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Racket or Bat Sports: No Association With Thumb-Base Osteoarthritis

Jeffrey B. Driban, PhD, ATC, CSCS*; Grace H. Lo, MD, MSc†; Mary B. Roberts, MS‡; Matthew S. Harkey, PhD, ATC§; Lena F. Schaefer, MD||; Ida K. Haugen, MD, PhD¶; Stacy E. Smith, MD#; Jeffrey Duryea, PhD#; Bing Lu, DrPH, MD; Charles B. Eaton, MD, MS‡; Marc C. Hochberg, MD, MPH††; Rebecca D. Jackson, MD‡‡; C. Kent Kwoh, MD§§; Michael C. Nevitt, PhD||||; Timothy E. McAlindon, MD, MPH***

*Division of Rheumatology, Allergy, and Immunology, Tufts Medical Center, Boston, MA; †Department of Medicine, Baylor College of Medicine, Houston, TX; ‡Center for Primary Care and Prevention, Alpert Medical School of Brown University, Pawtucket, RI; §Department of Kinesiology, Michigan State University, East Lansing; ||Department of Radiology, Klinikum Nuremberg, Germany; ¶Department of Rheumatology and Research, Diakonhjemmet Hospital, Oslo, Norway; Departments of #Radiology and **Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA; ††Departments of Medicine and Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore; ‡‡Division of Endocrinology, Diabetes and Metabolism, The Ohio State University Medical Center, Columbus; §§University of Arizona Arthritis Center, Tucson; ||||Department of Epidemiology and Biostatistics, University of California, San Francisco

Context: Repetitive joint use is a risk factor for osteoarthritis, which is a leading cause of disability. Sports requiring a racket or bat to perform repetitive high-velocity impacts may increase the risk of thumb-base osteoarthritis. However, this hypothesis remains untested.

Objective: To determine if a history of participation in racket or bat sports was associated with the prevalence of thumb-base osteoarthritis.

Design: Descriptive epidemiologic study.

Setting: Four US clinical sites associated with the Osteoarthritis Initiative.

Patients or Other Participants: We recruited 2309 men and women from the community. Eligible participants had dominant-hand radiographic readings, hand symptom assessments, and historical physical activity survey data.

Main Outcome Measure(s): A history of exposure to racket or bat sports (badminton, baseball or softball, racketball or squash, table tennis [or ping pong], tennis [doubles], or tennis [singles]) was based on self-reported recall data covering 3 age ranges (12–18, 19–34, and 35–49 years). *Prevalent radiographic thumb-base osteoarthritis* was defined as Kellgren-Lawrence grade >2 in the first carpometacarpal joint or scaphotrapezoidal joint at the Osteoarthritis Initiative baseline visit. *Symptomatic thumb-base osteoarthritis* was defined as radiographic osteoarthritis and hand or finger symptoms.

Results: Radiographic or symptomatic thumb-base osteoarthritis was present in 355 (34%) and 56 (5%), respectively, of men (total = 1049) and 535 (42%) and 170 (13%), respectively, of women (total = 1260). After adjusting for age, race, and education level, we found no significant associations between a history of any racket or bat sport participation and thumb-base osteoarthritis (radiographic or symptomatic; odds ratios ranged from 0.82 to 1.34).

Conclusions: In a community-based cohort, a self-reported history of participation in racket or bat sports was not associated with increased odds of having radiographic or symptomatic thumb-base osteoarthritis in the dominant hand.

Key Words: baseball, softball, tennis, first carpometacarpal joint, scaphotrapezoidal joint

Key Points

- Despite the large prevalence and burden of thumb-base osteoarthritis, we know little about whether sports that require holding a racket or bat to perform repetitive high-velocity impacts increase the likelihood of thumb-base osteoarthritis.
- A history of participation in a sport requiring a racket or bat was not associated with an increased chance of having dominant-hand thumb-base osteoarthritis.
- Clinicians can reassure patients who want to participate in racket or bat sports that engaging in these physical activities carries minimal or no risk of thumb-base osteoarthritis.

Repetitive joint use (eg, jobs requiring repeated pincer grip) is a risk factor for osteoarthritis.[1,2] This has contributed to the assumption that sport participation increases the risk of osteoarthritis. However, the risk of osteoarthritis among former athletes may depend on the type of sport, level of competition, and joint injury.[3–5] Most of the research on this topic is limited to hip or knee osteoarthritis.

Despite the large prevalence and burden of hand osteoarthritis,[6–8] especially at the thumb base (first carpometacarpal or scaphotrapezoidal joint),[9] few authors have explored whether sports that require holding a racket or bat to perform repetitive high-velocity impacts increase the likelihood of thumb-base osteoarthritis. Furthermore, most of the existing literature focused on the broad classification of hand osteoarthritis among elite athletes[10–12] despite evidence that thumb-base osteoarthritis may be distinct from interphalangeal osteoarthritis.[13–15] Additionally, the data from studies of elite or highly competitive athletes may not be generalizable to the average participant in these sports. Also, when authors compare elite athletes and nonelite athletes in the same sport, limitations result. For example, elite athletes may experience a greater volume of sport and differences in exposure to trauma, management of trauma, and biomechanics (eg, the composition of rackets or bats [wood versus metal bats] and the types of swings).

