
ORIGINAL RESEARCH

DEMOGRAPHIC AND EPIDEMIOLOGICAL TRENDS IN PATELLOFEMORAL PAIN

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ABSTRACT

Background: Understanding the demographics of patellofemoral pain is important to determine the best practices in diagnosis and treatment of this difficult pathology. The occurrence of patellofemoral pain has been reported from isolated sports medicine clinics and from within the military, but its incidence has never been examined in the general population within the United States.

Purpose: The purpose of this study was to examine the reported occurrence of patellofemoral pain for those individuals seeking medical care and to compare that to all other pathologies that result in anterior knee pain, such as tendinopathies, patella subluxation, osteoarthritis, or meniscal and bursal conditions. Occurrence rates were examined across sex, age and region within a large healthcare provider database that contains over 30 million individuals.

Methods: Data were queried with the PearlDiver Patient Record Database, a national database containing orthopedic patient records. Two common International Classification of Disease, Ninth Revision (ICD-9) codes for patellofemoral pain (717.7 – Patella Chondromalacia and 719.46 – Pain in joint, lower leg) were utilized and were searched from the years 2007-2011. The top twenty additional ICD-9 codes that were concurrently coded with 717.7 and 719.46 were removed from the data. Chi-squared and Mantel-Haenszel tests were utilized to identify statistically significant differences in the diagnosis of patellofemoral pain between sex, age, and year.

Results: During this five-year period, there were 2,188,753 individuals diagnosed with patellofemoral pain. The diagnosis was more common in females compared to males with 1,211,665 and 977,088 cases respectfully ($p < 0.001$). Statistically significant differences between ages was found, with 50-59 year olds having the most cases with 578,854, $p < 0.001$. And, during the five-year examination period, there was a steady increase between 2007-2011, $p < 0.01$.

Conclusion: Patellofemoral pain was diagnosed between 1.5% and 7.3% of all patients seeking medical care within the United States. Females experienced patellofemoral pain more often than males and there was a steady increase of cases in the United States during the 2007-2011 examination period. The diagnosis of patellofemoral pain increased with age and the 50-59 year old age group had the most cases.

Keywords: Anterior knee pain, chondromalacia, epidemiology

Level of Evidence: 2b

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INTRODUCTION

Patellofemoral Pain (PFP) is an overuse condition that increases pain and compressive force on the patellofemoral joint with activity and is generally not linked to trauma or known intra-articular damage to the knee.¹⁻⁶ PFP is also commonly referred to as anterior knee pain or chondromalacia patella, however while these conditions often present with similar symptoms and are exacerbated by similar activities, the subtle differences in improper interchanging nomenclature creates difficulty in the description of this pathology.^{7,8} Anterior knee pain is a generic term that can incorporate PFP as well as anterior knee pathologies such as a plica, fat pad fibrosis or bursitis compared to chondromalacia patella which requires softening or damage to the cartilage under the patella.⁹⁻¹¹ PFP is specifically pain to the retro- or peri-patellar area during an array of activities ranging from prolonged sitting, squatting, to jumping and running.¹²⁻¹⁷ Those experiencing PFP often have major limitations of daily activities, work, and athletic participation. It has been reported that 74% of individuals experiencing PFP will limit or stop sport participation due to their painful symptoms.¹⁸⁻²⁰ Emerging evidence suggests that PFP may also contribute to the development of patellofemoral osteoarthritis, which not only creates long-term implications for these individual's health but also increases healthcare costs.^{21,22}

PFP is often described as one of the most common knee conditions seen by sports medicine providers. Incidence rates have been reported to vary between 8% and 33% of all knee related injuries in small-scale epidemiological studies.²³⁻²⁶ It has also been reported that PFP not only occurs within physically active individuals and military personnel, but is also seen throughout the general population.^{25,27} While PFP is commonly believed to be experienced by adolescent and younger individuals, results of some of the earliest epidemiological studies suggest that PFP is one of the most frequently reported pathologies in individuals into their 60's.^{24,28} Females have been reported to experience PFP two to ten times more often than their male counterparts.^{25,29}

