Risk and Risk Perception of Knee Osteoarthritis in the US: Population-based Study

Griffin L Michl, BS, **Jeffrey N Katz, MD, MS**, and **Elena Losina, PhD**

Orthopedic and Arthritis Center for Outcomes Research, Department of Orthopedic Surgery (GM, JNK, EL), Division of Rheumatology, Immunology and Allergy (JNK, EL), Brigham and Women's Hospital, Harvard Medical School (JNK, EL), Boston, MA

Griffin L Michl: griffinmichl@gmail.com; Jeffrey N Katz: jnkatz@partners.org; Elena Losina: elosina@partners.org

Abstract

Objective—We sought to investigate risk perception among an online cohort of younger US adults compared with calculated risk estimates.

Design—We recruited a population-based cohort 25–44 years of age with no history of knee OA using Amazon's Mechanical Turk, an online marketplace used extensively for behavioral research. After collecting demographic and risk factor information, we asked participants to estimate their 10-year and lifetime risk of knee OA. We compared perceived risk with risk derived from the OA risk calculator (OARC), an online tool built on the basis of the validated OA Policy Model.

Results—375 people completed the study. 21% reported having 3+ risk factors for OA, 25% reported two risk factors, and 32% reported one risk factor. Using the OARC, we calculated a mean lifetime OA risk of 25% and 10-year risk of 4% for this sample. Participants overestimated their lifetime and 10-year OA risk at 48% and 26%, respectively. We found that obesity, female sex, family history of OA, history of knee injury, and occupational exposure were all significantly associated with greater perceived lifetime risk of OA.

Conclusions—Risk factors are prevalent in this relatively young cohort. Participants consistently overestimated their lifetime risk and showed even greater overestimation of their 10-year risk, suggesting a lack of knowledge about the timing of OA onset. These data offer insights for awareness and risk interventions among younger persons at risk for knee OA.

Keywords

Introduction

Knee osteoarthritis (OA) is a debilitating condition that affects over 9 million US adults[1]. While traditionally associated with aging, osteoarthritis is increasingly diagnosed in younger adults, with about half of diagnoses occurring in patients younger than 55[2] and 20% of total knee replacements occurring in patients younger than 65[3]. The shift in the age of the osteoarthritis patient population suggests that prevention efforts must also focus on younger individuals. However, perception of risk and knowledge of the disease among young people has not been investigated formally.

Risk perception plays an integral role in many theories of health-related behavior[4,5]. Accurate assessment of personal risk aids in appropriate medical decision making and behavioral planning. Individuals who underestimate their risk of disease may not take care in maintaining a healthy lifestyle[6]. Additionally, individuals who overestimate their risk may perceive illness as inevitable and not take steps to mitigate their risk[7]. Further, overestimation of risk can lead to excessive worry and inaction[8].

We sought to assess perception of knee osteoarthritis risk in a population of younger persons residing in the US. We recruited participants using an online platform and compared subjects' perceived knee osteoarthritis risk to estimates of each subject's risk generated by an osteoarthritis risk calculator that synthesized epidemiologic evidence of the impact of known risk factors for knee OA on individuals' lifetime risk of the disorder.

Methods

Screening

Participants between the ages of 25 and 44 and without a history of physician diagnosed OA were recruited from Amazon's Mechanical Turk. Mechanical Turk is an online crowd-sourcing platform on which workers complete human intelligence tasks (HITs) for requesters in exchange for monetary compensation dispensed directly into their amazon.com accounts[9]. Mechanical Turk has been extensively used for research purposes[10,11]. A screening HIT was initially posted on the site in order to identify users who met eligibility criteria. In order to participate in the screening phase, participants had to possess at least a 98% requester approval rate across at least 1000 previous HITs to ensure high quality, attentive participation. The screening questionnaire asked for simple demographic information (age, sex, race, history of OA diagnosis). Participants were paid $0.05 for completing the screening questionnaire regardless of their eligibility for the main study.

Main Study

Responders to screening that met the criteria for the main study were identified by their worker ID and invited to participate. Invited participants that chose to participate in the main study were provided a hyperlink to an external website that hosted the questionnaires and risk calculator. Upon clicking the hyperlink, participants were presented with a consent form approved by the Partner's Institutional Review Board. After consenting, participants were presented with an initial questionnaire to collect demographic (age, sex, race, height, and weight) and risk information (family history of OA, history of knee injury, occupational hazards) related to OA. Family history was assessed by using the question "Do your parents, siblings, or grandparents have any of the following? (check all that apply): (a) Arthritis, (b) knee or hip replacement(s), (c) Finger nodes, (d) Don't know." Occupational exposure was assessed with the question: "Have you been exposed to work-related risk factors associated with knee OA such as kneeling, squatting, or lifting?" History of knee injury was assessed by asking "Have you previously had a serious knee injury that limited your walking for at least 7 days?"

