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Gait Speed and Sit-to-Stand Performance Following Orthopedic Surgery: Influence of Anatomical Region and Surgical Procedure

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Abstract

Background: The preferred walking speed (PWS) and sit-to-stand (STS) performance are widely recognized functional mobility and physical performance measures in orthopedic rehabilitation. Postoperative mobility outcomes may differ across orthopedic procedures and anatomical regions because of variations in biomechanical demands, pain severity, and extent of locomotor system involvement.

Objective: To examine the differences in PWS and STS performance between patients with orthopedic conditions who underwent surgical procedures involving the spine and upper and lower extremity joints and healthy controls.

Methods: This exploratory cross-sectional pilot study included 197 participants, comprising 159 postoperative patients who had undergone arthroscopy, arthrodesis, or arthroplasty involving the cervical, thoracic, and lumbar spine, as well as the shoulder, hip, and knee joints, and 38 healthy control individuals. PWS was measured using a standardized 6-meter walkway protocol, and lower extremity functional performance was assessed using the STS-30s test. Groups were compared using one-way analysis of variance and independent t-tests. Multivariate regression analyses were performed to examine the associations between mobility outcomes and demographic, clinical, and surgical variables.

Results: Postoperatively, patients demonstrated significantly slower PWS and STS performance than controls. Functional performance varied across surgical procedures and anatomical regions, with the lumbar spine and lower extremity procedures generally demonstrating lower mobility than the cervical spine and shoulder procedures. Higher body mass index was associated with slower PWS. PWS and STS-30s performance demonstrated a moderate correlation, indicating shared functional and neuromuscular characteristics. As the surgical type and anatomical region demonstrated substantial conceptual overlap, the multivariable findings were interpreted cautiously.

Conclusion: Postoperative mobility performance varied across orthopedic surgical groups. Procedures involving the lumbar spine, hip, and knee were generally associated with lower PWS and STS performance than cervical spine and shoulder procedures. These findings support the clinical value of simple mobility measures for assessing postoperative functional status and rehabilitation planning.

Keywords: preferred walking speed; sit-to-stand; arthroplasty; arthrodesis; arthroscopy

List of Abbreviations

ACDF: anterior cervical discectomy and fusion

AVAS: anticipated pain before walking

PLIF: posterior lumbar interbody fusion

PWS: preferred walking speed

rTSR: reverse total shoulder replacement

STS: sit-to-stand

STS-30s: sit-to-stand in 30s

THR: total hip replacement

TKR: total knee replacement

TLIF: transforaminal lumbar interbody fusion

TSR: total shoulder replacement

TVAS: pain experienced during walking

VASs: visual analog scales

Introduction

The ability to stand and walk at a preferred walking speed (PWS) following surgical procedures to the spinal or lower extremity joint is the primary patient-centered objective and fundamental goal of physiotherapy rehabilitation.

PWS is increasingly recognized as a “functional vital sign” and is associated with future health outcomes, including hospitalization, cognitive decline, falls, and mortality [1-5]. A PWS > 1.0 m/s is generally associated with good health and functional independence, whereas walking speeds < 0.6 m/s may represent a clinical “yellow flag” for increased health risks and functional decline [1-3]. Furthermore, a change of approximately 0.1 m/s is considered minimally detectable or clinically meaningful improvement in walking performance [3-5]. However, walking safety and efficiency may be influenced by multiple factors including age, sex, medical comorbidities, musculoskeletal impairment, and orthopedic surgical procedures [5-7]. This is particularly relevant because arthroscopy, arthroplasty, and spinal arthrodesis are commonly performed in adults between 40 and 80 years of age [6]. Consequently, monitoring PWS following these procedures may provide clinically meaningful insights into the postoperative functional status and potential future mobility limitations.

