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Activity Impairment and Work Productivity Loss After Total Knee Arthroplasty: A Prospective Study

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ABSTRACT

Background: Total knee arthroplasty (TKA) is increasingly performed among working-aged individuals, highlighting the importance of work-related outcomes. Therefore, the aim is to examine the extent of both activity impairment outside work and work productivity (absenteeism, presenteeism, at-work productivity loss) at 6 and 24 months post-TKA surgery. Additionally, associated risk factors with these outcomes were evaluated.

Methods: This analysis included 183 patients <70 years undergoing TKA who completed questionnaires pre-operatively and during follow-up. Outcomes were derived from the Work Productivity and Activity Impairment questionnaire and included activity impairment, absenteeism (sick leave), presenteeism (reduced work performance), and at-work productivity loss (overall work productivity loss). All outcomes were scaled 0%–100%, with higher percentages indicating higher impairments. Covariates included age, gender, education, pain catastrophizing, pain, function, psychological distress, and knee-related and health-related quality of life. Linear and logistic regression was used to assess associations between covariates and Work Productivity and Activity Impairment scores at follow-up.

Results: At 6 months, the mean activity impairment was 22.8% (standard deviation [SD] 23.5) dropping to 17.1% (23.1) by 24 months. Among workers, presenteeism was 18.4% (24.6) and at-work productivity loss was 20.8% (26.1). Both dropped significantly by 24 months to 14.2% (22.4) and 12.9% (20.9), respectively. Absenteeism levels were low at both time points. Pain catastrophizing was associated with all outcomes.

Conclusion: This study showed that activity impairment and work productivity loss are common following TKA, decreased significantly over time, but still existed 2 years post-operatively. Those reporting high levels of pain catastrophizing may benefit from targeted rehabilitation guidance to reduce and possibly prevent activity impairment and work productivity loss.

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Total knee arthroplasty (TKA) is considered to be an effective surgical treatment for end-stage knee osteoarthritis (OA) [1]. TKA relieves pain and improves function and health-related quality of life. The number of TKA procedures performed is expected to increase in the coming decades, due to aging populations [1], an increase in persons with obesity [2,3], improvements in the longevity of arthroplasties [4], and an increase in individuals engaging in a more active lifestyle [2]. In 2014, approximately 750,000 TKAs were performed in the United States with approximately half of these procedures performed in patients between the age of 45–64 years [5], the time frame in which most adults are actively engaged in the

work force. Between 2005 and 2011 utilization of TKA surgery grew faster in patients between the ages of 45–65 than in older individuals [6] and by 2030 it is anticipated that at least 60% of TKAs will be performed in those under 65 years [7].

Activity impairment has been identified as an important health outcome following TKA surgery [8]. A distinction can be made between activity impairment in the context of daily functioning and in the context of work. Activity impairment in daily functioning usually refers to limitations in household work and chores, shopping, and recreational pursuits. Activity impairment in the context of work refers to reduced productivity, which can be operationalized as absenteeism (sick leave) and presenteeism, defined as reduced performance while working due to a health problem.

Prior research showed that the proportion of patients returning to work after TKA surgery up to 2 years post-operatively ranges from 41% to 67%, and the average time to return to work (RTW) ranged between 9 and 12 weeks [9,10]. Sankar et al [11] reported that the majority of TKA patients who RTW experience fewer functional limitations at work compared to pre-surgery. Furthermore, once patients have returned to work they still may experience difficulty performing both knee-intensive activities, such as ambulating around the workplace and meeting physical job demands, as well as non-knee intensive activities, including long hours and difficulty with sustained concentration [10,11]. Other than sick leave, the association between TKA surgery and work productivity has not been studied. Studies involving sick leave or absenteeism in those undergoing TKA have demonstrated that employees use more sick leave up to 2 years post-operatively than they do pre-operatively [12]. Similarly, presenteeism and at-work productivity loss have to be studied in a sample of TKA recipients. Therefore, the present study aimed to examine activity impairment, absenteeism, presenteeism, and at-work productivity loss following unilateral TKA for knee OA at 6 and 24 months post-surgery. Moreover, the risk factors associated with these outcomes over a 2-year period post-operatively were examined.

Methods

Design

The Study of Total knee Arthroplasty Responses (STARs) is a prospective cohort of patients with the primary diagnosis of knee OA undergoing elective unilateral TKA. STARs recruited patients at one academic center in New York city (NYU Langone Medical Center) and at 2 community orthopedic centers (Orthopaedic Center of the Rockies, Fort Collins, CO and University of Maryland St. Joseph Medical Center, Towson, MD) between September 2012 and April 2014. Patients completed paper-based surveys within 6 weeks prior to surgery and at several time points post-surgery. The study received Institutional Review Board approval from Brigham and Women's Hospital (BWH) and NYU Langone Medical Center while the Maryland and Colorado sites ceded authority to BWH.

