



TITLE:

# Physical Activity Mediates the Relationship between Gait Function and Fall Incidence after Total Knee Arthroplasty

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## 1 Abstract

2 The present study aimed to examine (1) the preoperative factors that can predict  
3 postoperative falls, (2) whether postoperative physical activity (PA) mediates the  
4 relationship between fall incidence and gait function, and (3) whether postoperative PA  
5 levels are associated with fall risk in total knee arthroplasty (TKA) patients. Ninety-six  
6 patients (mean age;  $72.0 \pm 6.1$  yrs.) who were observed postoperatively for 6 months  
7 were selected. Timed-up and go (TUG) was assessed as an indicator of gait function.  
8 Fall incidence and PA were investigated for 6 months post-TKA. The body mass index,  
9 history of preoperative falls, knee pain, knee extensor strength, range of motion in knee  
10 flexion, and modified gait efficacy scale were evaluated. Additionally, postoperative PA  
11 levels were categorized into three groups: low:  $<3000$ , moderate:  $3000\text{--}4000$ , and high:  
12  $\geq 4000$  steps/day. The relative fall incidence rate was calculated according to the total  
13 number of falls normalized for every 1000 steps/day for 6 months postoperatively.  
14 Twenty-five (26.0%) of the 96 patients had at least one fall. The TUG, knee pain, and  
15 knee extensor strength were identified preoperatively as significant variables affecting  
16 postoperative falls. The mediated effects model revealed that postoperative fall  
17 incidence was predicted by preoperative TUG and postoperative PA. Postoperative PA  
18 was significantly associated with preoperative TUG. Moreover, both the preoperative  
19 TUG and postoperative PA were selected as significant variables for predicting fall  
20 incidence. Thus, postoperative PA mediates the relationship between gait function and  
21 fall incidence after TKA. Furthermore, the relative fall incidence rate associated with a  
22 low PA level was significantly higher than that associated with moderate and high PA  
23 levels. In conclusion, preoperative assessments of TUG performance, muscle strength,  
24 and knee pain were effective in predicting fall risk. Additionally, an increase in PA could

25 contribute to reducing fall risk in TKA patients. Therefore, our results suggest that  
26 preoperative screening for fall predictors and managing postoperative PA could reduce  
27 the fall incidence in TKA patients.

28

29 **Keywords:** Physical activity, fall incidence, gait function and total knee arthroplasty

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31

32 **Text**

33 **Introduction**

34 The success of total knee arthroplasty (TKA) is measured based on pain relief and  
35 improvement of physical function in patients with end-stage knee osteoarthritis (OA).  
36 Functional recovery, particularly, improvement of gait function in patients with TKA  
37 contributes in enhancing activity of daily living and quality of life.<sup>1,2</sup> However, the fall  
38 incidence was 17% – 48% of patients after TKA, which is high compared with  
39 asymptomatic healthy older people.<sup>3-6</sup> A previous study<sup>6</sup> showed that the first fall  
40 occurred in a median of 15 weeks postoperatively, and occurred mostly during walking.  
41 Generally, the recovery of physical function reaches a plateau by 6 months after TKA.<sup>7,8</sup>  
42 Therefore, postoperative 6 months is considered important for patients who underwent  
43 TKA to recover physical function; nevertheless, fall risk was high during this period due  
44 to insufficient functional recovery.

45 The timed-up and go (TUG) test is useful for screening fall risks in older  
46 people with lower function<sup>9</sup> and reflects the balance performance in patients who  
47 underwent TKA.<sup>10</sup> In previous studies,<sup>8,11,12</sup> the TUG test was frequently used to assess  
48 gait function before and after TKA. Thus, we focused on TUG test that reflects fall risks

49 and gait function in patients who underwent TKA. In addition, poor physical function,  
50 particularly muscle weakness,<sup>5</sup> range of motion (ROM) restriction,<sup>3</sup> and pain<sup>13</sup> are fall  
51 risk factors for patients who underwent TKA. Previous studies<sup>14-16</sup> reported that the risk  
52 of postoperative fall incidence was predicted by a preoperative history of falls, the OA  
53 grade of the contralateral knee, and self-efficacy. However, it is not clear whether the  
54 preoperative TUG can predict postoperative falls, considering these fall risk factors.  
55 Screening the potential risk factors preoperatively is necessary to reduce fall incidence  
56 after TKA.