Although the original determinants of the gait model emphasized the role of the pelvis and lower extremities in optimizing mechanical efficiency [7], they did not account for upper-body contributions such as trunk rotation, arm swing, and proximal postural stabilization. These upper-body movements contribute to balance, coordination, and walking efficiency and may help explain differences in PWS influenced by pain, surgical intervention, and range-of-motion restrictions following surgery [8, 9].

Slower walking speed is an adopted strategy to avoid the risk of falling, enhance stability, reduce joint loading, or minimize discomfort and is commonly observed following surgeries of lumbar spine and surgical procedures of the lower extremities. By contrast, surgical procedures involving the cervical spine and upper extremity joints may impose fewer direct limitations on lower limb locomotion. Thus, PWS may be more sensitive to interventions involving weight-bearing anatomical regions than those involving non-weight-bearing regions [6,8,9]. These observations support PWS as a clinically meaningful indicator of overall locomotor function that extends beyond the purely mechanical determinants of gait.

Although slower walking speeds are mechanically less efficient, they often persist long after lower extremity orthopedic procedures and are associated with increased energy expenditure during walking, greater perceived exertion, and functional limitations [9-12]. Total knee replacement (TKR) improves stride length, walking speed, and gait efficiency; however, walking performance in these cases often remains lower than that in age-matched healthy individuals [13]. Similarly, total hip replacement (THR) is associated with functional improvement and pain reduction; however, residual gait alterations, including slower walking speed, shorter stride length, and reduced hip extension, may persist postoperatively [14].

Surgical interventions involving the upper-body regions may influence gait efficiency [15-17]. Pain, immobilization, and postoperative range-of-motion restrictions may affect gait characteristics such as stride length, cadence, and PWS [15-19]. The PWS is a clinically relevant indicator of spinal function and mobility [20]. During level walking, coordinated spinal motion and pelvic rotation contribute to step-length generation, weight transfer, and overall walking efficiency [20]. Although lumbar arthrodesis may improve spinal stability, it may reduce segmental mobility and transverse plane motion, which could influence pelvic rotation and gait mechanics [21,22]. Previous studies involving individuals with adolescent idiopathic scoliosis reported reductions in PWS following spinal fusion [21-24].

The cervical spine contributes to PWS by playing a role in head stability and postural control during gait [25]. Restricted cervical motion or impaired cervical function may be associated with a stiffer trunk, asymmetrical lower extremity movement, altered step length, and changes in swing timing, which could potentially influence walking speed [25-32]. However, studies evaluating gait outcomes after cervical decompression and fusion have reported inconsistent findings [26-32]. Some studies have demonstrated improvements in postural control, dynamic stability, and PWS following cervical spine surgery, whereas others have reported minimal changes during the first postoperative year [27-29]. Thus, postoperative walking performance may be influenced by multiple factors including age, severity of neurological or musculoskeletal impairment, symptom duration, and persistent pain-related movement avoidance. These observations support the use of PWS as a clinically meaningful indicator of functional mobility in patients undergoing major spinal surgery [20].

Sit-to-stand (STS) performance is a well-established indicator of lower-extremity strength, balance, and functional mobility [30,31]. Similar to PWS, poor STS performance has been associated with reduced quality of life and adverse future health outcomes [31-34]. Although PWS performance moderately correlates with STS performance, whether this relationship is preserved across different anatomical regions following orthopedic procedures remains unclear.

Most previous studies evaluated gait outcomes following a single surgical procedure or within a specific anatomical region, limiting the understanding of how different orthopedic interventions may relate to overall functional mobility. In addition, postoperative status is commonly assessed using joint- or region-specific outcome measures rather than broader functional indicators, such as PWS and STS performance. Evaluating these global functional measures across different procedures and anatomical regions may provide a broader perspective on postoperative locomotor function and inform individualized rehabilitation and functional assessment strategies. Therefore, this cross-sectional pilot study aimed to examine the differences in PWS and STS performance across multiple orthopedic procedures and anatomical regions in postoperative patients compared with healthy controls. We hypothesized that procedures involving the lumbar spine and lower extremities would demonstrate lower PWS and STS performances than those involving the cervical spine and upper extremities. To the best of our knowledge, this is the first exploratory study to evaluate multiple orthopedic interventions, including arthroscopy, arthrodesis, and arthroplasty, across different anatomical regions using the PWS and STS as broader performance-based measures of functional mobility and locomotor performance.

