North American Spine Society Journal (NASSJ) 8 (2021) 100087

Contents lists available at ScienceDirect

North American Spine Society Journal (NASSJ)

journal homepage: www.elsevier.com/locate/xnsj

Clinical Studies

Accelerometry-based physical activity, disability and quality of life before and after lumbar decompression surgery from a physiotherapeutic perspective: An observational cohort study

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ARTICLE INFO

Keywords:
Lumbar decompression surgery
Accelerometry
Physical activity
Steps per day
Moderate to vigorous activity
Physiotherapy
Health-related quality of life
Disability

ABSTRACT

Background: The effect of lumbar decompression on physical activity (PA) measures (measured as number of steps/day and as moderate to vigorous PA (MVPA)) is poorly understood. The aim of the current study was to compare PA in patients before and after lumbar decompression and to determine the association between change in steps/day and MVPA with change in disability, health-related quality of life (HRQOL) and pain.

Methods: Patients undergoing lumbar decompression surgery were recruited. Steps/day and MVPA MVPA were recorded with an accelerometer. Oswestry Disability Index (ODI), HRQOL (Short Form 36 questionnaire (SF-36)) and pain levels (visual analogue scale (VAS)) were collected prior to surgery and six and twelve weeks postoperatively. Steps/day were compared to the lower bound of steps/day in healthy persons (7,000 steps per day), and the relationship between changes in steps/day, MVPA, ODI, SF-36, and VAS were calculated.

Results: Twenty-six patients aged 37 to 75 years met inclusion criteria and were included in the study. Lumbar decompressions were performed for stenosis and/or disc herniation. Preoperatively, patients took an average 5,073±2,621 (mean±standard deviation) steps/day. At 6 weeks postoperatively, patients took 6,131±2,343 steps/day. At 12 weeks postoperatively, patients took 5,683±2,128 steps/day. Postoperative MVPA minutes per week increased compared to preoperative MVPA (preoperative: 94.6±122.9; 6 weeks: 173.9±181.9; 12 weeks: 145.7±132.8). From preoperative to 12 weeks postoperative, change in steps correlated with MVPA ($R=0.775$; $P<0.001$), but not with ODI ($R=0.069$; $P=0.739$), SF-36 ($R=0.138$; $P=0.371$), VAS in the back ($R=0.230$; $P=0.259$) or VAS in the leg ($R=-0.123$; $P=0.550$).

Conclusions: During the first 12 postoperative weeks, daily steps did not reach the lower bound of normal step activity of 7,000 steps/day, however postoperative steps/day were higher than before surgery. Steps/day and MVPA appear to be independent of ODI and SF-36 and represent additional outcome parameters in patients undergoing lumbar decompression surgery and should be considered e.g., by physiotherapists especially from 6 to 12 weeks postoperatively.

Level of evidence: 2, prospective cohort study

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https://doi.org/10.1016/j.xnsj.2021.100087
Received 12 March 2021; Received in revised form 18 October 2021; Accepted 18 October 2021
Available online 26 October 2021

Tweet

Steps/day and moderate physical activity remain low 12 weeks postoperatively but are valuable additional outcomes in patients after lumbar decompression surgery.

Study registration: NCT03452449 (clinicaltrials.gov)

Introduction

Physical activity (PA) is important for all body systems and general health as PA reduces the risk of obesity, osteoarthritis and the development of chronic pain [1–7]. Surrogate measures for PA include the number of steps per day (steps/day) and the amount of moderate to vigorous physical activity (MVPA). MVPA is defined as activity that is equal or greater than 100 steps/minute and should be taken in bouts (i.e. periods of activity) of at least 10 minutes [8].

In a meta-analysis, Bohannon et al. [9] reported an average steps/day count of 9,448 (95%CI [8,899; 9,996]) in healthy adults, which closely matches the recommendation of the World Health Organisation of 10,000 steps/day and at least 150 minutes of MVPA weekly [10]. Another review reported that U.S. adults achieve 6,500 steps/day and Swiss adults achieve 8,900–10,400 steps/day, and recommended 7,000–8,000 steps/day as a direct estimate of minimal amounts of MVPA [8].

Nerve root compression due to specific degenerative processes such as disc prolapse or spinal stenosis is known to lead to lumbar radiculopathy, radicular pain syndrome or neurogenic claudication [11]. Patients with radicular pain syndrome not only experience low back pain but also leg symptoms in the affected peripheral nerve area, such as gain or loss of sensation and/or motor function, pain or paraesthesia [12].

