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Certified Athletic Trainers' Knowledge and Perceptions of Posttraumatic Osteoarthritis After Knee Injury

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Context: Posttraumatic osteoarthritis (PTOA) is a specific phenotype of osteoarthritis (OA) that commonly develops after acute knee injury, such as anterior cruciate ligament (ACL) or meniscal injury (or both). Athletic trainers (ATs) are well positioned to educate patients and begin PTOA management during rehabilitation of the acute injury, yet it remains unknown if ATs currently prioritize long-term outcomes in patients with knee injury.

Objective: To investigate ATs' knowledge and perceptions of OA and its treatment after ACL injury, ACL reconstruction, or meniscal injury or surgery.

Design: Cross-sectional study.

Patients or Other Participants: An online survey was administered to 2000 randomly sampled certified ATs. We assessed participants' perceptions of knee OA, the risk of PTOA after ACL or meniscal injury or surgery, and therapeutic management of knee OA.

Results: Of the 437 ATs who responded (21.9%), the majority (84.7%) correctly identified the definition of OA, and 60.3% indicated that they were aware of PTOA. A high percentage of ATs selected full meniscectomy (98.9%), meniscal tear (95.4%), ACL injury (90.2%), and partial meniscectomy (90.1%) as injuries that would increase the risk of developing OA. Athletic trainers rated undertaking strategies to prevent OA development in patients after ACL injury or reconstruction (73.8%) or meniscal injury or surgery (74.7%) as extremely or somewhat important. Explaining the risk of OA to patients with an ACL or meniscal injury was considered appropriate by 98.8% and 96.8% of respondents, respectively; yet a lower percentage reported that they actually explained these risks to patients after an ACL (70.8%) or meniscal injury (80.6%).

Conclusions: Although 84.7% of ATs correctly identified the definition of OA, a lower percentage (60.3%) indicated awareness of PTOA. These results may reflect the need to guide ATs on how to educate patients regarding the long-term risks of ACL and meniscal injuries and how to implement strategies that may prevent PTOA.

Key Words: anterior cruciate ligament, meniscus, meniscectomy

Key Points

- Nearly 40% of athletic trainers (ATs) sampled did not have knowledge of posttraumatic osteoarthritis (OA).
- Fewer than two-thirds of participating ATs strongly agreed or agreed that knee OA would be a major health concern for a patient.
- Participating ATs agreed that the risk of OA increases after anterior cruciate ligament injury, anterior cruciate ligament reconstruction, meniscal injury, or meniscal surgery, yet they underestimated the percentage of patients who would likely develop OA in the first and second decades after such an injury.

Osteoarthritis (OA), which commonly affects the knee joint, is one of the 5 leading causes of disability in the United States.[1] Although much of the focus has been on the treatment of pain and disability in those with established knee OA, slowing the onset and progression of the disease in at-risk groups is also important. Posttraumatic OA (PTOA) is a rapidly progressive type of OA that occurs in individuals with a history of an acute joint injury.[2–7] The odds ratios for developing PTOA after a knee injury are as high as 2.86 and 4.95 compared with those who have never sustained a knee injury.[2,3] Of those who sustain an anterior cruciate ligament (ACL) injury, approximately one-third will develop knee OA within the first decade after injury, regardless of whether the patient undergoes an ACL reconstruction (ACL-R).[8] Meniscal injury and meniscectomy also have adverse consequences on longer-term joint health.[9–12] Meniscal damage often occurs in combination with ACL injury[13]; the combination of meniscal and ACL injuries seems to increase the risk of PTOA compared with isolated ACL injury.[8]

The progression to OA after knee injury has been hypothesized to result from altered biochemical and biomechanical processes that may begin soon after injury.[14,15] However, patients do not normally seek treatment for PTOA until symptoms present years after the inciting knee injury, when possibly irreversible arthritic changes have affected joint health. Of benefit to clinicians and patient outcomes, having a history of a traumatic knee injury means that patients who develop PTOA are more

easily identifiable than those who develop knee OA for idiopathic or unknown reasons. Furthermore, individuals typically seek immediate treatment for their acute traumatic knee injuries. As a result, treatments to prevent the development of PTOA or mitigate its progression could be implemented more easily before the disease begins or advances. Developing early intervention strategies to decrease the risk of PTOA after knee injury has emerged as a critical priority for researchers and clinicians interested in mitigating the global consequences of OA.[16] Guided by this early intervention goal, we must prepare health care professionals to deliver prophylactic PTOA care, which is a critical step in managing the chronic joint disease that will likely ensue in the years after acute knee injury.

Athletic trainers (ATs) commonly treat patients after knee injury and, therefore, are well positioned to administer early prophylactic interventions that may lower the risk of developing PTOA. Traditionally, the restoration of physical function for the purpose of returning a patient to unrestricted physical activity after ACL-R is the priority of postoperative knee rehabilitation. Implementing strategies to educate patients about and treat them for the future risk of developing PTOA may not be an immediate clinical focus of acute postoperative knee rehabilitation for most ATs. It is unfortunate that ATs may not focus on treating PTOA at the time of injury because early intervention may be extremely beneficial for maintaining long-term joint health. Athletic trainers may not perceive PTOA as a significant clinical problem because the serious effects of PTOA are not clinically evident until most patients are beyond the phase of acute injury care provided by ATs. Athletic trainers' knowledge and perceptions about the risk of PTOA may be an asset for or a barrier to implementing novel education and treatment strategies for mitigating the effect of PTOA after knee injury. For this reason, it is important to recognize if ATs who normally treat patients with acute knee injuries understand and perceive OA, and more specifically PTOA, as an important factor in managing acute knee injuries and postoperative knee rehabilitation. Therefore, the primary purpose of our study was to investigate ATs' knowledge of and perceptions about OA and PTOA after ACL injury, ACL-R, or meniscal injury or surgery. Our secondary goal was to evaluate if the potential use of treatment strategies after ACL injury, ACL-R, or meniscal injury or surgery differed between ATs who did and those who did not have knowledge of PTOA. Additionally, we evaluated if years of experience as an AT influenced the respondents' knowledge of PTOA.

METHODS

The Knowledge and Perceptions of Knee Osteoarthritis Survey (KPOAS) was administered online to 2000 ATs who were randomly sampled from all 10 National Athletic Trainers' Association (NATA) districts on April 1, 2014. We obtained e-mail addresses from the association, and the lead author (B.P.) sent potential respondents an invitation to complete the survey. The invitation included an embedded link to the survey, which was administered using a Qualtrics software platform (Research Suite; Qualtrics, LLC, Provo, UT). Reminder e-mails were sent 3, 5, and 7 days later to individuals who did not complete the survey. Following a 14-day period after the initial invitation to participate, data collection ended, and we sent nonrespondents no further correspondence. No incentives were provided to the survey participants. The Institutional Review Board at the University of North Carolina at Chapel Hill approved the online consent process and all KPOAS methods.

Instrumentation

The KPOAS was created to evaluate the knowledge and perceptions of ATs pertaining to the risk of knee OA after ACL injury, ACL-R, meniscal injury, and meniscal surgery. Because no existing instrument was suitable, we adapted the KPOAS from a similar questionnaire that had been developed by 1 of the coauthors (K.L.B.) to evaluate the knowledge and perceptions of the risk of developing knee OA of patients undergoing ACL-R. The KPOAS comprises 2 sections regarding knowledge and perceptions: the risk of knee OA after knee injury or surgery and the therapeutic management of knee OA after knee injury or surgery. The KPOAS includes Likert-scale, visual-analog scale, yes/no, and multiple choice questions. Once the KPOAS was developed, 5 content experts reviewed it for content validity, and then a convenience sample of 15 ATs completed a pilot version. We used the pilot survey feedback to edit the instrument for face validity and readability. Because the KPOAS contents were designed to be examined at the item level rather than as a higher-order knowledge variable, no specific factor analytic procedures were conducted. We provide the KPOAS in the Appendix.