57         Increases in physical activity (PA), which targeted approximately 3000 steps  
58 per day, was recommended for patients who underwent TKA to enhance gait function  
59 during 6 months postoperatively.<sup>17</sup> Previous studies<sup>18,19</sup> investigating the relationship  
60 between PA levels and fall incidence in community-dwelling older people prospectively  
61 showed that high PA level was associated with low fall risk. In contrast, another study<sup>20</sup>  
62 suggested that high PA could increase the exposure to situations during falls. Generally,  
63 increases in PA promoted improvement in physical function.<sup>21,22</sup> In fact, since  
64 postoperative PA promoted gait improvement in patients with TKA,<sup>17</sup> even patients with  
65 poor preoperative gait function could reduce the fall incidence risk by increasing  
66 postoperative PA. Thus, postoperative PA as a mediator might contribute to improving  
67 gait function and reducing the fall risk in patients who underwent TKA. However, to the  
68 best of our knowledge, no studies have evaluated whether postoperative PA was a  
69 mediator between gait function and fall incidence in patients who underwent TKA.  
70 A previous study<sup>19</sup> has indicated that both high and low PA levels increase the fall  
71 incidence risk.<sup>23</sup> To verify whether fall risk in both low and high PA were higher than  
72 that of moderate PA, Jefferis et al.,<sup>19</sup> investigated the frequency of exposure (objective

73 step counts) to falling. This approach has an advantage when fall risk was not linearly  
74 increased with PA. Investigating the relationship between various levels of PA and fall  
75 risk could provide valuable information for fall risk by considering PA after TKA.

76 The present study aimed to examine (1) the preoperative factors that can  
77 predict postoperative falls, (2) whether postoperative PA mediates the relationship  
78 between fall incidence and gait function, and (3) whether postoperative PA levels are  
79 associated with fall risk in patients who underwent TKA. We hypothesized that  
80 preoperative gait function would predict the postoperative fall incidence; postoperative  
81 PA would mediate the relationship between the fall incidence and gait function; and the  
82 fall risk would decrease with increasing activity.

83

84

## 85 **Material and Methods**

### 86 **Study design**

87 An observational cohort study of patients with knee osteoarthritis patients scheduled for  
88 primary TKA was conducted in XXX hospital. Patients who underwent revision TKA,  
89 or those who had impairments in the central or peripheral nervous systems,  
90 musculoskeletal disorders in other joints, or severe dementia were excluded from the  
91 present study. We enrolled 105 patients, and 9 were lost to follow-up; thus, 96 were  
92 included for data analysis. For the logistic regression analysis, at least 10 patients per  
93 independent variable were required for an adequate sample size.<sup>24</sup> The logistic  
94 regression analysis in this study involved a maximum of 9 independent variables; thus,  
95 the sample size was calculated to consist of at least 90 TKA patients.

96 The protocol of this retrospective study was approved by the ethics committee

97 of XXX. All patients underwent the same procedure of surgery and rehabilitation. The  
98 surgical approach used for TKA was a standard medial parapatellar approach by using a  
99 tourniquet. All patients started ambulation using a walker, or a wheelchair if required,  
100 on the first postoperative day. Physical therapists provided inhospital rehabilitation for 3  
101 weeks, including passive knee ROM exercise, muscle strength exercise, ambulation  
102 exercise, and activity of daily living supervision following the clinical pathway. All  
103 patients were followed-up by orthopedic surgeons at postoperative 2, 3, and 6 months  
104 and by physical therapists at postoperative 3 and 6 months.

105

#### 106 **Fall incidence**

107 Fall incidence was defined as any unintended contact with the ground or floor in  
108 accordance with a previous study.<sup>25</sup> We asked the patients if they had a fall during 6  
109 months preoperatively. During 6 months after TKA, the participants recorded the  
110 self-check sheet in case if they had a fall. In addition, physical therapists directly  
111 confirmed whether the patients had a fall at 3 and 6 months postoperatively. If the  
112 participant had a fall, the physical therapists also confirmed the number of falls and the  
113 injury severity.