It remains unclear if a history of sports and physical activity that require the repetitive use of a racket or bat to propel a ball influences the risk of thumb-base osteoarthritis. Hence, exploration is critically needed as to whether a history of participation in sports that involve a racket or bat used to propel a ball may be related to thumb-base osteoarthritis among a community-based cohort. Specifically, we focused on sports that require the use of a racket or bat because of the repetitive stress and impact on the thumb base. In exploratory analyses, we also assessed the association between a history of participation in an array of other physical activities and thumb-base osteoarthritis. We hypothesized that a history of participation in sports that use a racket or bat would be associated with the presence of thumb-base osteoarthritis later in life.

METHODS

Study Design and Study Sample

This was an observational study of participants in the Osteoarthritis Initiative (OAI) who had good-quality baseline hand radiographs with associated severity readings and a completed modified version of the historical physical activity survey instrument[16] at the 96-month visit (the only visit at which this instrument was administered). We excluded people who had radiographic evidence suggesting a musculoskeletal condition other than hand osteoarthritis (eg, psoriatic arthritis, rheumatoid arthritis, osteitis, gout). These findings were initially flagged by 1 reader (I.K.H.) and confirmed by a musculoskeletal radiologist (S.E.S.).

For this study, we evaluated the association between exposure to a sport requiring the use of a racket or bat and the outcome of radiographic or symptomatic thumb-base osteoarthritis. Because of constraints related to the cohort design, the exposure and outcomes were obtained at different visits. However, we selected exposures that would antedate the outcome assessments.

Osteoarthritis Initiative

The OAI is a prospective, multicenter cohort study specifically designed to study knee osteoarthritis; however, radiographs of the dominant hand were also acquired at baseline. Between 2004 and 2006, the study staff recruited men and women aged 45 to 79 years old with or at risk for symptomatic knee osteoarthritis. The 4 clinical sites were Memorial Hospital of Rhode Island, Ohio State University, University of Pittsburgh, and University of Maryland/Johns Hopkins University. Study team members at the University of California, San Francisco, served as coordinators. The institutional review board at each participating OAI site approved this investigation. Each participant provided written informed consent.

Historical Physical Activity Survey Instrument

Between September 2012 and October 2014, participants completed a self-administered modified version of the historical physical activity survey instrument[16,17] before their 96-month OAI clinic visit. At this visit, the study staff checked the surveys for completeness and helped to complete them if necessary. To implement this instrument efficiently in the OAI, it was modified to a self-administered questionnaire similar to that of Chasan-Taber et al.[18] Additionally, we implemented the following changes to limit the response burden: (1) we used ordinal categories for each of the frequency and duration selections, and (2) we asked for details on only the 3 activities recruits participated in most often during each age period.

From a list of 37 physical activities, participants identified activities that they performed $\geq$20 minutes/day at least 10 times during each of 4 age periods: teens (12–18 years), young adult (19–34 years), adults (35–49 years), and $\geq$50 years of age. Next, from those identified activities, participants selected the 3 most frequently performed activities for each age period. Additional questions established the number of years, months per year, and sessions per month the participants engaged in those activities. For these analyses, we omitted physical activities after 50 years of age to focus on exposures before the hand radiographs were obtained. Data from this instrument are publicly available (file available at https://nda.nih.gov/oai/full_downloads.html:allclinical10, version 10.2.2).[19]

Exposure—Racket or Bat Sports

For our primary analyses within each of the 3 age periods, we classified a person based on reported participation in a racket or bat sport: badminton, baseball or softball, racketball or squash, table tennis (or ping pong), tennis (doubles), or tennis (singles). We also examined data on participation for each sport separately. For the secondary analyses within each age period, we focused on individuals who reported a racket or bat sport among the top 3 activities. Furthermore, we provided data on 2 subsets of these participants: (1) people who played 9 or more sessions/month and (2) people who responded *yes* to “Did you perform this activity competitively? This does not have to mean that you participated in organized competitions but that you participated on a competitive level."

Finally, we combined data from the 3 age periods. We explored exposure to racket or bat sports between 12 and 49 years of age as a dichotomous variable (*yes* or *no*) and based on the number of age periods with participation in these sports (0–3).

Dominant Hand

The study staff asked each participant if he or she was left- or right-handed, and 95% responded with *left* or *right*. If a participant replied *ambidextrous* or *unknown* (or if data were missing), then we used 2 rules to define the *dominant hand*. First, if a person had unilateral hand radiographs, then we selected the imaged hand (4%). Second, if a person had bilateral hand radiographs, we chose the dominant hand based on the ipsilateral hand to the foot a participant reported using to kick a ball (1%). These data are publicly available (file: allclinical00, version: 0.2.3).[19]

Acquisition of Hand Radiographs

Study staff collected posteroanterior radiographs of the dominant hand of each participant at baseline. To position the hand, the participant placed the elbow flexed to 90° and the forearm flat against a table. Most participants had unilateral hand radiographs (only 22% had bilateral images); hence, our work focused on the dominant hand.

Hand Radiographic Readings

Using the hand radiographs, readers scored 16 joints in the dominant hand: distal interphalangeal joints (digits 2–5), proximal interphalangeal joints (digits 2–5), metacarpophalangeal joints (digits 1–5), thumb interphalangeal joint, and thumb-base joints (first carpometacarpal joint and scaphotrapezoidal joint).[20] A radiology fellow (L.F.S.), who was trained for these readings by a Board-certified musculoskeletal radiologist (S.E.S.), scored radiographic severity using a modified Kellgren-Lawrence (KL) scale, which was used in the Framingham Study[21]: *KL 0* = no osteophyte or joint space narrowing, *KL 1* = questionable osteophyte or joint space narrowing, *KL 2* = small osteophyte(s) or mild joint space narrowing, *KL 3* = moderate osteophyte(s) or joint space narrowing, and *KL 4* = large osteophyte(s) or joint space narrowing. Custom software displayed baseline and follow-up images side by side but blinded the reader to time. The radiology fellow scored 100 randomly selected pairs of hand radiographs twice at least 2 months apart and displayed good intrareader agreement (weighted $\kappa > 0.84$ across 16 joints). The readings from this project were reviewed by a rheumatology fellow with extensive experience in hand osteoarthritis imaging (I.K.H.). If the second reader disagreed with the KL score by more than 1 grade, it was flagged and sent to the musculoskeletal radiologist to adjudicate; 1% of joint readings required adjudication.