Previous studies provide some insight into the incidence rate of this chronic condition; however, the accuracy of these numbers has been called into question. Ireland et al,³⁰ McConnell et al,³¹ and Witvrouw

et al³² have all referenced incidence rates of PFP within the general population, yet there currently is insufficient data to support these claims.⁷ These studies only provide data collected within individual sports medicine clinics, military populations and running clinics, which decreases the generalizability of their findings.^{23-26,33} Such practices or sites typically provide care to specific populations and therefore there is minimal data on the occurrence of PFP across the lifespan.^{7,23-26} It is important to appreciate the incidence of PFP and who may be susceptible to developing the condition in order to provide early interventions. The true understanding of the epidemiology of the pathology and its long-term consequences will influence appropriate care from healthcare professionals and help develop mechanisms to ultimately improve outcomes.

Since previous research has only provided incidence data from isolated sports medicine centers, single military academies and small epidemiological studies, such research offers limited information and may represent only a narrow population. Therefore, the purpose of this study was to examine current trends in the diagnosis of patellofemoral pain by physicians within the general population by utilizing two International Classification of Disease, Ninth Revision (ICD-9) codes commonly used to diagnose PFP. The authors hypothesized that the incidence rate of patellofemoral pain would be lower than previously published incidence rates. The current data set included diagnoses from visits to orthopedic physicians while previous researchers examined smaller cohorts of potentially more physically active individuals. Based on previous literature, the authors also hypothesized that females would present with higher incidence rates of PFP compared to males, and that the majority of PFP cases would be seen in the younger active population, particularly in the 10-19 year old age group.

METHODS

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement recommendations to report the study methods and results was utilized.³⁴ Data were collected with the PearlDiver Patient Record Database (PearlDiver Inc., Fort Wayne IN). The PearlDiver Database is an online database that is commercially available for retrospective reviews of

all data submitted to private insurance companies. The largest provider within the database is the UnitedHealth Group (UnitedHealth Group, Minnetonka, MN). Patients who are insured via Medicare, Medicaid or uninsured are not included within the PearlDiver database. The database contains over 1.1 billion patient records on over 30 million individual patients records between 2007 and 2011. The database can be used to identify ICD-9 codes and Current Procedural Terminology (CPT) codes.

The methodology of the current study is represented as a flow chart and is reported in Figure 1. The database was queried for patients who had been diagnosed with ICD-9 codes for patellofemoral pain (717.7 – Chondromalacia of patella and 719.46 – Pain in joint, lower leg). These two ICD-9 codes were selected since previous research identified them as the two most common diagnostic codes for PFP that does not involve struc-

tural damage or patellar tendinitis.²⁵ Additionally, other common pathologies that may have been coded in conjunction to the 719.46 were also removed. For example, if a patient also concurrently had diagnoses corresponding to osteoarthritis, knee meniscal tears, cruciate ligament sprains, collateral ligament sprains, tendonitis, bursitis, or fractures to the patella, proximal tibia or proximal fibula, they were removed from the analysis. The authors also searched seven other possible sources of anterior knee pain using nine common ICD-9 codes and removed those diagnoses from the analysis as well. (Table 1, Figure 1) The decision to removed these pathologies and corresponding ICD-9 codes were related to the exclusion criteria of these pathologies seen within current PFP literature.^{15,35}

The remaining data were considered to be the PFP group, yet the authors chose to split the diagnoses of chondromalacia patella and pain in the lower leg