Lumbar decompression surgery can prevent long-lasting pain, disability and eventually damage of the nerve root [13]. In 2018, over 20,000 back surgeries were performed in Switzerland requiring postoperative rehabilitation [14]. Surgical outcome is usually assessed as postoperative changes in disability, health related quality of life (HRQOL) and pain levels [15,16].

Previous studies have shown that MVPA is low in patients with lumbar spinal stenosis with 75% of patients being inactive (less than 1 minute/week in MVPA) [17] but also that walking time remains low during the first week after lumbar decompression surgery [18].

Physiotherapy (PT) is a key feature of patient rehabilitation after lumbar decompression surgery including patient training, information about postoperative behaviour and pain management and has been shown to lead to postoperative improvement [19,20]. Aerobic exercise positively affects health [21], and PT has the potential to change PA levels [22,23]. Thus, achieving an adequate amount of PA in postoperative interventions might positively affect surgical outcomes. Understanding pre- and postoperative PA levels in patients undergoing lumbar decompression surgery is critical for defining therapeutic interventions and providing high-quality advice for postoperative behaviour and treatment options [24,25]. However, the current literature provides inconsistent findings and limited guidance for PT practice focusing on daily physical activity [26]. While previous studies have shown that steps/day counts increase but that PA levels remain low after lumbar discectomy, decompression or fusion surgery [17,27–30], to date comparison to norm data of healthy subjects is lacking.

The goal of the current study was to compare PA measured as steps/day count and MVPA minutes of patients undergoing lumbar decompression before and 6 and 12 weeks after surgery to the lower boundary of the normal free-living steps/day (= 7,000) in healthy persons [8] and to determine the association among changes in steps/day, MVPA, disability and HRQOL after surgery. We hypothesized that PA will steadily increase after surgery but stay below norm values because current postoperative rehabilitation programs mainly focus on strength and mobility training.

Materials and methods

Study design

This prospective observational study design with preoperative baseline and postoperative follow-up measurements at 6 and 12 weeks was approved by the regional ethics board and carried out in accordance with the Declaration of Helsinki [31]. All participants provided written informed consent prior to participation.

Patient recruitment

Patients scheduled for lumbar decompression surgery were screened through a shared decision process with the treating surgeon consecutively from June to December 2017. Inclusion criteria were: diagnosed lumbar spinal stenosis and radicular pain, and/or disc herniation; planned single or multi-level decompressive surgery at any segment between L2 and S1 (such as discectomy, decompression, laminotomy or foraminotomy), ability to go home after surgery (no need for further, intensive in-house rehabilitation); ability to complete questionnaires in German; and age between 18 and 75 years.

Exclusion criteria were: previous lumbar surgery, fusion surgery or surgery of segments above L2; surgery secondary to scoliosis, fracture, infection, or tumour; and any surgeries or circumstances limiting gait ability in the past 6 months (e.g. rheumatoid arthritis, multiple sclerosis, cerebrovascular insult, dementia, uncontrolled cardiovascular diseases).

Data collection

All data were collected at the PT department of a regional hospital. Baseline assessments were carried out 4 to 21 days preoperatively and included patient specific information, PA assessment in daily live, self-reported disability, HRQOL measurement. The participants were instructed on the use of the ActiGraph and on how to complete the wear-time diary. Follow-up measurements were conducted 6 ± 1 weeks and 12 ± 1 weeks postoperative by face-to-face contact to ensure data completeness and accelerometer adherence and included patient specific information, PA, self-reported disability and HRQOL measurement. Study data were managed and stored using REDCap (Research Electronic Data Capture) [32].

Assessments

Physical activity. Three-dimensional accelerometers (GT3X+, ActiGraph LLC, Pensacola, FL, USA) were used to measure PA parameters including steps/day count, percentages of sedentary, light, moderate and vigorous PA and thus the length of time spent in moderate to vigorous PA (MVPA in minutes). The ActiGraph is a well-accepted, reliable, valid and responsive activity monitor [[33–37]]. Compared to commercial activity trackers such as Fitbit or Apple Watch, the ActiGraph ensures patient blinding during the measurement and allows users to process data using independently developed and validated algorithms. The ActiGraph device uses a piezoelectric acceleration sensor. The software converts the signals produced from the sensor into translated output (counts per a given epoch). Finally, time spent in various physical activity intensity levels according to established movement intensity cut-points is computed [36].

