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Analysis of Fall Risk Factors Among Patients Undergoing Hip Arthroplasty in a Trauma and Orthopedic Surgery Department

Joanna Siąkała¹, Joanna Ziemiańska²,
Aneta Hardek-Skalny³,
Bogusława Kupczak-Wiśniowska¹

¹ University of Bielsko-Biala, Bielsko-Biala, Poland; Faculty of Health Sciences

² Pediatric Hospital in Bielsko-Biala

³ Municipal Hospital in Ruda Slaska

Corresponding author: Joanna Siąkała
e-mail: asdomibud@gmail.com

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ABSTRACT

Background. Hip arthroplasty is a widely performed surgical procedure in patients with various functional disorders of the hip joint.

Objective. The aim of this study was to analyze the factors determining the risk of falls in patients hospitalized in the trauma and orthopedic surgery department following hip replacement surgery.

Material and Methods. The study included 103 patients who underwent hip replacement surgery. Fall risk was assessed using a self-designed questionnaire and the Tinetti scale, which evaluates balance and gait.

Results. The findings demonstrated a significant correlation between age and sex and the level of fall risk. A higher risk was observed in females and elderly patients. It was also shown that regular physical activity, particularly cycling, can positively influence balance maintenance and reduce fall risk. Mobility difficulties and limited self-care capacity correlated with lower Tinetti scale scores. No conclusive effect of postoperative pain or chronic diseases on fall risk was found.

Conclusions. The results highlight the importance of preventive measures and individualized risk factor assessment in patients after hip arthroplasty. This study provides an opportunity to explore risk factors in greater depth and serves as a foundation for further research on fall prevention

KEYWORDS hip arthroplasty, postoperative pain, post-arthroplasty complications

1. Introduction

A patient fall following hip arthroplasty is one of the most serious postoperative complications. It can result in implant dislocation, periprosthetic fracture, and soft tissue injury [1]. Although this procedure effectively restores mobility and alleviates pain, the risk of falls increases sharply during the early postoperative period [2]. This is due to limited mobility, pain, and balance impairments. The consequences of such an event often necessitate reoperation, which, in turn, worsens the patient's psychosocial status, drastically restricts their mobility, prolongs hospitalization, and generates high healthcare costs. In trauma and orthopedic surgery departments, patient safety is influenced by both clinical and organizational factors. Among the most significant are advanced age, multimorbidity, limited mobility, and the administration of potent analgesics that impair concentration. The choice of this study topic stems from the growing scale of this problem, which is directly linked to an aging population and a higher volume of performed surgical procedures. Identifying and analyzing specific risk factors are essential for developing effective preventive protocols. This study aims to highlight areas of perioperative care that require particular attention from medical staff to enhance patient safety [1, 2].

Hip arthroplasty has become a widespread treatment method. Following joint replacement surgery, patients can return to full physical activity without pain or restrictions [3]. For many years, hip replacement has been utilized in the management of femoral neck fractures, significantly reducing the incidence of postoperative complications and accelerating the rehabilitation process. Replacing the hip joint with an artificial implant represents one of the many achievements of modern medicine. A deeper understanding of the wear of natural hip joint structures, advancements in medicine and engineering, and interdisciplinary collaboration play a crucial role in the ongoing development of 3D implant technology [4]. The primary objective of this study was to analyze selected fall risk factors in

patients hospitalized in a trauma and orthopedic surgery department following hip arthroplasty.

2. Methods

The research material consisted of two parts. The first part comprised a self-designed questionnaire. The second part was collected using the quantitative Tinetti scale, used to assess balance and gait in patients following hip arthroplasty. The assessment was conducted on the fifth postoperative day, capturing the early stage of postoperative recovery. The questionnaire items primarily addressed patients' physical fitness before and after surgery, chronic diseases, and postoperative complaints. A range of sociodemographic variables was also included, such as sex, age, educational level, marital status, and place of residence. Furthermore, information regarding respondents' family situation and occupational activity was collected. A diagnostic survey method was employed in this study. The primary research tool was a self-designed questionnaire developed specifically for the purposes of this study, allowing it to be tailored to the specifics of the analyzed research problem. The questionnaire consisted of 23 closed-ended questions, including both single-choice and multiple-choice options. The design of the tool was structured to enable a comprehensive evaluation of the investigated issues. The first section gathered basic sociodemographic data, such as age, sex, educational level, marital status, and place of residence. Subsequent sections focused on clinical and functional aspects, including the patients' subjective health status, the presence of comorbidities, and the nature and intensity of pain related to the pathological process in the hip joint. An essential element of the tool was the inclusion of items regarding the level of functional fitness both preoperatively and postoperatively following hip arthroplasty. Preoperative physical activity was also analyzed to evaluate its potential impact on the recovery process and fall risk. Additionally, the questionnaire contained questions regarding postoperative adverse events, limitations in daily functioning, and the course of the rehabilitation

process. These aspects were supplemented by questions on social support, particularly the availability of assistance from relatives following hospital discharge. The final section of the questionnaire was dedicated to evaluating surgical outcomes, including patient satisfaction and subjectively perceived improvements in quality of life after joint replacement. The study was conducted in accordance with scientific research ethics principles. Incorporating both clinical and psychosocial aspects provided a more comprehensive understanding of the research problem and enabled the identification of factors potentially influencing fall risk and patients' daily functioning. To assess the risk of falls, the Tinetti Performance-Oriented Mobility Assessment (POMA) scale was also utilized. This scale is one of the widely used tools for assessing balance and gait in patients [5]. It comprises a total of 16 tasks, 9 of which evaluate balance during basic activities of daily living, such as remaining seated, rising from a bed or chair, and post-verticalization posture stabilization. Additionally, the patient's ability to perform a 360-degree turn and their response to an external stimulus in the form of a gentle nudge (the sternal nudge test), conducted with both eyes open and closed, are evaluated to assess compensatory mechanisms and postural control. The remaining 7 tasks pertain to gait assessment, including step length and height, symmetry of lower extremity movements, locomotion continuity, and gait path. Such a comprehensive assessment enables the detection of even subtle mobility impairments. The interpretation of scores obtained from the Tinetti scale is based on the total point count, where a score below 26 indicates the presence of balance and gait impairments, whereas a score below 19 is associated with a significantly increased—up to five-fold—risk of falls.