Primary Outcome Measure: Radiographic Thumb-Base Osteoarthritis

We classified participants with KL $\geq$ 2 in the first carpometacarpal joint or scaphotrapezoidal joint at the OAI baseline visit as having *radiographic thumb-base osteoarthritis*. All other participants were classified as not having radiographic thumb-base osteoarthritis.

Pain Assessment

To assess hand or finger pain at the OAI baseline visit, participants were presented with a homunculus and asked, "During the past 30 days, which of these joints have had pain, aching, or stiffness on most days? By most days, we mean more than half the days of a month." Two of the options were right and left hand or finger. These data are publicly available (file: allclinical00, version: 0.2.3).[19]

Secondary Outcome Measure: Symptomatic Thumb-Base Osteoarthritis

We classified *symptomatic thumb-base osteoarthritis* as a KL $\geq$ 2 in the first carpometacarpal joint or scaphotrapezoidal joint and reported ipsilateral hand or finger symptoms at the OAI baseline visit. Those who did not meet this definition were classified as not having symptomatic thumb-base osteoarthritis.

Other Clinical Variables

At the OAI baseline visit, participants reported their sex, race or ethnicity (categorized as White, African American, Asian, or other and Hispanic or Latinx [*yes* or *no*]), education level (high school or less, 1–4 years of college, or graduate school), smoking status (never, past, or current), and physical activity (Physical Activity Scale for the Elderly). Age was calculated based on the dates of birth and the baseline visit. Body mass index was calculated based on measured weight divided by height squared (kg/m^2). Knee osteoarthritis severity was based on the KL grade as noted on centrally read bilateral knee radiographs. We also considered components of metabolic syndrome: self-reported diagnosis of diabetes, hyperlipidemia based on medications recorded in a medication inventory form (ie, ingredient codes 24060000 to 24060404), hypertension based on measured blood pressure or recorded medications (ie, ingredient codes 24080000 to 24080412, 24120400 to 24120449, 40280000 to 40280405, or 12160100 to 12160419), or sex-specific waist circumference thresholds (ie, men $\geq$ 100 cm; females $\geq$ 87.5 cm). These data are publicly available (files: allclinical00, version: 0.2.3; enrollees, version: 25; kxr_sq_bu00, version: 0.8; mif00, version: 0.2.2).[19]

Statistical Analysis

Before performing the primary analyses, we calculated descriptive characteristics for participants eligible or ineligible for the current analyses. Additionally, we explored which participant characteristics were associated with prevalent radiographic or symptomatic thumb-base osteoarthritis. We also evaluated if a history of other physical activities was associated with a history of racket or bat sports in the same age period (primary exposure) or radiographic thumb-base osteoarthritis (primary outcome). The results of these analyses informed us about possible covariates that needed to be adjusted for in the analyses.

For our primary analyses, we used a series of logistic regression models to assess the association between a history of racket or bat sports within each age range with prevalent radiographic thumb-base osteoarthritis. These models were stratified by sex and completed with (1) no adjustments; (2) adjustments for age, race, and education level; and (3) adjustments for age, race, education level, and any physical activity from the same age period as the exposure that related to both the exposure and outcome. Similar models were conducted with symptomatic thumb-base osteoarthritis as the outcome.

We performed secondary analyses with a history of racket or bat sports collapsed across all 3 age ranges (12–18, 19–34, and 35–49 years). First, we used a logistic regression model to assess the association between a history of racket or bat sports (dichotomous variable: *yes* or *no*) with prevalent radiographic thumb-base osteoarthritis. Next, we generated a logistic regression model to assess this association using a variable that ranged from 0 to 3 (0 = *no exposure to racket or bat sports*, 3 = *exposure to racket or bat sports during all 3 age ranges*). Similar models were computed with symptomatic thumb-base osteoarthritis as the outcome.

We also performed sensitivity analyses among people who indicated that a racket or bat sport was among their top 3 activities within each age period. To help explore if any specific sports, playing competitively, or playing at least 2 times/week might have produced discordant results, we calculated the prevalence of thumb-base osteoarthritis across each exposure. We did not model the associations among these exposures because the sample size was sometimes too small to offer estimates with reasonable CIs. Finally, we conducted a sensitivity analysis for our models that examined racket or bat sport involvement as an adult by excluding participants 45 to 50 years of age at the OAI baseline. This exclusion ensured that the exposure antedated the outcome assessment. All analyses were conducted in SAS Enterprise (version 8.1) with a P value $< .05$ used to define statistical significance.