For this study, cut points were divided into metabolic-equivalent-based PA classes using <100 counts/min for sedentary time, 100–1,951 counts/min for light, 1,952–5,724 counts/min for moderate, and 5,725–9,498 counts/min for vigorous, and >9,498 counts/min for very vigorous activity [37]. The participants wore the ActiGraph on the right side of their waist during waking hours. The ActiGraph recorded data at a frequency of 60 Hz that was downloaded in 60 second epochs of all three axes using ActiLife software version 6.13.3 (ActiGraph LLC, Pensacola, FL, USA). The wear position and observation period of 3 to 7 days including weekend days were chosen according to the literature [[33],[35],[38–41]] and in dependence of the surgical scheduling. PA was not recorded continuously for the entire study duration but for 3 to 7 consecutive days at each assessment. The ActiGraph does not have a light or button for participants to interfere or bias the measurement and was adjusted to the participants' baseline characteristics (body height, body mass, sex, date of birth). Raw data of each measurement period were used for further analysis when meeting a wear cut-off of at least 10 hours daily wear-time.

Disability, health-related quality of life and pain. Disability and HRQOL were assessed using the Oswestry Disability Index (ODI) and the 36-Item Short Form Health Survey (SF-36), respectively. Both outcomes are Likert-scaled, reliable and valid questionnaires [42–44] and their total results are expressed as scores between 0 and 100. The higher the score, the higher is disability according to the ODI and the better is HRQOL according to the SF-36. Back and leg pain were assessed using a 10-cm visual analogue scale. According to Copay et al. [45] the minimal detectable change and minimal clinically important changes are 12.8% for the ODI, 4.9% for the physical component of the SF-36, 1.2 points for back pain and 1.6 points for leg pain in patients receiving lumbar decompression and/or fusion surgery.

Patient specific information. The study sample characteristics age, sex, occupation, height, body mass, body mass index, type of surgery, dominant symptoms (sensorimotor signs, pain and needles), previous PT (numbers of treatments, and the length of the time period in which these treatments were carried out) and current pain medication (name, dose per day) were documented at baseline. For postoperative analysis, additional self-reported information was collected in a questionnaire at both follow-ups: number of hospitalisation days, pain medication, need of and the type of aids as well as outpatient PT (starting date, amount of therapy per week, total amount of therapy sessions up to study completion, active / passive / educative postoperative PT treatment forms, one to three treatment contents which were valued most by the participants).

Statistical analysis

The sample size calculation was based on the PA data published by Mobbs et al. [28]. To detect mean differences with an effect size of 0.6 with a one sample t-test at 80% power, significance level of 0.05 and assuming 20% drop-out rate, 29 patients were required.

Statistical analysis was performed using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). For the ordinal-scaled functional outcomes, Friedman tests with post-hoc Bonferroni correction were used to detect differences between time points. The PA parameters were checked for normal distribution using Shapiro-Wilk tests. Analysis of variance (ANOVA) was used to detect differences in outcomes between time points with paired t-test post-hoc analysis. Wilcoxon-tests were used to detect differences in steps/day between patients and the lower bound of the normal steps/day count of 7,000 at each time point. In this study, we used the steps/day classifications by Tudor-Locke et al. [8] who reported normative data of healthy adults of 4000 to 18,000 steps/day and suggested that 30 minutes of daily MVPA accumulated in addition to habitual daily activities in healthy adults (20-65 years as well as 65+ years) is equivalent to taking approximately 7,000 to 10,000 steps/day. Based on these considerations, we considered 7000 steps/day as reasonable target in our population.

Nonparametric Kendall's Tau correlation coefficients were used to detect correlations between the change in PA with the change in disability, the change in HRQOL and the change in pain. Based on the literature [28], a clinically relevant correlation cut-off value was set at R=-0.4 for ODI and R=+0.4 for SF-36. Missing data were tested by using the Little's Missing Completely at Random test and assessed as an arbitrary pattern. Multiple imputation was applied because of the smaller risk of bias and hence representing the best approach for replacing missing values [46]. The significance level for all statistical tests was set a priori to 0.05.

