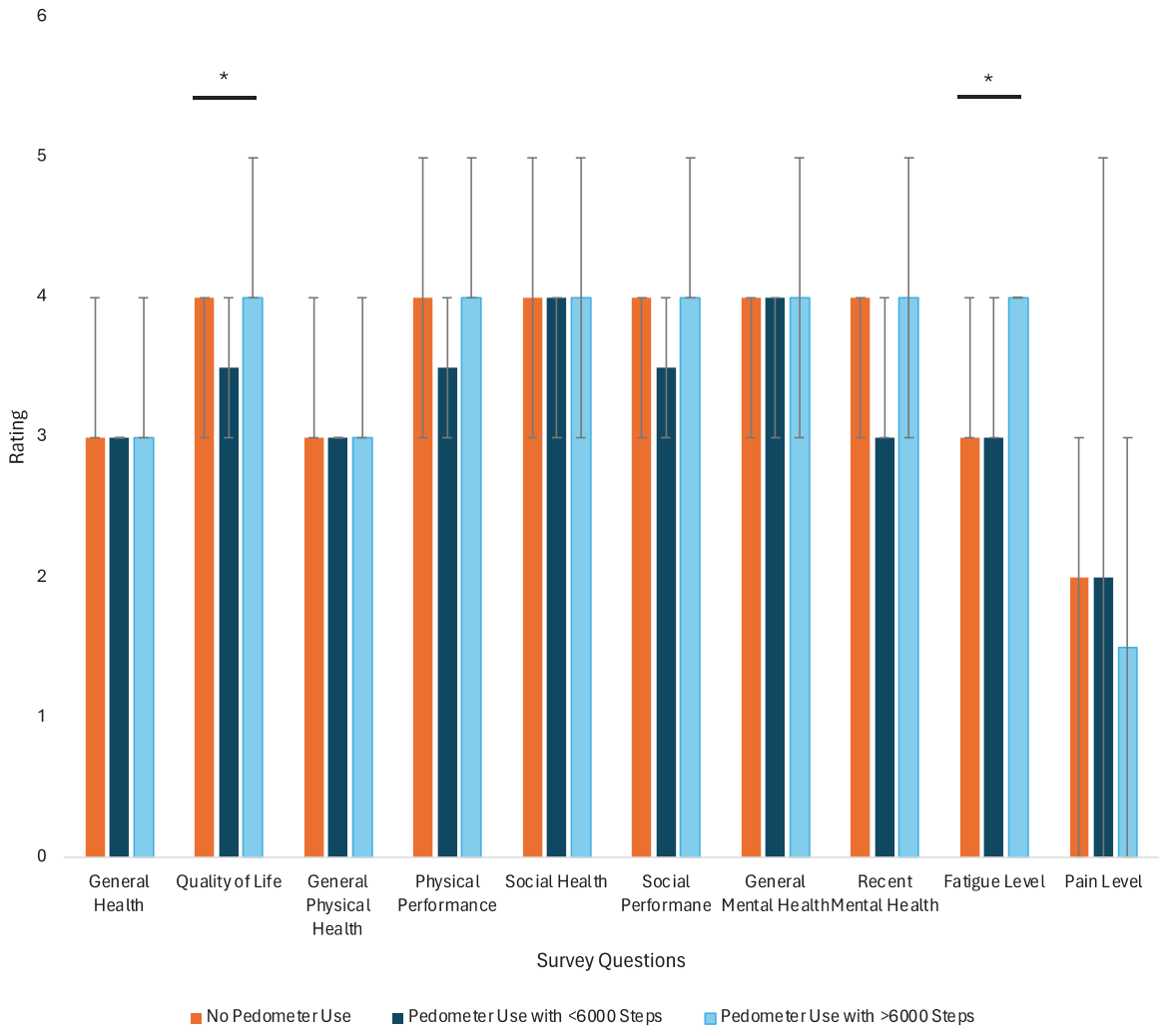

Figure 3. Pre-pedometer intervention PROMIS Global Health Scale data.
*$p < 0.05$.