Patient Selection

Subjects included English-speaking community-dwelling persons who were at least 40 years old at the time of study entry. At each surgery practice, a local study associate identified all potentially eligible subjects and provided the subject's contact information to the research coordinators at the coordinating center (BWH). The coordinators contacted all potential subjects to confirm eligibility, explain the study, and determine subject interest in participation. Surveys were sent by mail to their homes and participants were reimbursed (USD 25) for returning questionnaires to the study center. Of the 267 participants enrolled in [*anonymized*],

$n = 200$ returned the questionnaires at 6 months and $n = 228$ returned the questionnaires at 24 months. The present analysis only includes subjects under 70 years at baseline ($n = 183$), which is the typical age many US workers retire.

Dependent Variable

Participants completed the Work Productivity and Activity Impairment Specific Health Problem (WPAI:SHP) questionnaire at 6, 12, and 24 months post-operatively. The impact of TKA on work and other daily activities during the last 4 weeks was measured. The WPAI is a validated instrument that measures the impact of a specified disease on work and other daily activities during the last 4 weeks [13]. The WPAI consists of 6 questions (Q) assessing employment status (Q1), time missed from work due to TKA (Q2), time missed from work for other reasons (Q3), time worked (Q4), degree to which TKA reduced productivity at work on a scale of 0–10 (presenteeism) (Q5), and the degree to which TKA affected other activities outside work on a scale of 0–10 (activity impairment outside work) exemplified as household work, shopping, recreation, odd jobs, and chores around the house (Q6). All time-related data elements were analyzed as hours.

Four main outcomes can be generated from these questions and expressed in percentages by multiplying the following scores by 100. A higher score indicates greater impairment and lower productivity. Work time missed due to knee problems (absenteeism) was calculated as $Q2/(Q2 + Q4)$. Impairment while working because of knee problems (presenteeism) was calculated as $Q5/10$, and overall at-work productivity loss because of knee problems was calculated as $Q2/(Q2 + Q4) + [(1 - Q2/(Q2 + Q4)) \times [Q5/10]]$. Activity impairment was calculated as $Q6/10$. Absenteeism, presenteeism, and at-work productivity loss outcomes were calculated among those who returned to work after surgery. If the respondent reported no employment for pay, only question six (Q6) was calculated [13].

Patient Characteristics

Demographic data included age, gender, body mass index, and education level, which were dichotomized into low (attended or graduated from high school) and high (attended or graduated from college or technical school) categories. Furthermore, job titles were classified into three groups: non-manual, service, or manual workers. Non-manual workers included managers and professionals; service included clerks, service, and sales workers; non-manual included craft/trade workers, machine operators and elementary manual workers, based on the International Standard Classification of Occupations (ISCO-08) [14].

Self-perceived pain and function were assessed with the Western Ontario McMaster Universities Arthritis Index (WOMAC). The WOMAC is a valid, reliable, and responsive questionnaire to measure self-perceived pain, stiffness, and function [15,16]. In the present study, only subscales for pain and function were used. In each scale, the responses to questions were summed and scaled from 0 to 100 using a linear transformation with 100 being the worst possible score. Pain catastrophizing was assessed with the Pain Catastrophizing Scale (PCS) [17]. The PCS consists of 13 items answered on a scale from 0 to 4, where 0 is "not at all" and 4 "all the time." Responses to questions were summed and scaled from 0 to 52 and a higher score indicates a higher level of pain catastrophizing. Knee-related quality of life was assessed with the Quality of Life scale on the Knee Injury and Osteoarthritis Outcome Score. Scores ranged from 0 to 100 with higher scores indicative of a better quality of life. Health-related quality of life was measured with the EuroQoL 5 Dimension Health-3L questionnaire, a generic instrument for assessing health-related quality of life across 5

dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression). For each of these dimensions, respondents indicated whether they experience no, some/moderate, or extreme problems from which a health state can be calculated and converted into a utility index using country-specific conversion scale. A score of 1 represented perfect health, a score of 0 indicated death, and negative values were consistent with states considered worse death [18]. This widely used instrument showed satisfying results for measurement characteristics in knee patients [19]. Psychological distress was measured with the 5-item Mental Health Inventory, which asks about anxiety and depressive feelings [20,21]. Responses to questions were summed and scaled from 0 to 100, with higher scores indicating lower psychological distress.

Statistical Analysis

Baseline characteristics were summarized using means and standard deviations (SDs) for continuous variables, or as percentages for categorical variables. Baseline characteristics are presented for the total sample and for the subset of participants categorized as “workers,” defined as having paid employment at the 6-month time point. We did not assess baseline work status. The main outcomes, that is, activity impairment outside work, absenteeism, presenteeism, and at-work productivity levels, were presented as percentages with SDs at both the 6-month (short-term follow-up) and the 24-month (long-term follow-up) time points. Given that the 12-month data did not differ from the results at 24 months, these data were not presented. Analyses of activity impairment were conducted in the total sample and stratified by employment status while analyses involving absenteeism, presenteeism, and at-work productivity loss were restricted to subjects working at follow-up. Moreover, one-sample *t*-tests (reference value 0) were used to test for significant differences between 6 and 24 months for all 4 outcomes. We evaluated the correlation between activity impairment outside work and at-work productivity loss at 6 and 24 months with Spearman’s correlation coefficient.