114

#### 115 **Patients characteristics, physical function, and self-efficacy**

116 Patient characteristics, such as age, body mass index, gender, OA status of the  
117 contralateral knee (Kellgren/Lawrence grade or received TKA), and the presence of  
118 comorbidity (e.g., hypertension, diabetes, lumbar canal stenosis, and chronic respiratory  
119 disease), were obtained using clinical records. The TUG test measures the time it takes  
120 the patients to stand from a chair, walk a distance of 3 m, turn around, and sit down on a

121 chair, as quickly as possible. The participants could use assistive devices during TUG  
122 test if needed. The faster trial of the two measurements was used for analysis.  
123 Subjective knee pain during walking was assessed by using a visual analog scale. The  
124 knee extensor maximum voluntary contraction strength (knee extensor strength) in the  
125 operated side was measured on an isometric dynamometer (Isoforce GT-330; OG  
126 GIKEN Co, Japan) with a knee flexion of 60°. The patients performed knee extensor  
127 strength test thrice for 3 s. The maximum value of knee extensor strength was obtained  
128 and normalized torque to patient's weight. Passive knee flex ROM was measured by a  
129 physical therapist in the supine position by using a goniometer. Moreover, the modified  
130 gait efficacy scale (mGES) was used to assess the patient's self-efficacy for the walking  
131 task.<sup>26</sup> The mGES is a 10-term self-report measure that assesses the subjective  
132 confidence to safety. Each item was scored individually on a 10-point scale, with 10  
133 indicating the presence of best confidence. The total score is a maximum of 100 points,  
134 and a high score indicates higher confidence. Physical therapists assessed physical  
135 function and self-efficacy preoperatively and 6 months postoperatively.

136

### 137 **Physical activity**

138 The mean number of steps per day (1000 steps/day) as an index of PA was measured  
139 from the time patients were able to walk independently using a cane in the hospital to  
140 the postoperative follow-up at 6 months. The patients carried a pedometer with triaxial  
141 accelerometer (ES-500; YAMASA, Japan), except for bathing and sleeping, and  
142 recorded the number of daily steps in a self-check sheet. In addition, the pedometer  
143 which was used in this study was equipped with the memory for 30 days and 35 weeks;  
144 thus, we confirmed both the pedometer and self-check sheet. The mean number of steps

145 per day for every month and the entire 6 months postoperatively were calculated. PA  
146 levels were categorized into three groups (low, moderate, and high) based on the mean  
147 number of steps per day 6 months postoperatively. In accordance with a previous  
148 study<sup>17</sup> which recommended patients who underwent TKA to walk approximately 3000  
149 steps/day to improve gait function. The present study defined PA levels as follows:  
150 <3000, 3000–4000, and  $\geq 4000$  steps/day as low, moderate, and high PA, respectively.  
151 The relative fall incidence rate for the total number of falls normalized for every 1000  
152 steps/day 6 months postoperatively was calculated for each PA level.<sup>19</sup>

153

#### 154 **Statistical analysis**

155 The patients were categorized into non-fallers or fallers based on the observational data  
156 6 months postoperatively. The non-paired t-test or Fisher's exact test was performed to  
157 compare the two groups (i.e., non-fallers and fallers). Binary logistic regression analysis  
158 was applied to predict the fall incidence risk after TKA using preoperative outcome  
159 variables and covariates, and the adjusted odds ratio (OR) and 95% confidence interval  
160 (CI) were calculated.

161 For the mediating effects of PA, we performed binary logistic regression and  
162 multiple linear regression in accordance with a previous study<sup>27</sup> as follows: model 1)  
163 dependent variable: presence of fall and independent variable: preoperative TUG; model  
164 2) dependent variable: postoperative PA and independent variable: preoperative TUG;  
165 model 3) dependent variable: presence of fall and independent variable: postoperative  
166 PA; and model 4) dependent variable: presence of fall and independent variables:  
167 preoperative TUG and postoperative PA. First, we confirmed significant associations in  
168 models 1–3. Subsequently, as a condition for establishing the indirect effect of PA, we



169 examined whether PA was significantly associated with fall in model 4, and  
170 simultaneously whether the OR on TUG in model 4 was lower than that in model 1.  
171 Subsequently, age, body mass index, presence of preoperative fall, visual analog scale,  
172 knee extensor strength, knee flex ROM and mGES as covariates were combined in  
173 model 4, and the reduction in OR was calculated (model 5).