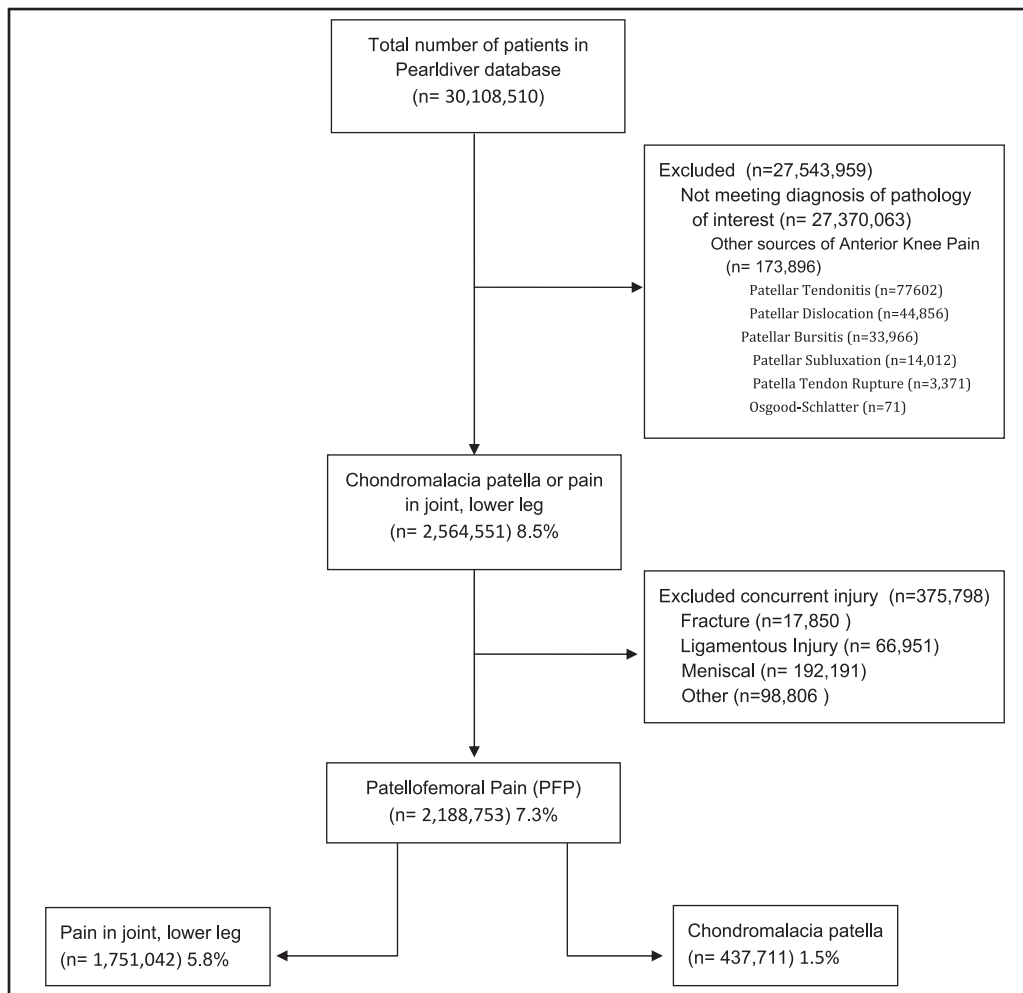


Figure 1. Flow Diagram.

Table 1. ICD-9 codes for the patellofemoral pain group and anterior knee pain pathologies

Patellofemoral Pain	Anterior Knee Pain Pathologies
717.7 – Chondromalacia of patella	718.36 – Patellar Subluxation
719.46- Pain in joint, lower leg	718.96 – Patellar Maltracking
	726.64 – Patellar Tendonitis
	726.65 – Patellar Bursitis
	727.66 – Patellar Tendon Rupture
	734.2 Osgood Schlatter
	755.64, 836.3, 836.4 – Patellar Dislocation

in order to distinguish the prevalence of each ICD-9 code. Within those two sub-diagnoses, the number of total visits to physician's offices by sex (male and female) and age (in ten year increments) were examined. Those data were also evaluated by region within the United States (South, Midwest, West and Northeast) and by year (2007, 2008, 2009, 2010, 2011) within the dataset.