Participants were then asked to estimate their 10-year and lifetime risk of OA and the risk of an average American at their age. In order to ascertain OA risk perception, we asked participants four questions: (1) What do you think is the chance that an average American of your age develops knee osteoarthritis in the next 10 years? (2) What do you think is the chance than an average American of your age develops osteoarthritis in their lifetime? (3) What do you think is your chance of developing osteoarthritis in the next 10 years? (4) What do you think is your chance of developing osteoarthritis in your lifetime?

After completing the questionnaires, participants received an alphanumeric code, which they were instructed to present to Mechanical Turk as confirmation that they completed the study. Participants were compensated with $3 for participation.

Knee OA Risk Calculator (Knee OA RC)

We used the Osteoarthritis Policy (OAPol) Model to generate data for *Knee OA RC,* a web-based risk calculator for knee osteoarthritis and total knee replacement (TKR). The OAPol Model is a validated, state-transition, Monte Carlo simulation of the natural history and treatment of knee OA.[3,12,13] The OAPol model transitions subjects through a set of health states with a cycle length of one year. Health states in the OAPol model are defined by knee OA presence and severity, obesity status (defined by a BMI of 30 kg/m^2 or greater), and prevalence of several common comorbidities (malignancy, cardiovascular disease, diabetes mellitus, chronic obstructive pulmonary disease, and musculoskeletal conditions besides knee OA). In the model we adjusted the knee OA incidence rate in the presence of risk factors using a prediction model published by Zhang et al[14]. We conducted 1920 model simulations using different combinations of age, sex (male, female), race/ethnicity (white, black, Hispanic), obesity status (obese, non-obese), family history of knee OA (present, absent), occupational exposure to OA risk (present, absent), and history of knee injury (present, absent). Each simulation was repeated one million times in order to obtain stable estimates of OA risk across various time points.

Statistical Analysis

Outcome—We assumed that the knee OA risk derived from the Knee OA RC is the 'gold standard'. We calculated the amount of over- and under-estimation of knee OA risk using the equation: (Predicted Risk – Calculated Risk) / (Calculated Risk). We further developed four categories of perceived risk accuracy: 1) underestimation of actual knee OA risk by at least 25%; 2) accurate perception of knee OA risk, within 25% of 'gold standard'; 3) overestimation of actual risk by at least 50%; 4) drastic overestimation of risk by at least two, three, or five fold.

Independent variables—We collected data on subjects' demographic (age, sex, race/ ethnicity, and education) and geographic (state of residence) characteristics and their OA risk factors (obesity, family history, occupational exposure, and history of knee injury). Geographic information was consolidated in five US regions (Northeast, Midwest, South, and West). Educational attainment was stratified by whether the subject had received a college degree.

Analysis—In bivariable analyses we examined the impact of age, sex, educational attainment, race/ethnicity, geographic region, obesity, history of knee injury, occupational exposure and family history on accuracy of risk perception. We used Chi-square tests for categorical variables and general linear models for continuous variables. All analyses were preformed in SAS 9.4.

Results

Cohort Characteristics

1000 participants completed the online screening questionnaire, of which 591 were found to be eligible for the main study. Three hundred eighty-three participated in the main study with complete data obtained from 375. Demographic and risk factor characteristics of study participants are presented in Table 1. Average age of study participants was 32 years, with 33% being over the age of age 35 and 67% being under. Forty-eight percent were females, 79% identified themselves as white, 5% as Blacks, 5% as Hispanics, and 11% as other. More than half of study participants had at least a college degree. Study participants represented all regions of the US: 17% were from the Northeastern region, 18% from Midwest, 38% from South and 27% from the West region.

Knee OA risk factors were prevalent among this cohort. Twenty-six percent of participants were obese, 70% had a family history of OA, 20% had a history of knee injury, and 48% reported having occupational risk factors. Twenty-one percent of study participants reported greater than three risk factors, 25% reported two risk factors, 32% reported one risk factor, and 22% reported no risk factors.

Knee OA Risk and Risk Perception

Knee OA Risk—Using demographic characteristics of study participants, the Knee OA RC-based average lifetime risk of knee OA was calculated at 25% and mean 10-year risk was calculated at 4%.