Univariable and multivariable linear and logistic regression was used to examine baseline risk factors (except occupational

classifications) associated with activity impairment outside work and absenteeism, presenteeism, and at-work productivity loss at work 6 and 24 months post-surgery. For the linear regression we used standardized regression coefficients (betas) to examine the relative importance of each coefficient in the model. We also examined change scores between baseline and 6 months, but these did not show any additional clinically or statistically significant findings and therefore these results were not reported. Given that most of the participants reported no absenteeism, this outcome was converted into a binary variable representing no absenteeism vs at least some absenteeism. For each outcome and at both time points a univariate analysis was conducted initially. For the multivariate analysis, we aimed to determine the most parsimonious or best fitting model. Therefore, backward stepwise regression methods were used to identify risk factors associated with each outcome. Complete case analysis was conducted and missing data were excluded listwise. Covariates were removed based on *P*-values (*P*(in) .05; *P*(out) .20) until all remaining covariates demonstrated statistical significance by *P*-value. All analyses were adjusted for age and gender. SPSS version 23 was used to perform the analysis and statistical significance was set at *P* < .05.

Results

Baseline Characteristics

At baseline, 183 participants were under the age of 70 years in STARS and were used for analysis. The mean age of the total sample (including workers and non-workers) was 61.0 (SD 6.3) years, ranging from 46.0 to 70.0, and a majority of subjects (62.3%) were female. The mean body mass index was 31.5 kg/m² and a majority (80%) attended or completed college/technical school or higher. Seventy-six (41.5%) subjects were classified as employed 6 months after TKA surgery. A majority was classified as non-manual workers (55%), which include managers and professionals. Demographic information for the total sample and for the subset of employed participants is presented separately in Table 1.

Table 1
Baseline Characteristics.

Variable	Total Sample (Workers and Non-Workers) (n = 183)	Subsample (Workers) (n = 76)
Age, mean (SD) (range)	61 (6.3) (46-70)	59 (6.0) (46-70)
Gender, n (%)		
Male	69 (37.7)	32 (42.1)
Female	114 (62.3)	44 (57.9)
BMI, mean (SD)	31.5 (7.0)	30.7 (7.2)
Education level, n (%)		
None beyond high school	36 (20.0)	14 (19.0)
Technical school or college	144 (80.0)	59 (81.0)
Occupation, n (%)		
Non-manual	NA	41 (55.4)
Service	NA	23 (31.0)
Manual	NA	10 (13.5)
Pain (WOMAC) (0-100), ^a mean (SD)	45.2 (18.7)	44.7 (19.0)
Pain catastrophizing (PCS) (0-52), ^b mean (SD)	13.1 (11.2)	11.8 (9.0)
Function (WOMAC) (0-100), ^a mean (SD)	46.9 (17.9)	46.4 (16.8)
Psychological distress (MHI) (0-100), ^c mean (SD)	72.5 (19.1)	72.0 (19.2)
Knee-related quality of life (KOOS) (0-100), ^d mean (SD)	25.8 (16.5)	27.1 (15.6)
Health-related quality of life (EQ-5D) (0-1), ^e mean (SD)	0.6 (0.3)	0.6 (0.3)

BMI, body mass index; KOOS, Knee Injury and Osteoarthritis Outcome Score; MHI, Mental Health Inventory; NA, not applicable; PCS, Pain Catastrophizing Scale; QoL, quality of life; SD, standard deviation; WOMAC, Western Ontario McMaster Universities Arthritis Index; EQ-5D, EuroQol 5 Dimensions questionnaire.

^a 0 is no pain or function loss.

^b 0 is no pain catastrophizing.

^c 0 is more psychological distress.

^d 0 is worst knee QoL.

^e 0 is worst health.

Activity Impairment Outside Work

Among the analysis sample, the mean score for impaired activity outside work 6 months post-TKA was 22.8% (SD 23.5, $n = 131$) (Figure 1). By the 24 months post-op time point, the mean score was 17.1% (SD 23.1, $n = 148$), a significant improvement in relation to 6 months (mean difference 5.7%, $P < .001$). Among the employed subgroup, the mean activity impairment at 6 months was 20.5% (SD 23.5, $n = 75$) and 18.0% (SD 23.7, $n = 83$) at 24 months. Among non-workers, the mean activity impairment at 6 months was 25.1% (SD 23.5, $n = 54$) and at 24 months was 16.2% (SD 22.5, $n = 64$).