RESULTS

The OAI included 4796 participants, of whom 3616 had good-quality hand radiographs. We excluded 26 people whose radiographic thumb-base data were missing due to unreadable radiographs and 18 people with radiographic evidence of a condition other than osteoarthritis (n reduced to 3572). We then excluded 1263 people who had missing activity data. Hence, our sample size was 2309 participants. Those who were and those who were not eligible to be included in our study are compared in Table 1. Eligible participants were slightly younger, and a lower percentage of eligible versus ineligible participants were female (54.6% vs 62.1%) and had a large waist conference (71.5% vs 78.1%) or hypertension (48.5% vs 55.0%). Eligible participants were also more educated, with a greater percentage having completed graduate school than ineligible peers (43.4% vs 34.0%).

Among those with radiographic thumb-base osteoarthritis, 365 (41.5%) had radiographic osteoarthritis in the first carpometacarpal joint, 221 (25.1%) in the scaphotrapezoidal joint, and 294 (33.4%) in both joints. Older age, being female, history of smoking, or having advanced-

Table 1. Characteristics of Eligible and Ineligible Participants Selected From the Osteoarthritis Initiative

Variable	Participants: Ineligible (n = 2487)	Participants: Eligible (n = 2309)
	Mean ± SD	
Age, y	62.0 ± 9.3	60.2 ± 9.0
PASE score[a]	156 ± 83	166 ± 82
Gender	No. (%)	
Male	943 (37.9)	1049 (45.4)
Female	1544 (62.1)	1260 (54.6)
Race[b]		
White	1936 (77.9)	1854 (80.4)
African American	477 (19.2)	397 (17.2)
Asian	25 (1.0)	20 (0.9)
Other	46 (1.9)	36 (1.6)
Hispanic or Latinx[c]	38 (1.5)	22 (1.0)
Education level[d]		
High school or less	486 (19.8)	289 (12.6)
1–4 years of college	1135 (46.2)	1012 (44.0)
Graduate school	836 (34.0)	997 (43.4)
Smoking status		
Never	1285 (51.7)	1289 (55.8)
Past	1016 (40.9)	893 (38.7)
Current	186 (7.5)	127 (5.5)
Maximum Kellgren-Lawrence grade in either knee		
0	610 (24.5)	689 (29.8)
1	370 (14.9)	406 (17.6)
2	717 (28.8)	709 (30.7)
3	588 (23.6)	384 (16.6)
4	202 (8.1)	121 (5.2)
Occupational exposure[e]		
Not working, sedentary, or light activity	1953 (78.9)	1831 (79.4)
Light manual	462 (18.7)	408 (17.7)
Heavy manual	62 (2.5)	67 (2.9)
Lift or move objects >25 lb (11 kg) by hand most days[f]	907 (36.7)	820 (35.9)
Body mass index category[g]		
Normal (<25 kg/m²)	567 (22.8)	581 (25.2)
Overweight (25–29.99 kg/m²)	958 (38.6)	919 (39.8)
Obese (>30 kg/m²)	960 (38.6)	807 (35.0)
Waist circumference > cut point[h]	1917 (78.1)	1595 (71.5)
Hypertension	1367 (55.0)	1119 (48.5)
Lipid disorder	712 (28.6)	625 (27.1)
Diabetes[i]	215 (8.9)	147 (6.5)
Metabolic syndrome components[j]		
0	276 (11.6)	347 (15.8)
1	766 (32.3)	763 (34.8)
2	821 (34.6)	683 (31.2)
3 or 4	511 (21.5)	399 (18.2)

Abbreviation: PASE, Physical Activity Scale for the Elderly.

[a] Missing = 29.
[b] Missing = 5.
[c] Missing = 2.
[d] Missing = 41.
[e] Occupational exposure defined based on PASE: Not working, sedentary, or light activity, mainly sitting with slight arm movements or sitting or standing with some walking; light manual, walking with some handling of materials generally weighing <50 lb (23 kg); heavy manual, walking and heavy manual work often requiring handling of materials weighing >50 lb. Missing = 13.
[f] Missing = 45.
[g] Missing = 4.
[h] Missing = 109.
[i] Missing = 123.
[j] Missing = 230.

Table 2. Association Between Participant Characteristics and Radiographic Thumb-Base Osteoarthritis[a]