Chi-square analyses were used to examine differences between stratifications by sex and age groups. A Mantel-Haenszel test was utilized to evaluate differences in each year that was examined within the dataset. Incidence proportions were calculated by comparing the number of individuals with PFP by the total number of individuals reported in the database. Statistical analyses were conducted using SPSS (Version 20; SPSS Inc., Chicago, IL) with an alpha level set a priori at $p \leq 0.05$.

This study was approved by the University of Virginia Institutional Review Board for Human Science Research. The review board granted access to utilize the aggregated data from the database without personal informed consent from the patients included within the study.

RESULTS

Patellofemoral Pain

The PearlDiver database contains a total of 30,108,510 patients with valid ICD-9 diagnosis or procedure codes during the years of 2007-2011. During this five-year period, there were 2,188,753 individuals diagnosed with PFP as defined by using the two selected ICD-9 codes, or 7.3% of all individuals within the database. There were 437,711 cases of Chondromalacia patella, (20% of the patients with PFP) and 1.5% of all diagnoses of individuals seeking care. There were 1,751,042 cases of joint pain of the lower limb

(80% of the patients with PFP) and representing 5.8% of all diagnoses.

Within the dataset of PFP, those with the diagnosis of joint pain of the lower limb were seen a total of 16,498,162 times while there were 2,803,842 physician visits for chondromalacia. Therefore, individuals with joint pain of the lower limb were seen by medical providers on average of 10.6 times, while those with chondromalacia were seen 6.4 times. When examining the location where medical providers diagnosed these individuals, the top three were medical healthcare office, 64%, outpatient hospital, 23%, and ambulatory surgical center, 3%. When comparing the percentage of PFP cases by region, the South resulted in 925,395 cases, followed by the Midwest region at 565,085, West region at 397,695 and Northeast region at 300,578. (Figure 2)

The total PFP incidence, and subcategories were compared by sex using Chi Square analyses and revealed that females accounted for 1,211, 665 cases

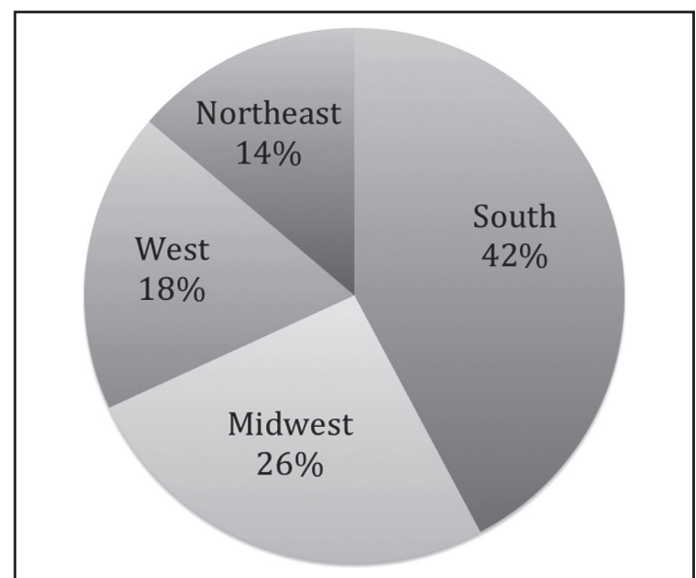


Figure 2. PFP breakdown by Region (In Percentages).

(55%) compared to males who had 977,088 cases (45%) ($p < .001$). Females accounted for 262,754 cases or 60% of all chondromalacia patella compared to 174,957 cases in males or 40% ($p < .001$). Joint pain of the lower limb had a similar trend, with females tallying 55% with 948,911 cases compared to males who had 45% with 802,131 cases ($p < .001$).

