Incidence of Morphologic Changes in Asymptomatic Achilles Tendons in an Active Young Adult Population

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Context: Achilles tendon rupture is often the result of a long-term degenerative process, frequently occurring asymptomatically. Objective: To determine the prevalence of asymptomatic Achilles tendinopathy in an active, asymptomatic, young-adult population and to compare these findings across gender. Design: Convenience sample, cohort study. Setting: Research laboratory Participants: A sample of 52 (28 male, 24 female) healthy, active subjects were recruited from the student body at the University of Connecticut. Images of 104 Achilles tendons were made. Intervention: Ultrasound images made with a Phillips HD11 with a 15-MHz real-time linear-array transducer were collected on both the longitudinal and transverse axes of the Achilles tendon. Activity level was measured with the International Physical Activity Questionnaire Short Form (IPAQ-SF). Main Outcome Measure: Presence of ultrasound evidence of Achilles tendinopathy as agreed on by 2 blinded assessors highly skilled in ultrasonography. Results: More subjects were categorized as highly active (57.4%) on the IPAQ-SF than moderately active (42.6%). One female and one male subject were found to have ultrasound evidence of asymptomatic Achilles tendinopathy, equaling 3.8% prevalence in this study. Conclusion: We found a low prevalence of asymptomatic Achilles tendinopathy in an active, young-adult population. Further work is necessary to identify an optimal group warranting ultrasound screening for asymptomatic tendinopathy. Keywords: tendinopathy, diagnostic ultrasound, medical screening

Achilles tendinopathy is a degenerative condition that may ultimately lead to tendon rupture asymptotically. In the landmark study conducted by Kannus and Jozsa1 on spontaneous tendon ruptures, 34% of asymptomatic control tendons showed histologic signs of degeneration. Achilles tendinopathy is common among people leading active lifestyles, particularly those participating in high-intensity load-bearing activities involving running and jumping. Elite gymnasts report up to a 40% lifetime incidence of Achilles symptoms, compared with no incidence in age- and gender-matched controls.2 Of note, male gymnasts had a greater incidence of asymptomatic tendinopathy in this cohort.

Correspondingly, in a large cross-sectional study of 298 individuals, asymptomatic Achilles tendon pathology was more than twice as likely to occur in males.3 Asymptomatic tendon degeneration in males may partly explain the large discrepancy in rupture rates between genders. In a massive retrospective review of 7375 Achilles ruptures occurring in Finland between 1987 and 1999, 79% occurred in males.4 Similarly, 68% of 298 ruptures occurred in males in the United States.5 Achilles rupture ended the career of one-third of NFL players sustaining the injury between 1997 and 2002.6 The proportion of asymptomatic incidence before rupture was not reported.

While it seems clear that males have an increased incidence of Achilles tendon ruptures, and may have an increased incidence of predisposing asymptomatic tendinopathy, connective-tissue injury in general occurs more frequently in women than in men.7,8 Several hypotheses for this have arisen, from hormonal to metabolic. Rate of collagen remodeling in response to exercise is significantly lower in females,7–10 as is tendon fascicle strength.7 The relationship of these physiologic differences to the development of degenerative changes in tendon remains unclear.

Diagnostic ultrasound is both reliable and accurate in assessing degenerative changes in the tendon.11–14 Of particular clinical utility, ultrasound imaging can reliably discriminate between symptomatic and asymptomatic Achilles tendinopathy by quantifying 3-dimensional pixel density. Symptomatic tendons demonstrated less pixel density, as well as increased diameter.15 Degenerative changes associated with Achilles tendinopathy as identified by diagnostic ultrasound are hypoechoic regions, increased tendon diameter, fiber disorganization, and neovascularization.14,16–18

Gaining a greater understanding of the incidence and progression of asymptomatic Achilles tendinopathy may reduce the debilitating natural history of this phenomenon, especially if valid screening protocols correlating to rupture and disability risk are developed. The purpose of this study was to determine the prevalence of asymptomatic Achilles tendinopathy in an active, young-adult population.
Methods

Participants
Fifty-two healthy subjects (28 men and 24 women: age \(22.0 \pm 3.6\) y, range 19–32; height \(175.3 \pm 6.3\) cm; mass \(72.8 \pm 15.2\) kg)—104 tendons—volunteered to enroll in this study. Participants were recruited through flyers, e-mail announcement, and word of mouth among individuals engaged in regular exercise at the University of Connecticut. Written, informed consent was obtained after approval of the protocol by the institutional review board. For inclusion, subjects must have been at least 18 years of age and categorized as at least moderately active on the International Physical Activity Questionnaire Short Form (IPAQ-SF; Figure 1), as well as having a lifetime absence of pain or discomfort in either Achilles tendon. A health-history form was also required to screen for exclusion criteria that included history of Achilles tendon pain of any duration or at any point in time, corticosteroid injection to the area of the Achilles tendon, fluoroquinolone use, surgery or rupture of the Achilles tendon, or neurologic conditions affecting the lower extremity. The recruitment materials clearly defined these criteria, and 9 volunteers were excluded from the study.

Procedures
IPAQ-SF. All participants were required to complete the IPAQ-SF before Achilles tendon scanning. The IPAQ was chosen for its ease of understanding and good criterion validity. Participants were asked to declare their average weekly level of activity over the previous 6 months in minutes of moderate or vigorous activity and time spent walking. Reported levels of activity were converted into an estimation of metabolic equivalent (MET) minutes using an equation (Figure 1) provided by the IPAQ-SF. The MET-minutes were calculated for each level of activity and combined to find the total estimated MET-minutes per week for each subject. Based on this estimate, subjects were categorized as either low, moderate, or highly active. For an in-depth discussion of these calculations, the reader is referred to the article by Craig et al. Subjects who did not meet the criteria for being either moderately or highly active were excluded from this study.