Variable	Radiographic Thumb-Base Osteoarthritis: None (n = 1429)	Radiographic Thumb-Base Osteoarthritis: Prevalent (n = 880)	Unadjusted Odds Ratio (95% CI)
		Mean ± SD	
Age, y[b]	**57.4 ± 8.4**	**64.7 ± 8.0**	**2.46 (2.23, 2.72)**
Physical Activity Scale for the Elderly score[b]	**177 ± 84**	**149 ± 77**	**0.70 (0.64, 0.77)**
Gender		No. (%)	
Male	694 (48.6)	355 (40.3)	Ref.
Female	**735 (51.4)**	**525 (59.7)**	**1.40 (1.18, 1.66)**
Race[c]			
White	1098 (76.9)	756 (85.9)	Ref.
African American	**289 (20.3)**	**108 (12.3)**	**0.54 (0.43, 0.69)**
Asian	14 (1.0)	6 (0.7)	0.62 (0.24, 1.63)
Other	26 (1.8)	10 (1.1)	0.56 (0.27, 1.17)
Hispanic or Latinx	18 (1.3)	4 (0.5)	0.36 (0.12, 1.06)
Education level[d]			
High school or less	162 (11.4)	127 (14.5)	Ref.
1–4 years of college	613 (43.1)	399 (45.5)	0.83 (0.64, 1.08)
Graduate school	**646 (45.5)**	**351 (40.0)**	**0.69 (0.53, 0.90)**
Smoking status			
Never	841 (58.9)	448 (50.9)	Ref.
Past	**496 (34.7)**	**397 (45.1)**	**1.50 (1.26, 1.79)**
Current	92 (6.4)	35 (4.0)	0.71 (0.48, 1.07)
Dominant hand			
Right	1305 (91.3)	833 (94.7)	Ref.
Left	**124 (8.7)**	**47 (5.3)**	**0.59 (0.42, 0.84)**
Maximum Kellgren-Lawrence grade in either knee			
0	477 (33.4)	212 (24.1)	Ref.
1	265 (18.5)	141 (16.0)	1.20 (0.92, 1.55)
2	**438 (30.7)**	**271 (30.8)**	**1.39 (1.12, 1.74)**
3	**191 (13.4)**	**193 (21.9)**	**2.27 (1.76, 2.94)**
4	**58 (4.1)**	**63 (7.2)**	**2.44 (1.65, 3.62)**
Body mass index category[e]			
Normal (<25 kg/m^2)	356 (24.9)	225 (25.6)	Ref.
Overweight (25–29.99 kg/m^2)	569 (39.8)	350 (39.9)	0.97 (0.79, 1.21)
Obese (>30 kg/m^2)	504 (35.3)	303 (34.5)	0.95 (0.76, 1.19)
Waist circumference > cut point[f]	**943 (69.1)**	**652 (75.2)**	**1.36 (1.12, 1.65)**
Hypertension	**629 (44.0)**	**490 (55.7)**	**1.60 (1.35, 1.89)**
Lipid disorder	**352 (24.6)**	**273 (31.0)**	**1.38 (1.14, 1.66)**
Diabetes[g]	87 (6.2)	60 (6.9)	1.12 (0.80, 1.58)
Metabolic syndrome components[h]			
0	247 (18.5)	100 (11.7)	Ref.
1	**490 (36.7)**	**273 (31.9)**	**1.38 (1.05, 1.81)**
2	**386 (28.9)**	**297 (34.7)**	**1.90 (1.44, 2.51)**
3 or 4	**214 (16.0)**	**185 (21.6)**	**2.14 (1.58, 2.90)**

Abbreviation: Ref, reference.

[a] Bold values indicate statistically significant associations ($P < .05$).
[b] Odds ratio per SD. Missing = 12.
[c] Missing = 2.
[d] Missing = 11.
[e] Missing = 2.
[f] Missing = 77.
[g] Missing = 41.
[h] Missing = 117.

stage radiographic knee osteoarthritis (KL $\geq$ 3), hypertension, or 2 or more metabolic syndrome components was associated with a greater chance of radiographic or symptomatic thumb-base osteoarthritis (Tables 2 and 3). In contrast, being more physically active or left-hand dominant was associated with a lesser chance of radiographic or symptomatic thumb-base osteoarthritis. During each age period, numerous physical activities were associated with radiographic thumb-base osteoarthritis and participation in racket or bat sports during the same period: teens (14 activities), young adult (13 activities), and adult (6 activities; available in Supplemental Table 1 at http://doi.org/10.4085/1062-6050-0208.21.s1). The most common sports during each period were baseball or softball and tennis (doubles or singles; see Supplemental Tables 2 and 3). Although badminton and table tennis (or ping pong) were commonly reported activities,

Table 3. Association Between Participant Characteristics and Symptomatic Thumb-Base Osteoarthritis[a]

Variable	Symptomatic Thumb-Base Osteoarthritis		Unadjusted Odds Ratio (95% CI)
	None (n = 2083)	Prevalent (n = 226)	
	Mean ± SD		
Age, y[b]	**59.7 ± 9.0**	**65.0 ± 7.5**	**1.84 (1.59 to 2.12)**
Physical Activity Scale for the Elderly score[c]	**169 ± 82**	**143 ± 75**	**0.71 (0.61 to 0.83)**
Sex	No. (%)		
Male	993 (47.7)	56 (24.8)	
Female	**1090 (52.3)**	**170 (75.2)**	**2.77 (2.02 to 3.79)**
Race or ethnicity[d]			
White	1663 (79.9)	191 (84.5)	Ref.
African American	367 (17.6)	30 (13.3)	0.71 (0.48 to 1.06)
Asian	17 (0.8)	3 (1.3)	1.54 (0.45 to 5.29)
Other	34 (1.6)	2 (0.9)	0.51 (0.12 to 2.15)
Hispanic or Latinx	22 (1.1%)	0 (0.0)	Not calculated
Education level[e]			
High school or less	258 (12.5)	31 (13.7)	Ref.
1–4 years of college	903 (43.6)	109 (48.2)	1.01 (0.66 to 1.53)
Graduate school	911 (44.0)	86 (38.1)	0.79 (0.51 to 1.21)
Smoking status			
Never	1185 (56.9)	104 (46.0)	Ref.
Past	**780 (37.5)**	**113 (50.0)**	**1.65 (1.25 to 2.19)**
Current	118 (5.7)	9 (4.0)	0.87 (0.43 to 1.76)
Dominant hand			
Right	1922 (92.3)	216 (95.6)	Ref.
Left	**161 (7.7)**	**10 (4.4)**	**0.55 (0.29 to 1.06)**
Maximum Kellgren-Lawrence grade in either knee			
0	640 (30.7)	49 (21.7)	Ref.
1	371 (17.8)	35 (15.5)	1.23 (0.78 to 1.94)
2	640 (30.7)	69 (30.5)	1.41 (0.96 to 2.06)
3	**329 (15.8)**	**55 (24.3)**	**2.18 (1.45 to 3.28)**
4	**103 (4.9)**	**18 (8.0)**	**2.28 (1.28 to 4.07)**
Body mass index category[f]			
Normal (<25 kg/m^2)	526 (25.3)	55 (24.4)	Ref.
Overweight (25–29.99 kg/m^2)	828 (39.8)	91 (40.4)	1.05 (0.74 to 1.50)
Obese (>30 kg/m^2)	728 (35.0)	79 (35.1)	1.04 (0.72 to 1.49)
Waist circumference > cut point[g]	1423 (70.9)	172 (76.8)	1.36 (0.98 to 1.88)
Hypertension	**988 (47.4)**	**131 (58.0)**	**1.53 (1.16 to 2.02)**
Lipid disorder	557 (26.7)	68 (30.1)	1.18 (0.87 to 1.59)
Diabetes[h]	131 (6.4)	16 (7.2)	1.13 (0.66 to 1.94)
Metabolic syndrome components[i]			
0	323 (16.4)	24 (10.9)	Ref.
1	693 (35.2)	70 (31.7)	1.36 (0.84 to 2.20)
2	605 (30.7)	78 (35.3)	**1.74 (1.08 to 2.80)**
3 or 4	350 (17.8)	49 (22.2)	**1.88 (1.13 to 3.14)**