From the post-pedometer survey, there were significant differences between the Groups with Group C reporting consistently higher scores for domains of general health ($p = 0.016$), QOL ($p = 0.03$), general physical health ($p = 0.002$), physical performance ($p = 0.03$), social health ($p = 0.009$), social performance ($p = 0.01$), and fatigue level, $p = 0.01$) as compared to Groups A and B (Figure 4).

Postoperative outcomes

Postoperative Outcomes related to pedometer use are summarized in Table 2. Survival at 30 days was 100% in Groups A, B, and C, and there were no statistically significant differences in postoperative event rates (Table 2). Any postoperative event was recorded in 23 (31%) patients in Group A, 5 (33%) in Group B, and 2 (20%) in Group C ($p = 0.66$). There were 6 (8.1%), 0 (0%), and 1 (6.7%) respiratory complications in Groups A, B, and C, respectively ($p = 0.52$). Out of the entire cohort, only one patient (6.7%) in Group C had a pulmonary embolism ($p = 0.05$). There was one case (1.4%) of pneumonia in Group A ($p = 0.81$). None of the patients had postoperative atelectasis, respiratory failure, pleural effusion, acute respiratory distress syndrome, or ventilator requirements. The median length of hospital stay was 2 (IQR 2–4) days for Group A, 3 (IQR 2–4) days for Group B, and 2 (IQR 1–4) for patients in Group C. AM-PAC score at the time of discharge was similarly high between groups (Table 2).