Materials and methods

Study design

This cross-sectional pilot study used a convenience sample of 197 participants, including 159 postoperative patients with orthopedic conditions and 38 healthy controls, to examine procedural- and anatomical region-specific differences in PWS and STS performance.

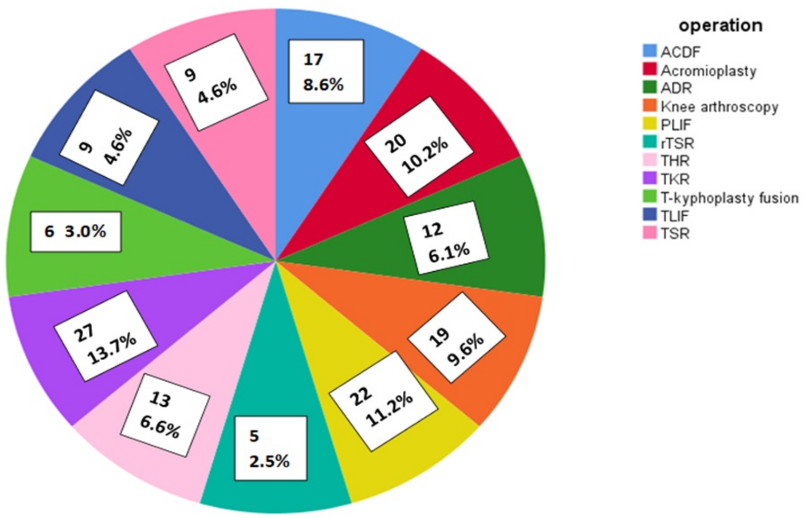

Figure 1: Distribution of Surgical Procedures. Distribution of participants across the included surgical procedure groups. Val-

ues represent the number and percentage of participants in each group. ACDF, anterior cervical discectomy and fusion; ADR, artificial disc replacement; PLIF, posterior lumbar interbody fusion; rTSR, reverse total shoulder replacement; THR, total hip replacement; TKR, total knee replacement; TLIF, transforaminal lumbar interbody fusion; TSR, total shoulder replacement.

The postoperative group included 51 men and 108 women with a mean age of 60.2 ± 10.2 years who had previously undergone arthroscopy, arthrodesis, or arthroplasty involving the spine or upper- or lower-extremity joints (Figure 1). The control group comprised 17 men and 21 women with a mean age of 52.2 ± 10.0 years. All participants were screened for eligibility before participation, and written informed consent was obtained. The study protocol was approved by the Institutional Ethics Committee and conducted in accordance with the Declaration of Helsinki.

Participants

Participants were eligible for inclusion if they had previously undergone arthroscopy, arthrodesis, or arthroplasty involving the spine or upper or lower extremity joints; were at least 1 year postoperatively; and were able to walk independently without using an assistive device. Participants were also required to have no severe medical comorbidities that could substantially limit their mobility or functional performance.

Participants were excluded if they had advanced joint disease, severe osteoporosis, active hip or knee range-of-motion limitations of <90°, a history of stroke or other neurological disorders, visual impairments affecting mobility, or neuromuscular conditions influencing gait performance. Individuals using assistive walking devices, narcotics, or medications associated with dizziness or impaired balance, including sedatives, antidepressants, antipsychotics, and antiseizure medications, were also excluded. Additional exclusion criteria included the presence of pacemakers, high fall risk, or inability to understand verbal or written instructions.