Knowledge and Perceptions of the Risk of Knee OA After Knee Injury: Section Methods

The first question in this section asks participants to choose the option that best defines OA and offers 7 options: (1) *a condition in which the bones become fragile and brittle, causing them to break more easily*, (2) *a name given to a group of symptoms marked by generalized pain and muscle stiffness*, (3) *a condition that affects a number of structures around the joint and is characterized by the breakdown of the joint's cartilage*, (4) *an autoimmune disease that causes pain and swelling of the joints*, (5) *all of the above*, (6) *none of the above*, and (7) *do not know*. Then respondents are asked where and how they learned about OA (ie, *personal experience*, *other clinicians*, *formal coursework*, and *continuing education*). The next portion consists of 16 Likert-scale items (*strongly disagree*, *disagree*, *do not know*, *agree*, *strongly agree*) designed to determine the knowledge of risk factors associated with knee OA and the perception of OA as a major health care concern. Three of the 16 items are incorrect and would be correctly identified as *strongly disagree* but were included in the KPOAS as distractor options (ie, *cold weather*, *high alcohol intake*, *being male*). Four visual-analog scale questions asked the percentage of patients who were ACL deficient (ACL-D) or had undergone ACL-R, partial meniscectomy, or full meniscectomy who would develop knee OA in the first, second, third, and fourth decades after injury; respondents choose a number between 1% and 100% indicating the percentage of patients who would develop knee OA at each time point. By selecting *yes* or *no*, participants state if they are aware of a condition termed

PTOA. This question was placed last in an effort to avoid biasing respondents regarding the purpose of the survey.

Therapeutic Management of Knee OA After Knee Injury and Surgery: Section Methods

This section of the KPOAS consists of dichotomous *yes* or *no* questions to evaluate if participating ATs (1) treat patients with ACL or meniscal injury, (2) explain the risk of developing knee OA after acute knee injury, and (3) provide strategies for preventing knee OA to patients after acute knee injury or surgery. The first of 7 Likert-scale items asks, "How important is it to you that your patients undertake strategies to prevent osteoarthritis from developing in their knee following ACL or meniscus injury?" Answer options are *not at all important*, *slightly important*, *moderately important*, *very important*, and *extremely important*. The next 6 questions were designed to determine how likely (*very unlikely*, *unlikely*, *unsure*, *likely*, or *very likely*) ATs are to prescribe specific interventions (*strengthening*, *maintaining an appropriate body weight*, *supportive knee braces*, *shoe orthotics*, or *wearing specially designed shoes*) that may reduce the risk of knee OA after an ACL or meniscal injury. We decided to collect data regarding these specific interventions based upon recommendations from previous researchers.[16] Participant demographic information was collected after all questions pertaining to OA risk and the therapeutic management of OA were answered.

Statistical Analysis

Data from all participants who submitted the survey were electronically converted from the Qualtrics platform to SPSS (version 17.0; IBM Corporation, Armonk, NY) for data analysis. We evaluated the ATs' knowledge and perceptions of knee OA as well as the potential use of treatment strategies by calculating and reporting the means, standard deviations, frequencies of responses to the survey questions in each section, and percentages for descriptive participants' demographic information. Respondents were allowed to skip any question they did not feel comfortable answering. Therefore, the number of ATs who responded to each question differed, and the sample size is reported for each question. We calculated the percentage of participants who believed that the incidence of knee OA would be higher in patients who underwent an ACL-R or meniscal repair compared with those who remained ACL-D or underwent a meniscectomy, respectively. Individual dependent-samples *t* tests were used to determine if the ATs' estimated percentages of patients who would develop OA after ACL-R versus ACL-D differed in each decade postinjury. Similar dependent-samples *t* tests were conducted to determine if the ATs' estimated percentages of patients who would develop OA after a meniscal repair versus meniscectomy differed in each decade postsurgery. Given the exploratory nature of the study, we set the α levels a priori at .05 for the dependent-samples *t* tests.

In addition to reporting frequencies, percentages, and descriptive statistics, we performed χ^2 analyses to understand the interaction between the knowledge of PTOA and the use of therapeutic strategies to mitigate the risk of knee OA development in patients with ACL or meniscal injury or surgery. We used separate Pearson χ^2 models to examine if the observed responses differed from the expected responses for 4 analyses: (1) Were ATs who reported specific overall treatment practices more likely to be aware of the condition of PTOA? (2) Did the relative importance placed on undertaking strategies to prevent knee OA after ACL injury and reconstruction or meniscal injury or surgery differ between respondents who were and were not aware of the condition of PTOA? (3) Were responses regarding the likelihood of using various treatments to mitigate the risk of developing knee OA different between respondents who were and were not aware of the condition of PTOA? (4) Did the percentage of respondents who were aware of the condition of PTOA differ by years of experience as an AT (1–5, 6–10, 11–15, 16–20, >20 years)? We used a Bonferroni correction for the χ^2 analyses evaluating the importance placed on undertaking strategies, likelihood of using different treatments, and reported years of experience as an AT based upon the number of potential responses (0.05/5) and set P at $\leq .01$. If a cell contained fewer than 5 samples, we used an α level associated with a 2-sided Fisher exact test to determine differences between cells.

RESULTS

The surveywide response rate was 21.9% (437/2000). The sample responding to all questions was 347 ATs (17.4%). Full demographic information was provided by 369 ATs (40.5% male and 44.6% female; Table 1). Fifty percent reported having completed a master's degree. Certification as a Strength and Conditioning Specialist was the most frequently reported credential (11%) after certified AT. Only 11.2% of the sample reported an athletic training clinic as the primary place of employment; physical therapy clinics (40.7%) and physician's offices (31.1%) were the most commonly reported places of employment (Table 1). Participants most often reported having more than 20 years of experience as an AT (20.6%). Of those sampled, 14%, 29.9%, and 22.8%, respectively, had personally sustained an ACL injury or a meniscal tear or had been diagnosed with OA. Of the 84 respondents who reported being diagnosed with OA, 67 (77%; 15.3% of the total sample) specifically reported it affected the knee joint.

Knowledge and Perceptions of the Risk of Knee OA After Knee Injury and Surgery

The majority of the sample (84.7%) correctly identified OA as *a condition that affects a number of structures around the joint and is characterized by the breakdown of the joint's cartilage*. Most reported that they learned about OA from personal experience (n = 241, 55.1%), other clinicians (n = 235, 53.8%), formal coursework (n = 277, 51.9%), and continuing education (n = 220, 50.3%). A combined 61.2% (n = 267) of the sample either strongly agreed or agreed that a patient having knee OA would be a major health concern, which was similar to the percentage of ATs who did have knowledge of the condition of PTOA (n = 225, 60.3%; Table 2). The majority of respondents either strongly agreed or agreed that certain factors would increase the risk of developing OA, including (1) full meniscectomy (n = 431, 98.9%), (2) being overweight (n = 420, 96.2%), (3) meniscal tear (n = 415, 95.4%), (4) altered biomechanics after an acute injury (n = 394, 90.3%), (5) an ACL tear (n = 393, 90.2%), (6) partial meniscectomy (n =

Table 1. Demographics of Study Volunteers (N = 437)

Characteristic	Value, No. (%)
Age, mean = 37.43 ± 10.23 y	369 (84.4)
Missing data	68 (15.6)
Sex	
Male	177 (40.5)
Female	195 (44.6)
Missing data	65 (14.9)
Ethnicity	
Hispanic	13 (3)
Non-Hispanic	352 (81.5)
Missing data	68 (15.6)
Race	
White	358 (81.9)
Black	3 (0.7)
Asian	1 (0.2)
American Indian/Alaska Native	5 (1.1)
Missing data	70 (16.0)
Highest level of education	
Bachelor's	117 (26.8)
Master's	219 (50.1)
Clinical doctorate (DPT)	26 (5.9)
Doctoral degree (PhD, EdD)	2 (0.5)
Professional degree (MD, JD)	8 (1.8)
Missing data	65 (14.9)
Credential held in addition to certified athletic trainer	
MPT	23 (5.3)
DPT	29 (6.6)
CSCS	48 (11)
MD	2 (0.5)
OT	2 (0.5)
Missing data	67 (15.3)
Employment setting	
Physical therapy clinic	178 (40.7)
Physician's office	136 (31.1)
Athletic training clinic	49 (11.2)
Hospital	36 (8.2)
Industrial	4 (0.9)
Military	1 (0.2)
Missing data	33 (7.5)
Years credentialed as a certified athletic trainer	
1–5	85 (19.5)
6–10	79 (18.1)
11–15	68 (15.6)
16–20	48 (11)
>20	90 (20.6)
Missing data	67 (15.3)
Sustained anterior cruciate ligament injury?	61 (14)
Sustained meniscal injury?	111 (29.9)
Personally have some type of arthritis?	96 (25.0)
Personally have osteoarthritis?	87 (19.9)
Personally have knee osteoarthritis?	67 (15.3)
Know someone with arthritis?	361 (82.6)

392, 90.1%), (7) persistent strength deficits after an acute injury (n = 368, 84.6%), and (8) smoking (n = 274, 62.7%; Table 3). There was no majority consensus (*agree*, *disagree*, or *do not know*) as to whether the following factors increased the risk of OA development: meniscal repair, male sex, or having a relative with knee OA (Table 2). A total of 51.3% (n = 224) of the respondents either strongly agreed or agreed that having strong quadriceps reduces the risk of developing knee OA, whereas 51.4% (n = 194) of respondents strongly disagreed or disagreed that ACL-R reduces the risk of developing knee OA (Table 2).

