

ORIGINAL ARTICLE

Prevalence and Risk Factors of Patellofemoral Pain in an Automobile Manufacturing Factory

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ABSTRACT

Introduction: Patellofemoral Pain (PFP) in workers is a common musculoskeletal problem that has a significant financial impact on industrial companies. The objective of this study was to investigate the prevalence of PFP, its demographic, occupational, and psychosocial risk factors, and the association of genu varum with PFP. **Methods:** In this cross-sectional study, simple random sampling was used to select 1570 male workers in a large Iranian automobile manufacturing company. Demographic, occupational, and psychosocial data were collected through self-report questions. There were also questions about any occurrence of PFP during the past year. The medial tibial intercondylar distance was measured, and a distance of more than 60 mm was defined as genu varum. **Results:** The prevalence of PFP occurrence in the past year was 34.9%, and the prevalence of genu varum was 14%. The prevalence of PFP occurrence in the past year was associated with salary ($P<0.001$), the job satisfaction ($P<0.001$), duration of standing per day ($P<0.001$), duration of walking per day ($P=0.042$), carrying loads ($P<0.001$), getting physical exercise ($P<0.001$), and genu varum ($P<0.001$). Age, weight, height, body mass index (BMI), work duration, and having a second job were not associated with PFP. There was an association between job satisfaction and having a non-sedentary job. Logistic regression revealed job satisfaction, duration of standing, and genu varum as predictors of PFP. **Conclusion:** The prevalence of PFP was high in this automobile manufacturing company workers. This was the first study of the prevalence of genu varum and its association with PFP in Iran. The results show an association between genu varum and PFP. However, according to the results of this study and similar studies in other countries, further investigations of PFP and its risk factors are a necessity.

Keywords: Patellofemoral pain, Genu varum, Job satisfaction, Intercondylar distance

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INTRODUCTION

Patellofemoral Pain (PFP) is a prevalent musculoskeletal disorder. A meta-analysis showed the prevalence of PFP to be 22.7% in the general population and 28.9% in adolescents (1). A recent study in Iran showed a prevalence of 29.9% for chronic knee pain in the general population (2). PFP is a known reason for absenteeism from work (3).

PFP characterized by an aching pain in the peri-patellar region is an overuse injury that is exacerbated by physical activities such as squatting, climbing stairs, jumping, running, or by sitting in knee-flexed positions for prolonged periods of time (4).

The association of different categories of risk factors with PFP has been studied. Several parameters

impact the pathogenesis of PFP. These risk factors are subcategorized as intrinsic and extrinsic risk factors (5). Although there are many original and review studies about PFP, most of them focus on intrinsic factors (6-9). A systematic review showed the main associated risk factors of PFP were high body mass index, female gender, older age, remaining in a kneeling position, and lifting objects at work (10).

A French prospective study showed associations between the incidence of PFP, handling loads more than 4kg, and kneeling more than 2 hours a day; however, this study did not find any associations between job categories, standing for a long time, and PFP (11).

Genu varum deformity is a prevalent knee deformity that is studied more in children and adolescents (12, 13). Genu varum is a known reason for malalignment. (14) Genu varum deformity is mentioned as a risk factor for PFP and knee osteoarthritis (15). Radiographic studies have shown an association between varus deformity and osteoarthritis (16). Despite these studies, a longitudinal 35-year study did not show any association between

genu varum and PFP (17).

Few studies have investigated the association between occupational and psychosocial factors such as job satisfaction and PFP. A British study reported an association between job satisfaction and musculoskeletal disorders such as knee pain (18). A small study in Iran showed an association between job satisfaction and musculoskeletal disorders among office workers, although the sample size was too small (N=81). Despite the wide variety of studies, the results of different aspects of PFP are contradictory, which indicates the need for further research. This study was conducted in the workers of an Iranian automobile factory to evaluate the prevalence of PFP and genu varum, their demographic, occupational, and psychosocial risk factors, and the effect of genu varum on PFP.

MATERIALS AND METHODS

The target population of this cross-sectional study was automobile manufacturing factory workers. During the course of the annual medical examinations, 1570 workers participated in the study and a general practitioner examined them for knee pain and asked them questions about PFP and its risk factors.

We collected demographic, occupational, psychosocial, and PFP data. Demographic data included age, weight, height, and the amount of physical exercise. Occupational data included recent and previous occupations, duration of working, having more than one job, duration of standing on foot at work, and carrying loads. Psychosocial data included satisfaction with the job, which was evaluated using a 0-10 visual analogue scale (VAS), and salary. The data on PFP and use of drugs for PFP in the past year were also collected.

In collaboration with the Health and Safety Department of the Company, we received the job analysis of all participants and divided them into sedentary and non-sedentary workers. The tibial medial intercondylar distance was measured in millimeters by calipers. In

our study, genu varum was defined as the tibial medial intercondylar distance of more than 60 mm. However, there are different classifications for genu varum (19, 20), none of which is considered definitive.