174 Two-way analysis of variance in split-plot design was used to compare the time  
175 course of postoperative PA in the two groups. Post hoc analysis was performed using the  
176 Tukey test to identify the group difference monthly. One-way analysis of variance was  
177 performed to test for possible differences in the relative fall incidence rate between PA  
178 levels. Post hoc comparisons were conducted using the Tukey test.

179 All data were expressed as mean  $\pm$  standard deviation. SPSS statistical software  
180 (version 22.0; SPSS Japan Inc., Japan) was used for all statistical tests. The significant  
181 level was set at  $p < 0.05$ .

182

183

## 184 **Results**

185 Of 96 patients, 25 (26.0%) had at least one fall 6 months postoperatively. Of the  
186 postoperative fallers, 4 patients fell twice, and one patient fell thrice. Fortunately, there  
187 was no fall-related fracture. Table 1 shows demographic characteristics of non-fallers  
188 and fallers. The body mass index and preoperative fall incidence in fallers were  
189 significantly higher than that in non-fallers, although no significant differences were  
190 found between the two groups in terms of age, gender, OA status of the contralateral  
191 knee, and the presence of comorbidity. Table 2 shows the results of the physical  
192 assessment. The TUG was significantly slower in fallers compared with that in

193 non-fallers preoperatively and at 6 months postoperatively. The postoperative mean PA  
 194 for the fallers during the 6-month follow-up period was significantly lower than that for  
 195 non-fallers (non-fallers,  $4.1 \pm 1.5$  [1000 steps/day]; fallers,  $2.7 \pm 0.8$  [1000 steps/day],  $p$   
 196  $< 0.001$ ).

197 Table 3 demonstrates the results of the binary logistic regression models for  
 198 predicting the fall incidence risk after TKA. The preoperative TUG, VAS, and knee  
 199 extensor strength were identified as the significant variables affecting postoperative  
 200 falls.

201 The results of testing the mediated effect are presented in Fig. 1 and Table 3.  
 202 With regard to the results of binary logistic regression in model 1, the preoperative TUG  
 203 was determined to be a significant fall risk factor. The postoperative PA was  
 204 significantly associated with the preoperative TUG in model 2 and fall risk factor in  
 205 model 3 ( $\beta = -0.36$ , 95% CI:  $-0.19 - -0.06$ ,  $p < 0.001$ ). Moreover, both the  
 206 preoperative TUG and postoperative PA were selected as significant variables for  
 207 predicting fall risk in model 4. The OR for the TUG decreased from model 1 to model 4,  
 208 which indicated that the PA mediated the relationship between the preoperative TUG  
 209 and fall risk after TKA. Similarly, a significant mediated effect was shown in model 5,  
 210 including covariates.

211 Fig. 2 shows the time courses of postoperative PA between non-fallers and  
 212 fallers. Two-way analysis of variance indicated a significant interaction ( $F = 3.25$ ,  $p =$   
 213  $0.029$ ) and main effect of time difference ( $F = 21.12$ ,  $p < 0.001$ ) for PA. Post hoc  
 214 analysis showed that PA in fallers was significantly lower than that in non-fallers  
 215 throughout 6 months postoperatively. The PA in non-fallers significantly increased in  
 216 stages throughout postoperative 6 months, whereas it did not increase in fallers. In

217 addition, the results of the fall incidence and relative fall incidence rate in each PA level  
218 were shown in Table 4. One-way analysis of variance indicated a significant difference  
219 in the relative fall incidence rate normalized with daily steps between PA levels ( $F$   
220  $=4.69$ ,  $p = 0.012$ ). The relative fall incidence rate of low PA level was significantly  
221 higher than those of moderate and high PA levels, whereas no significant differences  
222 were found between moderate and high PA levels.