Abbreviation: Ref, referent.

[a] Bold values indicate statistically significant associations ($P < .05$).
[b] Odds ratio per SD.
[c] Odds ratio per SD. Missing = 12.
[d] Missing = 2.
[e] Missing = 11.
[f] Missing = 2.
[g] Missing = 77.
[h] Missing = 41.
[i] Missing = 117.

participants rarely listed them among the top 3 activities performed in an age period.

We found no statistically significant associations between a history of racket or bat sport participation and greater odds of radiographic or symptomatic thumb-base osteoarthritis, regardless of the age of sport participation, sex, or frequency of participation (any or top 3 activities; Tables 4 and 5; see Supplemental Tables 2 and 3). Females who participated in racket or bat sports in their teens were 32% less likely to have radiographic thumb-base osteoarthritis at the OAI baseline visit (Table 4). However, the odds ratio was attenuated and no longer statistically significant after we adjusted for possible confounders (ie, age, race, education). Similar results were found among females who reported any exposure to racket or bat sports and females who reported participation during 1 or 2 periods (Table 4). Overall, we noted similar results when adjusting for other physical activities and when excluding people 45

Table 4. Association Between History of Racket or Bat Sport Participation and Radiographic Thumb-Base Osteoarthritis

	Males				Females			
Variable	None (n = 694)	Prevalent (n = 355)	Unadjusted	Adjusted[a]	None (n = 735)	Prevalent (n = 525)	Unadjusted[a]	Adjusted[b]
	No. (%)		OR (95% CI)		No. (%)		OR (95% CI)	
Any racket or bat sport participation								
Teens (12–18 y)	580 (83.6)	280 (78.9)	0.73 (0.53, 1.02)	0.98 (0.69, 1.39)	504 (68.6)	312 (59.5)	**0.68 (0.53, 0.85)**	0.84 (0.64, 1.11)
Young adult (19–34 y)	516 (74.4)	259 (73.0)	0.93 (0.70, 1.24)	1.34 (0.97, 1.84)	371 (50.5)	247 (47.0)	0.87 (0.70, 1.09)	0.98 (0.75, 1.27)
Adult (35–49 y)	352 (50.7)	183 (51.5)	1.03 (0.80, 1.34)	1.16 (0.88, 1.54)	177 (24.1)	143 (27.2)	1.18 (0.91, 1.52)	1.05 (0.78, 1.41)
Any time (12–49 y)	620 (89.3)	310 (87.3)	0.83 (0.56, 1.24)	1.16 (0.76, 1.79)	557 (75.8)	354 (67.4)	**0.66 (0.52, 0.85)**	0.82 (0.61, 1.10)
No. of Periods: racket or bat sports								
0	74 (10.7)	45 (12.7)	Ref.	Ref.	178 (24.2)	171 (32.6)	Ref.	Ref.
1 (12–18 y: 78%)[c]	103 (14.8)	55 (15.5)	0.89 (0.54, 1.46)	1.02 (0.60, 1.74)	201 (27.4)	114 (21.7)	**0.59 (0.43, 0.81)**	0.78 (0.54, 1.11)
2 (12–34 y: 83%)[c]	206 (29.7)	98 (27.6)	0.79 (0.51, 1.24)	1.12 (0.69, 1.80)	217 (29.5)	132 (25.1)	**0.63 (0.47, 0.85)**	0.80 (0.56, 1.13)
3	311 (44.8)	157 (44.2)	0.84 (0.55, 1.28)	1.26 (0.80, 1.99)	139 (18.9)	108 (20.6)	0.81 (0.58, 1.13)	0.92 (0.63, 1.37)
Racket or bat sports among top 3 sports								
Teens (12–18 y)	346 (49.9)	169 (47.6)	0.91 (0.71, 1.18)	0.95 (0.72, 1.25)	230 (31.3)	129 (24.6)	**0.72 (0.56, 0.92)**	0.82 (0.62, 1.09)
Young adult (19–34 y)	295 (42.5)	131 (36.9)	0.79 (0.61, 1.03)	0.87 (0.66, 1.15)	168 (22.9)	111 (21.1)	0.91 (0.69, 1.19)	1.08 (0.79, 1.48)
Adult (35–49 y)	162 (23.3)	87 (24.5)	1.07 (0.79, 1.44)	1.06 (0.77, 1.45)	79 (10.7)	48 (9.1)	0.84 (0.57, 1.22)	0.70 (0.46, 1.08)
Any time (12–49 y)	449 (64.7)	217 (61.1)	0.86 (0.66, 1.12)	0.95 (0.72, 1.26)	326 (44.4)	205 (39.1)	0.80 (0.64, 1.01)	0.92 (0.71, 1.20)
No. of Periods: racket or bat sports								
0	245 (35.3)	138 (38.9)	Ref.	Ref.	409 (55.7)	320 (61.0)	Ref.	Ref.
1 (12–18 y: 63%)[c]	195 (28.1)	94 (26.5)	0.86 (0.62, 1.18)	0.97 (0.69, 1.37)	203 (27.6)	135 (25.7)	0.85 (0.65, 1.10)	0.99 (0.73, 1.33)
2 (12–34 y: 65%)[c]	154 (22.2)	76 (21.4)	0.88 (0.62, 1.24)	0.98 (0.68, 1.41)	95 (12.9)	57 (10.9)	0.76 (0.53, 1.09)	0.87 (0.58, 1.31)
3	100 (14.4)	47 (13.2)	0.83 (0.56, 1.25)	0.89 (0.58, 1.36)	28 (3.8)	13 (2.5)	0.61 (0.31, 1.21)	0.63 (0.29, 1.36)