A greater number of participants hypothesized that 20-year-old ACL-injured patients would have a higher prevalence of OA at ages 30, 40, 50, and 60 years if they remained ACL-D versus undergoing ACL-R ($P = <.001$; Table 3). At all time points, the majority of ATs (30 years = 53%, 40 years = 56%, 50 years = 56%, and 60 years = 56%) believed that a higher percentage of ACL-D patients would develop knee OA compared with ACL-R patients. Similarly, more respondents hypothesized that 20-year-old patients with meniscal injury would have a higher prevalence of OA at ages 30, 40, 50, and 60 years if they underwent meniscectomy compared with meniscal repair ($P = <.001$; Table 3). At all time points, the majority of participants (30 years = 66%, 40 years = 66%, 50 years = 66%, and 60 years = 67%) believed that a higher percentage of meniscectomy patients would develop knee OA than patients who underwent a meniscal repair.

Therapeutic Management of Knee OA After Knee Injury and Surgery

Most respondents reported treating patients with ACL (n = 400, 92.8%) and meniscal injuries (n = 386, 88.3%). The majority rated the importance of undertaking strategies to prevent OA from developing after ACL injury or ACL-R (n = 296, 73.8%) and meniscal injury or surgery (n = 317, 74.7%) as extremely important or somewhat important (Table 4). Most reported it was very likely or likely that they would recommend the following interventions to patients after such an injury or surgery: (1) ongoing regular lower limb muscle strengthening/retraining (n = 396, 98.4%), (2) maintaining an appropriate body weight (n = 365, 97.1%), (3) wearing a supportive knee brace during physical activities and sports (n = 285, 76%), and (4) using shoe orthotics on a daily basis (n = 286, 76.5%; Table 4). There was no treatment for which the majority of ATs reported the usage as being very unlikely or unlikely. Although most believed that it was appropriate to explain the risk of OA to patients after ACL or meniscal injury (n = 419, 96.8%), a lower percentage actually reported explaining the risk of OA to patients after an ACL (n = 277, 70.8%) or meniscal (n = 308, 80.6%) injury or surgery. A similar percentage reported providing information to patients about strategies to lower their risk of developing knee OA after an ACL (n = 277, 70.8%) or meniscal (n = 294, 78.4%) injury or surgery.

We found that 60.5% of ATs (n = 210) who treated ACL-injured patients and the same percentage who treated meniscus-injured patients did have knowledge of PTOA. Participants who reported having knowledge of PTOA were more likely to explain the risk of developing OA after ACL injury ($P < .001$) and meniscal injury ($P = .001$) and to provide patients with strategies to lower the risk of OA after ACL ($P < .001$) and meniscal injury ($P < .001$; Table 5) compared with those who did not have such knowledge. No differences were evident in the likelihood of ATs choosing different treatments based on their knowledge of PTOA (Table 6). As years of credentialed experience increased, progressively higher percentages of ATs had knowledge of PTOA ($P = .009$). The ATs with more than 20 years of

Table 2. Answers to Questions from the Knowledge and Perceptions of Knee Osteoarthritis Survey: Risk of Knee Osteoarthritis After Injury and Surgery

Question[a]	No.	Answer, No. (%)				
		Strongly Agree	Agree	Do Not Know	Disagree	Strongly Disagree
One of your patients having knee osteoarthritis would be a major health concern.	436	45 (10.3)	222 (50.9)	7 (1.6)	148 (33.9)	14 (3.2)
Having strong quadriceps **reduces** a patient's chance of developing knee osteoarthritis.	437	34 (7.8)	190 (43.5)	31 (7.1)	169 (38.7)	13 (3.0)
An anterior cruciate ligament (ACL) tear **increases** a patient's chance of developing knee osteoarthritis.	435	203 (46.7)	190 (43.5)	16 (3.7)	25 (5.7)	1 (0.2)
Undergoing a surgical ACL reconstruction following an ACL tear **reduces** a patient's chance of developing knee osteoarthritis.	435	35 (8.0)	159 (36.6)	22 (5.1)	180 (41.4)	39 (9.0)
Having a meniscus tear **increases** a patient's chance of developing knee osteoarthritis.	435	170 (39.1)	245 (56.3)	9 (2.1)	11 (2.5)	0 (0.0)
Undergoing a **partial meniscectomy** (surgical removal of part of the meniscus) **increases** a patient's chance of developing knee osteoarthritis.	435	120 (27.6)	272 (62.5)	20 (4.6)	22 (5.1)	1 (0.2)
Undergoing a **full meniscectomy** (surgical removal of the entire meniscus) **increases** a patient's chance of developing knee osteoarthritis.	436	320 (73.4)	111 (25.5)	1 (0.2)	4 (0.9)	0 (0.0)
Undergoing a meniscal repair (surgical repair or suturing of torn meniscus) **increases** a patient's chance of developing knee osteoarthritis.	435	21 (4.8)	155 (35.6)	60 (13.8)	184 (42.3)	15 (3.4)
Being overweight or obese **increases** a patient's chance of developing knee osteoarthritis.	437	262 (60)	158 (36.2)	9 (2.1)	8 (1.8)	0 (0.0)
High alcohol intake **increases** a patient's chance of developing knee osteoarthritis.	435	35 (8.0)	96 (22.1)	243 (55.6)	50 (11.4)	11 (2.5)
Cold weather **increases** a patient's chance of developing knee osteoarthritis.	436	0 (0.0)	9 (2.1)	62 (14.2)	240 (54.9)	125 (28.6)
Persistent lower extremity strength deficits following acute knee injury **increases** a patient's chance of developing knee osteoarthritis.	435	89 (20.5)	279 (64.1)	30 (6.9)	35 (8.0)	2 (0.2)
Males have an **increased** risk of developing knee osteoarthritis.	434	5 (1.2)	56 (12.9)	173 (39.9)	179 (41.2)	21 (4.8)
Smoking **increases** a patient's chance of developing knee osteoarthritis.	437	54 (12.4)	220 (50.3)	121 (27.7)	35 (8.0)	7 (1.6)
Having a relative with knee osteoarthritis **increases** a patient's chance of developing knee osteoarthritis.	435	24 (5.5)	190 (43.7)	72 (16.5)	135 (30.9)	14 (3.2)
Altered biomechanics in the lower extremity following acute injury **increases** a patient's chance of developing knee osteoarthritis.	436	124 (28.4)	270 (61.9)	21 (4.8)	19 (4.4)	2 (0.5)
		Yes, No. (%)	No, No. (%)			
Are you aware of the condition of posttraumatic osteoarthritis?	373	225 (60.3)	148 (39.7)			

[a] Survey questions are presented as in the instrument.

clinical experience (74.4%) had the highest percentage of respondents with knowledge of PTOA, whereas those with 1–5 or 11–15 years of clinical experience had the lowest percentage of respondents with such knowledge (52.9%). Of the respondents with 6–10 and 16–20 years of experience, 54.4% and 68.8%, respectively, reported having knowledge of PTOA.