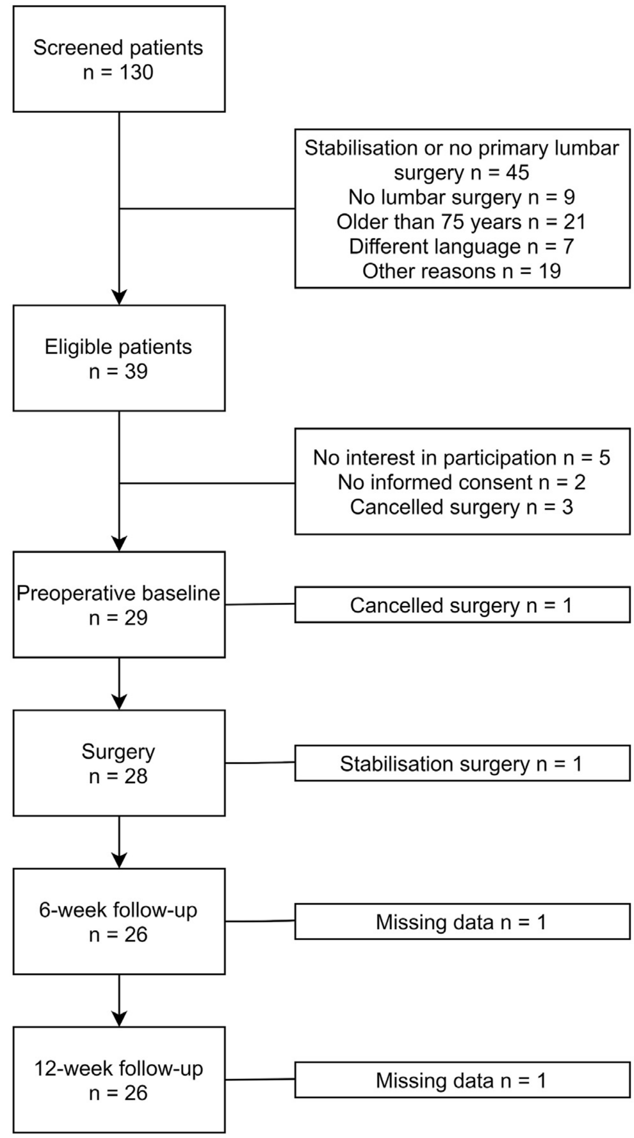

Fig. 1. Study flow chart revision.

Results

Overall, 130 patients were screened consecutively, and 29 participants (18 women, 11 men, aged 56.6 ± 11.7 years) were included and assessed before surgery. Table 1 presents all the baseline characteristics of the study sample. Twenty-eight participants underwent surgery as planned while one surgery was cancelled because of lacking coverage. Data of two participants were excluded from statistical analysis as the surgeon had to deviate to a stabilisation surgery (Figure 1). In 65% of the cases the lumbar surgeries were unisegmental while 35% were on two or three segments. The 6- and 12-week follow-ups were performed in 26 patients (17 women, 9 men), however missing data occurred due to unwillingness to participate at the 6-week measurement (n=1, male) or to wear the ActiGraph for the 12-week measurement (n=1, female). All measurements with the ActiGraph fulfilled the criteria of minimum 3 days of 10 hours wear-time. None of the participants needed second surgery during the 12-week follow-up period.

Physical activity measures

Compared to baseline, patients completed on the average 1,058 more steps/day (+20%) at the 6-week follow-up and 610 more steps/day

Table 1
Demographics of the patient population (n=29).

Parameter at baseline	Mean ± SD
Age (years)	56.5 ± 11.7
Body height (m)	1.69 ± 0.10
Body mass (kg)	76.9 ± 21.7
Body mass index (kg/m^2)	26.5 ± 5.5
Onset of out-patient physiotherapy before surgery (week)	34.2 ± 32.9
Number of conducted therapies before surgery (N)	24.2 ± 32.6
Number of participants without out-patient physiotherapy before surgery (N)	6
Participants' occupation classification: office job / physical job / retired (N)	12 / 6 / 11
Number of the participants' living area (N) rural / urban	12 / 17

Legend: SD—standard deviation

(+12%) at the 12-week follow-up, but differences were not statistically significant (Table 2). Compared to the lower limit of normal steps/day (7,000 steps/day), steps/day counts were significantly lower at all time points (preoperatively: -1,926 steps/day, P=0.001; 6 weeks postoperatively: -868 steps/day, P=0.020; 12 weeks postoperatively: -1,316 steps/day, P=0.004). Nonparametric correlations of steps/day count with age were very weak at baseline (R=-0.158; P=0.260), 6 weeks (R=0.000; P=1.000) and 12 weeks after surgery (R=-0.071; P=0.623). Six, 8 and 7 participants surpassed the 7,000 steps/day count before, 6 weeks and 12 weeks after surgery, respectively. Seven, 11 and 12 participants surpassed the threshold value of 150 minutes MVPA per week before, 6 weeks and 12 weeks after surgery, respectively.