Abbreviations: OR, odds ratio; Ref, referent.

[a] Bold values indicate statistically significant associations ($P < .05$).

[b] Adjusted for age, race, and education.

[c] Frequency of the most common No. of exposure years.

Table 5. Association Between History of Racket or Bat Sport Participation and Symptomatic Thumb-Base Osteoarthritis

	Symptomatic Thumb-Base Osteoarthritis							
	Males				Females			
Variable	None (n = 993)	Prevalent (n = 56)	Unadjusted	Adjusted[a]	None (n = 1090)	Prevalent (n = 170)	Unadjusted	Adjusted[a]
	No. (%)		OR (95% CI)		No. (%)		OR (95% CI)	
Any racket or bat sport participation								
Teens (12–18 y)	817 (82.3)	43 (76.8)	0.71 (0.38, 1.35)	0.98 (0.50, 1.91)	709 (65.1)	107 (62.9)	0.91 (0.65, 1.27)	1.01 (0.71, 1.44)
Young adult (19–34 y)	739 (74.4)	36 (64.3)	0.62 (0.35, 1.09)	0.88 (0.49, 1.60)	532 (48.8)	86 (50.6)	1.07 (0.78, 1.48)	1.08 (0.77, 1.51)
Adult (35–49 y)	508 (51.2)	27 (48.2)	0.89 (0.52, 1.52)	1.08 (0.61, 1.90)	271 (24.9)	49 (28.8)	1.22 (0.86, 1.75)	1.07 (0.73, 1.55)
Any time (12–49 y)	882 (88.8)	48 (85.7)	0.74 (0.34, 1.61)	1.07 (0.48, 2.39)	792 (72.7)	119 (70.0)	0.87 (0.61, 1.24)	0.96 (0.66, 1.40)
No. of Periods: racket or bat sports								
0	111 (11.2)	8 (14.3)	Ref.	Ref.	298 (27.3)	51 (30.0)	Ref.	Ref.
1 (12–18 y: 78%)[b]	146 (14.7)	12 (21.4)	1.12 (0.44, 2.83)	1.29 (0.50, 3.34)	280 (25.7)	35 (20.6)	0.72 (0.46, 1.15)	0.86 (0.54, 1.39)
2 (12–34 y: 83%)[b]	290 (29.2)	14 (25.0)	0.66 (0.27, 1.62)	0.91 (0.36, 2.29)	304 (27.9)	45 (26.5)	0.85 (0.55, 1.31)	0.97 (0.61, 1.52)
3	446 (44.9)	22 (39.3)	0.67 (0.29, 1.55)	1.08 (0.45, 2.60)	208 (19.1)	39 (22.9)	1.08 (0.69, 1.70)	1.08 (0.67, 1.74)
Racket or bat sports among top 3 sports								
Teens (12–18 y)	487 (49.0)	28 (50.0)	1.04 (0.61, 1.78)	1.13 (0.65, 1.96)	314 (28.8)	45 (26.5)	0.89 (0.62, 1.28)	0.97 (0.67, 1.41)
Young adult (19–34 y)	405 (40.8)	21 (37.5)	0.87 (0.50, 1.52)	1.03 (0.58, 1.82)	243 (22.3)	36 (21.2)	0.94 (0.63, 1.39)	0.99 (0.66, 1.49)
Adult (35–49 y)	233 (23.5)	16 (28.6)	1.31 (0.72, 2.37)	1.43 (0.77, 2.65)	107 (9.8)	20 (11.8)	1.23 (0.74, 2.04)	1.13 (0.67, 1.91)
Any time (12–49 y)	631 (63.5)	35 (62.5)	0.95 (0.54, 1.65)	1.15 (0.65, 2.05)	463 (42.5)	68 (40.0)	0.90 (0.64, 1.24)	0.96 (0.69, 1.35)
No. of Periods: racket or bat sports								
0	362 (36.5)	21 (37.5)	Ref.	Ref.	627 (57.5)	102 (60.0)	Ref.	Ref.
1 (12–18 y: 78%)[b]	275 (27.7)	14 (25.0)	0.87 (0.44, 1.74)	1.06 (0.52, 2.17)	296 (27.2)	42 (24.7)	0.86 (0.59, 1.27)	0.94 (0.63, 1.39)
2 (12–34 y: 83%)[b]	218 (22.0)	12 (21.4)	0.94 (0.45, 1.95)	1.15 (0.55, 2.44)	133 (12.2)	19 (11.2)	0.87 (0.51, 1.47)	0.93 (0.54, 1.59)
3	138 (13.9)	9 (16.1)	1.12 (0.50, 2.49)	1.33 (0.58, 3.05)	34 (3.1)	7 (4.1)	1.29 (0.56, 2.99)	1.33 (0.56, 3.18)

Abbreviations: OR, odds ratio, 95%; Ref, referent.