Post Hoc Analyses

We conducted post hoc Pearson χ^2 analyses to investigate the results of the planned primary analyses. A previous history of an ACL injury ($\chi^2 = 0.12$, $P = .73$) or a meniscal injury ($\chi^2 = 1.51$, $P = .73$) did not increase the percentage of people who were aware of PTOA. A greater percentage of respondents reported being diagnosed with arthritis and aware of the condition of PTOA (70.8%) compared with those who had never been diagnosed with arthritis and were aware of the condition of PTOA (56.7%, $\chi^2 = 5.97$, $P = .02$). Additionally, the ability to correctly define OA was not affected by years of experience as an AT ($\chi^2 = 25.25$, $P = .19$).

Table 3. Answers to Questions from the Knowledge and Perceptions of Knee Osteoarthritis Survey: Specific Knowledge about the Risk of Posttraumatic OA in Patients with Anterior Cruciate Ligament (ACL) Injuries and Meniscal Injuries[a]

In a group of 20-year-old ACL injured patients, that ***undergo ACL reconstruction and a group that DOES NOT undergo ACL reconstruction***, what percentage of these patients will develop OA by the following ages?

At age (y)	No.	ACL Reconstruction, Mean ± SD, %	ACL Deficient, Mean ± SD, %
30	338	16.56 ± 13.56	26.4 ± 19.0
40	350	31.37 ± 16.99	41.27 ± 21.21
50	357	47.5 ± 18.93	56.63 ± 21.6
60	355	62.43 ± 21.17	69.26 ± 23.1

In a group of 20-year-old patients with meniscus tears, that undergo a ***MENISCAL REPAIR or MENISCECTOMY***, what percentage of these patients will develop OA by the following ages?

At age (y)	No.	Meniscal Repair, Mean ± SD, %	Meniscectomy, Mean ± SD, %
30	327	14.66 ± 12.3	24.13 ± 16.07
40	346	25.58 ± 14.53	38.61 ± 17.83
50	352	38.83 ± 18.39	54.32 ± 19.6
60	352	51.18 ± 22.04	67.92 ± 21.69

[a] Survey questions are presented as in the instrument.

Table 4. Answers to Questions from the Knowledge and Perceptions of Knee Osteoarthritis Survey: Therapeutic Management of Knee Osteoarthritis After Knee Injury and Surgery

Question[a]	No.	Answer, No. (%)				
		Extremely Important	Somewhat Important	Moderately Important	Slightly Important	Not At All Important
How important is it to you that your patients undertake strategies to prevent osteoarthritis from developing in their knee following **ACL injury or Reconstruction**?	401	186 (46.4)	110 (27.4)	79 (19.7)	21 (5.2)	5 (1.2)
How important is it to you that your patients undertake strategies to prevent osteoarthritis from developing in their knee following **meniscus injury or surgery**?	401	211 (52.6)	106 (26.4)	66 (16.5)	12 (3.0)	6 (1.5)
		Very Likely	Likely	Unsure	Unlikely	Very Likely
If the following treatments could reduce the risk of developing knee osteoarthritis, how likely would you be to recommend to patients or utilize in your clinical practice **specifically to reduce the risk of knee osteoarthritis following an ACL or meniscus injury**:						
Ongoing regular lower limb muscle strengthening/retraining	375	290 (77.3)	79 (21.1)	4 (1.1)	0 (0.0)	2 (0.5)
Maintaining an appropriate body weight	376	268 (71.3)	97 (25.8)	8 (2.1)	2 (0.5)	1 (0.3)
Wearing a supportive knee brace daily (not an elastic/neoprene sleeve but a rigid supportive brace)	375	45 (12.1)	106 (28.5)	98 (26.3)	104 (28)	19 (5.1)
Wearing a supportive knee brace during physical activities and sports (not a elastic/neoprene sleeve but a rigid supportive brace)	375	118 (31.5)	167 (44.5)	42 (11.2)	45 (12.0)	3 (0.8)
Using shoe orthotics on a daily basis	374	113 (30.2)	173 (46.3)	53 (14.2)	31 (8.3)	4 (1.1)
Wearing specially designed shoes on a daily basis	373	41 (11)	110 (29.5)	128 (34.3)	77 (20.1)	17 (4.6)
		Yes	No			
Do you think it is appropriate to explain the risk of osteoarthritis to patients following an **anterior cruciate ligament (ACL) injury** or **meniscus injury**?	433	419 (96.8)	14 (3.2)			
Do you treat patients with an **ACL injury**?	431	400 (92.8)	31 (7.2)			
Do you treat patients with a **meniscus injury?**	416	386 (92.8)	30 (7.2)			
		Yes	No	N/A		
Do you explain the risk of osteoarthritis to patients following an **ACL injury**?	395	279 (70.6)	116 (29.4)	N/A		
Do you provide information to your patients on strategies to lower their risk of knee osteoarthritis following an **ACL injury**?	391	277 (70.8)	114 (29.2)	N/A		
Do you explain the risk of osteoarthritis to patients following a **meniscus injury**?	382	308 (80.6)	74 (19.4)	N/A		
Do you provide information to your patients on strategies to lower their risk of knee osteoarthritis following a **meniscus injury**?	375	294 (78.4)	81 (21.6)	N/A		

Abbreviation: N/A, not available.

[a] Survey questions are presented as in the instrument. If an athletic trainer answered *no* to treating ACL- or meniscus-injured patients, he or she was not asked follow-up questions about explaining the osteoarthritis risk to patients or providing information or strategies to patients to lower their risk of osteoarthritis.

DISCUSSION

We surveyed a large number of ATs about their knowledge and perceptions of OA, as well as their educational strategies and treatment recommendations for patients with PTOA. We found that ATs were knowledgeable about the general condition of OA. Although most knew that ACL and meniscal injury or related surgery increased the risk of developing knee OA, more than one-third (approximately 40%) were not familiar with the condition labeled *PTOA*. The unfamiliarity with the term *PTOA* may be evidence that a large proportion of ATs are not knowledgeable about the specific factors that differ between PTOA and other OA phenotypes that develop via idiopathic origins. Data from the current study suggest that ATs may not be aware of the high percentage of patients who develop PTOA after traumatic injury and the rapid onset of metabolic and structural osteoarthritic changes after an acute injury. Knowledge of risk factors for knee OA was generally good, but the ATs seemed to overestimate the prophylactic benefit of ACL-R in decreasing the risk of PTOA; current evidence[8] indicates that ACL-R does not decrease the risk of OA. Athletic trainers believed that undertaking strategies to prevent the onset of knee OA in patients with knee injuries was important, and they were likely to recommend a number of interventions. Differences in the likelihood of explaining the risk of developing knee OA and providing treatment recommendations were noted when we compared ATs with and without knowledge of PTOA. The ability to correctly identify the definition of OA was not affected by years of experience as an AT, yet knowledge of PTOA seemed to be related to more years of clinical experience. A history of a personal ACL or meniscal injury did not affect the percentage of respondents who were aware of the condition of PTOA; however, a greater percentage of those who had been diagnosed with arthritis were aware of PTOA than those who had not been

Table 5. χ^2 Analysis Describing the Frequency of Athletic Trainers Who Reported Different Treatment Practices Based on Knowledge of Posttraumatic Osteoarthritis (PTOA) from the Knowledge and Perceptions of Knee Osteoarthritis Survey

Question[a]	No.	Knowledge of PTOA/ No Knowledge of PTOA	Knowledge of PTOA, No. (%)		No Knowledge of PTOA, No. (%)		χ^2 (*P* Value)
			Yes	No	Yes	No	
Do you treat patients with an **ACL injury**?	373	225/148	210 (60.5)	15 (57.7)	137 (39.5)	11 (42.3)	0.081 (.776)
Do you treat patients with a **meniscus injury?**	371	224/147	210 (60.5)	14 (58.3)	137 (39.5)	10 (41.7)	0.045 (.832)
Do you think it is appropriate to explain the risk of osteoarthritis to patients following an **anterior cruciate ligament (ACL) injury** or **meniscus injury**?	373	225/148	221 (60.7)	4 (44.4)	143 (39.3)	5 (55.6)	0.971 (.324)
Do you explain the risk of osteoarthritis to patients following an **ACL injury**?	347	210/137	173 (68.7)	37 (38.9)	79 (31.3)	58 (61.1)	25.476 (<.001)[b]
Do you provide information to your patients on strategies to lower their risk of knee osteoarthritis following an **ACL injury**?	347	210/137	167 (66.3)	43 (45.3)	85 (33.7)	52 (54.7)	12.742 (<.001)[b]
Do you explain the risk of osteoarthritis to patients following a **meniscus injury**?		210/137	184 (64.8)	26 (41.3)	100 (35.2)	37 (58.7)	11.94 (.001)[b]
Do you provide information to your patients on strategies to lower their risk of knee osteoarthritis following a **meniscus injury**?	342	207/135	175 (65.5)	32 (42.7)	92 (34%)	43 (57.3)	12.83 (<.001)[b]

[a] Survey questions are presented as in the instrument.
[b] Indicates difference (after Bonferroni correction) between those with and those without knowledge of PTOA.

diagnosed with arthritis. Athletic trainers with a diagnosis of arthritis may be more aware of PTOA, but respondents who have had a traumatic knee (ACL or meniscal) injury and may be at higher risk for developing PTOA themselves were not more aware of PTOA than those who had not sustained such an injury.