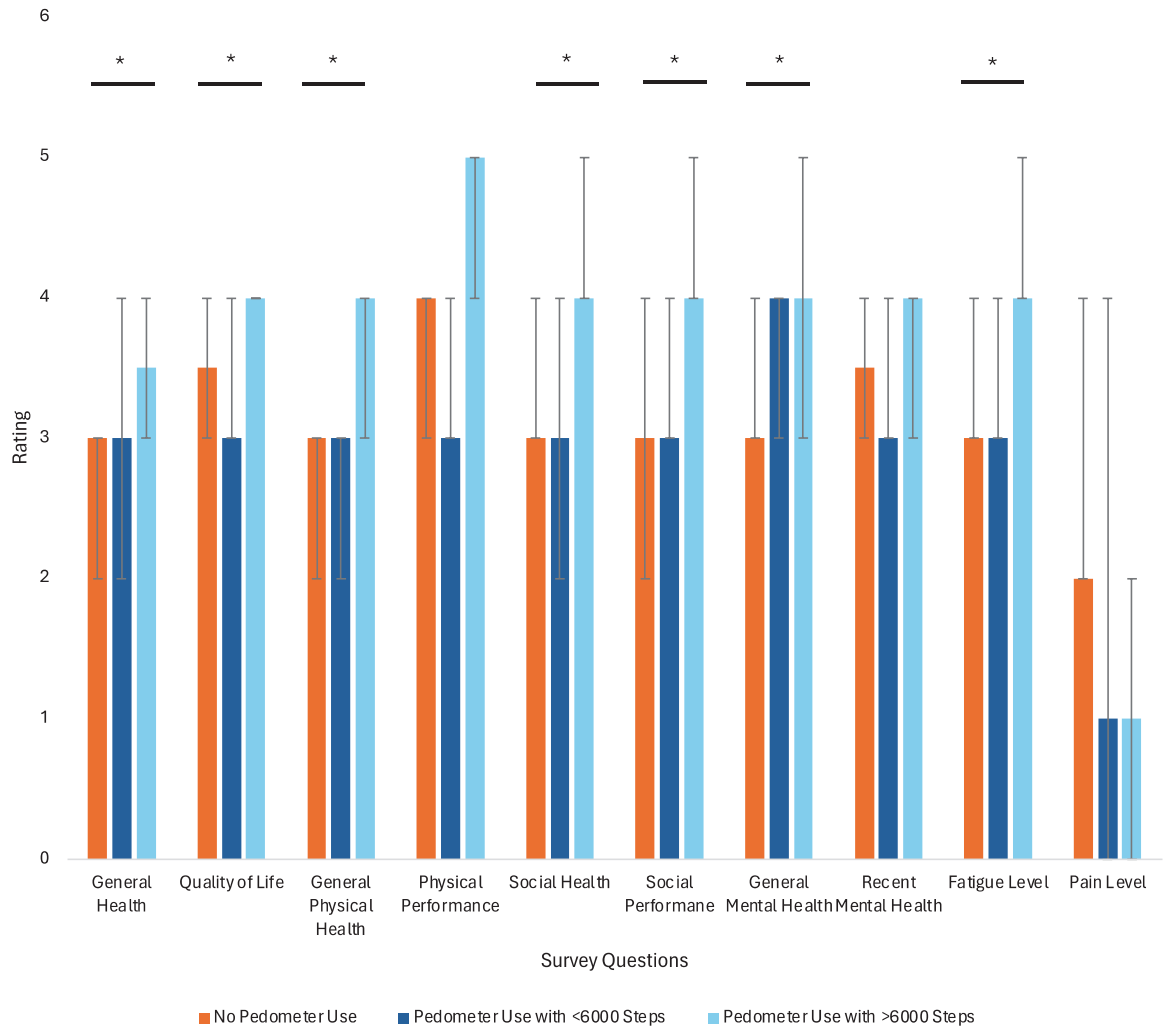

Figure 4. Post-pedometer intervention PROMIS Global Health Scale data on the day of surgery.
*$p < 0.05$.

Discussion

This quality improvement study evaluated the use of a wearable pedometer in patients prior to undergoing lung surgery. We found a low utilization rate of 26% when patients were provided the pedometer and placed in charge of keeping a log of their daily steps relative to a personal goal. Possible reasons for low compliance include incomplete step logging, technical challenges of carrying a pedometer, and the patient perceived lack of benefit from step tracking. Further, only approximately half of the patients who used the pedometer were able to achieve their daily goal regularly. Differences were observed in the health-related QOL assessment for patients with high daily step counts, who reported significantly higher self-perceived general health, general physical health, social health, social performance, and general mental health as compared to patients with low daily step counts or patients who did not use the pedometer. While there was no significant difference in postoperative outcomes, the median length of stay and overall complication rates were lowest in patients who regularly used the device and recorded higher step counts. Nonetheless, this cannot be generalized given the lack of significance. Further, patients in Group C have slightly increased fatigue levels on the day of surgery, possibly due to strong motivation to meet their higher established step goals and factors unrelated to activity, such as poor sleep or diet in the perioperative period. This pilot study provides proof-of-concept for both the feasibility of pedometer usage in the preoperative setting and

Table 2. Postoperative outcomes after lung resection stratified by preoperative pedometer use.

Variable	No pedometer use ($n = 74$)	Pedometer use with <6000 steps ($n = 15$)	Pedometer use with $\geqslant 6000$ Steps ($n = 15$)	*p*-Value
30-Day survival	74 (100%)	15 (100%)	15 (100%)	—
30-Day readmission	6 (8.1%)	1 (6%)	1 (7%)	0.97
Length of stay (Days)	2.0 (2.0–4.0)	3.0 (2.0–4.0)	2.0 (1.0–4.0)	0.77
AM-PAC at discharge	19.0 (18.0–19.5)	18.0 (16.5–19.0)	19.0 (19.0–19.0)	0.46
Any postoperative event	23 (31%)	5 (33%)	2 (20%)	0.66
Respiratory complication	6 (8%)	0 (0%)	1 (7%)	0.52
Pneumonia	1 (1.4%)	0 (0%)	0 (0%)	0.81
Atelectasis	0 (0%)	0 (0%)	0 (0%)	—
Respiratory failure	0 (0%)	0 (0%)	0 (0%)	—
Air leak	5 (7%)	0 (0%)	1 (7%)	0.58
Pulmonary embolism	0 (0%)	0 (0%)	1 (7%)	0.05
Pleural effusion	0 (0%)	0 (0%)	0 (0%)	—
ARDS	0 (0%)	0 (0%)	0 (0%)	—
Ventilator requirements	0 (0%)	0 (0%)	0 (0%)	—
Reoperation	3 (4%)	1 (7%)	3 (20%)	0.08

AMPAC, activity measure for post-acute care; ARDS, acute respiratory distress syndrome.

accentuates the relationship of preoperative conditioning with self-reflected QOL measures.