Outcome measures

Pain assessment

Pain perception was assessed using two 100-mm visual analog scales (VASs). The first scale measured anticipated pain before walking (AVAS), and the second assessed pain experienced during walking (TVAS). The participants completed the AVAS immediately before the walking trials and the TVAS immediately after completing the walking assessment. The VAS is a widely used and reliable measure for assessing pain intensity and pain-related perception [35].

PWS assessment

PWS was assessed using a standardized 10-meter walkway protocol. A central 6-meter walking zone was used for the timed measurements, with 2-meter acceleration and deceleration zones positioned at each end to minimize the influence of gait initiation and termination. The participants were instructed to walk at a comfortable self-selected speed, and the walking time was recorded using a stopwatch. Each participant completed two walking trials. PWS was calculated by dividing the 6-meter walking distance by the mean trial completion time and expressed in meters per second (m/s).

STS assessment

Functional lower extremity performance was assessed using the STS in 30s (STS-30s). The participants performed repeated STS movements from a standardized chair with a seat height of 46 cm, armrest height of 68 cm, seat depth of 45 cm, and backrest height of 83 cm. The testing procedures followed standardized recommendations [34]. The participants were instructed to sit upright without contacting the backrest, with their arms crossed over the chest, feet positioned shoulder-width apart, and knees maintained at approximately 90° flexion. Participants unable to stand independently were permitted to use armrests for assistance. Following two to three practice repetitions, participants completed one recorded 30-s trial.

Statistical analysis

Statistical analyses were performed using SPSS version 25 (IBM Corp., Armonk, NY, USA) and Jamovi version 2.7.16. Continuous variables are presented as means ± standard deviations, and categorical variables as frequencies and percentages. Data normality was assessed using the Shapiro–Wilk test. Independent-sample t-tests were used to compare the postoperative patients with healthy controls. Multivariate linear regression analyses were performed to examine the factors associated with PWS and STS-30s performance.

Results

Patient demographics

(Table 1) presents the demographic characteristics of the participants. The control group had a mean age of 50.28 ± 9.26 years, mean height of 165.5 ± 7.67 cm, mean weight of 80.78 ± 21.89 kg, and mean body mass index (BMI) of 29 ± 6.25 kg/m². The average age of postoperative cohort exceeded that of the control group.

Table 1: Descriptive statistics of the voluntary participants

	N	Minimum	Maximum	Mean	SD
Age (years)	106	40	84	60.566	11.51729
Height (cm)	106	1 40.00	187	162.283	10.75153
Weigt (kg)	106	57.71	112	80.0823	12.28893
Body mass index (kg/m2)	106	22.7	41.6	30.3636	4.25476
Postoperative years	106	1	9	4.2736	1.90004
Valid N (listwise)	106				

Males, n = 33 (31.1%); Females, n = 73 (69%); SD, standard deviation.

Group differences in functional outcomes

(Table 2) presents the analysis of variance results demonstrating significant differences in PWS, AVAS, TVAS, and STS-30s performance across surgical procedures and anatomical regions. Participants who underwent shoulder arthroscopy and anterior cervical discectomy and fusion (ACDF) exhibited a higher mean PWS, whereas those who underwent transforaminal lumbar interbody fusion (TLIF) exhibited a lower mean PWS.

Participants who underwent THR reported higher anticipated pain scores than those in the other surgical groups, whereas the lowest AVAS scores were observed following shoulder arthroscopy. Similarly, participants who underwent knee arthroscopy reported higher TVAS scores, whereas those who underwent total shoulder replacement (TSR) and reverse total shoulder replacement (rTSR) demonstrated lower TVAS values.

Participants who underwent ACDF exhibited higher STS-30s performance, followed by those who underwent TSR and posterior lumbar interbody fusion (PLIF), whereas lower STS-30s performance was observed in participants who underwent THR and TKR.