223

224

## 225 **Discussion**

226 The result of the present study demonstrated that 26.0% of patients who  
227 underwent TKA had falls 6 months postoperatively. The fall incidence rate in present  
228 study was almost equivalent to two previous studies that reported 24.2% (age;  $75.9 \pm$   
229  $5.1$  years)<sup>4</sup> and 32.9% (age;  $75.5 \pm 6.0$  years)<sup>3</sup>; however, it was higher than another  
230 study (17.2%, age;  $66.3 \pm 6.6$  years)<sup>6</sup>. Those differences in fall incidence rates between  
231 studies maybe affected by the age the patients underwent TKA. The results of predicting  
232 the fall incidence after TKA from preoperative factors revealed that the fall incidence  
233 was predicted by the TUG, VAS, and knee extensor strength. The TUG test was useful  
234 preoperatively for screening the fall incidence risk in TKA patients, which is consistent  
235 with that in previous reports involving older individuals.<sup>9</sup> In agreement with our  
236 hypothesis, these results indicated that postoperative PA mediated the relationship  
237 between preoperative gait function and fall incidence after TKA, and moderate and high  
238 PA levels were associated with a lower fall risk. To the best of our knowledge, this is the  
239 first study that revealed the contribution of postoperative PA to the relationship between  
240 gait function and the fall incidence.

241           The preoperative TUG predicted the postoperative fall incidence, and the  
242 patients with poor TUG performance were at a high risk of falling. In model 3, the  
243 results of the multiple linear regression indicated that patients with poor TUG  
244 performance were associated with lower PA postoperatively. PA was the predictor of fall  
245 incidence risk and had a mediation effect between preoperative gait function and fall  
246 incidence after TKA. PA was both the predictor of fall incidence risk and had a  
247 mediation effect between gait function and fall incidence, suggesting that an increase in  
248 postoperative PA could decrease fall incidence. A previous study<sup>17</sup> showed that  
249 postoperative PA promoted gait function after TKA regardless of low preoperative gait  
250 function. The results showed that postoperative PA could contribute to the reduction of  
251 fall risk incidence. These relationships were maintained even after covariates were  
252 entered. Therefore, these results suggested that the promotion of PA in patients who  
253 underwent TKA might be useful to reduce future fall incidence.

254           Because the results of time course of PA changes, non-fallers had a  
255 significantly higher PA compared with fallers, and their PA increased throughout the  
256 postoperative 6 months, whereas no significant change was found throughout the  
257 postoperative 6 months in fallers. In addition, the relative fall incidence rate in the low  
258 PA group was higher than that in the moderate and high PA groups. A previous report<sup>20</sup>  
259 that investigated patients with osteoporotic fractures indicated that high PA increased  
260 the relative fall risk. However, our results were consistent with a previous study<sup>19</sup> for  
261 healthy elderly living in the community, and high PA was not associated with fall  
262 incidence. Because patients who underwent TKA generally enhanced PA with  
263 improvement of postoperative knee function,<sup>28</sup> continuous monitoring of PA was  
264 important. Although previous studies<sup>29,30</sup> have measured PA during short time periods,

265 this present study had a strong point because it continuously investigated the transverse  
266 changes of PA 6 months postoperatively. Thus, these results have suggested that patients  
267 who underwent TKA are recommended to increase postoperative PA in stages and to  
268 perform moderate PA, namely >3000 steps/day.

269 This study provided two major clinical implications for reducing the fall  
270 incidence after TKA. First, our results suggest that preoperative assessments of muscle  
271 strength, knee pain, as well as TUG performance were effective for predicting the fall  
272 risk. Since these factors can be conveniently assessed in the clinical setting, these  
273 screening tests may provide valuable information to reduce fall incidence after TKA.  
274 Second, postoperative PA had a mediation effect between gait function and fall  
275 incidence, and moderate-to-high PA was associated with a lower fall risk; thus, the  
276 monitoring of PA could be important in reducing the fall incidence. Therefore, it is  
277 important for the clinician to manage postoperative PA in their patients and provide  
278 preoperative screening for fall risk. The present study is an observational study; hence,  
279 the aim of future research should be to investigate whether these suggestions can reduce  
280 fall incidence after TKA.