Perception of knee OA risk—Mean perceived personal lifetime and 10-year risk were 48% and 26%, respectively. Perceived average American lifetime and 10-year risk were 47% and 26%.

Lifetime and 10-year knee OA risk perception and actual risk by demographic and risk factor are presented in Table 2. In bivariable analyses, obesity, female sex, family history, history of knee injury, and occupational exposure were all significantly associated with greater perceived risk of OA. The data did not provide evidence that age, education, and race had impact on lifetime OA risk perception. These data are shown in Table 2.

More risk factors were significantly associated with greater perceived lifetime risk. Participants with 0, 1, 2, and 3+ risk factors estimated their lifetime risk at 37%, 45%, 49%, and 60%, respectively (p < 0.0001). Meanwhile, participants with more risk factors did not perceive the average American's risk differently than participants with fewer risk factors. Perceived average American risk ranged from 44% in participants with 0 risk factors to 47% in participants with 3+ risk factors (p = 0.4112).

Accuracy of Risk Perception

Fifteen percent of study participants estimated their lifetime OA risk within 25% of the lifetime risk determined by the risk calculator. 61% of participants overestimated their lifetime risk by at least 50%, while 16% underestimated their lifetime risk by at least 25 percentage points. About a half of the cohort (46%) overestimated their lifetime risk of knee OA at least two fold, and one out of five persons drastically overestimated their risk three fold. Even greater level of overestimation occurred in relationship to the perception of a 10-year risk. Three out of four study participants overestimated their 10 year risk by at least 2 fold, two out of three by at least threefold, and about one out of two by at least five fold.

Discussion

We recruited 375 participants from Amazon's Mechanical Turk and collected data on knee osteoarthritis risk perception along with self-reported demographic and risk factor information. We found that risk factors were prevalent among this relatively young cohort. Comparing risk perception to calculated risk estimates using the osteoarthritis risk calculator, we found that people significantly overestimated their osteoarthritis risk. Bivariate analyses showed that participants with risk factors correctly estimated their risk higher than those without risk factors.

To our knowledge, this is the first study examining osteoarthritis risk perception in a population of younger adults. The results suggest that people in this age group may perceive knee osteoarthritis as an inevitable part of life. Given the substantial impact of modifiable risk factors, such as obesity, injury, and occupational exposure on knee osteoarthritis risk, pessimistic attitudes surrounding the disease could undermine prevention efforts.

Tools like the knee osteoarthritis risk calculator could represent a means of raising awareness about osteoarthritis risk and prevention. A surprising finding in this study was that participants who indicated having immediate family members with osteoarthritis were

actually less accurate in their perception of risk than those without a family history of OA. Family members of osteoarthritis patients may represent a potential target for prevention.

Our study had several limitations. The knee osteoarthritis risk calculator uses underlying data from multiple sources to determine risk of knee OA. Additionally, we recruited a convenience sample of Mechanical Turk users, who may not be entirely representative of the overall population. We did not assess the reasons why study participants chose to participate in the study and whether they had been thinking about their OA risk prior to the study. Finally, participants were asked to estimate their OA risk after filling out their demographic and risk factor information. While no indication was given that these questions were related to osteoarthritis risk, asking them may have impacted answers given in subsequent questions.

Understanding the knowledge and attitudes of target populations is vital to disease prevention efforts. The data reported here offer insights into the awareness of younger persons at risk for knee OA and suggest directions for public health educational efforts.

Acknowledgments

References

1. Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. Arthritis Rheum. 2008; 58:26–35. [PubMed: 18163497]

2. Losina E, Weinstein AM, Reichmann WM, Burbine SA, Solomon DH, Daigle ME, et al. Lifetime risk and age at diagnosis of symptomatic knee osteoarthritis in the US. Arthritis Care Res (Hoboken). 2013; 65:703–711. [PubMed: 23203864]

3. Losina E, Paltiel AD, Weinstein AM, Yelin E, Hunter DJ, Chen SP, et al. Lifetime medical costs of knee osteoarthritis management in the United States: impact of extending indications for total knee arthroplasty. Arthritis Care Res (Hoboken). 2015; 67:203–215. [PubMed: 25048053]

4. Weinstein ND. Testing four competing theories of health-protective behavior. Health Psychol. 1993; 12:324–333. [PubMed: 8404807]

5. Sutton S. Social-psychological approaches to understanding addictive behaviours: attitude-behaviour and decision-making models. Br J Addict. 1987; 82:355–370. [PubMed: 3472583]