Disability, health related quality of life (HRQOL) and pain

Functional limitations (ODI, SF-36 and pain) improved significantly from baseline to 6 and especially to 12 weeks postoperatively (Table 2).

Association between changes in steps/day and MVPA and changes in disability, HRQOL or pain

From preoperative to 6-weeks postoperative, change in steps/day count correlated with the change in MVPA (R=0.808; P<0.001), the change in ODI (R=-0.495; P=0.010), the change in SF-36 (R=0.444; P=0.023) but not with the change in VAS in the back (R=0.051; P=0.805) or the change in VAS in the leg (R=-0.311; P=0.122). The change in MVPA did not correlate with the change in ODI (R=-0.221; P=0.277), the change in SF-36 (R=-0.206; P=0.312), the change in VAS in the back (R=0.231; P=0.256) or the change in VAS in the leg (R=-0.185; P=0.365). The change in ODI correlated with the change in HRQOL (R=-0.586; P=0.002).

From 6 to 12 weeks postoperative, the change in steps/day correlated with the change in MVPA (R=0.837; P<0.001) but not with the change in ODI (R=0.069; P=0.739), the change in SF-36 (R=-0.138; P=0.371), the change in VAS in the back (R=0.168; P=0.413) or the change in VAS in the leg (R=-0.171; P=0.404). Change in MVPA did not correlate with the change in ODI (R=0.063; P=0.761), the change in SF-36 (R=-0.018; P=0.930), the change in VAS in the back (R=0.034; P=0.870) or the change in VAS in the leg (R=-0.240; P=0.238). The change in ODI correlated with the change in SF-36 (R=-0.705; P<0.001).

From preoperative to 12-weeks postoperative, the change in steps/day correlated with the change in MVPA (R=0.775; P<0.001) but not with the change in ODI (R=0.069; P=0.739), the change in SF-36 (R=0.138; P=0.371), the change in VAS in the back (R=0.230; P=0.259) or the change in VAS in the leg (R=-0.123; P=0.550). Change in MVPA did not correlate with the change in ODI (R=-0.053; P=0.795), the change in SF-36 (R=0.178; P=0.384), the change in VAS in the back (R=0.116; P=0.571) or the change in VAS in the leg (R=-0.080; P=0.696). Change in ODI correlated with the change in SF-36 (R=-0.758; P<0.001).

Aspects of physiotherapeutic treatments

Participants started postoperative PT sessions according to their surgeon's advice concerning start and frequency. The first PT out-patient session was 20.2 ± 8.3 days postoperative (range 7–37 days), and 14.3 ± 7.0 PT sessions were conducted from hospital discharge to the 12-week assessment. Further information about active, passive and educative therapy content during the first and the second 6 weeks of rehabilitation are provided in Table 3. The number of therapy sessions did not correlate with the change in steps/day from preoperative to 6-week postoperative (R=0.363; P=0.074) but from the 6-week to the 12-week follow-up (R=-0.402; P=0.042). The three most valued PT treatment types reported by the participants were: strength and endurance training (n=15), pain relief (n=11), learning exercises (n=11), and education / information (n=8).

Discussion

This study compared PA of patients undergoing lumbar decompression surgery preoperatively and 6 and 12 weeks postoperatively to the lower bound of the normal free-living PA. Although the averaged steps/day count increased postoperatively, mean steps/day counts remained below 7,000 steps/day at all three measurements confirming our main hypothesis. Seven, 11 and 12 participants surpassed the threshold value of 150 minutes MVPA per week before, 6 weeks and 12 weeks after surgery, relatively. The change in steps/day and MVPA correlated with the change in ODI and the change in SF-36 at 6 weeks, but not at 12 weeks postoperatively. The change of steps/day correlated with the change of MVPA at every measurement. The postoperative out-patient PT treatment consisted of predominantly active interventions throughout the entire study period. Behavioural aspects were addressed less often between the 6- and 12-week assessment. Participants valued the strengthening and endurance training most. Overall, changes in PA appear to be independent of changes in disability or in HRQOL during the first 3 months after surgery.