The study was approved by the Ethics Committee of Tehran University of Medical Sciences (ethical code: IR.TUMS.MEDICINE.REC 1395.2851)

Statistical analysis

The collected data were analyzed with SPSS version 20 (SPSS, Chicago, IL, USA), using the independent T-test and chi-square analysis. Modeling was done with logistics regression.

The results are presented as mean (standard deviation) for continuous variables and frequency (percentage) for discrete variables. We divided samples into participants with and without PFP. Univariate analysis, the independent T-test, and chi-square test were applied to assess associations. P values less than 0.05 were considered significant.

In logistic regression analysis, we entered and analyzed different demographic, psychosocial, and occupational data considering PFP in the past year as a dependent variable.

RESULTS

The mean (SD) age of the study population was 38.8 (5.4) years. The mean (SD) years of employment in their current job was 12.6 (5.5) years. The mean BMI(kg/m²) was 27 (3.5). All participants were male.

Prevalence and risk factors of PFP

At least one occurrence of PFP during the past year was reported by 548 (34.9%) participants. The participants were divided into workers who did and workers who did not have PFP during the past year. As showed in table I and table II, we compared all variables between the two groups. Table I contains numeric variables analyzed with the T-test, and table II shows categorical variables analyzed with the chi-square method. The

Table I: Demographic, occupational and psychosocial factors data and association with PFP

	Total N=1570		Without PFP (N=1022) Mean(SD)	With PFP (N=548) Mean(SD)	PF- p-value
	Mean(SD)	Min-max			
Age (year)	38.8 (5.4)	25-68	38.9 (5.2)	38.8 (5.6)	0.702
Weight(Kg)	83.2 (12.4)	47-155	83.2 (12.6)	83.1 (11.9)	0.781
Height(CM)	175.5 (6.5)	146-198	175.4 (6.6)	175.5 (6.3)	0.834
BMI	27.0 (3.5)	14.51-43.16	27.0 (3.6)	26.9 (3.4)	0.632
Work duration in recent job (year)	12.6 (5.5)	1-31	12.6 (5.6)	12.6 (5.3)	0.901
Salary(USD)	480 (16)	180-2000	491 (16)	463 (15)	<0.001
Job satisfaction(VAS)	6.3 (2.4)	0-10	6.8 (2.2)	5.4 (2.5)	<0.001
Duration of standing at work per shift (hour)	5.6 (2.8)	0-12	5.3 (2.5)	6.2 (2.7)	<0.001
Time of walking per shift(hour)	1.2 (0.8)	0-3	1.1 (0.8)	1.2 (0.8)	0.042

Table II: Demographic, occupational and psychosocial factors data and association with PFP

		Without PFP (N=1022)	With PFP (N=548)	P-value	Odds ratio	95% C.I.	
		N (%)	N (%)			Lower	Upper
Second job	Yes (N=79)	48(60.8)	31(39.2)	0.411	1.21	0.76	1.93
	No(N= 1438)	939(65.3)	499(34.7)				
Load carriage	Yes(N=535)	308(57.6)	227(42.4)	<0.001	1.65	1.32	2.04
	No(N=1012)	699(69.1)	313(30.9)				
Doing physical exercise	Yes(N=196)	146(74.5)	50(25.5)	<0.001	0.59	0.42	0.84
	No(N=1311)	832(63.5)	479(36.5)				
non-sedentary job	Yes(N=925)	568(61.4)	357(38.6)	<0.001	1.41	1.19	1.82
	No(N=638)	447(70.1)	191(29.9)				
Genu varum	Yes(N=219)	115(52.5)	104(47.5)	<0.001	1.83	1.37	2.45
	No(N=1344)	900(67.0)	444(33.0)				

results revealed that PFP was associated with salary, job satisfaction, duration of standing per shift, duration of walking per shift, duration of load carrying per shift, and physical exercise. PFP had no association with age, weight (kg), height (m), BMI (kg/m²), and working more than one job. There was a significant association between job satisfaction and non-sedentary work.

Genu varum and PFP

Considering the cut-off point (60 mm), 220 workers (14%) had genu varum. This deformity was associated with PFP in univariate analysis (P<0.001). Genu varum was associated with weight, job satisfaction, and duration of standing.

Non-sedentary job and PFP

Nine hundred and twenty-five workers (59.1%) had non-sedentary jobs. The prevalence of PFP was significantly higher in those participants who had non-sedentary jobs (P<0.001, OR: 1.41)

Results of logistic regression analysis

Despite the significance of multiple variables in univariate analysis, as shown in table III, only three variables (job satisfaction, duration of standing, and genu varum) served as predictors of PFP. The R-square was 0.112 in the Negelkerke modelling method.

