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ORIGINAL RESEARCH

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Supervised preoperative walking on increasing early postoperative stamina and mobility in older adults with frailty traits: A pilot and feasibility study

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Abstract

Background and Aims: Frail older adults are more than twice as likely to experience postoperative complications. Preoperative exercise may better prepare these patients through improved stamina and mobility experienced in the days following surgery. We measured the impact of a walking intervention using an activity tracker and coaching on postoperative stamina, and mobility in older adults with frailty traits.

Methods: We included patients aged 60+ and scoring 4+ on the Edmonton Frailty Scale. We then randomized patients to intervention versus control stratified by anticipated hospital stay (1 night vs. 2+ night) and baseline stamina (i.e., 6-min walk distance [6MWD]). Intervention patients received an activity tracker and linked smart phone. An athletic trainer (AT) prescribed a daily step count goal and titrated this up after checking in with patients during weekly telephone calls. Controls received general walking recommendations. We then measured postoperative 6MWD 1–3 days after surgery. We also assessed postoperative mobility by measuring steps walked the day after surgery using a thigh-worn monitor. Because many patients could not walk postoperatively, we compared intervention-control difference in both 6MWD and steps using Wilcoxon rank testing and Tobit and ordinal logistic regression adjusting for several patient characteristics.

Results: We randomized 104 eligible patients; 80 patients remained for final analysis. There was no difference in intervention versus control postoperative 6MWD (median 72 vs. 74 m Wilcoxon $p = 0.54$) or postoperative steps taken

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(median 128 vs. 51 steps Wilcoxon $p = 0.76$). Analysis adjusting for patient characteristics was consistent with these findings.

Conclusion: Our intervention consisting of goal setting with an activity tracker and telephonic coaching by an AT did not appear to improve stamina or mobility measured in the days after surgery. Small sample size limited our ability to examine this impact in subsets defined by surgical specialty or baseline stamina.

KEYWORDS
frailty, perioperative, prehabilitation, stamina, surgery

1 | INTRODUCTION

When compared against their nonfrail counterparts, frail older adult surgical patients have more than a twofold increased risk for postoperative complications, including deep vein thrombosis, renal failure, stroke, deep wound infection, and pneumonia.[1,2] Older adults with frailty traits represent individuals having several of the features and vulnerability of complete syndrome of frailty defined further below in Section 2. As adults age, many lose proprioception, muscular strength, and visual perception. Together these deficits lead to a more sedentary lifestyle. This sedentary lifestyle exacerbates lower extremity muscle weakness which manifests as decreased physical activity, stamina, and mobility.[3]

Preoperative exercise, or prehabilitation, may be a feasible solution to improve patient stamina and mobility. Previous interventions have required costly in-person therapy sessions and focused on general surgical patients and not frail older adults.[4–6] They also did not include goal setting with a modern pedometer or remote coaching. Prior studies also focused on outcomes collected 4 weeks or longer after surgery, a point at which significant variation in rehabilitation, nursing, and other services has taken place.[5–7]

In this brief report, we present the results of a pilot study to assess the impact of a preoperative walking intervention using goal setting with a modern pedometer and telephonic coaching on early, that is, in-hospital, postoperative stamina, and mobility in older adults with some or all of the frailty traits.

2 | METHODS

We previously described our methods but will summarize the main features below.[8] All human research conducted by University of Massachusetts Chan Medical School investigators is monitored by the University of Massachusetts Institutional Review Board (IRB). The IRB is comprised of faculty who have reviewed and approved this study. The IRB is independent from competing interests and the funders of this study.

2.1 | Population

We screened surgery request orders and appointment logs of patients aged 60 and older seeing surgeons from specialties participating in our study. Specialties participating included colorectal, thoracic, urological, transplant, oncological, and vascular surgery. Once we identified potentially eligible patients, we approached them at a visit with their surgeon or by telephone. We then consented them to participate and screened them for frailty using the Edmonton Frailty Scale (EFS). Those scoring 4 or higher on the EFS were eligible to participate in the randomized trial of our intervention. Scores of 8 or higher typically define the full frailty syndrome but previous research suggests that patients scoring 4 or higher, that is, older adults with frailty traits, are also vulnerable to postoperative complications.[9] To have sufficient time to intervene and also standardize the intervention, we restricted enrollment to patients for whom the anticipated surgery date was at least 3 but not more than 8 weeks from time of enrollment.