Absenteeism, Presenteeism, and At-Work Productivity Loss Among Employed Participants

At the 6-month follow-up time point, the mean score for absenteeism was 3.5% (SD 12.5, $n = 72$). Assuming a full-time 40-hour work week (or 160 h/mo), 3.5% absenteeism translates to 5.6 hours sick leave per month. By the 24-month time point, absenteeism was 1.2% (SD 6.3, $n = 73$) or almost 2 hours of sick leave per month based on a full-time work week with a mean difference of 2.3% between both time points ($P = .15$). The mean score for presenteeism was 18.4% (SD 24.6, $n = 73$) 6 months post-TKA, and 14.2% (SD 22.4, $n = 82$) by 24 months post-surgery, which represents a significant reduction (mean difference 4.2%, $P = .001$). Based on a 40-hour work week, 18.4% presenteeism means that about 30 hours of work performance per month was affected by the TKA and 14.2% presenteeism is translated to a reduction of 23 hours in work performance over 1 month. For at-work productivity loss, the mean value was 20.8% (SD 26.1, $n = 70$) at the 6-month time point and 12.9% (SD 20.9, $n = 72$) at 24 months, which was a significant reduction in lost productivity (mean difference 7.9%, $P = .001$) (Figure 1). Based on a 40-hour work week, 20.8% at-work productivity loss can be translated to around 33 hours of at-work productivity loss per month, and 12.9% at-work productivity loss is about 20.6 hours at-work productivity loss per month.

Activity Impairment Outside Work and Work Productivity

At the 6-month follow-up time point, a strong, positive correlation (Spearman correlation coefficient (r_s) = 0.69, $P < .001$) was noted between activity impairment outside work and at-work productivity loss at 6 months. Activity impairment outside work

was also associated with at-work productivity loss at work at 24 months ($r_2 = 0.81$, $P < .001$).

Associations Between Participant Characteristics and Activity Impairment Outside Work

At 6 months post-TKA, significant univariate associations with activity impairment outside work were found with higher levels of pain catastrophizing (beta = 0.35, 95% confidence interval [CI] 0.20-0.61), lower psychological distress (beta = -0.25, 95% CI -0.41 to -0.08), better knee-related quality of life (beta = -0.18, 95% CI -0.39 to -0.01), and better health-related quality of life (beta = -0.22, 95% CI -0.39 to -0.05). In the multivariate model, higher levels of pain catastrophizing were significantly associated (beta = 0.37, 95% CI 0.21-0.64) with more activity impairment.

By 24 months post-TKA, all independent variables except age and gender were significantly associated with activity impairment in the univariate analysis. In the multivariate model, higher levels of pain catastrophizing (beta = 0.28, 95% CI 0.09-0.54) were the strongest risk factors for more activity impairment outside work followed by lower education level attainment (beta = 0.18, 95% CI 0.03-1.01) (Table 2).

Associations Between Patient Characteristics and Absenteeism

In the univariate logistic regression analyses at 6 months, no associations between demographic or clinical characteristics and absenteeism were found. However, in the multivariate model higher levels of pain catastrophizing was significantly associated (odds ratio [OR] 1.10, 95% CI 1.00-1.22) with more absenteeism. In other words, every point increase on the pain catastrophizing scale has a greater odds of 10% of missing at least a day of work. At 24-month follow-up, lower educational level (OR 0.03, 95% CI 0.003-0.37) and higher levels of pain catastrophizing (OR 1.14, 95% CI 1.03-1.27) were associated with more absenteeism in the univariate analyses, but neither factor appeared statistically significant in the multivariate analysis (see Table 3).

Associations Between Patient Characteristics and Presenteeism

In the univariate analysis, higher levels of pain catastrophizing (beta = 0.38, 95% CI 0.17-0.79) and lower health-related quality of life (beta = -0.24, 95% CI -0.43 to -0.01) were associated with more presenteeism 6 months post-surgery. In the multivariate

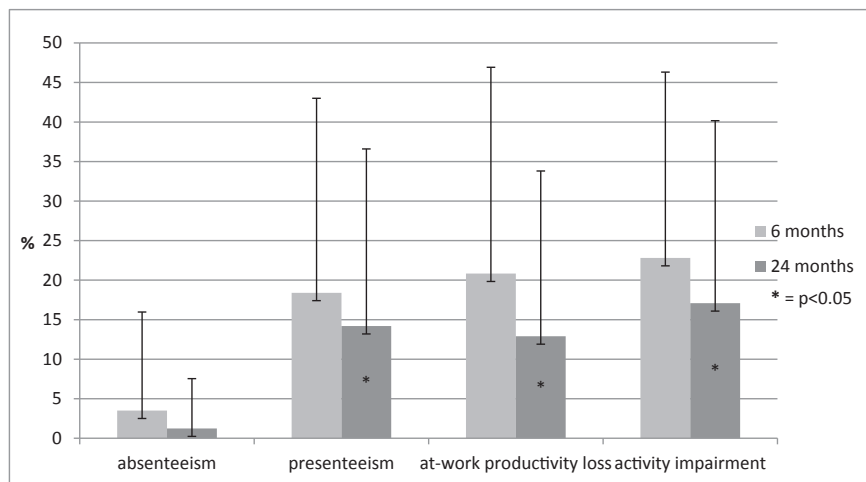


Fig. 1. Absenteeism, presenteeism, at-work productivity loss, and activity impairment at 6 and 24 months.

Table 2
Univariate and Multivariate Linear Regression Analysis of Associations Between Baseline Patient Characteristics and Activity Impairment at 6 and 24-mo Follow-Up.