Table 2: Distinct clinical parameters across various surgical procedures of the spine and upper and lower extremities

Dependent variable	ACDF(n = 11)	ADR (n = 8)	PLIF (n = 17)	TLIF (n = 7)	TKR (n = 19)	Knee arthroscopy (n =13)	THR (n = 6)	TSR (n = 7)	rTSR (n = 6)	Shoulder arthroscopy (n = 12)	Total N = 106	P-value
PWS x̄ SD	1.2 (0.3)	0.8 (0.2)	0.9 (0.2)	0.7 (0.0)	0.8 (0.1)	1.0 (0.2)	0.7 (0.1)	0.9 (0.0)	1.1 (0.4)	1.4 (0.5)	1.0 (0.3)	<0.0011
Range	0.7–1.5	0.7–1.2	0.7–1.3	0.6–0.8	0.6–1.1	0.8–1.3	0.6–0.9	0.8–0.9	0.8–1.4	0.9–1.8	0.6–1.8	
AVAS x̄ SD	3.6 (2.3)	6.0 (0.0)	5.6 (1.4)	4.1 (1.5)	4.7 (1.5)	6.9 (2.6)	8.0 (0.0)	6.0 (0.0)	5.0 (2.2)	3.0 (2.5)	5.2 (2.2)	<0.0011
Range	1.0–8.0	6.0–6.0	3.0-7.0	1.0–5.0	1.0–7.0	1.0–8.0	8.0–8.0	6.0–6.0	3.0–7.0	0.0–6.0	0.0–8.0	
AVAS x̄ SD	2.2 (0.9)	2.6 (0.5)	3.0 (2.1)	2.4 (0.8)	2.6 (1.6)	3.5 (1.1)	3.0 (0.0)	3.0 (0.0)	1.0 (0.0)	1.0 (0.0)	2.5 (1.4)	<0.0011
Range	1.0–4.0	2.0–3.0	1.0–7.0	1.0–3.0	1.0–5.0	1.0–4.0	3.0–3.0	3.0–3.0	1.0–1.0	1.0–1.0	1.0–7.0	
30-STS x̄ SD	15.8 (1.1)	10.8 (1.6)	12.9 (2.5)	11.1 (2.7)	9.2 (1.6)	11.9 (2.4)	8.7 (2.0)	14.6 (2.1)	12.0 (1.5)	12.6 (1.6)	11.9 (2.8)	<0.0011
Range	14.0–17.0	7.0–12.0	8.0–17.0	6.0–15.0	6.0–12.0	7.0–16.0	6.0–12.0	12.0–8.0	11.0–14.0	10.0–15.0	6.0–18.0	

PWS and STS-30s performance

(Table 3) presents the descriptive statistics for PWS and STS-30s performance in the postoperative and control groups. The mean and median PWS values were 0.96 and 0.86 m/s in the postoperative group and 1.40 and 1.44 m/s in the control group, respectively. The mean and median STS-30s repetitions were 11.92 and 12.00 repetitions in the postoperative group and 16.90 and 16.00 repetitions in the control group, respectively.

Table 3: Descriptive statistics of PWS and ability to 30-STS

	Group	N	Mean	Median	SD	SE
PWS	Control	32	1.403	1.445	0.297	0.053
	Patient	106	0.969	0.86	0.319	0.031
30-STS	Control	32	16.906	16	2.821	0.499
	Patient	106	11.925	12	2.824	0.274