2.2 | Randomization

We randomized patients in 1:1 fashion to receive our intervention versus general walking instructions stratified on anticipated length of stay and baseline stamina grouped into four categories (<200, 201–300, 301–400, and >400 m).

2.3 | Intervention and control procedures

To intervention patients, we issued a wrist worn pedometer, a Garmin Vivofit 4, and a linked smart phone with cellular connectivity. Through these devices, an athletic trainer reviewed baseline activity, prescribed a daily step count goal, and then titrated up the goal during weekly check-in calls. For controls, we provided general recommendations to stay active and walk before surgery.

2.4 | Primary outcomes

2.4.1 | Postoperative stamina

We evaluated stamina and mobility in the days after surgery. Prior studies have not measured recovery in frail older adults in the days following surgery. We selected this phase of care because it avoids confounding by heterogeneity in post-acute care rehab and other services. For patients whose stay was anticipated to last two or more nights, we measured 6MWD on the second postoperative day (POD2). If the patient was unable, we re-attempted on POD3. For patients staying only one night, we measured 6MWD on POD1. For any patient unable to walk after these attempts, we assigned a 0 as their postoperative 6MWD.

2.4.2 | Postoperative mobility

For postoperative mobility, we compared intervention and control patients for steps walked from 9:00 a.m. to 5:00 p.m. on POD1 using the ActivPal3, a thigh-worn research grade accelerometer.[10] For patients for whom the full 8 hour was not available (such as those discharged early on POD1), we projected number of steps they walked based on their hourly average. We also analyzed the adherence and preoperative step counts of intervention patients. Specifically, we calculated the percentage of days that the patients met their step count goal as well as the change in the average daily step count that they walked in the first 3 days of wearing the wrist pedometer (baseline assessment period) compared with the week leading up to surgery.

2.5 | Secondary outcomes

2.5.1 | Postoperative loss of stamina

We also examined loss of stamina (Δ6MWD) as the difference between baseline and postoperative 6MWD. We elected not to make loss of stamina our primary outcome given the ambiguous significance and difficulty analyzing values for patients unable to walk postoperatively.

2.5.2 | Covariates

Covariates included patient characteristics (i.e., age, gender, race/ethnicity, frailty score as measured by the EFS, specialty of surgery performed, baseline 6MWD, days elapsed from randomization to surgery, anticipated length of stay, and American Society of Anesthesiologists classification).

2.5.3 | Sample calculation and analysis

Applying 80% power with 5% type I error rate for two-sided hypothesis testing and using a standard deviation of 48 m for normally distributed within-patient Δ6MWD found in Gillis et al.,[5] we originally computed that we would need follow-up outcome data on 40 patients per treatment arm to detect a mean between-group difference in Δ6MWD of 30.5 m (0.63 effect size). Because several patients could not walk for the postoperative 6MWD measurement when approached, yielding a nonnormal distribution, we assessed the intervention-control difference using Wilcoxon rank testing. We also assessed the difference using covariate-adjusted analyses following the Tobit approach[11] and ordinal logistic regression. For the ordinal regression, we grouped patients into three distance categories 0, 1–100, and >100 m. We followed a similar procedure for our postoperative step outcome. For our secondary outcome, that is, loss of stamina, we examined the distribution of values. Given these values followed a normal distribution as described in Section 3, we constructed a linear regression model adjusting for covariates.

3 | RESULTS

3.1 | Descriptive

We identified and randomized 104 eligible patients. Twenty-four patients did not undergo surgery, withdrew, or were not available for outcome assessment. Eighty patients remained for analysis. (Figure 1).

Mean patient age was 69 years. The vast majority of patients (91%) had 2+ night stays. The most common surgery types were colorectal and thoracic (30% each). Most patients (65%) had a EFS score of 4 or 5. Although we intended to have 3 weeks or more before surgery for each patient, 19% of patients had surgery rescheduled to an earlier date. Fifty-three percent had surgery between 21 and 40 days from randomization and 28% had surgery 40+ days from randomization. Most characteristics were balanced in intervention versus control patients. There were three American Society of Anesthesiologists (ASA) class IV patients (patients with an incapacitating systemic disease, i.e., a constant threat to life) in the intervention arm compared with none in the controls. Offsetting that imbalance was a 5% lower prevalence of patients with ASA class III (a patient with severe systemic disease that limits activity but is not incapacitating) in the intervention group (Table 1).