281 This study has some limitations. First, although the fall incidence in patients  
282 who underwent TKA is known to be associated with depressive symptoms, they were  
283 not investigated in the present study. The mGES could also assess the patient's fear,<sup>26</sup>  
284 and was not related with the fall incidence in the current study. Thus, we expect that the  
285 effect of depressive symptoms in the results of this study was not significant. Second,  
286 other factors such as surgical factors and medication status were not investigated and  
287 may have affected our results. Finally, the survey periods were postoperative 6 months,  
288 which could have been longer. Because 48.0% of the fall incidence occurred 12 months

289 postoperatively,<sup>5</sup> future studies are needed to evaluate the fall incidence in the long  
290 term.

291

292

### 293 **Conclusion**

294 Preoperative assessments of TUG performance, muscle strength, and knee pain were  
295 effective for predicting the fall risk. Additionally, postoperative PA mediated the  
296 relationship between preoperative gait function and fall incidence after TKA; moderate  
297 and high PA levels were associated with a lower fall risk. Therefore, an increase in PA  
298 could contribute to reducing the fall risk in patients who underwent TKA. The results of  
299 our study suggest that preoperative screening for fall predictors and managing  
300 postoperative PA could reduce the fall incidence in TKA patients.

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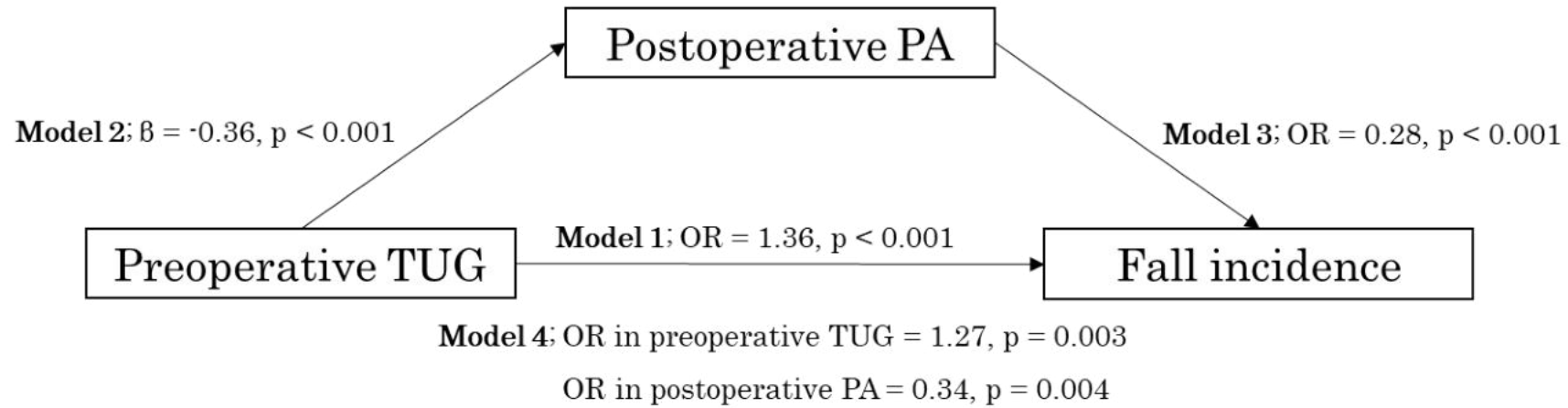
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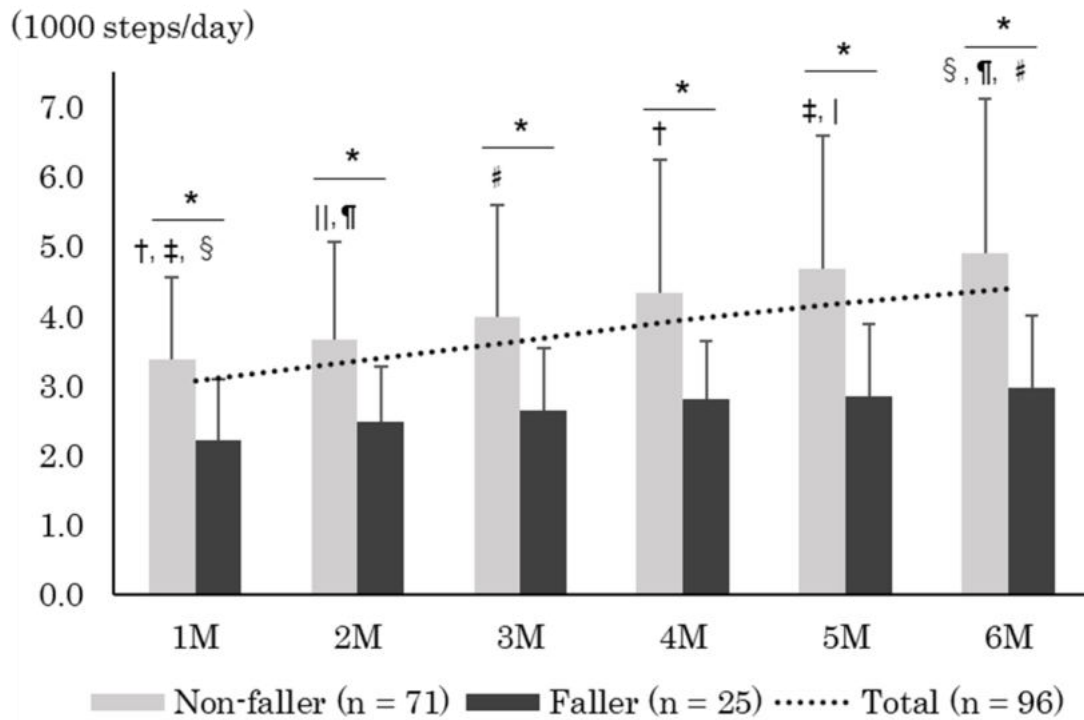