One of the 5 most debilitating conditions in the United States,[1] OA is also the fourth most common cause of hospitalization.[17] Knee OA may increase chronic pain and decrease physical activity, leading to inactivity-related conditions and comorbidities that increase mortality rates.[18] Knee OA has been linked to decreased physical activity[19,20] and higher risks of cardiovascular disease, obesity, diabetes,[18] and depression.[21] Although PTOA patients account for only 12% of the total population with OA,[22] because they develop the condition earlier in life, they may live more years with disability than OA patients who develop the disease later in life. Additionally, people with PTOA have higher rates of knee arthroplasty failure and revision.[23,24] More than 90% of the ATs sampled agreed that ACL or meniscal injury or surgery increases the risk of developing knee OA, but only about 60% agreed that knee OA is a serious health concern (Table 2). There may be a disconnection between the knowledge of the risk of PTOA and the perception of the seriousness of developing OA. Educating ATs about the possibility that their patients with ACL or meniscal injury will develop OA may help advance treatment strategies and maximize long-term joint health.

Athletic trainers who responded to the survey provided appropriate answers to questions about their specific knowledge of OA, suggesting a general working knowledge of the disease. The literature supports the answers provided by the majority of respondents who strongly agreed or agreed that full meniscectomy (98.9%), meniscal tear (95.4%), ACL injury (90.2%), or partial meniscectomy (90.1%) increases the risk of knee OA (Table 2).[8,25–27] Athletic trainers estimated the risk of OA as higher at all hypothetical time points (decades 1, 2, 3, and 4 after ACL injury) for patients who remained ACL-D compared with patients who underwent ACL-R (Table 5, $P < .001$). However, current research[8] does not support the notion that ACL-R decreases the risk of knee OA compared with patients who remain ACL-D. Investigators[8] have observed a 6% absolute increase in the risk of developing OA after ACL-R compared with patients who remained ACL-D. We can speculate that ACL-R patients may engage in more physical activity or activities that require more load on the knee than ACL-D patients and, therefore, develop PTOA at a similar rate to ACL-D patients who may have less physically active lifestyles. Although the authors of a previous systematic review[8] reported similarly decreased physical activity levels in both ACL-R and ACL-D patients postinjury, more research is necessary to determine the mechanisms that lead to a similar prevalence of PTOA among ACL-R and ACL-D patients. Similarly, ATs estimated the risk of OA as higher after meniscectomy than after meniscal repair (Table 3). The comparative risk of OA after meniscectomy versus meniscal repair is not yet known, but the amount of meniscus removed may be related to the progression of early joint degeneration.[28] Athletic trainers may underestimate the overall risk and rapid onset of OA after knee injury. Conversely, they potentially overestimate the prophylactic capability of ACL-R to decrease the risk of OA. This could result in their giving patients inaccurate information and lead patients considering an ACL-R to discount OA as a future concern.

Table 6. χ^2 Analysis Describing the Frequency of Likelihood That Athletic Trainers Who Conducted Specific Treatment Practices Based on Knowledge of Posttraumatic Osteoarthritis (PTOA) from the Knowledge and Perceptions of Knee Osteoarthritis Survey

Question[a]	Total	Knowledge of PTOA? (No.)	Answer, No. (%)					χ^2 (*P* Value)
			Extremely Important	Somewhat Important	Moderately Important	Slightly Important	Not At All Important	
How important is it to you that your patients undertake strategies to prevent osteoarthritis from developing in their knee following **ACL injury or Reconstruction**?	372	Yes (225) No (147)	119 (52.9) 55 (37.4)	62 (27.6) 43 (29.3)	36 (16.0) 34 (23.1)	8 (3.6) 10 (6.8)	0 (0) 5 (3.4)	16.63 (.002)[b]
How important is it to you that your patients undertake strategies to prevent osteoarthritis from developing in their knee following **meniscus injury or surgery**?	372	Yes (225) No (147)	136 (60.4) 63 (42.9)	54 (24.0) 44 (29.9)	30 (13.3) 28 (19.0)	5 (2.2) 7 (4.8)	0 (0) 5 (3.4)	17.62 (.001)[b]
If the following treatments could reduce the risk of developing knee osteoarthritis, how likely would you be to recommend to patients or utilize in your clinical practice specifically to reduce the risk of knee osteoarthritis following an ACL or meniscus injury:								
Ongoing regular lower limb muscle strengthening/retraining	372	Yes (224) No (148)	176 (78.6) 111 (75.0)	45 (20.1) 34 (23.0)	2 (0.9) 2 (1.4)	0 (0) 0 (0)	1 (0.4) 1 (0.7)	0.758 (.860)
Maintaining an appropriate body weight	373	Yes (225) No (148)	172 (76.4) 93 (62.8)	46 (20.4) 51 (34.5)	5 (2.2) 3 (2.0)	1 (0.4) 1 (0.7)	1 (0.4) 0 (0)	9.832 (.043)
Wearing a supportive knee brace daily (not an elastic/neoprene sleeve but a rigid supportive brace)	369	Yes (222) No (147)	29 (13.1) 16 (10.9)	70 (31.5) 35 (23.8)	55 (24.8) 42 (28.6)	56 (25.2) 48 (32.7)	12 (5.4) 6 (4.1)	4.731 (.316)
Wearing a supportive knee brace during physical activities and sports (not a elastic/neoprene sleeve but a rigid supportive brace)	372	Yes (225) No (147)	70 (31.1) 47 (32.0)	105 (46.7) 60 (40.8)	19 (8.4) 23 (15.6)	29 (12.9) 16 (10.9)	2 (0.9) 1 (0.7)	5.135 (.274)
Using shoe orthotics on a daily basis	371	Yes (223) No (148)	68 (30.5) 44 (29.7)	105 (47.1) 68 (45.9)	29 (13.0) 22 (14.9)	18 (8.1) 13 (8.8)	3 (1.3) 1 (0.7)	0.690 (.953)
Wearing specially designed shoes on a daily basis	370	Yes (222) No (148)	26 (11.7) 14 (9.5)	64 (28.8) 46 (31.1)	70 (31.5) 56 (37.8)	52 (23.4) 25 (16.9)	10 (4.5) 7 (4.7)	3.435 (.488)

Abbreviation: ACL, anterior cruciate ligament.

[a] Survey questions are presented as in the instrument.

[b] Indicates difference (after Bonferroni correction) between those with and without knowledge of PTOA.