2.1. Study Setting

The study was conducted among 103 patients hospitalized in the Trauma and Orthopedic Surgery Department at the Rheumatology Center in Ustron between September 29, 2025, and April 3, 2026. The

implementation of the research project was made possible after obtaining prior written approval from the facility management. Participation in the study was entirely voluntary, and the survey was conducted anonymously.

2.2. Statistical Analysis

Several statistical tools were applied depending on the correlations examined. The analysis commenced with descriptive statistics, which enabled the identification of key areas relevant to the primary and specific objectives. The Chi-square test (

3. Results

3.1. Sociodemographic Characteristics

A total of 103 patients participated in the study: 55 (53.4%) females and 48 (46.6%) males. The age of the participants ranged from 25 to 88 years. Specifically, 45 patients (43.7%) were under 65 years of age, 39 patients (37.9%) were aged 65 to 74 years, and 19 patients (18.4%) were 75 years or older.

Urban areas were inhabited by 66 respondents (64.1%), while 37 individuals (35.9%) resided in rural areas. The level of education among participants was distributed as follows: primary education was reported by 3 individuals (2.9%), vocational education by 37 individuals (35.9%), secondary education by 42 individuals (40.8%), and higher education by 21 respondents (20.4%). The marital status of the surveyed patients was as follows: single (17 individuals, 16.5%), married (74 individuals, 71.8%), and widowed (12 individuals, 11.7%). The majority of respondents—59 individuals (57.3%)—were retirees or disability pensioners; 25 individuals (24.3%) performed manual labor, and 24 individuals (23.3%) performed white-collar work. A vast majority of the studied patients, 83 individuals (80.6%), did not live alone, whereas the remaining 20 respondents (19.4%) lived alone.

The majority of the evaluated patient group rated their financial status positively. Very good conditions were reported by 19 individuals (18.4%), while a good financial situation was indicated by 41

respondents (39.8%). An average (moderate) financial status applied to 36 subjects (35.0%). The percentage of individuals rating their situation negatively was small: a below-average status was reported by 5 individuals (4.9%), and a poor situation by only 2 patients (1.9%). Detailed data are presented in Table I.

The distribution of descriptive statistics results for the evaluation using the Tinetti scale is presented in Table 2. The overall mean score was 22.5 points: 9.5 points for gait and 12.97 points for balance. The standard deviation was 3.72 overall, 2.32 points for

balance, and 1.85 points for gait. The minimum total score obtained was 11 points (6 points for balance and 3 points for gait). The maximum total score was 28 points (16 points for balance and 12 points for gait). A maximum of 28 points could be achieved in the assessment: 16 points for the balance section and 12 points for gait. A score below 26 points may indicate an impairment. If a participant scored fewer than 19 points, their risk of falls increased fivefold [56]. The percentage distribution of fall risk in the analyzed group indicates a predominance of individuals with a low risk (Fig. 1).

Table I. Sociodemographic characteristics of the study group

Sociodemographic Factors		Total (N=103)		Female (n=55)		Male (n=48)	
Sociodemographic Factors		n	%	n	%	n	%
Sex	Female	55	53.4	55	100.0	0	0.0
Sex	Male	48	46.6	0	0.0	48	100.0
Age	under 65	45	43.7	15	27.3	30	62.5
Age	65-74	39	37.9	24	43.6	15	31.2
Age	75 and older	19	18.4	16	29.1	3	46087
Age	M±SD	65.5±10.7	65.5±10.7	68.6±9.8	68.6±9.8	62.0±10.7	62.0±10.7
Place of residence	Urban	66	64.1	40	72.7	26	54.2
Place of residence	Rural	37	35.9	15	27.3	22	45.8
Educational level	Primary	3	2.9	3	5.5	0	0.0
Educational level	Vocational	37	35.9	16	29.1	21	43.8
Educational level	Secondary	42	40.8	25	45.5	17	35.4
Educational level	Higher	21	20.4	11	20.0	10	46254
Marital status	Single	17	16.5	10	18.2	7	46187
Marital status	Married	74	71.8	33	60.0	41	85.4
Marital status	Widowed	12	11.7	12	21.8	0	0.0
Occupational status*	White-collar work	24	23.3	13	23.6	11	46287
Occupational status*	Manual labor	25	24.3	7	12.7	18	37.5
Occupational status*	Disability pensioner	6	5.8	2	3.6	4	46089
Occupational status*	Retiree	53	51.5	35	63.6	18	37.5
Living alone	Yes	20	19.4	15	27.3	5	46122
Living alone	No	83	80.6	40	72.7	43	89.6
Financial status	Very good	19	18.4	7	12.7	12	25.0
Financial status	Good	41	39.8	19	34.5	22	45.8
Financial status	Average	36	35.0	25	45.5	11	46287
Financial status	Below average	5	4.9	4	7.3	1	46024
Financial status	Poor	2	1.9	0	0.0	2	46057
Financial status	M±SD	3.7±0.9	3.7±0.9	3.5±0.8	3.5±0.8	3.8±1.0	3.8±1.0