6. Masiero M, Lucchiari C, Pravettoni G. Personal fable: optimistic bias in cigarette smokers. Int J High Risk Behav Addict. 2015; 4:e20939. [PubMed: 25883917]

7. Wachinger G, Renn O, Begg C, Kuhlicke C. The risk perception paradox--implications for governance and communication of natural hazards. Risk Anal. 2013; 33:1049–1065. [PubMed: 23278120]

8. Ferrer RA, Portnoy DB, Klein WM. Worry and risk perceptions as independent and interacting predictors of health protective behaviors. J Health Commun. 2013; 18:397–409. [PubMed: 23272708]

9. Amazon Mechanical Turk. [Accessed June 18, 2015] 2015. https://www.mturk.com/mturk/welcome

10. Buhrmester M, Kwang T, Gosling SD. Amazon's Mechanical Turk: A New Source of Inexpensive, Yet High-Quality, Data? Perspectives on Psychological Science. 2011; 6:3–5. [PubMed: 26162106]

11. Paolacci G, Chandler J. Inside the Turk: Understanding Mechanical Turk as a Participant Pool. Current Directions in Psychological Science. 2014; 23:184–188.

12. Losina E, Walensky RP, Reichmann WM, Holt HL, Gerlovin H, Solomon DH, et al. Impact of obesity and knee osteoarthritis on morbidity and mortality in older Americans. Ann Intern Med. 2011; 154:217–226. [PubMed: 21320937]

13. Losina E, Burbine SA, Suter LG, Hunter DJ, Solomon DH, Daigle ME, et al. Pharmacologic regimens for knee osteoarthritis prevention: can they be cost-effective? Osteoarthritis Cartilage. 2014; 22:415–430. [PubMed: 24487044]

14. Zhang W, McWilliams DF, Ingham SL, Doherty SA, Muthuri S, Muir KR, et al. Nottingham knee osteoarthritis risk prediction models. Ann Rheum Dis. 2011; 70:1599–1604. [PubMed: 21613308]

Table 1

Cohort Characteristics

This figure portrays demographics and risk factors reported by study participants in online questionnaires.

Parameter	N (%)
Demographics	
Age	
< 35	253 (67%)
> 35	122 (33%)
BMI	
< 25	164 (44%)
25 – 30	115 (31%)
>= 30	96 (26%)
Sex	
Male	195 (52%)
Female	180 (48%)
Race	
White	295 (79%)
Black	20 (5%)
Hispanic	20 (5%)
Other	40 (11%)
Education	
4-year graduate	211 (56%)
Non-graduate	164 (44%)
Risk Factors	
Family History (All)	262 (70%)
Arthritis	250 (67%)
Joint Replacement	93 (25%)
Injury	76 (20%)
Occupation	179 (48%)

Table 2

Mean perceived lifetime risk by demographic characteristics and number of knee OA risk Factors

This table portrays Knee OA Risk Calculator derived risk compared to perceived risk as reported by study participants. We present information for both lifetime and 10-year risk across factors: age, BMI, sex, race, education level, family history, history of injury, and occupational exposure to risk factors. p-values correspond to the difference in perceived risk between subjects across a given factor (e.g. the difference between men and women's perceived risk)

Factor	Lifetime Risk			10-Year Risk		
	Actual	Perceived	p-value*	Actual	Perceived	p-value*
Age						
< 35	25%	48%	0.6058	3%	25%	0.3361
>= 35	25%	47%		4%	28%	
BMI						
>= 30	39%	54%	0.0189	6%	31%	0.0184
< 30	21%	46%		3%	24%	
Sex						
Male	22%	42%	0.0001	3%	22%	0.0002
Female	29%	54%		4%	31%	
Race						
White	26%	49%	0.2168	4%	26%	0.8336
Non-White	22%	44%		3%	26%	
Education						
College grad	23%	45%	0.0341	3%	23%	0.0014
No college grad	28%	51%		4%	31%	
Family History						
Present	29%	53%	<0.0001	4%	29%	0.0002
Absent	17%	36%		2%	19%	
History of Injury						
Present	38%	58%	0.0004	6%	33%	0.0036
Absent	22%	45%		3%	24%	
Occupational Exposure						
Present	29%	53%	0.0003	4%	31%	<0.0001

Factor	Lifetime Risk			10-Year Risk		
	Actual	Perceived	p-value[*]	Actual	Perceived	p-value[*]
Absent	22%	43%		3%	21%	

[*]
p-value for difference between perceived risk across risk factors (eg. perceived risk of male *vs.* female subjects)