This study is unique in that the use of a pedometer and personal step goals was completely patient controlled. The study design differs from the physical therapy interventions using pedometers in previous clinical trials in which patients receive physical therapy coaching or undergo structured protocols.[13,14] Therefore, the most important finding may be that physicians may realistically expect that pedometers may only be used by a minority of patients prior to lung surgery based on their own motivation outside of a clinical trial protocol. This suggests the importance of a formal prehabilitation regimen. However, pedometer use and achievement of higher step goals may be associated with improved QOL, leading up to surgery (Figure 4). The study was likely underpowered to detect differences in outcomes.

A variety of tools have been used to measure physical activity levels prior to lung surgery: pedometers, accelerometers, whole-body indirect calorimeters, and bicarbonate-urea tracers.[15] In our study, pedometers were a user-friendly method to measure physical activity levels. Nonetheless, having multimodality tools can provide a quantification of physical activities for people of all abilities. A review of patients undergoing thoracic, colorectal, or hepato-biliary surgeries found that an increased step count either before or after surgery was associated with decreased postoperative complications, length of stay, and readmission.[16] Specifically looking at thoracic surgery, preoperative exercise training programs were linked with better postoperative outcomes including reduced atelectasis, pulmonary infection, hypoxemia, and postoperative oxygen therapy time.[2,17] As seen in trends with our study, there is also a relationship between the number of preoperative daily steps and postoperative complications. Billé et al. found that patients in the highest quartile of physical activity had fewer respiratory complications.[18] The present study underscores the gap in understanding patient compliance with

a preoperative activity goal. By using shared decision making to determine a daily step goal, the aim was to set a reachable target to motivate patient engagement for physical conditioning. As such, a more formal baseline physical assessment is likely necessary for setting a realistic goal, and exploring a comprehensive multidisciplinary prehabilitation program can aid in motivation. This study is also novel in that it relies on the patient-driven performance of preoperative physical conditioning as opposed to a formal exercise program. In addition, while patients who ultimately had a median daily step count >6000 also set higher daily step goals, there was no significant difference in AM-PAC score at discharge. As such, it is important to recognize how physical conditioning may be influenced by environmental factors.

The strength of this study is the focus on patient self-reflection following the pedometer intervention. There is a significant difference in overall perceived QOL and general, physical, social, and mental health among the three groups of the study. There is a paucity of data in the literature at present, understanding the role of preoperative conditioning on patients' QOL in the perioperative period. Limitations of this study include a small cohort, which resulted in the study being underpowered to show differences in postoperative outcomes. Additional limitations include a single-institution design and some loss of data due to the quality improvement nature of the protocol. In addition, as many patients had lung cancer, it is possible they were unable to meet step goals due to disease burden. Baseline functional status, social factors, and barriers to pedometer use were also not captured at the initial clinic visit. The lack of formal physical assessment by a physiotherapist could have led to the establishment of unrealistic daily step goals. In addition, there was no psychotherapy program to understand patient psychosocial factors that may have influenced their motivations for completing a self-driven daily step goal.

Conclusion

This pilot study demonstrated that a patient-led walking program using pedometers prior to lung surgery was feasible in just over a quarter of patients without additional supervision or a physical therapy protocol. However, self-controlled pedometer use with a high daily step count is associated with a positive impact on health-related QOL. Further research is needed to optimize patients' activity and motivation for prehabilitation prior to lung surgery using wearable devices.

Declarations

Ethics approval and consent to participate

The institutional Review Board of The Ohio State University Wexner Medical Center approved this study (C0055). Informed consent to participate has been waived by the Institutional Review Board.

Consent for publication

Not applicable.

Author contributions

Neelesh Bagrodia: Conceptualization; Data curation; Methodology; Writing – original draft; Writing – review & editing.

Kyle Hansotia: Data curation; Writing – original draft.

Mahmoud Abdel-Rasoul: Formal analysis.