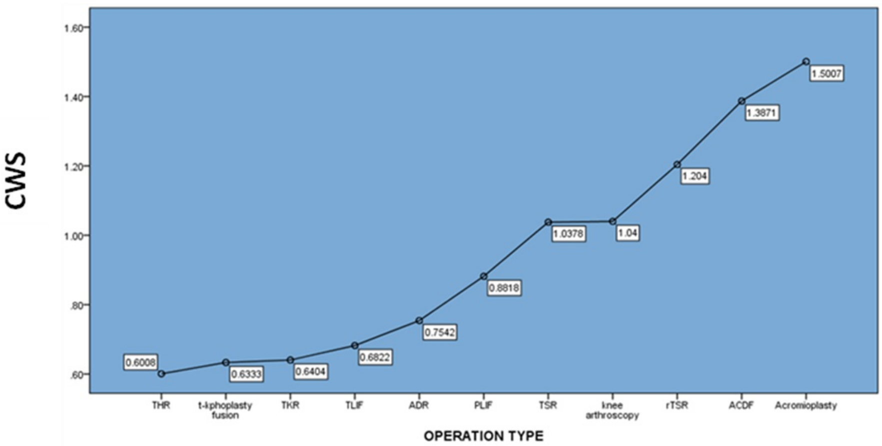

Figure 2: Comfortable Walking Speed by Surgical Procedure. Mean comfortable walking speed (CWS) according to surgical procedure type. ACDF, anterior cervical discectomy and fusion; ADR, artificial disc replacement; CWS, comfortable walking speed; PLIF, posterior lumbar interbody fusion; rTSR, reverse total shoulder replacement; THR, total hip replacement; TKR, total knee replacement; TLIF, transforaminal lumbar interbody fusion; TSR, total shoulder replacement.

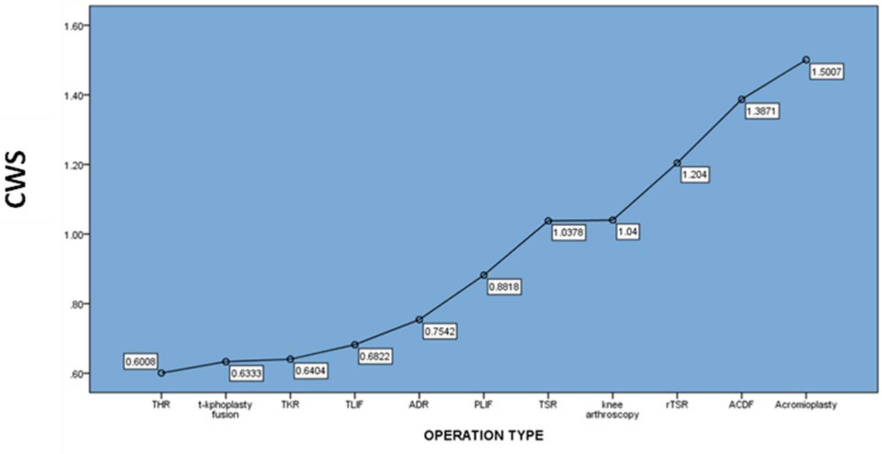

Figure 3: Sit-to-Stand Performance by Surgical Procedure. Mean STS-30s performance according to the surgical procedure type. ACDF, anterior cervical discectomy and fusion; ADR, artificial disc replacement; PLIF, posterior lumbar interbody fusion; rTSR, reverse total shoulder replacement; THR, total hip replacement; TKR, total knee replacement; TLIF, transforaminal lumbar interbody fusion; TSR, total shoulder replacement; STS, sit-to-stand.

(Figures 2,3) illustrate the group differences in PWS and STS-30s performance. Independent-sample t-tests demonstrated significant between-group differences in both outcomes ($p < 0.001$) (Table 4).

Table 4: Comparison between the control and patient groups using the independent sample t-test

		t	df	Sig. (two-tailed)	Mean difference	SE difference	95% confidence interval of the difference	
							Lower limit	Upper limit
PWS	Equal variances assumed	6.86	136	0	0.43488	0.0634	0.30951	0.56025
	Equal variances not assumed	7.126	54.358	0	0.43488	0.06103	0.31254	0.55722
30-STS ability	Equal variances assumed	8.748	136	0	4.98172	0.56948	3.85554	6.10791
	Equal variances not assumed	8.753	51.209	0	4.98172	0.56916	3.83919	6.12425

Factors associated with PWS

(Table 5) presents the results of the multivariate regression analysis examining the factors associated with PWS. The regression model explained approximately 53.8% of the variance in PWS ($R^2 = 0.54$).