The majority of ATs indicated that it was extremely or somewhat important to undertake strategies to prevent OA after ACL injury, ACL-R, meniscal injury, and meniscal surgery (Table 4). Athletic trainers who had knowledge of PTOA were more likely to indicate that undertaking strategies to prevent OA was extremely important for patients than those who did not have knowledge of PTOA (Table 6). Although 96.8% of ATs indicated that it was appropriate to explain the risk of OA to patients after an ACL injury or meniscal injury, only 70.6% and 80.6%, respectively, provided such information to patients. A higher percentage of ATs who had knowledge of PTOA explained the risk of OA after ACL or meniscal injury compared with those who did not have such knowledge. At this point, it is unclear why ATs who believe that it is appropriate to explain the risk of developing OA after ACL or meniscal injury fail to do so. Perhaps some ATs are uncomfortable providing information about the OA risk to their patients, do not feel equipped with effective strategies to explain the risk, or rely on other health care professionals to deliver that information. It is important to identify the barriers that prevent ATs from delivering information about the PTOA risk to patients so that strategies can be developed to overcome these barriers and more effectively engage patients. We are careful not to conclude that educating ATs will change clinical practice regarding interventions to limit PTOA, but improving their knowledge about PTOA may increase the likelihood that they will provide information regarding the risk of OA to patients. For the most part, knowledge of PTOA did not affect the likelihood of using the specific types of interventions that we provided as options, indicating that, regardless of their knowledge of the disease, clinicians use muscle strengthening, knee braces, orthotics, specialized footwear, and maintenance of a proper body weight to the same extent to prevent OA (Table 6).

Improving knowledge of PTOA among ATs may be a critical step in continuing to mitigate the risk of developing OA after acute injury. It is important to train clinicians to be attentive and responsive to the rapid advances in knowledge about the pathogenesis and the best management of PTOA that are generated by new research efforts. Educating ATs will likely lead to patients, caregivers (eg, parents), spouses, and coaches who are better informed

about the future risk of developing a chronic disease and methods to maintain physical function over a lifespan. Athletic trainers most commonly reported learning about OA from personal experience (55.1%) or other clinicians (53.8%), yet only 22% reported actually being diagnosed with OA (Table 1). Consequently, a higher percentage of ATs who were knowledgeable about PTOA were in the cohort of clinicians who reported more than 20 years of clinical experience (74.4%) than in cohorts with less clinical experience. Athletic trainers with more years of practice may have experienced previous patients' reporting early-onset OA after a knee injury and be more knowledgeable about the negative long-term consequences of traumatic joint injury. Slightly more than 50% of respondents reported learning about OA from formal coursework (51.9%) or through continuing education (50.3%). Only 52.9% who had 1 to 5 years of clinical experience reported knowledge of PTOA, suggesting that efforts to integrate data about PTOA into undergraduate and graduate athletic training education coursework may improve the ability of novice ATs to treat patients at risk for PTOA. Our post hoc analyses did not demonstrate that the number of years of experience as a certified AT influenced the respondents' ability to correctly identify the definition of OA. Therefore, the deficiency may be in awareness about the pathogenesis and risk of the specific PTOA phenotype rather than knowledge of OA in general among less experienced ATs. Additionally, the largest cohort of ATs is between 22 and 37 years of age[29]; our sample may have been slightly older, yet the age of our respondents was similar to the age of ATs who responded to online surveys in recently published research.[30,31] Although it is important to provide ATs with a better understanding of the risk and the factors related to the development of PTOA, it is also important to develop multimodal mechanisms that provide ATs with the most current information and innovative methods for decreasing the risk of PTOA in patients. Education about the long-term risks to joint health may need to be integrated into accredited athletic training education programs and the most current information disseminated to practicing ATs. Special interest groups within the NATA who are concerned about joint injury and disease should develop programs and online materials to inform ATs about PTOA. Furthermore, other organizations concerned with mitigating the negative effects of OA in the United States may educate ATs about PTOA as a way to improve early intervention and decrease the risk of OA after joint injury.

Despite the important implications of our findings, we acknowledge study limitations, which might inform future research and clinical efforts in this area. We sent our survey to a relatively large sample size (n = 2000), but only a small percentage responded (21.9%). Our sample contained more women than men, which is similar to membership trends reported by the NATA. However, compared with the NATA membership, a smaller percentage of respondents indicated that they were nonwhite or a minority race (12.4% versus 2.1%, respectively; Table 1).[32] Approximately 40% of the ATs stated that they worked in a physical therapy clinic and 31% worked in a physician's office, percentages that are much higher those reported by the NATA (18.4% and 4.2%, respectively).[32] It is possible that the ATs who responded to the study were interested in knee injury and more knowledgeable about it than those who did not reply, thereby leading to response bias. An additional study limitation involves the item-level interpretation of the KPOAS, which restricts our ability to examine a higher-order PTOA knowledge construct and its associated psychometric properties. Such efforts, though beyond the scope of the current study, would enhance our understanding of the construct validity of the KPOAS.

It is also possible that, due to the nature of the questions, respondents presumed a link between knee injury and OA, which may have affected how they answered the questions as they continued through the questionnaire. In case participants ended the survey prematurely, we elected to place the demographic questions at the end of the survey, which allowed us to collect the data pertaining to the knowledge of OA risk and treatment first. Unfortunately, we did not gain demographic information from approximately 3.5% of the ATs who volunteered. Despite these limitations, our study provides a solid baseline with which to better understand and influence ATs' knowledge and best practices regarding knee injury and OA.

CONCLUSIONS

Although ATs were knowledgeable about the general condition of OA and most knew that ACL and meniscal injury increase the risk of developing knee OA, we found that more than one-third of the sample (approximately 40%) were not familiar with the condition when labeled as *PTOA*. Additionally, ATs seemed to overestimate the ability of ACL-R and current rehabilitative methods to decrease the risk of OA. We did note that ATs who were knowledgeable about PTOA were more likely to explain the risk of OA and provide patients with strategies that may help prevent OA after traumatic knee injury. Improving the knowledge about the risk of PTOA among ATs may be an initial step in improving treatment strategies to mitigate the risk of developing PTOA after acute knee injury.

REFERENCES

1. Guccione AA, Felson DT, Anderson JJ, et al. The effects of specific medical conditions on the functional limitations of elders in the Framingham Study. *Am J Public Health*. 1994;84(3):351–358.
2. Blagojevic M, Jinks C, Jeffery A, Jordan KP. Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. *Osteoarthritis Cartilage*. 2010;18(1):24–33.
3. Muthuri SG, McWilliams DF, Doherty M, Zhang W. History of knee injuries and knee osteoarthritis: a meta-analysis of observational studies. *Osteoarthritis Cartilage*. 2011;19(11):1286–1293.
4. Lohmander LS, Ostenberg A, Englund M, Roos H. High prevalence of knee osteoarthritis, pain, and functional limitations in female soccer players twelve years after anterior cruciate ligament injury. *Arthritis Rheum*. 2004;50(10):3145–3152.
5. Lohmander LS, Englund PM, Dahl LL, Roos EM. The long-term consequence of anterior cruciate ligament and meniscus injuries: osteoarthritis. *Am J Sports Med*. 2007;35(10):1756–1769.
6. Roos EM. Joint injury causes knee osteoarthritis in young adults. *Curr Opin Rheum*. 2005;17(2):195–200.
7. Wilder FV, Hall BJ, Barrett JP Jr, Lemrow NB. History of acute knee injury and osteoarthritis of the knee: a prospective epidemiological assessment. The Clearwater Osteoarthritis Study. *Osteoarthritis Cartilage*. 2002;10(8):611–666.
8. Luc B, Gribble PA, Pietrosimone BG. Osteoarthritis prevalence following anterior cruciate ligament reconstruction: a systematic