Comparison by age group demonstrated that the occurrence of PFP increased within the age groups and peaked within the 50-59 year old group. The age groups of 50-59, 40-49, and 30-39 had the greatest incidence, respectively, followed by the 10-19 year old group. (Figure 3) Chi-squared testing identified statistically significant differences between ages for both total and subcategories of PFP cases, $p < 0.001$. Differences between the sexes were examined within the age groups for the combined and sub-

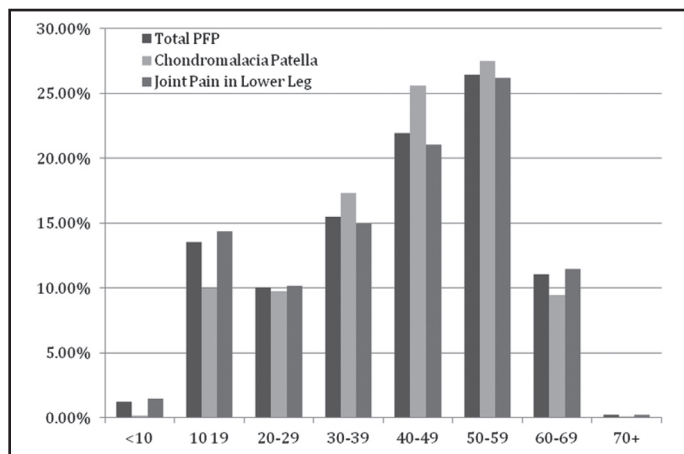


Figure 3. Percentage of PFP by Age Group.

division as well. (Table 2) Within most age groups, females reported PFP more often than males.

Of the total 2,188,753 cases reported between 2007 and 2011, there appeared to be an increase in the condition over this five-year period. (Table 3) The smallest percentage of those experiencing PFP occurred in 2007 at 18.7% from 410,852 cases, while 2011 had the largest percentage at 22.7% including 496,816 cases. Mantel-Haenszel test identified a statistically significant difference in the condition over the five-year period, $p < .001$.

Additional Sources of Anterior Knee Pain:

The incidence of other sources of anterior knee pain totaled 173,896 individuals during this 5-year period. (Figure 1) Osgood-Schlatters disease, patellar tendonitis, dislocation, bursitis and subluxations were most common diagnoses. There were 375,798 cases of other pathologies that were diagnosed on the same day the 719.46 ICD-9 codes and were removed from the analysis.

Females were more likely to present with Osgood-Schlatter, patellar dislocation, and patellar subluxation, with statistically significant differences in both patellar dislocation and subluxation as compared to males ($p < 0.001$) (Figure 4). Statistically significant differences between sexes were also found with males having greater incidence of patellar tendonitis, patellar bursitis, and patellar tendon rupture, ($p < 0.001$). Statistical differences between the seven additional sources of anterior knee pain could not be computed within age groups in order

Table 2. Breakdown of Joint Pain in Lower Leg, Chondromalacia and total PFP by age									
	Joint Pain in Lower Leg			Chondromalacia Patella			PFP		
	Male	Female	Combined	Male	Female	Combined	Male	Female	Combined
<10	17,180	8,644	25,824	341	534	341	17,521	9,178	26,699
10-19	127,348	124,682	252,030	14,639	29,257	14,639	141,987	153,939	295,926
20-29	93,308	84,421	177,729	17,442	25,209	17,442	110,750	109,630	220,380
30-39	133,361	129,870	263,231	33,003	42,857	33,003	166,364	172,727	339,091
40-49	168,196	200,075	368,271	47,052	65,059	47,052	215,248	265,134	480,382
50-59	181,508	276,928	458,436	45,986	74,432	45,986	227,494	351,360	578,854
60-69	78,954	122,133	201,087	16,236	25,164	16,236	95,190	147,297	242,487
70+	2,276	2,158	4,434	258	242	258	2,534	2,400	4,934
Total	802,131	948,911	1,751,042	174,957	262,754	437,711	977,088	1,211,665	2,188,753

Table 3. Number of PFP cases and percentage during 2007-2011

Year	Number of Cases	Percentage of cases
2007	410,852	18.77%
2008	423,042	19.33%
2009	419,073	19.15%
2010	438,970	20.06%
2011	496,816	22.70%
Total	2,188,753	100%

to maintain patient confidentiality, as PearlDiver would not provide exact numbers if fewer than 10 patients existed in a subdivision. This occurred in multiple age group subdivisions in all of the lower incidence pathologies.