Older age, BMI, and higher AVAS scores were associated with slower walking speed, whereas higher STS-30s performance was associated with faster walking speed. Surgical procedures involving the lumbar spine and lower extremities were associated with lower PWS values than those involving the cervical spine and upper extremities. Sex, TVAS score, and postoperative duration were not significantly associated with PWS in the regression model.

Because surgical procedure type and anatomical region are conceptually related variables, the regression findings should be interpreted cautiously.

Table 5: Results of linear regression analysis for predicting PWS

Predictor	Estimate	SE	t	P-value
Intercept [a]	1.911	0.221	8.657	<0.001
Age	0.009	0.002	4.526	<0.001
Sex				
Female–male	0.03	0.054	0.553	0.582
BMI	0.017	0.006	2.803	0.006
AVAS	0.04	0.011	3.516	<0.001
TVAS	0.035	0.018	1.894	0.061
30-STS	0.04	0.009	4.363	<0.001
Postoperative years	0.007	0.012	0.565	0.573
Group				
Lower part–upper part	0.009	0.073	0.127	0.899
Middle part–upper part	0.242	0.061	3.97	<0.001

[a] Represents reference level, R = .733 R^2 = 0.538

Discussion

This cross-sectional pilot study demonstrated substantial heterogeneity in functional performance across different orthopedic surgical procedures and anatomical regions. Postoperative patients demonstrated significantly slower PWS and lower STS-30s performance than the control group. Approximately 12% of patients walk at speeds < 0.60 m/s, a threshold previously associated with an increased risk of mobility limitation, falls, hospitalization, and reduced quality of life [1-5]. Thus, functional mobility limitations may persist in some individuals following orthopedic surgery, which supports the potential value of continued functional assessment using performance-based outcome measures, such as the PWS and STS.

A major finding of this study was the observed variability in the PWS and STS performance across different surgical procedures. Procedures involving the lumbar spine and lower extremities, particularly PLIF, TLIF, total TKR, and THR, demonstrated lower functional performance than the cervical spine and shoulder procedures, which generally demonstrated relatively preserved locomotor performance. These findings are generally consistent with those of previous studies on gait and functional mobility limitations following lumbar fusion and lower-extremity arthroplasty, even in the presence of pain reduction and structural stabilization [10-18].

The observed differences may partially reflect the different biomechanical and functional demands imposed on locomotor performance across anatomical regions. Procedures involving the lumbar spine may influence trunk mobility and pelvic rotation, which are factors associated with gait efficiency, dynamic balance, and walking economy [15-18]. Similarly, hip and knee arthroplasty involves major weight-bearing joints that contribute to propulsion, shock absorption, stride length, and transitional movements that require lower-extremity strength [13,14]. Therefore, reduced walking speed after these procedures may be associated with residual biomechanical adaptations, altered movement strategies, muscular weakness, pain-related movement modifications, or protective gait behaviors.

In this study, compared to lumbar spine and lower extremity procedures, cervical spine and shoulder procedures demonstrated relatively preserved walking performance. These findings may be explained by the relatively lower direct involvement of the cervical spine and upper extremity procedures in PWS, although postoperative pain, movement limitations, and altered coordination may still contribute to gait impairment. Previous studies evaluating cervical spine surgery outcomes have reported inconsistent findings, with some demonstrating improvements in dynamic stability and others reporting continued locomotor limitations [24-29]. Our findings show that functional performance varies following surgical procedures performed across different anatomical regions. The moderate correlation observed between the PWS and STS-30s performance shows that these measures may share common functional and neuromuscular contributors related to locomotion and lower extremity performance. Similar associations between walking speed and STS-30s ability have been previously reported, supporting the concept that both measures reflect multidimensional functional capacity, including strength, balance, coordination, and endurance [30-32]. Importantly, these associations remain relevant across heterogeneous orthopedic populations involving different anatomical regions.