Table II. Results of the assessment using the Tinetti scale

	M	SD	Q1	Me	Q3	Min	Max
Balance	12.97	2.32	12.00	13.00	15.00	6.00	16.00
Gait	9.50	1.85	9.00	10.00	11.00	3.00	12.00
Total Tinetti scale score	22.47	3.72	21.00	24.00	25.00	11.00	28.00

Notes: M – mean, SD – standard deviation, Min – minimal value, Max – maximal value, Q1 – 25th percentile (first quartile); Me – median value; Q3 – 75th percentile (third quartile).

Source: Author's own calculations.

Fig. 1. Percentage distribution of fall risk among study participants. Source: Author's own elaboration .

The results of the analysis regarding preferred forms of physical activity in relation to fall risk are presented in Tables III and IV. Analysis of the Chi-square test results revealed a statistically significant association between a preference for cycling and fall risk. Among individuals who preferred cycling, 55.1% exhibited a high level of balance, whereas in the group preferring other forms of physical activity, a high fall risk was observed in 24.1% of cases. Analysis of the Mann-Whitney

Table III. Analysis of fall risk relative to preferred forms of physical activity using the Chi-square test

Preferred forms of physical activity	Fall risk (overall)						χ^2	p
Preferred forms of physical activity	High risk		Moderate risk		Low risk		χ^2	p
Preferred forms of physical activity	n	%	n	%	n	%	χ^2	p
Walking	11	18.3	19	31.7	30	50.0	0.958	0.6194
Cycling	3	6.1	19	38.8	27	55.1	6.356	0.0417
Gymnastics	5	20.0	10	40.0	10	40.0	-	0.4734
Swimming	3	13.0	6	26.1	14	60.9	1.294	0.5237
Skiing	1	20.0	0	0.0	4	80.0	-	0.2310
Dancing	0	0.0	4	40.0	6	60.0	-	0.4835
Other	0	0.0	1	33.3	2	66.7	-	1.0000

χ^2 – Chi-square statistic value, p – p-value (level of significance). Source: Author's own calculations.

Table IV. Analysis of fall risk relative to preferred forms of physical activity using the Mann-Whitney

Preferred forms of physical activity		Tinetti Scale					
Preferred forms of physical activity		Balance		Gait		Total score	
Preferred forms of physical activity		M	SD	M	SD	M	SD
Walking	Yes	12.75	2.41	9.43	1.65	22.18	3.74
Walking	No	13.28	2.17	9.58	2.11	22.86	3.70
Walking	p	0.2907	0.2907	0.2003	0.2003	0.2907	0.2907
Cycling	Yes	13.53	1.94	9.71	1.57	23.24	3.08
Cycling	No	12.46	2.53	9.30	2.06	21.76	4.13
Cycling	p	0.0212	0.0212	0.6019	0.6019	0.1123	0.1123
Gymnastics	Yes	13.04	2.01	9.12	2.22	22.16	3.58
Gymnastics	No	12.95	2.42	9.62	1.71	22.56	3.79

Gymnastics	p	0.6863	0.6863	0.3402	0.3402	0.4744	0.4744
Swimming	Yes	12.78	2.35	9.65	1.77	22.43	3.91
Swimming	No	13.03	2.32	9.45	1.88	22.48	3.69
Swimming	p	0.6179	0.6179	0.4192	0.4192	0.7544	0.7544
Skiing	Yes	13.40	3.65	10.20	1.48	23.60	5.03
Skiing	No	12.95	2.26	9.46	1.86	22.41	3.67
Skiing	p	0.2343	0.2343	0.4475	0.4475	0.2111	0.2111
Dancing	Yes	13.60	1.51	9.70	1.64	23.30	1.89
Dancing	No	12.90	2.39	9.47	1.87	22.38	3.86
Dancing	p	0.5776	0.5776	0.7299	0.7299	0.8629	0.8629
Other	Yes	14.33	1.15	10.67	0.58	25.00	1.73
Other	No	12.93	2.34	9.46	1.86	22.39	3.74
Other	p	0.2553	0.2553	0.1922	0.1922	0.1608	0.1608

M – mean value, *SD* – standard deviation, *p* – *p*-value (level of significance).

Source: Author's own calculations.

Tables V and VI present the results of the fall risk analysis according to sports disciplines practiced in the past. The results obtained using the Chi-square test (Table V) revealed no statistically significant

association between past participation in sports disciplines and fall risk. Furthermore, the analysis showed no statistically significant differences in Tinetti scale scores based on past sports participation. This indicates that prior sports activity does not differentiate participants in terms of fall risk, balance, or gait performance.

Table V. Analysis of fall risk relative to past sports participation using the Chi-square test

Past participation in sports disciplines		Fall risk (overall)				χ^2	p
Past participation in sports disciplines		High risk		Moderate risk		Low risk	
Past participation in sports disciplines		n	%	n	%	n	%
Yes	8	46071	11	25.0	25	56.8	2.780
No	8	46186	24	40.7	27	45.8	2.780

χ^2 – Chi-square statistic value, *p* – *p*-value (level of significance).

Source: Author's own calculations.