DISCUSSION

The purpose of this study was to examine trends in diagnosis of PFP using two common ICD-9 codes in the general population based on age, sex, and region for those individuals within the United States seeking orthopedic medical care. Over 30 million cases were used to determine the diagnosis rates. The incidence rate of PFP was approximately 7.3% of all orthopedic visits and that there were differences in age and sex and an increase in the rate of PFP over the five-year period that was examined. The authors believed that these data are representative of the occurrence of PFP in the general population, compared to the previous studies that only examined sports medicine clinics, military settings or small epidemiological samples.^{23-26,36}

Whitman et al³⁷ conducted one of the first studies to provide incidence rates of individuals experiencing

patellofemoral pain. They found that PFP accounted for 25% of all knee related injuries within a 4 1/2 year study performed in a single sports medicine clinic.³⁷ This reported rate is similar to other data from other sports medicine clinics during a comparable time period.²⁶ These values do differ slightly from previously collected data examining military personnel, which have been reported to range between 12- 15%.^{25,36} PFP was also identified by Baquie et al as the most common orthopedic conditions treated during a single year in Australia sports medicine clinic.³⁸ While Baquie et al³⁸ did not provide an exact incidence rate, these findings suggest PFP is a common pathology presenting in patients from multiple countries.

PFP has also been studied in multiple sports, with a focus on female participants due to their higher suggested prevalence and incidence rates.^{25,39} Nejadi et al found prevalence rates of between 13 – 26% in females participating in soccer, volleyball, running, fencing and rock climbing.³⁹ This incidence is higher than the current results, which ranged from 1.5 – 7.3% of those seeking orthopedic care. The difference is likely attributed to the wider age group, varied activity levels, the much larger sample size, and where/how the data was collected in the current study. (Table 4)

Females presented with PFP more often than males in the combined PFP data and the isolated ICD-9 code analysis in the majority of age groups. The largest differences between sex within age groups was the chondromalacia subdivision in the 10-19 age group, with 66.6% of all cases being females compared to 33.4%