Ultrasound Scanning Protocol. Scans were performed using a Phillips HD11 with a 15-MHz real-time linear-array transducer (Koninklijke Philips Electronics N.V., Amsterdam). Participants were positioned in prone, with both Achilles tendons exposed. Images were made in the longitudinal and transverse planes at the following sites: calcaneal insertion and 3, 6, 9, and 12 cm proximal to the insertion, for a total of 20 images per subject. Images were made at these increments to account for the size of the transducer head, which is 3 cm in length. When the images are made in concert, the increments allow for a continuous image of the entire length of the Achilles tendon in the longitudinal plane.

Two physicians blinded to subject demographics analyzed the images separately. Images were graded for the presence of hypoechoogenic features. A positive lesion was defined as a definitive hypoechoic region in both the longitudinal and transverse planes in the tendon and agreed on by both physicians independently.

![Table 1: The International Physical Activity Questionnaire Short Form.](image1)

Figure 1 — The International Physical Activity Questionnaire Short Form.
Results
Participants were 55.7% men (mean age 22.8 ± 2.5 y and mass 85.5 ± 15.2 kg), and 44.4% were women (mean age 21.1 ± 2.7 y and mass 60.5 ± 14.6 kg). Subjects were categorized as at least moderately active (42.6%) on the IPAQ-SF, with 57.4% as highly active. Evidence of tendinopathy was found in 2 individuals unilaterally, 1 man (age 24 y, mass 68.2 kg) and 1 woman (age 31 y, mass 61.4 kg), resulting in an incidence of 3.8% among the 52 participants (Figure 2).

Discussion
We conducted a preliminary study with relatively wide inclusion criteria in which we quantified incidence of Achilles tendinopathy in active, young adults. We identified evidence of tendinopathy in 3.8% of participants, suggesting that the prevalence of asymptomatic tendinopathy was relatively low among our participants. Comparatively, Gaida et al3 found that 13% of men showed ultrasonographic signs of tendinopathy, compared with 5% of women. Among the men in that study, those with the highest prevalence of asymptomatic tendinopathy had a waist circumference of more than 83 cm and were over 40 years of age. In younger (<40 y), more fit men the prevalence of asymptomatic tendinopathy was 7% (2/27 subjects, mean age 34 y). The mean age of men in our study was 22.8 years, potentially accounting for the lower incidence found in this study.

Gaida et al3 found that female participants with asymptomatic tendinopathy were also older than those with normal tendon (47.4 ± 10.0 vs 36.0 ± 10.3 y). The average age of female subjects in our study was 21.1 ± 3.7 years. Thus, it is possible that younger, active, asymptomatic individuals have a lower prevalence of ultrasonically identified changes consistent with tendinopathy. Nicol et al23 examined Achilles tendons for evidence of tendinopathy in an active military population. Fifty-nine percent of 252 tendons were found to have ultrasound evidence of hypoechoic regions; however, Nicol et al did not exclude participants with a history of Achilles symptoms. The presence of tendinopathy was positively correlated with a high activity level.23

Our data suggest that ultrasonographic changes indicative of tendinopathy are relatively rare in a young active population. We found no difference across genders in the prevalence of asymptomatic Achilles tendinopathy. This finding is most likely due to our sample size and is contrary to those of studies conducted by Emerson et al2 and Gaida et al3 reporting significantly higher rates of asymptomatic Achilles tendinopathy in older men.

We chose to examine an active, young population in this prevalence study due to the mounting evidence of tendinopathy as a chronic, asymptomatic degenerative process. Future studies with a larger participant pool should seek to identify an optimal age and activity level at which to screen for asymptomatic Achilles tendinopathy.

Conclusion
Achilles tendon rupture is often the result of a long-term degenerative process, frequently occurring asymptotically. We found a low prevalence of asymptomatic Achilles tendinopathy in an active, young-adult population. Further work is necessary to identify an optimal group warranting ultrasound screening for asymptomatic tendinopathy.

Limitations
The primary limitation of our study is the use of still images for review. Diagnostic ultrasound imaging is a dynamic process allowing real-time adjustments to best

Figure 2 — Longitudinal sections with areas of hypoechogeticity and disorganized collagen. (A) Male participant. (B) Female participant.
determine if areas of hypoechogenicity are representative of true degeneration. However, efforts were made to make these adjustments at the time of scanning. Blind review of images by 2 physicians experienced in diagnostic ultrasound minimized the risk of false positive findings, as both had to concur on both longitudinal and cross-sectional views indicative of tendinopathy. Thus, we may have underestimated the presence of tendinopathy in our sample, although we do not believe that the prevalence of degenerative changes in this sample was anywhere near that of Nicol et al\textsuperscript{23} and others.

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References

Erratum

In the article by Joseph MF et al, “Incidence of Morphologic Changes in Asymptomatic Achilles Tendons in an Active Young Adult Population,” in *J Sport Rehabil.* 21(3), 249–252, 3 authors were omitted from the byline. The full list of authors is Michael F. Joseph, Thomas H. Trojan, Jeffrey M. Anderson, John Crowley, Lindsay Dilieto, Brian O’Neil, and Craig R. Denegar.