3.2 | Postoperative stamina

Intervention patients had similar postoperative 6MWD compared with controls. Twelve of 40 patients (30%) in each group could not walk to

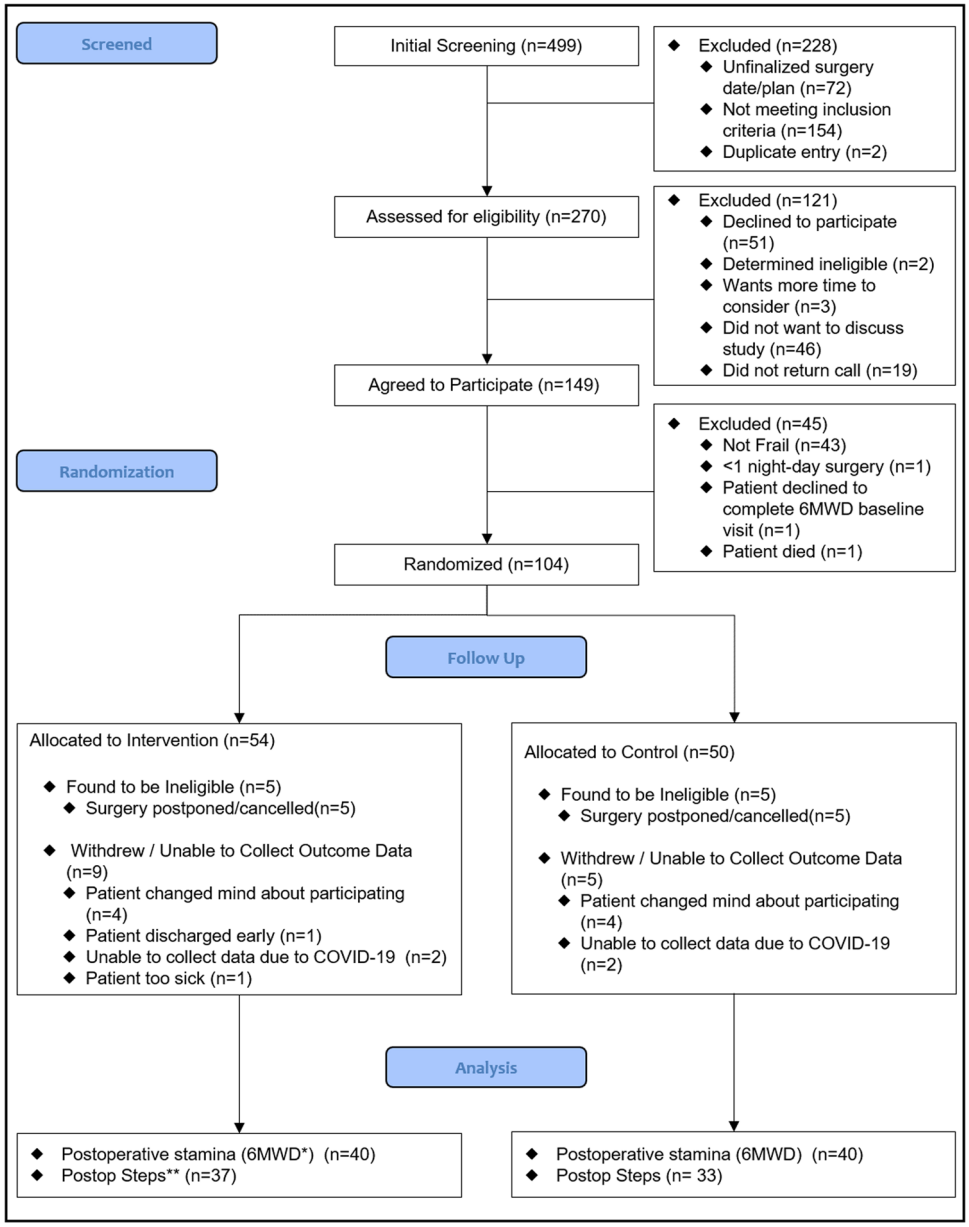

FIGURE 1 CONSORT flow diagram. *Measured on second or third postoperative day (POD2 or POD3) for patients that stayed 2+ nights. For patients staying one night, we measured 6MWD on POD1. **Step counts walked 9:00 a.m. to 5:00 p.m. on POD1. 6MWD, 6-min walk distance; CONSORT, consolidated standards of reporting trials.