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**Fig. 1** Result of mediating effect of postoperative PA between preoperative TUG and fall incidence after TKA.

Abbreviation: TUG; Timed Up and Go, TKA; Total Knee Arthroplasty, PA; Physical Activity.



**Fig. 2** Time courses of postoperative PA between non-fallers and fallers.

The dotted line shows mean number of steps/day in all patients who underwent TKA (n = 96).

\* Significant difference between two groups.

† Significant time difference in non-fallers between 1M and 4M, ‡ between 1M and 5M,

§ between 1M and 6M, || between 2M and 5M, ¶ between 2M and 6M, and # between

3M and 6M, respectively.

Abbreviation: PA; Physical Activity, TKA; Total Knee Arthroplasty.

**Table 1.** Demographic characteristics of non-fallers and fallers.

		Total (n = 96)	Non-fallers (n = 71)	Fallers (n = 25)	<i>p</i> -value
Age	years	72.0 ± 6.1	71.6 ± 6.2	73.3 ± 5.9	0.235
Body mass index	kg/m <sup>2</sup>	26.6 ± 4.2	26.1 ± 4.0	28.1 ± 4.5	0.043
Gender	women; n (%)	88 (91.7%)	70 (90.1%)	24 (96.0%)	0.081
	K/L grade ≥ 1	27 (28.1%)	22 (22.9%)	5 (5.2%)	
OA status of the contralateral knee	K/L grade ≥ 3	41 (42.7%)	27 (28.1%)	14 (14.6%)	0.286
	Received TKA	28 (29.2%)	22 (22.9%)	6 (6.3%)	
Hypertension	n (%)	34 (35.4%)	25 (35.2%)	9 (36.0%)	0.944
Diabetes	n (%)	20 (20.8%)	14 (19.7%)	6 (24.0%)	0.652

Lumbar canal stenosis	n (%)	18 (18.8%)	15 (21.1%)	3 (12.0%)	0.317
Chronic respiratory disease	n (%)	8 (8.3%)	6 (6.3%)	2 (2.1%)	1.000
Preoperative fall incidence	n (%)	28 (29.2%)	16 (22.5%)	12 (48.0%)	0.019

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Abbreviation: OA; Osteoarthritis, K/L; Kellgren/Lawrence