Physical activity measures

The finding of the highest mean steps/day count at 6 weeks after surgery was surprising as we expected a steady improvement in steps/day after surgery especially because participants were allowed by the surgeons to live free of restrictions from approximate 6 weeks postoperatively. Nonetheless, several factors may limit the steps/day count. Steps/day distribution of our study population was asymmetric due to outliers to the top and many participants stayed below the mean steps/day count. Generally, people aged above 65 years have lower mean steps/day counts [9], but only 20% of our study population was older than 65 years old. Hence, age might only partly explain why only few patients reached the lower limit of normative values of 7,000 steps/day.

The participants had a long disease history before surgery, were treated conservatively for more than 6 months on average and possi-

Table 2
Pre- and postoperative functional limitations and physical activity

	Descriptive analysis			*p-value*	*Post-hoc tests*					
	Preoperative (n=26)	*6-week postop. (n=26)*	*12-week postop. (n=26)*		*Difference 6-week to preop.*		*Difference 12-week to 6-week*		*Difference 12-week to preop.*	
Functional outcomes	*median, range*	*median, range*	*median, range*	*Friedman*	*p-value*	*min; max*	*p-value*	*min; max*	*p-value*	*min; max*
ODI (%)	43.0, 16.0 - 78.0	22.0, 0.0 - 56.0	15.0, 0.0 - 54.0	**<0.001**	**<0.001**	**-51, 14**	**0.003**	**-36, 32**	**<0.001**	**-64, 12**
SF-36 (%)	44.0, 9.0 - 75.0	63.5, 42.1 - 89.9	75.8, 35.1 - 93.1	**<0.001**	**<0.001**	**-18.6, 49.7**	**0.001**	**-23.6, 47.6**	**<0.001**	**-22.6, 60.7**
Maximal back pain	6.5, 0.0 - 8.9	2.0, 0.0 - 8.3	2.3, 0.0 - 9.1	**<0.001**	**0.002**	**-8.1, 3.1**	0.695	-4.5, 6.8	**<0.003**	**-8.0, 2.2**
Maximal leg pain	7.4, 0.0 - 10.0	0.0, 0.0 - 9.4	0.1, 0.0 - 9.0	**<0.001**	**<0.001**	**-10.0, 1.6**	0.808	-9.4, 9	**<0.001**	**-10.0, 3.6**
Physical activity outcomes	*mean ± SD*	*mean ± SD*	*mean ± SD*	*ANOVA*	*p-value*	*[95% CI]*	*p-value*	*[95% CI]*	*p-value*	*[95% CI]*
ActiGraph wear days (N)	5.9 ± 1.2	6.6 ± 0.5	6.2 ± 1.2	**0.034**	**0.007**	**[0.2; 1.2]**	0.330	[-1.1; 0.2]	1.000	[-0.5; 1.1]
Steps/day (N)	5073 ± 2621	6131 ± 2343	5683 ± 2128	0.051	0.138	[-234; 2350]	0.686	[-1387; 483]	0.389	[-389; 1609]
Sedentary activity (%)	69.1 ± 11.3	67.0 ± 6.3	67.1 ± 6.8	0.298	0.723	[-6.8; 2.5]	1.000	[-2.5; 2.7]	0.763	[-6.7; 2.5]
Light activity (%)	29.2 ± 10.1	29.8 ± 6.2	30.0 ± 6.8	0.838	1.000	[-3.6; 4.9]	1.000	[-2.7; 3.0]	1.000	[-3.3; 4.9]
Moderate activity (%)	1.7 ± 2.2	3.0 ± 2.8	2.5 ± 2.2	**0.003**	**0.010**	**[0.3; 2.4]**	0.438	[-1.5; 0.4]	0.053	[-0.0; 1.6]
MVPA/week (min)	94.6 ± 122.9	173.9 ± 181.9	145.7 ± 132.8	**0.005**	**0.016**	**[1.8; 21.1]**	0.760	[-4.7; 12.6]	**0.047**	**[0.1; 14.9]**

postop.—postoperative; ODI—Oswestry Disability Index; SF-36—36-item short-form health survey; MVPA—moderate to vigorous physical activity; ANOVA—Analysis of variance; significance levels of post-hoc tests for functional outcomes were adjusted by the Bonferroni correction; post-hoc t-tests were used to calculate significance levels of physical activity outcomes; statistically significant results are shown in bold

Table 3
Patient-reported information about content of out-patient physiotherapy at the 6-week and 12-week assessment.