review and numbers needed to treat analysis. *J Athl Train*. 2014; 49(6):806–819.
9. Shelbourne KD, Dickens JF. Digital radiographic evaluation of medial joint space narrowing after partial meniscectomy of bucket-handle medial meniscus tears in anterior cruciate ligament-intact knees. *Am J Phys Med*. 2006;34(10):1648–1655.
10. Roos H, Lauren M, Adalberth T, Roos EM, Jonsson K, Lohmander LS. Knee osteoarthritis after meniscectomy: prevalence of radiographic changes after twenty-one years, compared with matched controls. *Arthritis Rheum* 1998;41(4):687–693.
11. Ilich SS, Dempsey AR, Mills PM, et al. Physical activity patterns and function 3 months after arthroscopic partial meniscectomy. *J Sci Med Sport*. 2013;16(3):195–199.
12. Roos H, Adalberth T, Dahlberg L, Lohmander LS. Osteoarthritis of the knee after injury to the anterior cruciate ligament or meniscus: the influence of time and age. *Osteoarthritis Cartilage*. 1995;3(4):261–267.
13. Westermann RW, Wright RW, Spindler KP, Huston LJ, MOON Knee Group, Wolf BR. Meniscal repair with concurrent anterior cruciate ligament reconstruction: operative success and patient outcomes at 6-year follow-up. *Am J Sports Med*. 2014;42(9):2184–2192.
14. Andriacchi TP, Mundermann A. The role of ambulatory mechanics in the initiation and progression of knee osteoarthritis. *Curr Opin Rheum*. 2006;18(5):514–518.
15. Chu CR, Andriacchi TP. Dance between biology, mechanics, and structure: a systems-based approach to developing osteoarthritis prevention strategies. *J Orthop Res*. 2015;33(7):939–947.
16. Nelson AE, Allen KD, Golightly YM, Goode AP, Jordan JM. A systematic review of recommendations and guidelines for the management of osteoarthritis: the chronic osteoarthritis management initiative of the U.S. bone and joint initiative. *Semin Arthritis Rheum*. 2014;43(6):701–712.
17. Murphy L, Helmick CG. The impact of osteoarthritis in the United States: a population-health perspective: a population-based review of the fourth most common cause of hospitalization in U.S. adults. *Orthop Nurs*. 2012;31(2):85–91.
18. Nuesch E, Dieppe P, Reichenbach S, Iff S, Juni P. All-cause and disease-specific mortality in patients with knee or hip osteoarthritis: population-based cohort study. *Osteoarthritis Cartilage*. 2010; 18(suppl 2):S151–S152.
19. McAlindon TE, Wilson PW, Aliabadi P, Weissman B, Felson DT. Level of physical activity and the risk of radiographic and symptomatic knee osteoarthritis in the elderly: the Framingham study. *Am J Med*. 1999;106(2):151–157.
20. Ageberg E, Engstrom G, de Verdier MG, Rollof J, Roos EM, Lohmander L. Effect of leisure time physical activity and physical work load on severe knee or hip osteoarthritis: a population-based prospective cohort study. *Osteoarthritis Cartilage*. 2010;18(suppl 2): S153–S154.
21. Duivenvoorden T, Vissers M, Verhaar JA, et al. Anxiety and depressive symptoms before and after total hip and knee arthroplasty: a prospective multicentre study. *Osteoarthritis Cartilage*. 2013; 21(12):1834–1840.
22. Brown TD, Johnston RC, Saltzman CL, Marsh JL, Buckwalter JA. Posttraumatic osteoarthritis: a first estimate of incidence, prevalence, and burden of disease. *J Orthop Trauma*. 2006;20(10):739–744.
23. Lonner JH, Pedlow FX, Siliski JM. Total knee arthroplasty for post-traumatic arthrosis. *J Arthroplasty*. 1999;14(8):969–975.
24. Weiss NG, Parvizi J, Hanssen AD, Trousdale RT, Lewallen DG. Total knee arthroplasty in post-traumatic arthrosis of the knee. *J Arthroplasty*. 2003;18(3 suppl 1):23–26.
25. Englund M, Lohmander LS. Risk factors for symptomatic knee osteoarthritis fifteen to twenty-two years after meniscectomy. *Arthritis Rheum*. 2004;50(9):2811–2819.
26. Sonnery-Cottet B, Archbold P, Thaunat M, Carnesecchi O, Tostes M, Chambat P. Rapid chondrolysis of the knee after partial lateral meniscectomy in professional athletes. *Knee*. 2014;21(2):504–508.
27. Rangger C, Klestil T, Gloetzer W, Kemmler G, Benedetto KP. Osteoarthritis after arthroscopic partial meniscectomy. *Am J Sports Med*. 1995;23(2):240–244.
28. Souza RB, Wu SJ, Morse LJ, Subburaj K, Allen CR, Feeley BT. Cartilage MRI relaxation times after arthroscopic partial medial meniscectomy reveal localized degeneration. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(1):188–197.
29. Kahanov L, Eberman LE. Age, sex, and setting factors and labor force in athletic training. *J Athl Train*. 2011;46(4):424–430.
30. Mazerolle SM, Pitney WA, Eason CM. Experiences of work-life conflict for the athletic trainer employed outside the National Collegiate Athletic Association Division I clinical setting. *J Athl Train*. 2015;50(7):748–759.
31. Williams RM, Welch CE, Parsons JT, McLeod TC. Athletic trainers' familiarity with and perceptions of academic accommodations in secondary school athletes after sport-related concussion. *J Athl Train*. 2015;50(3):262–269.
32. National Athletic Trainers' Association. National Athletic Trainers' Association membership statistics: 2014 year-end statistics. http://members.nata.org/members1/documents/membstats/2014EOY-stats.htm. Published 2015. Accessed May 12, 2015.

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Knowledge and Perceptions of Osteoarthritis Survey:

What do clinicians know about osteoarthritis risk following past knee injuries?[a]

Knowledge of Osteoarthritis:

Based on your current knowledge, please select the most appropriate answer from the provided list:

1. Osteoarthritis is:
   - ☐ a condition where the bones become fragile and brittle, causing them to break more easily
   - ☐ a name given to a group of symptoms marked by generalized pain and muscle stiffness
   - ☐ a condition that affects a number of structures around the joint and is characterized by the breakdown of the joint's cartilage
   - ☐ an autoimmune disease that causes pain and swelling of the joints
   - ☐ all of the above
   - ☐ none of the above
   - ☐ do not know

For the following statement please select if you "Strongly Disagree", "Disagree", "Do Not Know", "Agree" or "Strongly Agree":

2. One of your patients having knee osteoarthritis would be a major health concern

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

3. Having strong quadriceps **reduces** a patient's chance of developing knee osteoarthritis.

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

4. An anterior cruciate ligament (ACL) tear **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

5. Undergoing a surgical ACL reconstruction following an ACL tear **reduces** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

6. Having a meniscus tear **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

7. Undergoing a **partial meniscectomy** (surgical removal of part of the meniscus) **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

8. Undergoing a **full meniscectomy** (surgical removal of the entire meniscus) **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

9. Undergoing a meniscal repair (surgical repair or suturing of torn meniscus) **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

10. Being overweight or obese **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

11. High alcohol intake **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

12. Cold weather **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

13. Persistent lower extremity strength deficits following acute knee injury **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

14. Males have an **increased** risk of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

15. Smoking **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

16. Having a relative with knee osteoarthritis **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

17. Altered biomechanics in the lower extremity following acute injury **increases** a patient's chance of developing knee osteoarthritis

Strongly Disagree	Disagree	Do Not Know	Agree	Strongly Agree
☐	☐	☐	☐	☐

18. *How did you learn about risks of knee osteoarthritis?*
(Check all that apply)
- ☐ Formal Course work
- ☐ Continuing education course
- ☐ News
- ☐ Other Clinician
- ☐ Research Article
- ☐ Personal Experience
- ☐ Other; *please specify:*_____
- ☐ None

Treatment of Osteoarthritis:

19. Do you think it is appropriate to explain the risk of osteoarthritis to patients following an **anterior cruciate ligament (ACL) injury** or **meniscus injury**?
- ☐ Yes
- ☐ No; *briefly explain why not:*_____
_____

20. Do you treat patients with an **ACL injury**?
- ☐ Yes; how many pear year? _____
- ☐ No

If yes, answer the following, if no continue to 33

a. Do you explain the risk of osteoarthritis to patients following an **ACL injury**?
- ☐ Yes
- ☐ No; *briefly explain why not:* _____
_____

b. Do you provide information to your patients on strategies to lower their risk of knee osteoarthritis following an **ACL injury**?
- ☐ Yes
- ☐ No; *briefly explain why not:* _____
_____

21. Do you treat patients with a **meniscus injury**?
- ☐ Yes; how many per year? _____
- ☐ No

If yes, answer the following; if no, continue to 35

a. Do you explain the risk of osteoarthritis to patients following a **meniscus injury**?
- ☐ Yes
- ☐ No; *briefly explain why not:* _____
_____

b. Do you provide information to your patients on strategies to lower their risk of knee osteoarthritis following a **meniscus injury**?