Table VI. Analysis of fall risk relative to past sports participation using the Mann-Whitney

Past participation in sports disciplines						Z	p
Yes			No			Z	p
M	SD		M	SD		Z	p
Balance	13.02	2.54	12.93	2.16		0.887	0.3752
Gait	9.43	1.92	9.54	1.80		0.027	0.9787
Total Tinetti scale score	22.45	3.87	22.47	3.64		0.330	0.7414

M – mean value, *SD* – standard deviation, *Z* – statistic value approximated by the normal distribution; *p* – *p*-value (level of significance)

Source: Author's own calculations.

Tables VII and VIII present the results of the fall risk analysis according to participants' motivation for participating in physical activities. The results

confirmed a statistically significant association between underYesing physical activity for relaxation and social purposes and the risk of falling. In the group of participants whose primary motivation was relaxation and making new acquaintances, as many as 91.7% were individuals with a low fall risk. Conversely, among those

focusing on improving fitness, improving health, and spending leisure time actively, a high fall risk was recorded in 16.5% of respondents. This indicates that regular physical activity aimed at relaxation and social integration is an effective form of fall prevention. Analysis of the results demonstrated statistically significant differences in

gait stability levels depending on the participants' motivation for physical activity. Higher gait stability was observed in individuals whose primary goal was relaxation and making new acquaintances. On the other hand, participants who cited fitness improvement as their main reason for Yesing part in activities presented greater gait impairments.

Table VII. Fall risk level relative to motivation for participating in physical activities using the Chi-square test

Reason for participating in physical activities		Fall risk (overall)						χ^2	p
Reason for participating in physical activities		High risk		Moderate risk		Low risk		χ^2	p
Reason for participating in physical activities	n	%	n	%	n	%	χ^2	p	
Fitness improvement	8	20.5	16	41.0	15	38.5	3.716	0.1560	
Health improvement	5	15.2	11	33.3	17	51.5	0.021	0.9897	
Relaxation and making new acquaintances	1	8.3	0	0.0	11	91.7	9.631	0.0081	
Active leisure time	2	10.5	8	42.1	9	47.4	0.874	0.6461	
Other	0	0.0	1	100.0	0	0.0	-	-	

χ^2 – Chi-square statistic value, p – p-value (level of significance).

Source: Author's own calculations.

Table VIII. Fall risk level relative to motivation for participating in physical activities using the Mann-Whitney

Reason for participating in physical activities		Tinetti Scale					
Reason for participating in physical activities		Balance		Gait		Overall score	
Reason for participating in physical activities		M	SD	M	SD	M	SD
Fitness improvement	Yes	12.90	2.25	9.00	1.92	21.90	3.63
Fitness improvement	No	13.02	2.38	9.80	1.75	22.81	3.76
Fitness improvement	p	0.6341	0.6341	0.0072	0.0072	0.0978	0.0978
Health improvement	Yes	12.67	2.51	9.36	1.82	22.03	3.79
Health improvement	No	13.11	2.23	9.56	1.87	22.67	3.70
Health improvement	p	0.3751	0.3751	0.5042	0.5042	0.3564	0.3564
Relaxation and making	Yes	13.75	2.01	10.67	0.98	24.42	2.84

new acquaintance							
Relaxation and making new acquaintance	No	12.87	2.35	9.34	1.88	22.21	3.76
Relaxation and making new acquaintance	p	0.1347	0.1347	0.0035	0.0035	0.0090	0.0090
Active leisure time	Yes	13.16	2.36	10.00	1.83	23.16	46057
Active leisure time	No	12.93	2.32	9.38	1.84	22.31	3.66
Active leisure time	p	0.6707	0.6707	0.0799	0.0799	0.3076	0.3076

M – mean value, *SD* – standard deviation, *p* – *p*-value (level of significance)

Source: Author's own calculations.

Tables IX and X present the results of the analysis of the association between postoperative symptoms and fall risk. The conducted analysis revealed a statistically significant association between symptoms occurring in the postoperative period and fall risk. Among participants reporting balance

impairment, a high fall risk was identified in 40%, whereas the remaining symptoms did not significantly contribute to an increase in this risk. The obtained results showed no statistically significant differences in the total Tinetti scale score, including balance levels and gait performance, based on symptoms occurring in the postoperative period.

Table IX. Analysis of fall risk relative to postoperative symptoms using the Chi-square test and Fisher's exact test

Postoperative symptoms		Fall risk (overall)				χ^2	p		
Postoperative symptoms		High risk		Moderate risk		Low risk		χ^2	p
Postoperative symptoms	n	%	n	%	n	%	χ^2	p	
Dizziness	3	7.1	15	35.7	24	57.1	3.900	0.14231	
Balance impairment	6	40.0	4	26.7	5	33.3	-	0.03332	
Sensation of ground movement	3	25.0	4	33.3	5	41.7	-	0.58742	
Nausea	1	7.7	5	38.5	7	53.8	-	0.84742	
Vomiting	1	12.5	5	62.5	2	25.0	-	0.17242	
Headche	0	0.0	6	50.0	6	50.0	-	0.23662	
Hip pain	12	46.187	28	34.1	42	51.2	-	0.89312	

χ^2 – Chi-square test statistic value, 1Chi-square test, 2Fisher's exact test, p – p-value (level of significance).

Source: Author's own calculations.