Physiotherapy content (numbers of mentions)	6-week postop.	12-week postop.
Active forms		
Free spine stabilisation exercises	24	24
Medical training therapy	1	4
Endurance training	1	1
Water therapy	2	1
Active movement exercises	3	10
Back discipline	3	2
Balance exercises	3	1
Stretching exercises	0	3
Subtotal active forms	*36*	*46*
Passive forms		
Massage	10	13
Physical therapy (ultrasound, heat wrapping)	2	3
Scar massage	3	2
Subtotal passive forms	*14*	*18*
Cognitive behavioural forms:		
Education (back health, information about illness/complaints)	6	2
Instructions about increase in activities of daily life	4	2
Subtotal behavioral forms	*10*	*4*

postop.—postoperative; participants were asked to report one to three treatment forms

bly had changed their lifestyle to being less active because of persisting pain and/or disability or general lifestyle due to a predominantly urban patient population. Further, patients normally resumed work 6 to 8 weeks postoperatively and possibly reduced their steps/day count because of sitting habits at their workplaces. This fact might explain why the mean steps/day decreased from the 6-week to the 12-week follow-up. Interestingly, the proportion of participants who met at least 150 minutes MVPA per week increased from before to 6 weeks to 12 weeks after surgery. Thus, although the mean steps/day stayed below 7,000 steps/day, some participants improved their MVPA to a satisfactory level which is known to positively impact health [10]. Nonetheless, overall steps/day improved by 20% at week 6 and by 12% at week 12 compared to preoperative levels, and even a small improvement in steps/day is better than a reduction to the preoperative level or even lower.

Association between changes in PA and changes in disability or HRQOL

The change in steps/day correlated with the change in MVPA at every measurement but only steps/day correlated with the change in disability and the change in HRQOL and only from baseline to 6-weeks postoperatively. These results indicate that changes in steps/day and MVPA also reflect changes in ODI or SF-36 in the early rehabilitation stage. This finding is in agreement with the given circumstance that the rehabilitation period from surgery to 6 weeks postoperatively is the phase with the greatest change in the overall perceived effect and pain [15,47]. Patients are able to focus on their postoperative rehabilitation in this first postoperative phase because they are on sick leave and instructed to slowly increase the amount and intensity of loaded activities in their daily life.

Correlations of the change in steps/day and MVPA with the change in ODI and in SF-36 from 6 to 12 weeks postoperatively are weak possibly because not only the work can be resumed but also greater loads can be applied after 6 to 8 weeks postoperatively with a higher probability of experiencing muscle strain, provoked pain or fatigue. This could explain why the averaged steps/day count decreased but ODI and SF-36 improved by being aware of physical capacities. However, it appears plausible that changes in both PA parameters after the first 6 postoperative weeks are important because of the still ongoing healing process of the spine and the surrounding soft tissues. Overall, these results suggest that steps/day and MVPA may be outcome parameters that complement established outcomes (ODI, SF-36, pain levels, neurological signs and work ability) and that PTs should apply therapeutic interventions and education to support the patient in returning to a more active midterm and long-term lifestyle.

Aspects of physiotherapeutic treatments

All participants completed out-patient PT after surgery. Most patients valued PT on the basis of gaining confidence, written and face-to-face input as well as recommendations for further improvement [48]. Our participants emphasize the importance of PT by the fact that they found the strengthening and endurance training the most important part of their therapy. The negative correlation between the number of PT sessions and change in steps/day agrees with our clinical observation that patients with poor postoperative outcome require more frequent PT intervention and active rehabilitation and hence have less change in PA despite of receiving PT.

Our results of active and passive treatments go in line with a recently published study that stated that physiotherapists fail to unlock the full potential of PA for back health by adding passive treatments and thereby losing the focus on the active part [49]. The immediate impact of PT on lifestyle can be questioned, especially as the change in PA means a change of lifestyle and cannot be implemented immediately in patients who were disabled for many weeks yet have to return to their workplace as soon as possible, for instance, for financial reasons. Yet, it should not be neglected that in our study surgeons or physiotherapists did not specifically seek postoperative improvements in PA. Freene et al. [50] reported that only 54% physiotherapists promoted PA to their patients and that physiotherapists should place a greater emphasis on promoting PA to patients by knowing barriers and facilitators of PA [48,49]. Therefore, self-monitoring with feedback of PA but also web-based competitions are feasible options because they have been shown to increase PA by boosting goal importance and intrinsic motivation [51].