[a] Adjusted for age, race, and education.

[b] Frequency of the most common No. of exposure years.

to 50 years of age at the OAI baseline from analyses that included exposure to racket or bat sports between 35 and 49 years of age (ie, racket or bat sports between 35 and 49 years of age, participation between 12 and 49 years of age, number of periods exposed to racket or bat sports).

DISCUSSION

A history of participation in sports requiring a racket or bat was not associated with the prevalence of thumb-base osteoarthritis later in life. These findings were consistent among men and women regardless of when the person participated in these sports. Based on these results, clinicians can reassure patients that sports requiring a racket or bat can be effective strategies for engaging in physical activity with minimal or no risk of thumb-base osteoarthritis among people willing and able to participate in the sport. Therefore, these findings are relevant to clinicians in sports medicine, especially athletic trainers, who are responsible for implementing measures to prevent or mitigate illness and long-term disability.

Our results contradicted our assumption that repetitive use of the hand to hold a racket or bat during high-velocity impacts would increase the likelihood of thumb-base osteoarthritis. Within a community-based cohort, the frequency and magnitude of loading may be insufficient to increase the risk of thumb-base osteoarthritis. Furthermore, within this community-based cohort, people chose to participate in racket or bat sports. Hence, these results may not apply to those required to perform a sport despite reasons to withdraw (eg, pain). It is unclear if these results would apply to elite-level athletes; however, we saw no evidence of elevated odds of osteoarthritis among people who played these sports competitively or more frequently. Besides the frequency or magnitude of loading, the long-term consequences of these sports on the thumb base may be negated through improved neuromuscular control[22–24] or beneficial bone adaptations to loading.[25–28] Overall, these findings can be reassuring for the vast majority of people who play these sports.

The current study is one of the first to examine the association between a history of sport participation and thumb-base osteoarthritis. Among athletes at the National Football League Combine (20–24 years of age), 1 in 3 athletes with a history of scaphoid fracture had radiographic thumb-base osteoarthritis, which is consistent with the prevalence observed among men on average 40 years older than the young athletic population.[29] Hence, future authors need to consider the implications of hand trauma when examining the association and burden of thumb-base osteoarthritis among former athletes.

Former elite cricketers were more likely to report hand pain than former rugby union players or recreational players.[10,11] Similarly, competitive or expert climbers had a greater prevalence of radiographic hand osteoarthritis than recreational climbers or nonclimbers.[12,30] Yet the authors of these studies focused on hand pain or osteoarthritis without describing associations with thumb-base osteoarthritis. Thus, it is unclear if the discordance in our findings is because these prior researchers used different outcomes that lacked specificity to the thumb base or if elite cricketers are unique based on their exposure. For example, elite cricketers may be subject to greater frequency or magnitude of loading, years played, or risk of thumb-base injury, as well as differences in injury management (eg, playing through pain, returning to play more quickly). Therefore, we need to understand how different sports and factors that characterize an athletic career influence the risk of thumb-base osteoarthritis.[3] Still, it is reassuring that our primary findings of no association between racket or bat sport participation and thumb-base osteoarthritis were supported by complementary findings among other sports that require gripping an object to propel a ball or puck (eg, hockey, golf; see Supplemental Table 1).

Although we are among the first to explore the association between a history of racket or bat sport participation and thumb-base osteoarthritis in a community-based sample, it is important to acknowledge the limitations of this investigation. First, we relied on a self-reported history of sports participation, and we lacked detailed data on that participation (eg, level of competition, history of related injuries). Furthermore, we lacked data on participant characteristics (eg, body mass index, occupational exposure) at the time of the racket or bat sport participation. Despite these limitations, the OAI offered an excellent opportunity to study high-quality data regarding radiographic thumb-base osteoarthritis in a large study sample. Even with the large sample size, the power was insufficient to analyze each sport individually, but we provided the data for each sport to highlight our seemingly consistent results across a range of racket and bat sports. Finally, our radiographs were limited to the dominant hand. Hence, we cannot offer any conclusions about the relationship between sports and thumb-base osteoarthritis in the nondominant hand. Future investigators may benefit from acquiring bilateral hand radiographs to explore if these findings apply to both hands.

CONCLUSIONS

A self-reported history of participation in a sport requiring a racket or bat was not associated with an increased chance of dominant-hand, thumb-base osteoarthritis (radiographic or symptomatic) among a community-based cohort. Therefore, clinicians can reassure patients who want to participate in racket or bat sports that these activities can be effective strategies for engaging in physical activity with minimal or no risk of thumb-base osteoarthritis.

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SUPPLEMENTAL MATERIAL

Supplemental Tables.

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Address correspondence to Jeffrey B. Driban, PhD, ATC, CSCS, Division of Rheumatology, Allergy, and Immunology, Tufts Medical Center, 800 Washington Street, Box 406, Boston, MA 02111. Address email to jeffrey.driban@tufts.edu.