Table X. Analysis of fall risk relative to postoperative symptoms using the Mann-Whitney

Postoperative symptoms		Tinetti Scale					
Postoperative symptoms		Balance		Gait		Overall score	
Postoperative symptoms		M	SD	M	SD	M	SD
Dizziness	Yes	13.45	1.97	9.83	1.23	23.29	2.79

Dizziness	No	12.64	2.50	9.26	2.15	21.90	4.18
Dizziness	p	0.1110	0.1110	0.5821	0.5821	0.1336	0.1336
Balance impairment	Yes	11.80	3.14	8.60	2.16	20.40	46239
Balance impairment	No	13.17	2.11	9.65	1.76	22.82	3.35
Balance impairment	p	0.1012	0.1012	0.0829	0.0829	0.0881	0.0881
Sensation of ground movement	Yes	12.75	2.30	9.25	2.26	22.00	3.79
Sensation of ground movement	No	13.00	2.33	9.53	1.80	22.53	3.73
Sensation of ground movement	p	0.5252	0.5252	0.6809	0.6809	0.5797	0.5797
Nausea	Yes	12.92	2.43	9.69	2.02	22.62	4.21
Nausea	No	12.98	2.32	9.47	1.83	22.44	3.67
Nausea	p	0.9570	0.9570	0.6199	0.6199	0.7646	0.7646
Headche	Yes	11.75	11.75	2.38	2.38	9.25	9.25
Headche	No	13.07	13.07	2.30	2.30	9.52	9.52
Headche	p	0.0611	0.0611	0.9278	0.9278	0.2154	0.2154
Hip pain	Yes	13.42	13.42	1.38	1.38	9.83	9.83
Hip pain	No	12.91	12.91	2.42	2.42	9.45	9.45
Hip pain	p	0.7723	0.7723	0.9474	0.9474	0.7568	0.7568

M – mean value, *SD* – standard deviation, *p* – level of significance (Manna-Whitney *U*-test).

Source: Author's own calculations.

Tables XI and XII present the results of the analysis regarding the impact of postoperative pain causing mobility difficulties on fall risk. The obtained results showed no statistically significant association between postoperative pain causing mobility

difficulties and fall risk. The analysis demonstrated no statistically significant differences in the total Tinetti scale score based on postoperative pain limiting mobility. However, differences in the balance subscale were observed at a significance level of 0.07. Patients experiencing pain achieved lower balance scores compared to those who reported no pain.

Table XI. Analysis of fall risk level relative to pain using the Chi-square test

Pain causing mobility difficulties		Fall risk (overall)				χ^2	p	
Pain causing mobility difficulties	High risk		Moderate risk		Low risk		χ^2	p
Pain causing mobility difficulties	n	%	n	%	n	%	χ^2	p
Yes	12	75.0	24	68.6	28	53.8	3.260	0.1959
No	4	25.0	11	31.4	24	46.2	3.260	0.1959

χ^2 – Chi-square test statistic value; p – p-value (level of significance).

Source: Author's own calculations.

Table XII. Analysis of fall risk level relative to pain using the Mann-Whitney

Pain causing mobility impairment		Z	p
Yes	No	Z	p

	M	SD	M	SD	Z	p
Balance	12.61	2.54	13.56	1.77	1.812	0.0700
Gait	9.33	2.00	9.77	1.55	0.938	0.3481
Total Tinetti scale score	21.94	46269	23.33	2.86	1.564	0.1179

M – mean value, SD – standard deviation, Z – statistic value approximated by the normal distribution; p – p-value (level of significance) Source: Author's own calculations.

Table XIII presents the results of the analysis of patients' subjective self-rated health relative to the scores obtained in the Tinetti scale assessment

Table XIII. Association between subjective self-rated health and Tinetti scale scores

Health status assessment	tau	p
Balance	0.102	0.1269
Gait	0.054	0.4165
Total Tinetti scale score	0.064	0.3359

Table XIV presents the subjective assessment of mobility problems in correlation with the Tinetti scale test scores. The obtained results demonstrated a statistically significant association between mobility difficulties and fall risk assessed using the

following endoprosthesis implantation. The obtained results showed no statistically significant association between health status assessment and functional performance assessment in patients after hip joint endoprosthesis implantation surgery.

Table XIV. Analysis of subjective assessment of mobility problems relative to Tinetti scale scores

Mobility problems following hip arthroplasty	tau	p
Balance	-0.289	0.0000
Gait	-0.134	0.0451
Total Tinetti scale score	-0.219	0.0011

Source: Author's own calculations.

Table XV presents the results of the analysis of patients' self-care level following hip joint endoprosthesis implantation surgery relative to the scores obtained on the Tinetti scale. The obtained results demonstrated a statistically significant

association between the level of functional performance in bathing and dressing and fall risk assessed using the Tinetti scale. The negative sign of the correlation coefficients indicates that a lower level of functional performance is associated with a higher fall risk, poorer balance, and greater gait difficulties.

Table XV. Analysis of patients' self-care level post-surgery relative to Tinetti scale scores

Difficulties with bathing and dressing after hip arthroplasty	tau	p
Balance	-0.205	0.0022
Gait	-0.142	0.0329
Total Tinetti scale score	-0.193	0.0040

tau – Kendall's tau correlation coefficient;

Source: Author's own calculations.

Table XVI presents the relationship between age and the score obtained on the Tinetti scale, examined using Spearman's rank correlation coefficient. The obtained results demonstrated a statistically significant association between age and

fall risk measured using the Tinetti scale, particularly in the domain of balance. The negative sign of the correlation coefficients indicates that older individuals experience greater difficulties with balance maintenance, and consequently, their fall risk is significantly higher. No statistically

significant associations were found between age and gait difficulties.