Patient Characteristics	Univariate 6 mo			Multivariate 6 mo (n = 104)		Univariate 24 mo			Multivariate 24 mo (n = 119)	
	Beta ^a (95% CI)	P-Value	N	Beta (95% CI)	P-Value	Beta (95% CI)	P-Value	N	Beta (95% CI)	P-Value
Age (y)	−0.08 (−0.26 to 0.09)	.34	131			−0.12 (−0.30 to 0.05)	.15	148		
Female	−0.05 (−0.22 to 0.12)	.57	131			−0.10 (−0.17 to 0.15)	.90	148		
Low education level	0.14 (−0.03 to 0.33)	.11	128			0.25 (0.09–0.41)	.003	146	0.18 (0.03–1.01)	.04
Pain (WOMAC) (0–100) ^b	0.08 (−0.10 to 0.26)	.39	130			0.21 (0.05–0.39)	.01	147		
Pain catastrophizing (PCS) (0–52) ^c	0.35 (0.20–0.61)	<.001	108	0.37 (0.21–0.64)	<.001	0.39 (0.26–0.64)	<.001	124	0.28 (0.09–0.54)	.006
Function (WOMAC) (0–100) ^b	0.14 (−0.03 to 0.33)	.11	131			0.19 (0.03–0.36)	.02	148		
Psychological distress (MHI) (0–100) ^d	−0.25 (−0.41 to −0.08)	.01	130			−0.24 (−0.42 to −0.08)	.003	147		
Knee-related quality of life (KOOS) (0–100) ^e	−0.18 (−0.39 to −0.01)	.04	130			−0.20 (−0.38 to −0.04)	.01	147		
Health-related quality of life (EQ-5D) (0–1) ^f	−0.22 (−0.39 to −0.05)	.01	129			−0.26 (−0.45 to −0.11)	.001	145	−0.14 (−0.36 to 0.06)	.16

CI, confidence interval; KOOS, Knee Injury and Osteoarthritis Outcome Score; MHI, Mental Health Inventory; PCS, Pain Catastrophizing Scale; QoL, quality of life; WOMAC, Western Ontario McMaster Universities Arthritis Index; EQ-5D, EuroQol 5 Dimensions questionnaire.

Bolded values represents significant associations ($P < .05$).

^a Betas represent standardized regression coefficients.

^b 0 is no pain or function loss.

^c 0 is no pain catastrophizing.

^d 0 is more psychological distress.

^e 0 is worst knee QoL.

^f 0 is worst health.

Table 3
Univariate and Multivariate Logistic Regression Analysis of Associations Between Baseline Patient Characteristics and Absenteeism at 6 and 24-mo Follow-Up.

Patient Characteristics	Univariate 6 mo			Multivariate 6 mo (n = 54)		Univariate 24 mo			Multivariate 24 mo (n = 58)	
	OR (95% CI)	P-Value	N	OR (95% CI)	P-Value	OR (95% CI)	P-Value	N	OR (95% CI)	P-Value
Age (y)	1.02 (0.91–1.14)	.72	72			1.17 (0.93–1.48)	.17	73		
Female	0.40 (0.11–1.50)	.17	72			0.27 (0.03–2.75)	.27	73		
Low education level	1.09 (0.20–5.87)	.92	69			0.03 (0.003–0.37)	.006	71		
Pain (WOMAC) (0–100) ^a	0.99 (0.96–1.03)	.83	71	0.96 (0.92–1.01)	.13	0.99 (0.94–1.05)	.76	72		
Pain catastrophizing (PCS) (0–52) ^b	1.04 (0.97–1.12)	.23	57	1.10 (1.00–1.22)	.04	1.14 (1.03–1.26)	.01	62		
Function (WOMAC) (0–100) ^a	1.02 (0.98–1.06)	.39	72			0.98 (0.93–1.04)	.46	73		
Psychological distress (MHI) (0–100) ^c	1.00 (0.97–1.04)	.82	71			0.98 (0.93–1.03)	.44	72		
Knee-related quality of life (KOOS) (0–100) ^d	0.95 (0.91–1.00)	.06	71			1.03 (0.96–1.10)	.36	72		
Health-related quality of life (EQ-5D) (0–1) ^e	0.19 (0.02–1.70)	.14	71			0.58 (0.01–36.28)	.80	71		

CI, confidence interval; KOOS, Knee Injury and Osteoarthritis Outcome Score; MHI, Mental Health Inventory; OR, odds ratio; PCS, Pain Catastrophizing Scale; QoL, quality of life; WOMAC, Western Ontario McMaster Universities Arthritis Index; EQ-5D, EuroQol 5 Dimensions questionnaire.

Bolded values represents significant associations ($P < .05$).

^a 0 is no pain or function loss.

^b 0 is no pain catastrophizing.

^c 0 is more psychological distress.

^d 0 is worst knee QoL.

^e 0 is worst health.

model, higher pain catastrophizing remained significantly associated with more presenteeism at 6 months (beta = 0.42, 95% CI 0.22–0.84).