**Table 2.** Physical assessment of non-fallers and fallers at preoperatively and 6 months postoperatively.

		preoperative				6 months postoperative			
		total	Non-fallers	Fallers	p-value	total	Non-fallers	Fallers	p-value
		(n=96)	(n=71)	(n=25)		(n=96)	(n=71)	(n=25)	
TUG	s	11.1 ± 4.6	9.7 ± 3.2	14.5 ± 5.9	<0.001	8.1 ± 1.9	7.5 ± 1.1	9.7 ± 2.6	<0.001
VAS during gait	mm	54.1 ± 25.6	56.1 ± 24.5	48.2 ± 28.3	0.184	4.1 ± 7.8	3.7 ± 6.3	5.4 ± 11.1	0.348
Knee extension strength	Nm/kg	0.8 ± 0.3	0.9 ± 0.3	0.6 ± 0.2	<0.001	1.0 ± 0.3	1.1 ± 0.3	0.8 ± 0.3	<0.001
Knee flex ROM	deg.	119.7 ± 16.4	121.1 ± 16.3	115.8 ± 16.5	0.165	123.2 ± 10.8	123.9 ± 11.3	121.2 ± 9.1	0.276
mGES	/100	33.0 ± 18.7	34.5 ± 18.8	28.5 ± 18.1	0.167	61.8 ± 21.0	65.1 ± 20.6	52.5 ± 19.8	0.009

Abbreviation: TUG; Timed Up and Go, VAS; Visual Analog Scale, ROM; Range of Motion, mGES; modified Gait Efficacy Scale.

**Table 3.** Binary logistic regression models for predicting fall incidence after TKA from preoperative factors.

Abbreviation: TKA; Total Knee Arthroplasty.

	OR	95% CI	<i>p</i> -value
TUG	1.28	1.07 – 1.54	0.007
Preoperative fall incidence	3.07	0.74 – 12.70	0.121
VAS during gait	0.96	0.93 – 0.99	0.015
Knee extensor strength	0.02	0.01 – 0.47	0.014
Knee flex ROM	1.02	0.97 – 1.06	0.464
mGES	1.00	0.96 – 1.04	0.945
Age	1.01	0.90 – 1.14	0.822
Body mass index	1.09	0.93 – 1.29	0.279
OA status of the contralateral knee	0.89	0.37 – 2.13	0.787

Abbreviation: OR; Odds Ratio, CI; Confidence Interval, TUG; Timed Up and Go, VAS;

Visual Analog Scale, ROM; Range of Motion, mGES; modified Gait Efficacy Scale;

OA; Osteoarthritis.

**Table 4.** The mediating effects models of postoperative PA on the relationship between preoperative TUG and fall incidence after TKA.

	OR	95% CI	<i>p</i> -value
Model 1: Univariate			
Preoperative TUG	1.36	1.16 – 1.59	< 0.001
Model 4: Model 1 with mediator			
Preoperative TUG	1.27	1.08 – 1.48	0.003
Postoperative PA	0.34	0.16 – 0.71	0.004
Model 5: Model 4 with multiple covariates			
Preoperative TUG	1.22	1.01 – 1.47	0.036
Postoperative PA	0.28	0.11 – 0.71	0.007
Preoperative fall incidence	1.76	0.37 – 8.50	0.481
Visual analog scale	0.97	0.93 – 0.99	0.030
Knee extensor strength	0.01	0.00 – 0.35	0.011
Knee flex ROM	1.00	0.96 – 1.05	0.910
mGES	1.02	0.97 – 1.06	0.464
Age	0.97	0.86 – 1.10	0.673



Body mass index	1.02	0.85 – 1.22	0.845
OA grade of the contralateral knee	0.812	0.32 – 2.04	0.658

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Abbreviation: OR; Odds Ratio, CI; Confidence Interval, TUG; Timed Up and Go, PA;

Physical Activity, ROM; Range of Motion, mGES; modified Gait Efficacy Scale; OA;

Osteoarthritis.

**Table 5.** Fall incidence and incidence rate in each PA level.

		low-PA	moderate-PA	high-PA
PA levels		(n=37)	(n=27)	(n=32)
Fall incidence	n (%)	17 (45.9%)	7 (25.9%)	1 (3.1%)
The relative fall incidence rate	per 1000 steps/d	0.31 <sup>*,†</sup>	0.07 <sup>*</sup>	0.01 <sup>†</sup>

\* Significant group difference between low-and moderate PA; p<0.05.

† Significant group difference between low-and high-PA; p<0.05.

Abbreviation: PA; Physical Activity.