measure 6MWD when approached. The median distance for intervention vs controls was 72 versus 74 m with Wilcoxon $p = 0.54$ (Figure 2). Results from our ordinal logistic regression model and Tobit modeling adjusting for covariates were consistent with the above findings. More specifically, in the logistic model, compared with control patients, intervention patients had no significant increase in the odds of having lower stamina—for example, highest versus middle or lowest category or highest or middle category versus the lowest category. The odds ratio for the intervention compared with controls was 0.84 (95% confidence interval: 0.34–2.08) (Supporting Information: Appendix 1, for full model results).

3.3 | Postoperative mobility

Intervention patients had similar postoperative step counts compared with controls. Seventy patients contributed to postop step count. Nine intervention and seven control patients did not take any steps. Intervention patients took a median of 128 versus 51 steps for controls (Wilcoxon $p = 0.76$). Results adjusting for covariates were consistent with the unadjusted results.

In terms of the adherence, we found few intervention patients consistently met their daily step counts with mean

TABLE 1 Frequency of patient characteristics and postoperative outcomes

Characteristic and patient outcomes	Total *N* (% out of 80 unless specified)	Intervention *N* (% out of 40 unless specified)	Control *N* (% out of 40 unless specified)
Patient characteristic			
Age mean ± SD	69 ± 8	68 ± 9	70 ± 6
Female gender	42 (53)	21 (53)	21 (53)
Nonwhite race/ethnicity[a]	9 (11)	5 (12)	4 (10)
Edmonton Frail Scale[b]			
Less frail (4 or 5)	51 (64)	25 (63)	26 (65)
More frail (6+)	29 (36)	15 (37)	14 (35)
Type of surgery			
Colorectal	26 (33)	14 (35)	12 (30)
Thoracic	26 (33)	11 (28)	15 (38)
Urological	13 (16)	7 (17)	6 (15)
Other[c]	15 (18)	8 (20)	7 (17)
Baseline stamina (6MWD)			
Less than 200 m	12 (15)	5 (12)	7 (17)
200–300 m	25 (31)	13 (33)	12 (30)
301–400 m	25 (31)	12 (30)	13 (33)
Greater than 400 m	18 (23)	10 (25)	8 (20)
Preoperative duration[d]			
<20 days	12 (15)	6 (15)	6 (15)
20–40 days	45 (56)	21 (53)	24 (60)
>40 days	23 (29)	13 (32)	10 (25)
Length of stay[e]			
Long stay	73 (91)	37 (93)	36 (90)
Short stay	7 (9)	3 (7)	4 (10)
ASA classification of physical health[f]			
Mild systemic disease (II)	12 (15)	7 (18)	5 (12)
Severe systemic disease (III)	65 (81)	30 (75)	35 (88)
Severe systemic disease/constant threat to life (IV)	3 (4)	3 (7)	0 (0)

Abbreviations: 6MWD, 6 min walk distance; ASA, American Society of Anesthesiologists; POD, postoperative day.

[a]Includes Black, Hispanic/Latino ethnicity, Asian, Native American, Alaska Native, or other.

[b]Range 0–17 for scale; we exclude patients scoring <4.

[c]Other surgery types include oncology, vascular, and transplant.

[d]Days elapsed from randomization to day of surgery.

[e]Short stay (patient stayed 1 night in hospital); long stay (patient stayed 2+ nights in hospital).

[f]No eligible patient had an ASA I status.

percentage of days where a patient met their goals equaling 41% ± standard deviation of 17%. Despite this, intervention patients improved their average daily step count by 879 ± standard deviation of 1720 from beginning to end of the intervention.