At the 24-month follow-up time point, the univariate analysis showed that lower education attainment (beta = 0.32, 95% CI 0.13–0.63), higher levels of pain catastrophizing (beta = 0.55, 95% CI 0.39–0.81), and lower health-related quality of life (beta = –0.29, 95% CI –0.46 to –0.07) were significantly associated with more presenteeism. In the multivariate model, higher levels of pain catastrophizing (beta = 0.38, 95% CI 0.21–0.68) was the strongest risk factor for more presenteeism, followed by lower education level (beta = 0.35, 95% CI 0.19–0.66) and worse WOMAC pain (beta = 0.25, 95% CI 0.21–0.49) (see Table 4).

Associations Between Participant Characteristics and At-Work Productivity Loss

In the univariate analysis, female gender (beta = –0.27, 95% CI –0.49 to –0.04) was associated with lower at-work productivity loss. Moreover, the univariate analysis revealed that higher levels of pain catastrophizing (beta = 0.38, 95% CI 0.15–0.76), lower knee-related quality of life (beta = –0.29, 95% CI –0.55 to –0.06), and lower health-related quality of life (beta = –0.28, 95% CI –0.46 to –0.04) were associated with higher at-work productivity loss 6 months post-operatively. The multivariate model revealed only higher levels of pain catastrophizing (beta = 0.44, 95% CI 0.23–0.83) to be significantly associated with higher at-work productivity loss.

At 24-month follow-up, lower education level (beta = 0.36, 95% CI 0.17–0.72) and higher levels of pain catastrophizing (beta = 0.48, 95% CI 0.29–0.83) were associated with higher at-work productivity loss in the univariate analysis. Lower education level (beta = 0.45, 95% CI 0.27–0.81) was the strongest risk factor for higher at-work productivity loss, followed by higher pain catastrophizing (beta = 0.33, 95% CI 0.12–0.61) in the multivariate model (see Table 5).

Discussion

This study examined activity impairment and work productivity following TKA surgery. At 6 months post-surgery, study participants experienced substantial activity impairment outside work and both presenteeism and at-work productivity loss, but low levels of absenteeism. Extending follow-up of these subjects another 18 months revealed sharp reductions in activity impairment and work productivity loss, although impairments and work productivity loss still existed. Absenteeism remained low. In particular, less educated participants and those reporting higher levels of pre-operative pain catastrophizing were more prone to experience impairments during activities and higher work productivity losses.

Participants reported a substantial proportion of activity impairment outside work. To our knowledge, this is the first study that examined activity impairment among those undergoing TKA. Until recently, impairments in physical functioning were identified with instruments, such as WOMAC or KSS. Huang et al [22] examined change in WOMAC scores in a slightly older TKA study population (mean age 70 years) and found that while total WOMAC scores fell dramatically from a mean pre-op value of 56.8 to post-op value of 20.4, substantial limitations in daily functioning remain. Moreover, working-aged TKA recipients reported high residual symptoms [23,24]. Following TKA, kneeling has been found to be the second most important activity to patients, and the second most difficult activity to perform, behind squatting. The failure to restore the ability to kneel and squat contribute to impairments in daily functioning, most notably involving household activities, or when engaging in sporting or gardening-related activities [25].

These residual symptoms could also have played a role in the activity impairment found in the present study.

Higher activity impairment outside work was strongly correlated with higher at-work productivity loss. This analysis was conducted to demonstrate the inter-correlated relationship between impairments both outside and at work and the presence of activity impairment might also be indicative of at-work productivity loss [26].

Among the subgroup of participants that returned to work after surgery, absenteeism due to their TKA remained low over the 2 years of follow-up. This finding, however, is markedly different compared to TKA patients living in Europe who report substantially higher (approximately 3 days per month) sick leave levels 2 years after surgery [12]. This finding is likely due to differences in social security systems [27,28]. The United States is the only industrialized country without universal sick leave coverage and on average, only 55% of all employees have a sick leave coverage [29]. In contrast, European countries' sick leave insurance is well covered and obligatory. As a result, about 3 million US employees go to work while sick, mainly due to not being able to afford the loss in income. Consequently, absenteeism levels in the United States are the lowest worldwide [29]. Furthermore, European workers retire, on average, at 64.3 years while persons in the United States tend to work until older ages [30].

This analysis is the first to examine the constructs of presenteeism and at-work productivity loss among TKA patients during a follow-up period of 2 years. Although Sankar et al [11] examined workplace activity limitations, their limitations could not be translated into productivity losses such as presenteeism or at-work productivity loss. We showed a significant improvement in presenteeism and at-work productivity loss over a 2-year period. Although this is a positive finding, a substantial proportion of impairment still exists even after 2 years. This can be considered problematic, as work impairments are associated with a high economic burden whereby productivity costs account for 83% of the total costs [31].