Table XVII summarizes the statistics evaluating the correlation between sex and Tinetti scale scores. The obtained results revealed statistically significant differences in the level of fall risk by sex, particularly regarding balance and gait. A higher fall risk occurs more frequently in women than in men, owing to greater difficulties with both balance maintenance and gait. Table XVIII presents the relationship of patients' age and sex relative to fall risk. The obtained results showed a statistically

significant association between age and fall risk measured on the Tinetti scale:

High fall risk was identified in 25.5% of the surveyed women, whereas low risk predominated in the male group (64.6%),

With advancing age, the proportion of participants with a high fall risk increases. It affects 36.8% of participants over 75 years of age, whereas more than half of participants under 75 years of age fall into the low fall risk category.

Table XVI. Association between age and Tinetti scale scores

Age	R	p
Balance	-0.460	<0.0001
Gait	-0.144	0.1453
Total Tinetti scale score	-0.352	0.0003

R – Spearman's rank correlation coefficient, p – level of significance (p-value). Source: Author's own calculations.

Table XVII. Results of the correlation analysis between sex and Tinetti scale scores using the Mann-Whitney U-test

Sex					Z	p
Female			Male		Z	p
	M	SD	M	SD	Z	p
Balance	12.40	2.58	13.63	1.79	2.522	0.0117
Gait	9.02	2.18	10.04	1.17	2.244	0.0248
Total Tinetti scale score	21.42	4.31	23.67	2.45	2.592	0.0096

M – mean value, SD – standard deviation, Z – statistic value approximated by the normal distribution; p – p-value (level of significance)

Source: Author's own calculations.

Table XVIII. Results of the analysis of the association between participants' age and sex relative to Tinetti scale scores using the chi-square test

		Fall risk (overall)						χ^2	p
		High risk		Moderate risk		Low risk		χ^2	p
		n	%	n	%	n	%	χ^2	p
Sex	Female	14	25.5	20	36.4	21	38.2	11.213	0.0037
Sex	Male	2	4.2	15	31.3	31	64.6	11.213	0.0037
Age	under 65	3	6.7	12	26.7	30	66.7	18.838	0.0008
Age	65-74 years old	6	15.4	13	33.3	20	51.3	18.838	0.0008
Age	75 and over	7	36.8	10	52.6	2	46.152	18.838	0.0008

χ^2 – Chi-square statistic value, p – p-value (level of significance).

Source: Author's own calculations.

Tables XIX and XX present the results evaluating the significance of the impact of chronic conditions on fall risk. The obtained results showed no statistically

significant associations between comorbidities and fall risk.

Table XIX. Results of the analysis of the significance of the impact of chronic conditions on fall risk using the chi-square statistic and Fisher's exact test

Comorbidities	Fall risk (overall)						χ^2	p
Comorbidities	High risk		Moderate risk		Low risk		χ^2	p
Comorbidities	n	%	n	%	n	%	χ^2	p
Diabetes	3	17.6	6	35.3	8	47.1	-	0.93762
Rheumatoid arthritis (RA)	5	33.3	3	20.0	7	46.7	-	0.12082
Post-stroke status	0	0.0	0	0.0	3	100.0	-	-
Cancer	0	0.0	0	0.0	1	100.0	-	-
Obesity	3	16.7	5	27.8	10	55.6	-	0.82892
Cardiovascular diseases	1	7.1	7	50.0	6	42.9	-	0.41862
Hypertension	11	19.0	20	34.5	27	46.6	1.423	0.49091
Ankylosing spondylitis (AS)	1	16.7	3	50.0	2	33.3	-	0.53302
Balance disorders	0	0.0	0	0.0	2	100.0	-	-
Ménière's disease	0	0.0	0	0.0	0	0.0	-	-
Other	8.9	14	31.1	27	60.0	8.9	3.898	0.14241

χ^2 – Chi-square test statistic value, 1Chi-square test, Source: Author's own calculations.

2Fisher's exact test, p – p-value (level of significance).

Tabela XX. Results of the study of the significance level of the influence of chronic diseases on the number of points obtained in the Tinetti scale using the Mann-Whitney U test.

Comorbidities			Tinetti Scale					
Comorbidities			Balance		Gait		Overall score	
Comorbidities			M	SD	M	SD	M	SD
Diabetes	Yes	Yes	12.76	2.59	9.24	1.79	22.00	4.08
Diabetes	No	No	13.01	2.28	9.55	1.86	22.56	3.67
Diabetes	p	p	0.6187	0.6187	0.2792	0.2792	0.6125	0.6125
Rheumatoid arthritis (RA)	Yes	Yes	13.07	2.25	8.47	2.75	21.53	4.34
Rheumatoid arthritis (RA)	No	No	12.95	2.34	9.67	1.60	22.62	3.61
Rheumatoid arthritis (RA)	p	p	0.9889	0.9889	0.1581	0.1581	0.6268	0.6268
Obesity	Yes	Yes	12.33	2.68	9.39	2.12	21.72	4.60
Obesity	No	No	13.11	2.23	9.52	1.80	22.62	3.52
Obesity	p	p	0.2595	0.2595	0.9691	0.9691	0.7273	0.7273
Cardiovascular diseases	Yes	Yes	13.50	2.21	9.36	1.55	22.86	3.44
Cardiovascular diseases	No	No	12.89	2.34	9.52	1.90	22.40	3.78
Cardiovascular diseases	p	p	0.3825	0.3825	0.3421	0.3421	0.9355	0.9355
Hypertension	Yes	Yes	12.76	2.38	9.34	1.80	22.10	3.76
Hypertension	No	No	13.24	2.24	9.69	1.90	22.93	3.66

Hypertension	p	p	0.2160	0.2160	0.1177	0.1177	0.1855	0.1855
Ankylosing spondylitis (AS)	Yes	Yes	12.33	2.73	9.00	2.53	21.33	5.16
Ankylosing spondylitis (AS)	No	No	13.01	2.30	9.53	1.81	22.54	3.64
Ankylosing spondylitis (AS)	p	p	0.5130	0.5130	0.5680	0.5680	0.4277	0.4277

*M – mean value, SD – standard deviation, p – level of significance
(Mann-Whitney U-test).*

Source: Author's own calculations.