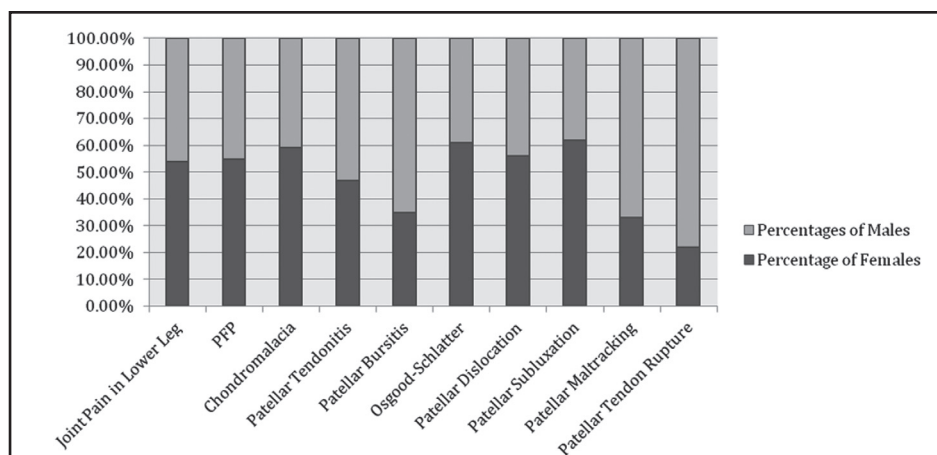


Figure 4. Breakdown of all sources of AKP by Sex

Table 4. Previous PFP incidence and prevalence studies

Author	Setting	Percentage of PFP Injuries	Number of Participants
Whitman et al. (1981)	Sports Medicine Clinic	Incidence rate of 25.2%	1,280
Devereaux and Lachmann (1984)	Sports Medicine Clinic	25% of knee injuries were patellofemoral arthralgia	2,519
DeHaven and Linter (1986)	Sports Medicine Clinic	18.1% of knee injuries to males 33.2% of knee injuries to females	3,431
Kannus et al. (1987)	Sports Medicine Clinic	33% of knee injuries	814
Milgrom et al. (1991)	Military Recruits	15% of recruits	390
Baquie and Bruncker (1997)	Sports Medicine Clinic	Most common pathology	2,429
Taunton (2002)	Sports Medicine Clinic	17% of knee injuries	2,002
Boling (2010)	Naval Academy	Prevalence of 15% in females and 12% in males	1,525
Wood (2011)	Database of 8 General Practitioner's	17% knee injuries	57,555
Nejati (2011)	Sports Medicine Clinis	Prevalence of 16.74%	418

in males. Females had significantly higher prevalence of chondromalacia in all age groups except the 70+ group. For joint pain in the lower leg, females presented with significantly more diagnoses in the 40-69 age groups. When the ICD-9 codes were combined, there were more females diagnosed within 10-19 and 30-69 age groups. These findings support other claims that females present with PFP more than males.^{25,40} Boling et al reported that females in the United States Naval Academy were 2.23 times more likely to develop PFP than males.²⁵ PFP has also been studied in running clinics and of the 331 cases reported, 62% were by female runners.³³ The higher PFP rates in females have also been a reason they are often solely enrolled in studies examining screening methods, muscle function, electromyography, and kinematic alteration during functional tasks.⁴⁰⁻⁴³

Perhaps the most surprising finding of the current research was that the highest percentage of a PFP diagnosis occurred in the 50-59 year age group and that the 10-19 year age group was the fourth highest percentage. The frequency of PFP was 13.5% and 10% in the 10-19 and 20-29 age groups respectively, while previous research has reported that 70% of all PFP is found in individuals between the ages of 16 and 25.²⁶ Age has also been previously identified as a risk for developing PFP, as those under the age of 34 years were considered at a greater risk than older individuals.³³ The current conflicting findings may be due to the previous study only examining athletes in a sports medicine clinic over a 5-year period. The current methodology of retrospective chart review

used data from insurance company reported ICD-9 codes, so high school and college aged athletes being treated or evaluated in athletic training settings or direct access physical therapy clinics would not be included unless they sought medical attention at a physicians office. Other researchers have reported that females seek medical care more often with traumatic knee pain compared to when they experience insidious knee pain²⁸ The current data indicates that PFP is experienced by a wide age range, which is supported by DeHaven et al who reported that the condition was one of the most commonly treated conditions seen in their sports medicine clinic in patients between the ages of 10 and 60.²⁴

The increased number of older individuals being diagnosed with PFP may actually represent those experiencing patellofemoral osteoarthritis (PFOA) or osteoarthrosis. The recognition of PFOA has increased over past years, and has been recently labeled a subgroup of knee osteoarthritis.²² Isolated PFOA has been studied over the last 20 years, with linear trends in occurrence rates identified between the ages of 50-70, which is similar to the findings of this study.⁴⁴ It has been estimated that 25% of all individuals over the age of 50 who experience knee pain have isolated PFOA.⁴⁵ Wood et al collected PFP disorder rates from a database of 57,555 patients representing eight general practitioner clinics over a single year and found high rates of PFP between 15-44 year olds and an increased rate in 75+ individuals.⁴⁶ They also found a gradual increase in PFOA between the ages of 30 and 75+, which is similar to this study's findings and

may explain the increase in reported cases in the 50-59 year old group.⁴⁶ While there were increased cases reported within the 50-59 year old age group, it is not possible to truly ascertain which individuals presented with PFP or PFOA. While individuals with concurrent osteoarthritic ICD-9 codes were removed, the challenge in calculating the occurrence of PFP within this dataset is dependent on proper ICD-9 coding from the medical healthcare provider. It is also difficult to use the findings gleaned from this dataset without the benefit of a movement based assessment or physical evaluation which are commonly needed to diagnose this condition and to differentiate between PFP and additional pathologies that present with pain to the anterior knee.