Pre-operative pain catastrophizing, a reflection of stress and coping characterized by negative thoughts about pain, rumination about pain, and helplessness in coping with pain [32], was significantly associated with activity impairment, presenteeism, and at-work productivity loss at both 6 and 24 months post-operatively. Unsurprisingly, an examination of activity and at-work limitations among only subjects with high PCS scores (≥ 16) revealed higher levels of all outcomes compared to the analysis sample. Catastrophizers reported 32.3% (n = 33) activity impairment, 2.4% (n = 16) absenteeism, 29.4% (n = 16) presenteeism, and 31.8% (n = 15) at-work productivity loss at 6 months. At 24 months these levels of activity impairment, presenteeism, and at-work productivity loss decreased to 30.0% (n = 35), 31.7% (n = 22), and 28.2% (n = 16) respectively. Absenteeism levels increased to 5.3% (n = 17) at 24 months. These findings show that this small group of high pain catastrophizers scored at least twice as high on these outcomes compared to the analysis sample. These results are consistent with the literature involving clinical outcome measures such as pain and function. Two meta-analyses among TKA patients found that pain catastrophizing was associated with significantly higher pain levels post-operatively and lower knee functions [33,34]. Moreover, pre-operative pain catastrophizing exerts an effect for months to years [34], as we also found in the present study. The present study adds to the knowledge base that pain catastrophizing is also strongly associated with activity impairment and work productivity loss outcomes.

Previous studies have found that pain catastrophizing can be modified with a broad range of interventions in a variety of surgical patients [35]. Although in other patient groups, patient education,

Table 4

Univariate and Multivariate Linear Regression Analysis of Associations Between Baseline Patient Characteristics and Presenteeism at 6 and 24-mo Follow-Up.

Patient Characteristics	Univariate 6 mo			Multivariate 6 mo (n = 56)		Univariate 24 mo			Multivariate 24 mo (n = 65)	
	Beta ^a (95% CI)	P-Value	N	Beta (95% CI)	P-Value	Beta (95% CI)	P-Value	N	Beta (95% CI)	P-Value
Age (y)	−0.08 (−0.33 to 0.17)	.51	73			0.02 (−0.22 to 0.27)	.85	82		
Female	−0.21 (−0.43 to 0.02)	.07	73			−0.09 (−0.30 to 0.12)	.43	82		
Low education level	0.05 (−0.30 to 0.19)	.68	70			0.32 (0.13–0.63)	.003	80	0.35 (0.19–0.66)	.001
Pain (WOMAC) (0–100) ^b	−0.03 (−0.26 to 0.20)	.79	72			0.17 (−0.05 to 0.41)	.12	82	0.25 (0.21–0.49)	.01
Pain catastrophizing (PCS) (0–52) ^c	0.38 (0.17–0.79)	.003	58	0.42 (0.22–0.84)	<.001	0.55 (0.39–0.81)	<.001	69	0.38 (0.21–0.68)	<.001
Function (WOMAC) (0–100) ^b	0.15 (−0.09 to 0.40)	.21	73			0.19 (−0.03 to 0.40)	.09	82		
Psychological distress (MHI) (0–100) ^d	−0.15 (−0.38 to 0.08)	.21	72			−0.16 (−0.40 to 0.07)	.16	81		
Knee-related quality of life (KOOS) (0–100) ^e	−0.17 (−0.43 to 0.07)	.15	73			−0.16 (−0.38 to 0.06)	.15	81		
Health-related quality of life (EQ-5D) (0–1) ^f	−0.24 (−0.43 to −0.01)	.04	73			−0.29 (−0.46 to −0.07)	.009	80		

CI, confidence interval; KOOS, Knee Injury and Osteoarthritis Outcome Score; MHI, Mental Health Inventory; PCS, Pain Catastrophizing Scale; QoL, quality of life; WOMAC, Western Ontario McMaster Universities Arthritis Index; EQ-5D, EuroQol 5 Dimensions questionnaire.

Bolded values represents significant associations ($P < .05$).

^a Betas represent standardized regression coefficients.

^b 0 is no pain or function loss.

^c 0 is no pain catastrophizing.

^d 0 is more psychological distress.

^e 0 is worst knee QoL.

^f 0 is worst health.

Table 5

Univariate and Multivariate Linear Regression Analysis of Associations Between Baseline Patient Characteristics and At-Work Productivity Loss at 6 and 24-mo Follow-Up.