☐ Yes
☐ No; *briefly explain why not:* _____
_____

22. *If Yes to question 32b or 33b*, Which interventions do you prescribe or recommend to your patients **specifically for the purpose of reducing their risk of developing knee osteoarthritis**? *(Check all that apply)*
    - ☐ Strengthening exercises
    - ☐ Aerobic exercises
    - ☐ Maintaining an appropriate body weight
    - ☐ Anti-inflammatory Medication
    - ☐ Surgery
    - ☐ Herbal treatments
    - ☐ Glucosamine
    - ☐ Activity modification
    - ☐ Footwear/Orthotics
    - ☐ Injections
    - ☐ Braces
    - ☐ Other, please specify:_____
    - ☐ None

For the following statement, please select if "Not at all important", "Slightly Important", "Moderately Important", "Somewhat Important" or "Extremely Important":

23. How important is it to you that your patients undertake strategies to prevent osteoarthritis from developing in their knee following **ACL injury or reconstruction**?

Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
☐	☐	☐	☐	☐

24. How important is it to you that your patients undertake strategies to prevent osteoarthritis from developing in their knee following **meniscus injury or surgery**?

Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
☐	☐	☐	☐	☐

For the following statements, please select if you would be "Very Unlikely", "Unlikely", "Unsure", "Likely" or "Very Likely":

25. If the following treatments could reduce the risk of developing knee osteoarthritis, how likely would you be to recommend to patients or utilize in your clinical practice **specifically to reduce the risk of knee osteoarthritis following an ACL or meniscus injury**:

    a. Ongoing regular lower limb muscle strengthening/retraining

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
☐	☐	☐	☐	☐

b. Maintaining an appropriate body weight

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
☐	☐	☐	☐	☐

c. Wearing a supportive knee brace daily (not an elastic/neoprene sleeve but a rigid supportive brace)

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
☐	☐	☐	☐	☐

d. Wearing a supportive knee brace during physical activities and sports (not a elastic/neoprene sleeve but a rigid supportive brace)

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
☐	☐	☐	☐	☐

e. Using shoe orthotics on a daily basis

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
☐	☐	☐	☐	☐

f. Wearing specially designed shoes on a daily basis

Very Unlikely	Unlikely	Unsure	Likely	Very Likely
☐	☐	☐	☐	☐

Please rank the following interventions in the order of the preference that you would use in your clinical practice to decrease the risk of knee osteoarthritis following ***ACL or meniscus injury/ surgery****. The intervention with 1 being most preferred (ie. top choice) and 6 being least preferred (ie. last choice):*

a) ☐Ongoing regular lower limb muscle strengthening/retraining

b) ☐Maintaining an appropriate body weight

c) ☐Wearing a supportive knee brace daily (not a elastic/neoprene sleeve but a rigid supportive brace)

d) ☐Wearing a supportive knee brace during physical activities and sports (not a elastic/neoprene sleeve but a rigid supportive brace)

e) ☐Using shoe orthotics on a daily basis

f) ☐Wearing specially designed shoes on a daily basis

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26. In a group of 20 year old ACL injured patients, that ***undergo ACL reconstruction***, what percentage of these patients will develop OA by the following ages? (Please fill in 0-100% in space provided)

- **a.** 30 years of age _____
- **b.** 40 years of age _____
- **c.** 50 years of age _____
- **d.** 60 years of age _____

27. In a group of 20 year old ACL injured patients, that ***DO NOT*** undergo ACL reconstruction, what percentage of these patients will develop OA by the following ages? (Please fill in 0-100% in space provided)

- **a.** 30 years of age _____
- **b.** 40 years of age _____
- **c.** 50 years of age _____
- **d.** 60 years of age _____

28. In a group of 20 year old patients with meniscus tears, that undergo a ***MENISCAL REPAIR***, what percentage of these patients will develop OA by the following ages?

- **a.** 30 years of age _____
- **b.** 40 years of age _____
- **c.** 50 years of age _____
- **d.** 60 years of age _____

29. In a group of 20 year old patients with meniscus tears, that ***UNDERGO MENISCECTOMY***, what percentage of these patients will develop OA by the following ages?

- **a.** 30 years of age _____
- **b.** 40 years of age _____
- **c.** 50 years of age _____
- **d.** 60 years of age _____

Demographics

30. What is your age (in years)?

_____

31. What is your gender?

☐Male ☐Female

32. Are you Hispanic, Latino, or of Spanish origin?

☐Yes ☐No

33. What is your race?

☐American Indian/Alaska Native
☐Asian
☐Native Hawaiian or Other Pacific Islander
☐Black or African American
☐White

34. In which country do you currently live?

- ☐ United States of America
- ☐ United Kingdom (England, Wales, Scotland, Northern Ireland)
- ☐ Australia
- ☐ Other*; please specify:*_____

35. What is the highest level of education you have received?

- ☐ Bachelor degree
- ☐ Master's degree
- ☐ Clinical Doctoral Degree (DPT)
- ☐ Doctoral degree (PhD)
- ☐ Professional degree (MD, JD, etc.)
- ☐ Other; *please specify*:_____

36. What are your credentials? How many years have you been credentialed?

☐ ATC	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20
☐ MPT	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20
☐ DPT	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20
☐ CSCS	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20
☐ MD	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20
☐ DO	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20
☐ OT	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20
☐ Other; *please specify*:_____	○ ≤5	○ 6-10	○ 11-15	○ 16-20	○ >20

37. How many years have you worked clinically?

- ☐ ≤5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ >20

38. What is the primary setting in which you work? *(Check all that apply)*

- ☐ Physical Therapy Clinic
- ☐ Physician's Office
- ☐ Industry; *please specify:* _____
- ☐ Military
- ☐ Hospital
- ☐ Athletic Training Clinic
- ☐ Other; *please specify:* _____

39. If you work with athletes, what is the level of athlete? *(Check all that apply)*

- ☐ Elementary School
- ☐ Middle School
- ☐ High School
- ☐ Collegiate

☐Semi-Professional
☐Professional
☐I do not work with athletes

40. Have you ever sustained an anterior cruciate ligament (ACL) injury?
☐Yes
a. How many years since injury? _____
b. Did you have surgical reconstruction? ☐Yes ☐No
c. *If yes to 11b,* what graft was used?
☐patellar tendon autograft
☐hamstring tendon autograft
☐allograft
☐Other; *please specify:*_____
☐No

41. Have you ever sustained a meniscus injury in your knee?
☐Yes
d. How many years since injury? _____
e. Did you have a partial meniscectomy? ☐Yes ☐No
f. Did you have a full meniscectomy? ☐Yes ☐No
g. Did you have a meniscal repair? ☐Yes ☐No
☐No

42. Have you ever had any type of arthritis?
☐Yes
h. If yes, what type:
☐Rheumatoid Arthritis ☐Gout
☐Osteoarthritis ☐Other; *please specify*:_____
☐Do not know
i. What body part was/is affected?
☐Hand ☐Wrist ☐Elbow ☐Shoulder ☐Neck/Spine
☐Hip ☐Ankle ☐Knee ☐Ankle ☐Foot
☐No

43. Do you know someone who has/had arthritis?
☐Yes
j. If yes, what type:
☐Rheumatoid Arthritis ☐Gout
☐Osteoarthritis ☐Other*; please specify:*_____
☐Do not know
k. What body part was/is affected?
☐Hand ☐Wrist ☐Elbow ☐Shoulder ☐Neck/Spine
☐Hip ☐Ankle ☐Knee ☐Ankle ☐Foot
☐No

44. Are you aware of the condition of post-traumatic osteoarthritis?

a. Yes
b. No
   i. If yes, please provide a brief definition for post-traumatic osteoarthritis

   _____
   _____
   _____

   ii. If no, please provide your best guess for the definition for post-traumatic osteoarthritis

   _____
   _____
   _____

Lastly, do you have any comments regarding this survey or any suggestions to make this survey better?

_____
_____
_____
_____
_____
_____
_____
_____
_____

End of Survey

Thank you for taking part in our survey. Information gathered from the survey will provide insight into clinicians' knowledge of the risk of osteoarthritis following an ACL or meniscus injury and potential ways to reduce the risk of developing osteoarthritis. This information may lead to future interventions for people who have had an ACL or meniscus injury.

[a] The survey is provided in its original form.