Three previous studies on PA after lumbar decompression surgery have shown comparable results to ours indicating that steps/day and MVPA levels stay below the recommended thresholds even 2 years after surgery even though functional capacities improved [27,30,52]. Two studies used the same or a previous comparable version of the ActiGraph device, and the third study used the Paffenbarger Physical Activity Questionnaire, which is self-administered and has adequate validity and satisfactory reliability [53]. While short- and long-term changes were well-described in these studies, they did not provide clear answer regarding the need of PT to focus on PA during mid-term rehabilitation. For example, Mobbs et al. [28] measured PA using Fitbit devices at 1-, 2- and 3-months after surgery. Although the small Fitbit device might be a bit easier to handle than the ActiGraph, study participants might be influenced by the data reported on the display. The decrease in average steps/day at the 12-week assessment in our study supports the hypothesis that changes in steps/day are not easy to induce in people who might not acknowledge the health-related effects of long-lasting higher PA levels when they commence their daily work routine after lumbar decompression surgery. This goes in line with the results of other published articles [29,52,54]. Our results therefore provide evidence that steps/day and MVPA should be included as additional, quantifiable outcome parameters as well as therapeutic components to be included into out-patient physiotherapeutical rehabilitation.

Because only some participants recovered their daily PA amount to the norm, subgroups of participants may need extra effort to achieve greater PA levels. Future research should therefore investigate larger cohorts over a longer time period and focus also on the effect of sex, profession or leisure activities on PA in patients after lumbar surgery. Additionally, investigations of the implementation and effect of PA promotion and interventions in postoperative PT are of interest.

Strengths and limitations

All participants wore the same ActiGraph device and received the same instructions for every measurement period in order to enhance reliability of our results. The ActiGraph use was assessed carefully during study preparation by consulting the producer company's instructions and existing literature [31,33,40]. The ActiGraph captures PA data without providing direct feedback to patients – hence the patients were blinded to their respective PA level – and allows the user to process data using independently developed and validated algorithms. In addition, the participants completed a wear diary to increase adherence. However, because the accelerometer was placed on the patients' waist, the ActiGraph was unable to distinguish between sitting and standing resulting in categorising these positions to be a sedentary activity. Smart Watches have been shown to systematically underestimate MVPA measurement [55] possibly missing changes in MVPA and that patients achieve >150 minutes MVPA without surpassing 7000 steps/day as observed in our study emphasizing the importance of accurate measures of MVPA. Further,continuous activity wear times over the entire follow-up period rather than at selected periods as in the current study would facilitate capturing PA profiles after surgery in individual patients and provide information to the PT useful for tailoring treatment to the patient's specific needs. The relatively small study cohort recruited at a single hospital limits the generalisability of our results. Finally, more women than men participated in this study even though we screened approximately equal proportions of both sexes. Women are known to have lower PA and worse pre- and postoperative pain, disability and HRQOL than men [54,56]. Hence, the sex distribution may have impacted the results.

Conclusions

This study showed that the steps/day counts did not reach normal levels of 7,000 steps/day during the first 12 postoperative weeks. Improvements in steps/day were associated with improvements in MVPA, ODI and SF-36 at 6 weeks postoperatively. However, improvements in steps/day were associated with improvements in MVPA but not with improvements in ODI and SF-36 at 12 weeks postoperatively. Our patients showed high interest in improving their physical capacities, e.g., muscle strength, that were addressed in their PT predominantly during the first 6 postoperative weeks. Regular PT appointments during outpatient rehabilitation may serve as a promising basis to positively affect PA. Despite postoperative improvements in disability and HRQOL, physiotherapists should therefore emphasise the effects and the importance of PA on health by promoting and propagating the clinical implementation of training routine. Overall, PA parameters such as steps/day and MVPA appear to be valuable additional, quantifiable outcome parameters and treatment components in patients undergoing lumbar decompression surgery.

Informed Patient Consent

The authors declare that informed patient consent was taken from all the patients.

Declaration of Competing Interest

The authors declare no conflict of interest.

Funding statement

The authors received no specific funding for this work.

Acknowledgments

The authors thank Peter Goerttler for providing administrative support during data collection and Christian Marti for his input into the study design.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.xnsj.2021.100087.

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