Patient Characteristics	Univariate 6 mo			Multivariate 6 mo (n = 53)		Univariate 24 mo			Multivariate 24 mo (n = 57)	
	Beta ^a (95% CI)	P-Value	N	Beta (95% CI)	P-Value	Beta (95% CI)	P-Value	N	Beta (95% CI)	P-Value
Age (y)	−0.08 (−0.35 to 0.17)	.50	70			0.09 (−0.15 to 0.37)	.41	72		
Female	−0.27 (−0.49 to −0.04)	.02	70			−0.19 (−0.41 to 0.05)	.11	72		
Low education level	0.03 (−0.29 to 0.22)	.79	67			0.36 (0.17–0.72)	.002	70	0.45 (0.27–0.81)	<.001
Pain (WOMAC) (0–100) ^b	−0.002 (−0.24 to 0.23)	.99	69			−0.002 (−0.26 to 0.25)	.99	71		
Pain catastrophizing (PCS) (0–52) ^c	0.38 (0.15–0.76)	.005	55	0.44 (0.23–0.83)	.001	0.48 (0.29–0.83)	<.001	61	0.33 (0.12–0.61)	.005
Function (WOMAC) (0–100) ^b	0.20 (−0.04 to 0.45)	.10	70			0.01 (−0.23 to 0.26)	.93	72		
Psychological distress (MHI) (0–100) ^d	−0.17 (−0.40 to 0.06)	.15	69			0.001 (−0.26 to 0.26)	.99	71		
Knee-related quality of life (KOOS) (0–100) ^e	−0.29 (−0.55 to −0.06)	.02	70			−0.06 (−0.28 to 0.17)	.63	71		
Health-related quality of life (EQ-5D) (0–1) ^f	−0.28 (−0.46 to −0.04)	.02	70			−0.06 (−0.29 to 0.17)	.60	70		

CI, confidence interval; KOOS, Knee Injury and Osteoarthritis Outcome Score; MHI, Mental Health Inventory; PCS, Pain Catastrophizing Scale; QoL, quality of life; WOMAC, Western Ontario McMaster Universities Arthritis Index; EQ-5D, EuroQol 5 Dimensions questionnaire.

Bolded values represents significant associations ($P < .05$).

^a Betas represent standardized regression coefficients.

^b 0 is no pain or function loss.

^c 0 is no pain catastrophizing.

^d 0 is more psychological distress.

^e 0 is worst knee QoL.

^f 0 is worst health.

physiotherapy, cognitive behavioral therapy, and pharmacological treatment have shown clinically important reductions in catastrophizing. Among TKA patients, 2 trials by Riddle et al (2011, 2019) [36,37] found reductions in pain catastrophizing in both the intervention (patient education, cognitive behavioral therapy and psychologist-directed therapy) and control (TKA surgery) groups. These findings suggest that TKA surgery has a large, primary effect on pain catastrophizing and that secondary psychological interventions do not necessarily add an extra effect in these patients. In our study, we also found a large reduction in pain catastrophizing scores as assessed with the PCS in the analysis sample (mean change 6.8, SD 8.9) after TKA surgery, although a clinically important improvement in pain catastrophizing among TKA patients have reported to be 9.1 [35,36].

Strengths and Limitations

The strength of our study is the longitudinal design and the collection of data through 24 months post-TKA. Until now, most studies in TKA patients used a cross-sectional design or presented results solely based on a short-term follow-up period [10,38,39]. The current study included participants from several different geographic regions in the United States, creating a more representative study population. Moreover, it includes a broad spectrum of demographic and clinical characteristics. Study limitations include the lack of pre-operative WPAI data collection and post-operative assessment of complications, which limits the interpretability of post-operative WPAI levels.

Implications and Recommendations

The proportion of working-aged persons undergoing TKA continues to increase and it is expected that the average age of TKA recipients will drop slightly in the future as surgery will be performed increasingly in younger individuals. Given the substantial proportion of activity impairment and work productivity loss found in the present study, working-aged patients are in need of more active guidance during the rehabilitation process. Provision and appropriate timing of rehabilitation interventions that target activity impairment and work productivity are critical to maximize outcomes [40]. Currently, post-op rehabilitation programs focusing on pain and functional improvements have not yet been adapted for working-aged TKA patients. Regarding the impairments at the workplace examined in the present study, together with recent literature concerning RTW after TKA surgery [11,41], active referrals to occupational physicians should be supported to assess patient circumstances so that a plan can be created that provides recommendations to prevent post-operative impairments in work. The need for an intervention on pain catastrophizing is underlined by the present study. In addition, further research on interventions to modify or change pain catastrophizing is warranted among TKA patients.

More studies are needed focusing on the impact of impairments on activities and work productivity in TKA patients. Beyond the scope of impairments, more information is needed on the types of impairments and specifically where gains can be made for patients so that interventions aimed at improving outcomes can be designed and evaluated. The interventions should target not only work productivity, but also activity impairments outside work because better outcomes are related to better work productivity and vice versa as shown in this study. Finally, our finding that subjects with high levels of pain catastrophizing report higher levels of impairments in daily functioning and work productivity losses necessitates further research to identify interventions that might improve these outcomes for these patients. We also

encourage further identification of prognostic factors, such as work-related factors, to improve impairments in daily functioning and at work.

Conclusion

Six months after TKA surgery, participants still experienced a substantial proportion of activity impairment and work productivity loss, although absence due to their TKA was low. Two years post-operatively, the proportion of subjects reporting activity impairment and work productivity loss decreased significantly, but TKA recipients continued to experience activity impairments and work productivity losses. Post-operative rehabilitative care should be modified to provide strategies to reduce and eventually prevent impairments in daily functioning and work productivity losses. In particular, individuals reporting high levels of pain catastrophizing pre-operatively may benefit from targeted guidance during rehabilitation to reduce and prevent high impairments during activities and work productivity loss.

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