Table III: Logistic regression analysis

	B	S.E.	Sig.	Exp(B)	95% C.I. for EXP(B)	
					Lower	Upper
Job satisfaction (VAS)	-.214	.028	.000	.807	.764	.853
time of standing (hour)	.084	.026	.001	1.088	1.034	1.145
Genu varum	.477	.173	.006	1.611	1.147	2.262
Constant	.179	.258	.487	1.197		

DISCUSSION

In this study, we investigated the prevalence and risk factors of PFP in automobile manufacturing workers. The prevalence of PFP in this group was higher than that in the general Iranian population (34.9% vs 29.9%) (2, 19), but it was not higher than the prevalence of PFP in Iranian sugar manufacturing workers, truck drivers, and office workers (20-22). The lower prevalence of knee pain in automobile manufacturing workers compared to office workers may be due to the healthy worker effect: healthier workers choose heavier jobs (23). Moreover, the higher prevalence of knee pain in office workers may be related to the weakness of quadriceps muscle due to prolonged sitting. It has been shown that the strength of the quadriceps muscle plays a role in PFP, and it is clear that office workers' prolonged immobility during work leads to a decline in the strength of the quadriceps muscle (24-26).

With regards to different etiologies of genu varum, it is not possible to discuss the etiology of genu varum in a cross-sectional study in adults, but since there are no employment criteria or pre-employment exams regarding genu varum, our result may imply its prevalence in the general male population. This was the first study on the prevalence of genu varum in an adult Iranian population.

In the non-occupational category, age, weight, height, and BMI had no association with PFP, while physical exercise and genu varum had an association with PFP. Our findings regarding age can be related to the mean age of our participant that was 38.8 (5.4) years. A prospective study showed no increase in the prevalence of PFP in the age group 35-44 years old, while it was more prevalent in older age groups, with osteoarthritis being the most important pathology (27).

Our study showed neither height nor weight to be

associated with PFP. This finding is consistent with a pooled analysis of six studies that showed height and weight were not predictors of PFP(8). The results for BMI were similar to the results of height and weight.

Contrary to some previous studies (27), we found an association between physical exercise and PFP. The prevalence of PFP was lower in subjects who exercised.

Few studies have assessed the effect of genu varum on knee pain, especially in an occupational setting. Zayer et al., who conducted a longitudinal study on healthy individuals in Sweden with a follow-up duration of 35 years, did not find any association between genu varum and PFP (17), while a study in infantry recruits showed an increased intercondylar distance as a prospective risk factor for PFP (28). The most critical problem in the study by Zayer is the age group, since PFP mostly starts at ages above this age range. Our findings were consistent with the results of the study on infantry recruits, which indicated an increase in the prevalence of PFP as well as increased intercondylar distance ($p < 0.001$).

In the occupational category, workers' satisfaction with their job was a protective factor for PFP. This finding confirmed the results of a previous study, indicating an association between job satisfaction and PFP (18). A meta-analysis of job satisfaction on nurses showed high-demand, low-control jobs increased the risk of knee pain (OR= 2.1) (29). The salary was another variable associated with PFP. It was not a predictor in regression analysis and may be a part of job satisfaction.

Our study showed an association between carrying loads at work and PFP in workers; however, this finding was not consistent with the results of a study by Miranda et al., which did not find any associations between PFP and frequency of lifting objects during work hours (27). Further investigations seem to be needed.

Our study showed an association between non-sedentary jobs and PFP. In the study by Miranda, although highly strenuous jobs were associated with PFP, they were a non-significant predictor in the multivariable model, which may be related to the unclear definition of highly strenuous jobs. It may also be related to a theory proposed by Jensen et al., arguing that knee-straining work positions seem to be more important risk factors compared to the overall physical workload (30).

In univariate analysis, job satisfaction measured by the VAS was associated with PFP. It should be noted that non-sedentary jobs had a direct association with job satisfaction ($P < 0.001$). The reason for the association between PFP and job satisfaction may be that subjects with non-sedentary jobs have lower job satisfaction. Therefore, having a non-sedentary job is a confounding factor in this association.

CONCLUSION

We concluded that PFP is a prevalent musculoskeletal disorder that is associated with occupational and non-occupational factors. This study has been one of the few studies that measured the bicondylar distance to diagnose genu varum, and concluded that genu varum is associated with PFP. Despite multiple original studies and systematic review studies on PFP and its risk factors, there still are conflicting results and, therefore, further investigations are needed, especially in the occupational category. More studies are required to determine the causal association of genu varum, as a prevalent deformity, with PFP. Finding this association will help in fitness-to-work examinations and can prevent some PFP cases and decrease PFP-related lost workdays. The limitations of this study include that this is a cross-sectional design study. Longitudinal and cohort studies can provide more comprehensive information about the nature of musculoskeletal disorders. Although measuring the bicondylar distance was one of the unique features of our study, it should be considered that there are more accurate methods for this purpose than what we employed, such as measuring the Q angle by X-ray studies.

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