4. Discussion

A patient fall following hip joint endoprosthesis implantation surgery, which may result in dislocation or periprosthetic fracture, represents one of the most dangerous adverse events. It can occur both in the surgical ward during hospitalization and after discharge from the hospital. Assessing and analyzing the risk of this event is one of the most critical components of prevention, aimed at ensuring patient well-being and minimizing costs associated with revision surgery and prolonged hospital stays. Research in this field enables the identification of factors contributing to increased fall risk and can assist in developing preventive measures [6,7,8,9]. The study, aimed at evaluating the impact of selected clinical, environmental, and functional factors on fall risk in patients after hip endoprosthesis implantation during hospitalization, included 103 patients. Over 50% of the participants were over 65 years of age. Fall risk in this age group may stem not only from post-operative rehabilitation but also from a general decline in physical fitness [10].

Among the patients' preferred forms of physical activity, cycling had a statistically significant effect on reducing fall risk and achieving higher balance scores on the Tinetti scale. The study demonstrated that 55.1% of respondents choosing this form of activity were in the low fall risk group. Only 6.1% of individuals were in the high-risk group. In terms of balance assessment, the score was on average 1 point higher for patients who preferred cycling. In general terms, cycling can strengthen the musculoligamentous apparatus. Following

endoprosthesis implantation surgery, the unoperated part of the locomotor system assumes an additional load resulting from taking on a stabilizing and functional role. The direct cause of altered motor function in the musculoskeletal system is post-operative pain.

There are no extensive studies regarding the impact of athletic experience or regularly practiced sports disciplines on fall risk after hip joint endoprosthesis implantation. However, literature can be found focusing on preparatory exercises and the importance of muscle strength in the context of balance assessment, which serves as an indicator of fall risk

A study by Chen et al. demonstrated that a combination of preoperative and postoperative hip muscle training of the operated limb leads to a higher level of patient balance. The authors suggest a direct effect of musculoskeletal muscle strength on improving gait stability and balance [11]. In another study, Kawakami et al. showed a correlation between preoperative muscle strength on the unaffected side and Timed Up and Go (TUG) test scores. Weakness of the abductor muscles on the unaffected side worsens performance on the test, suggesting reduced gait stability. The authors recommend performing hip joint endoprosthesis implantation surgery before significant weakening occurs on the unaffected side. However, it should be noted that the study included only women [12]. A systematic review conducted by Labanca et al. also indicates the possibility of improving patient balance through balance-focused exercises before, immediately after, and in the late postoperative period. However, the authors point out the small number of publications and high heterogeneity of research methods, thereby precluding definitive conclusions [13].

In the present study, the relationship between postoperative adverse symptoms, including pain, and fall risk was investigated. Among the patients' responses, balance disorders emerged as a statistically significant factor. It was found that 40% of participants who reported experiencing this symptom postoperatively belonged to the high fall risk group. However, this result was not confirmed to be statistically significant using the Mann-Whitney U test. Regarding surgical pain, no correlation with balance disorders was observed using the chi-square statistic either. For this symptom, the Mann-Whitney U test indicated, at a significance level close to the assumed threshold of

A study by Sayilan et al. involving 202 respondents over 65 years of age, examining the general correlation between postoperative pain and falls, indicates a statistically significant correlation between pain and postoperative fall risk (using the Itaca Fall Risk Scale). The authors note that research

focusing on the relationship between postoperative pain and fall risk is limited. High heterogeneity and the subjective nature of pain perception, combined with a lack of tools for its objective evaluation, limit the utility of the conclusions of such analyses [14].

A cross-sectional study by Mata et al., which was not limited exclusively to patients after hip arthroplasty, identifies pain as the most statistically significant predictor of falls among surgical patients. Similarly, however, the authors note that the lack of extensive research in this area limits discussion. The investigation of pain incidents is broad in scope, encompassing timing, location, and severity level. Due to the subjective nature of pain perception, its assessment should be conducted using validated tools [15].

A meta-analysis by Welsh et al. indicates that older adults experiencing multisite pain have a 56% higher likelihood of falling. The analysis was not limited to patients following hip arthroplasty [16].

The examination of patients' subjective health status in relation to Tinetti scale scores revealed no statistically significant association. However, correlations were observed in the analysis of mobility problems and self-care levels relative to an increased fall risk. The negative sign of Kendall's tau coefficient indicates a decrease in test scores associated with greater difficulties in both balance maintenance and gait.

Within the broader body of research, few studies analyze the correlation between patients' subjective perceptions and their actual physical function. A study of functional relationships in the context of fall risk by Agnihotri and Dabholkar highlights the complexity of the issue. According to the authors, fall risk depends on patients' physical capabilities, their behavior (fear), and the environment in which they move. The cited study demonstrated a strong relationship between patients' subjective confidence during daily activities measured using the Falls Efficacy Scale and the Sit-to-Stand test measuring lower limb strength and balance levels. However, it should be noted that increased patient mobility does not always directly translate into a

lower number of falls. The study involved geriatric patients (mean age approximately 69 years), thus covering a cohort that only partially overlaps with the group examined in this master's thesis. Consequently, the results should not be extrapolated to younger age groups [17].