3.4 | Postoperative loss of stamina

Loss of stamina generally followed a normal distribution with range of −172 (i.e., a gain in stamina) to 446 m, mean of 196 m, and standard deviation of 122. Intervention patients had a similar loss of

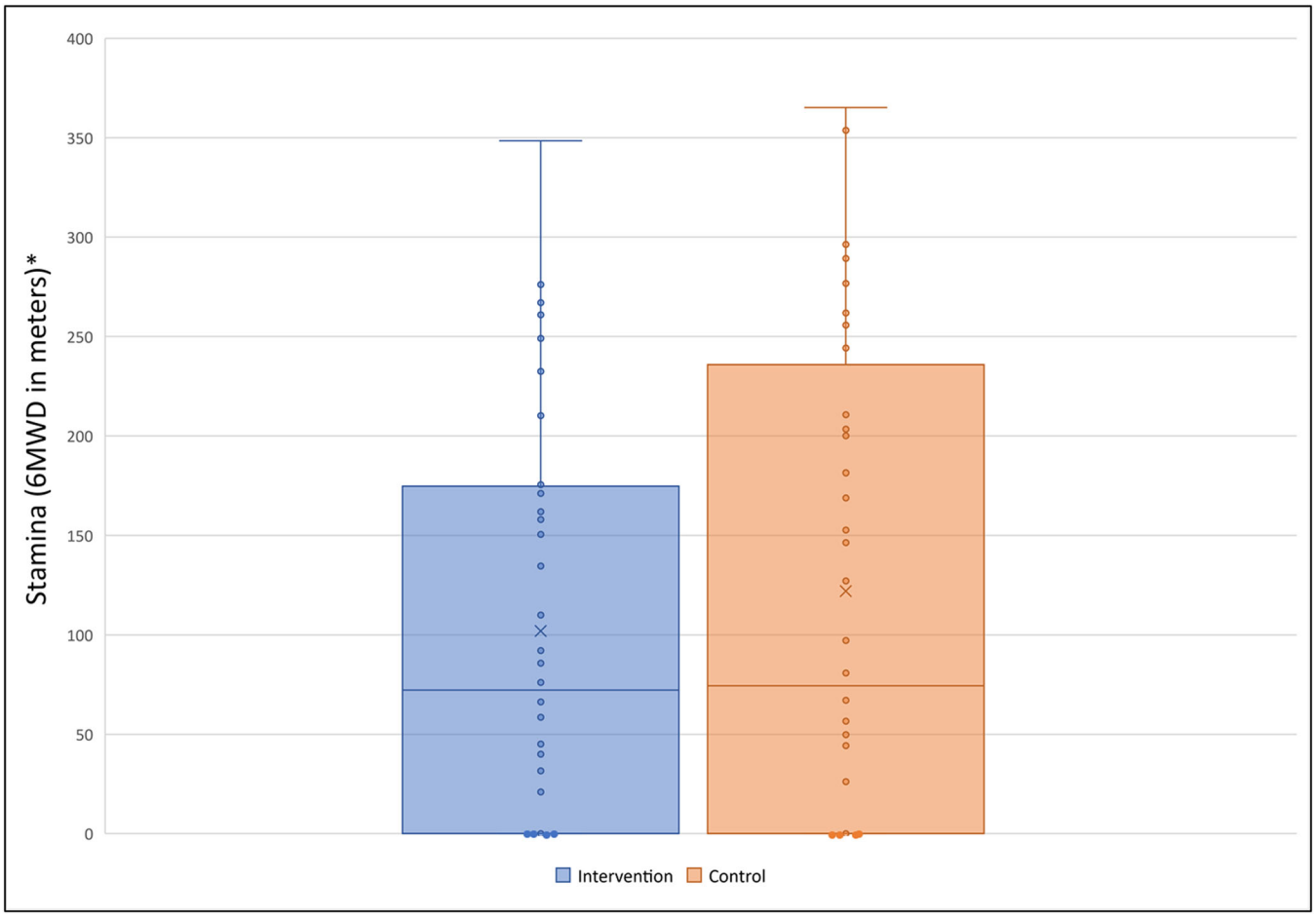

FIGURE 2 Postoperative stamina (6MWD) for intervention and control patients. *Box and whisker plots above indicate that the distributions of postoperative stamina were similar for intervention and control patients with median values of 72 and 74 m, respectively. The ends of the boxes represent the 25th and 75th percentiles. The whiskers represent the total range of values. Note that 12 of 40 patients in each group could not walk when approached. We assigned each a 6MWD of 0 m. 6MWD, 6-min walk distance.

stamina compared with controls adjusting for covariates (204 vs. 181 m, $p = 0.70$).