A higher BMI was also associated with slower walking speed, consistent with previous evidence demonstrating that increased body mass may increase energy expenditure during walking and negatively influence gait economy [35, 36, 38, 39]. Interestingly, age and postoperative duration were not significantly associated with walking speed after adjusting for surgical procedure type. Thus, the mobility performance within this cohort may have been more closely related to procedure-specific functional and biomechanical factors than to chronological age or time since surgery. The reduced walking performance observed in some surgical groups, despite the relatively long postoperative duration, may reflect ongoing functional limitations, altered movement strategies, or variability in postoperative rehabilitation and physical conditioning.

Pain-related effects were also evident. The participants reported higher AVAS scores than TVAS scores, which may reflect pain-related expectations or movement-related apprehension. Psychological factors such as fear of movement, catastrophizing, and pain-related avoidance behaviors have been associated with reduced mobility and persistent postoperative disability [40, 41]. These findings highlight the potential interaction between pain-related perceptions and physical performance, and support the consideration of psychologically informed rehabilitation approaches alongside conventional strengthening and biomechanical interventions.

From a rehabilitation perspective, the present findings support the potential clinical utility of incorporating PWS and STS assessments in postoperative evaluations. These measures may provide complementary indicators of mobility limitations that cannot be fully captured by joint-specific outcome measures alone. Functional performance was lower following lumbar spine, hip, and knee procedures, indicating that some individuals may benefit from continued gait-focused rehabilitation, lower extremity strengthening, endurance training, and pain management strategies beyond the early postoperative period.

This study has some limitations. First, the cross-sectional design precluded causal interpretation and did not permit the evaluation of functional changes over time. Second, convenience sampling and unequal representation of surgical procedures may limit the generalizability and contribute to subgroup imbalances. Third, the variability in rehabilitation exposure and postoperative duration may have contributed to the observed functional heterogeneity. Fourth, the type of surgical procedure and anatomical region were conceptually related variables that should be considered when interpreting the regression findings. Finally, the control group was younger than the postoperative cohort, which may have introduced age-related confounding factors despite statistical adjustment. Future longitudinal studies incorporating preoperative baseline measures, standardized rehabilitation protocols, and detailed biomechanical gait analyses are warranted to clarify procedure-specific differences in postoperative functional performance.

Conclusions

Postoperative mobility varied according to the orthopedic surgical procedures and anatomical regions. Procedures involving the lumbar spine, hip, and knee were associated with slower PWS and lower STS performance than those involving the cervical spine and upper extremities. Mobility differences in this cohort may be more closely associated with surgical procedure characteristics than with demographic variables or postoperative duration.

These findings support the potential clinical utility of the PWS and STS assessments as complementary measures for postoperative evaluation and rehabilitation monitoring. Incorporating these performance-based measures into physiotherapy assessments may help identify mobility limitations and assist in guiding individualized rehabilitation strategies following orthopedic surgery.

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Declarations of interest

None

Declaration of generative AI in scientific writing

None

Ethical Approval and Informed Consent

This study was performed in accordance with the principles of the Declaration of Helsinki, and the Institutional Review Board of Dar Al Shifa Hospital approved the protocol for data acquisition and patient participation (approval no.: DASH?HIM/006/0222). All participants were screened for eligibility and signed consent forms.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analyzed in the current study are available from the corresponding author upon reasonable request.

Authors' contributions

S.M.A.: Conception, design, data analysis, interpretation, and drafting of the manuscript; N.S. and F.R.: Data acquisition and examination of participants based on the inclusion and exclusion criteria. T.A.: Study design, statistical analysis, and interpretation of results. All the authors have read and approved the final version of the manuscript.

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