A study by Vertesich et al. regarding balance and mobility compared to patients' subjective assessments evaluated Patient-Reported Outcomes against quantitative results from the Tinetti scale and the Timed Up and Go test. No statistically significant associations were found between patient self-assessment and the results of objective research methods. However, it should be noted that participants often struggle to accurately evaluate their health status. Pain relief, and thus an improvement in overall well-being, often occurs earlier than measurable balance improvement, which may lead patients to overestimate their functional capabilities while underestimating balance impairments. As a result, this can lead to an increased fall risk, particularly during the initial period of recovery [18].

As a result of the present research, a negative correlation was found between age and fall risk measured on the Tinetti scale. For balance, a Spearman's rank correlation coefficient

In a 2019 meta-analysis titled Risk factors for falls in patients with total hip arthroplasty and total knee arthroplasty: a systematic review and meta-analysis, which included 12 studies and over 1.2 million participants, the odds ratio for increased fall risk ranged from 1.04 to 21.50. This indicates a correlation between age and increased risk. However, it should be noted that these results have a low level of evidence and include patients following both total hip and total knee arthroplasty [19].

In another cohort study, Preoperative Factors Associated With Falls Following Total Hip Arthroplasty in Older Adults from 2025, involving approximately 4.5 thousand patients, the average odds ratio for fall risk was 1.04 at a significance level of

Another 2020 meta-analysis, A systematic review and meta-analysis of fall incidence and risk factors in elderly patients after total joint arthroplasty, encompassing 14 studies with over 1.2 million patients, indicates an increase in fall risk with age. Fallers were, on average, 3.2 years older than non-fallers. The average odds ratio for increased fall risk was 1.05. However, attention should be drawn to high heterogeneity across studies and the fact that falls following both total hip and total knee replacement were included [21].

The research conducted as part of the present study confirms an association between sex and higher fall risk in the examined patients. The results indicate statistically significantly worse scores for women in both balance and gait. On average, women score 1 point lower on the Tinetti scale compared to men for each of the mentioned subscales. This is also supported by the overall study result, in which women score an average of 2 points lower than men. Approximately 25% of women belong to the high fall risk group, compared to about 4% of men in the same group. The obtained results appear to be consistent with the literature.

In the aforementioned meta-analysis, A systematic review and meta-analysis of fall incidence and risk factors in elderly patients after total joint arthroplasty, women were characterized by an average of approximately 62% higher risk of falling—the odds ratio was within the confidence interval of 1.36 to 1.90. Additionally, the lack of heterogeneity among the analyzed publications indicates high statistical power of this conclusion [21]. Less specific but identical conclusions emerge from the previously cited study Risk factors for falls in patients with total hip arthroplasty and total knee arthroplasty: a systematic review and meta-analysis. Women fell more frequently, but only within the analysis of post-discharge falls [19]

The trend reversed to the disadvantage of men regarding falls during hospitalization. The authors of the meta-analysis point to potential reasons for these findings. It is suspected that men overestimate their ability to maintain balance and less frequently

report fall incidents after discharge [19]. The cohort study Preoperative Factors Associated With Falls Following Total Hip Arthroplasty in Older Adults, despite examining the impact of sex on fall risk, did not demonstrate a statistically significant association—the odds ratio was 1.10, but with a confidence interval of 0.92–1.31 and a significance level of

The identification of chronic conditions having the most significant impact on fall risk did not yield statistically significant results. Among the most common chronic conditions reported by the participants were heart and cardiovascular diseases, particularly hypertension (approximately 56%), obesity (17.5%), diabetes (16.5%), and rheumatoid arthritis (14.6%).

A meta-analysis conducted by Yang Liu et al. regarding fall risk analysis indicates an association between individual conditions and fall risk. The study identifies 6 disease entities correlating with a higher probability of balance loss (the average risk increase is provided in parentheses): obesity (18%), diabetes (43%), heart disease (26%), hypertension (9.5%), depressive episodes (27.5%), and chronic obstructive pulmonary disease (12%). High study heterogeneity (93%) was demonstrated for depressive disorders; however, the authors highlight the significant role of psychotropic medications in increasing fall risk [21].

A cohort study conducted by Craig P. Hensley et al. confirms a higher statistical significance of depression (95% risk level). Overweight, defined as a BMI between 25 and

5. Conclusions

Preoperative physical activity significantly affects postoperative patient balance, and its effects depend on the form of exercise. At the same time, past athletic experience—unrelated to current recreational activity or prehabilitation—does not have a significant impact on postoperative fall risk. The presence of adverse symptoms, particularly balance disorders, correlates with a higher fall risk, whereas postoperative pain is a significant predictor of postoperative falls overall; however, data regarding hip arthroplasty remain inconclusive. Mobility issues and lower self-care levels in patients following hip joint endoprosthesis implantation indicate a higher fall risk. Postoperative fall risk increases significantly with patient age (36.8% of participants over 75 years of age are in the high-risk group), with female sex serving as an independent predisposing factor for a higher incidence of balance loss (25.5% of women in the high-risk group). In the examined patient group, no significant association was found between the presence of comorbidities and decreased postoperative balance levels. This result stands in contrast to most reports in the scientific literature

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