4 | DISCUSSION

We successfully evaluated a low cost, preoperative walking intervention consisting of goal setting with an activity tracker and telephonic coaching in 80 older adults with frailty traits. Few intervention patients met their daily step count goals, but preoperative daily step counts improved for them nevertheless. Despite improved preoperative step counts, there was no difference between intervention and control patients in postoperative stamina or postoperative mobility. Intervention patients were walking substantially more steps by the time of surgery compared with baseline.

Our results resemble a recent trial conducted by Carli et al.[7] focused on colorectal cancer patients with frailty traits. They did not find a difference in 4-week postoperative 6MWD after administering a multimodal intervention consisting of nutritional and psychological components in addition to in-person exercise sessions and home walking. Our study in contrast, distinguishes itself in its low cost and convenience. Few other studies have assessed the role of prehabilitation in frail older adults and no other (to our knowledge) assesses its role in these patients in the days immediately after surgery, avoiding confounding by heterogeneity in post-acute care rehab and other services.

There are several limitations to our findings. Small sample size limited the extent that we could analyze our intervention's effectiveness in patient subsets, particularly by surgery type. To address the heterogeneity, we randomized in blocks based on anticipated length of stay and baseline stamina, each of which can vary in patients with different surgical conditions. Each surgery group had similar baseline stamina and similar decline in stamina. As such, there is no clear group for which the intervention would be more beneficial based on the sample we analyzed. Future investigations should strive for enrolling larger cohorts to evaluate effectiveness in these subsets. It is also possible that the short duration of the training and the lack of resistance exercise may have contributed to the

absence of a significant increase in postoperative stamina and mobility. Outside of the perioperative context, studies exist that support longer duration and resistive training.[12,13] In many cases, it would be infeasible to delay surgery more than 8 weeks. Further pilot study of the duration and acceptability of a longer training period would be informative in planning larger trials. The absence of impact on postoperative stamina and mobility for our intervention occurred despite significant improvements in physical activity. We did not monitor preoperative step counts in control patients, but it is possible that they also improved physical activity. Because we did not have preoperative step counts for control patients, we could not measure between group difference in change in step counts from baseline to after surgery. Equipping controls with activity trackers to capture these counts may have unduly encouraged them to walk more. At the time of our study, there was no significant alternative exercise program recommended for participants. We are unaware of any studies looking at improvements in physical activity based on general recommendations such as those provided to our control patients.

In conclusion, our intervention consisting of goal setting with an activity tracker and telephonic coaching did not appear to have an impact on stamina or mobility measured in the days after surgery. Small sample size limited our ability to examine this impact in subsets defined by surgical specialty or baseline stamina. Future studies may want to look at the impact of preoperative walking in subsets and/or assess prehabilitation interventions with longer duration of training or resistance training.

AUTHOR CONTRIBUTIONS

Sanjeev Rampam: Data curation; formal analysis; investigation; visualization; and writing–original draft. **Hammad Sadiq**: Data curation; formal analysis; investigation; visualization; and writing–original draft. **Jay Patel**: Data curation; formal analysis; and investigation. **David Meyer**: Investigation and writing – original draft. **Karl Uy**: Investigation; methodology; and writing–review and editing. **Jennifer Yates**: Investigation; and writing–review and editing. **Andres Schanzer**: Investigation; and writing–review and editing. **Babak Movahedi**: Investigation; and writing–review and editing. **James Lindberg**: Investigation; and writing–review and editing. **Sybil Crawford**: Data curation; formal analysis; methodology; software; and writing–review and editing. **Jerry Gurwitz**: Formal analysis and methodology. **Kathleen Mazor**: Formal analysis and methodology. **Mihaela Stefan**: Methodology; and writing–review and editing. **Daniel White**: Formal analysis; and writing–review and editing. **Matthias Walz**: Funding acquisition and methodology. **Alok Kapoor**: Formal analysis; funding acquisition; investigation; methodology; software; visualization; writing–original draft; and writing–review and editing.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are not publicly available as the authors currently do not have the permissions to share the data.

TRANSPARENCY STATEMENT

All authors confirm that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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