Desmond M. D'Souza: Data curation; Writing – review & editing.

Robert E. Merritt: Data curation; Writing – review & editing.

Peter J. Kneuertz: Conceptualization; Data curation; Formal analysis; Methodology; Visualization; Writing – original draft; Writing – review & editing.

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Competing interests

The authors declare that there is no conflict of interest.

Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author.

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Supplemental material

Supplemental material for this article is available online.

References

1. Semenkovich TR, Hudson JL, Subramanian M, et al. Enhanced recovery after surgery (ERAS) in thoracic surgery. *Semin Thorac Cardiovasc Surg* 2018; 30(3): 342–349.
2. Lee J, Kong S, Shin S, et al. Wearable device-based intervention for promoting patient physical activity after lung cancer surgery: a nonrandomized clinical trial. *JAMA Netw Open* 2024; 7(9): e2434180.
3. Carli F, Gillis C and Scheede-Bergdahl C. Promoting a culture of prehabilitation for the surgical cancer patient. *Acta Oncol* 2017; 56(2): 128–133.
4. Möller T, Becker T and Egberts JH. [Preconditioning of the lungs and circulation before visceral and thoracic surgical interventions]. *Chirurg* 2019; 90(7): 529–536.
5. Wesolowski S, Orlowski TM and Kram M. The 6-min walk test in the functional evaluation of patients with lung cancer qualified for lobectomy. *Interact Cardiovasc Thorac Surg* 2020; 30(4): 559–564.
6. Chen CH, Ho-Chang Huang YZ, et al. Hand-grip strength is a simple and effective outcome predictor in esophageal cancer following esophagectomy with reconstruction: a prospective study. *J Cardiothorac Surg* 2011; 6: 98.
7. Gehl CJ, Verhagen NB, Shaik TJ, et al. Association of daily step count and postoperative complication among all of us research participants. *J Am Coll Surg* 2024; 239(6): 539–546.
8. Hays RD, Bjorner JB, Revicki DA, et al. Development of physical and mental health summary scores from the patient-reported outcomes measurement information system (PROMIS) global items. *Qual Life Res*. Sep 2009; 18(7): 873–80. doi:10.1007/s11136-009-9496-9
9. Haley SM, Andres PL, Coster WJ, et al. Short-form activity measure for post-acute care. *Arch Phys Med Rehabil*. 2004; 85(4): 649–660.
10. Power AD, Merritt RE, Patterson K, et al. Early postoperative functional assessment predicts non-home discharge after pulmonary lobectomy. *Ann Thorac Surg* 2021; 111(5): 1710–1716.
11. Begg C, Cho M, Eastwood S, et al. Improving the quality of reporting of randomized controlled trials. The CONSORT statement. *JAMA* Aug 28 1996; 276(8): 637–639.
12. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008; 61(4): 344–349.
13. Sun V, Guthrie KA, Arnold KB, et al. Comparative effectiveness of perioperative physical activity in older adults with lung cancer and their family caregivers: design of a multicenter pragmatic randomized trial. *BMC Cancer* 2024; 24(1): 976.
14. Zhao JY, Presley C, Madariaga ML, et al. Prehabilitation for older adults undergoing lung cancer surgery: a literature review and needs assessment. *Clin Lung Cancer* 2024; 25(7): 595–600.
15. Edbrooke L, Denehy L, Parry SM, et al. How is physical activity measured in lung cancer?A systematic review of outcome measures and their psychometric properties. *Respirology* 2017; 22(2): 263–277.
16. Jin Z, Lee C, Zhang K, et al. Utilization of wearable pedometer devices in the perioperative period: a qualitative systematic review. *Anesth Analg* 2023; 136(4): 646–654.
17. Chen Z, Wang Y, Qiu P, et al. Pulmonary rehabilitation exercise based on wearable device pedometer improved lung cancer patients with impaired pulmonary function. *Altern Ther Health Med* 2024; 30(1): 78–82.
18. Billé A, Buxton J, Viviano A, et al. Preoperative physical activity predicts surgical outcomes following lung cancer resection. *Integr Cancer Ther* 2021; 20: 1534735420975853.