Seven additional pathologies were included within the database search in order to provide a picture of all potential anterior knee pain sources. Since there is no true ICD-9 code for PFP, there are multiple possible diagnoses that medical providers can classify the condition. Due to this limitation, inspecting other possible diagnoses of anterior knee pain can provide insight into what pathologies healthcare providers are commonly evaluating and treating within the population who seek medical care. This information can help clinicians become aware of the frequency of multiple pathologies they commonly treat. If there are high numbers of individuals developing PFP pain severe enough to receive treatment, a specific ICD-9 code would be vital to provide the accurate diagnosis. As medicine advances to a more evidence based approach, proper evaluation and coding of diagnoses will be vital in providing optimal treatment plans.

It is of interest that diagnoses of patellar maltracking and Osgood-Schlatter each had fewer than 100 cases over a five-year period, which is extremely low. The frequency of patella maltracking may actually be underreported as physicians may view it as a mechanism that leads to the pathological process for PFP, but not an actual diagnosis. However, when the incidence of patella maltracking with a concurrent diagnosis of chondromalacia or lower extremity joint pain, there was an increase to 13% of all reported cases, indicating a prevalence of medical care providers that use multiple ICD-9 codes. While there is empirical evidence PFP and patella maltracking are

related, current research does not support the association.⁴⁷ The treatments of each may be different as well, supporting the notion that clinicians need accurate diagnoses to provide optimal care. The frequency of patellar tendonitis, the next most common anterior knee pathology, is also very low at .25% of all individuals over the 5-year period. Rutland et al found that overuse tendon injuries accounted for 7% of all orthopedic physician visits, but they did not provide a specific categorical analysis.⁴⁸

There are limitations to this retrospective chart review that should be considered; specifically, a lack of a true, stand-alone ICD-9 code for PFP. The ICD-9 codes of 719.46 (general joint pain in the lower leg) and 717.7 (chondromalacia patella) are the two most frequent codes used to classify PFP.²⁵ Boling et al used these two ICD-9 codes in previous published PFP epidemiological research in addition to a screening process for concurrent ligamentous and meniscal injuries.²² While this study was modeled for data extraction to also remove these pathologies; there may be the concern for improper or mistaken coding. While advancement and evolution of ICD-9 codes has occurred culminating in the recent release of ICD-10 codes, there is still no true PFP code for clinicians to use for the diagnosis of this condition. Differentiating between PFP and patellofemoral osteoarthritis in the older population is also difficult, as it is not possible to identify true PFP versus PFOA. Removal of concurrent osteoarthritis codes was performed, however there is still a chance that improper diagnostic codes were utilized. Another limitation is the distribution of insurance providers who provide data for PearlDiver. UnitedHealthcare is the largest contributor to the PearlDiver system and is primarily utilized within the southern states, which may explain the higher occurrence in that region. These values also only include individuals who have received care through their insurance provider. High school and college aged athletes may receive care from their athletic trainers, patients treated by physical therapists via direct access and military personnel who utilized TriCare insurance were not included in this database which may account for the lower values in the younger population. However, with over 30 million data points, this database represents the largest general population sample that has been evaluated.

CONCLUSION

This study provides evidence that PFP accounts for 1.5 - 7.3% of the diagnoses of those who seek orthopedic care by physicians in the United States. Females experienced PFP more often than males and that PFP is experienced within the general population at high rates in all age groups, with an increase in the ages of 50-59. Due to the large percentage of individuals who require medical treatment for this condition, risk factors to prospectively identify those susceptible to develop PFP should be examined. Effective interventions should also be studied to decrease the long-term care needed to minimize the possible progression of PFP into PFOA and decrease health costs associated with this condition.

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