

Are we asking the right questions to people with Achilles tendinopathy? The best questions to distinguish mild versus severe disability to improve your clinical management

Myles C. Murphy^{a,b,*}, Brady Green^{b,c}, Igor Sancho Amundarain^d, Robert-Jan de Vos^e, Ebonie K. Rio^{f,g,h}

^a Nutrition & Health Innovation Research Institute, School of Medical and Health Sciences, Edith Cowan University, Joondalup, Western Australia, Australia

^b School of Health Sciences, The University of Notre Dame Australia, Fremantle, Western Australia, Australia

^c School of Allied Health, Human Services and Sport, La Trobe University, Bundoora, Victoria, Australia

^d Deusto Physical Therapist Group, Physical Therapy Department, Faculty of Health Sciences, University of Deusto, Donostia - San Sebastián, Spain

^e Department of Orthopaedics and Sports Medicine, Erasmus MC University Medical Centre, Rotterdam, the Netherlands

^f La Trobe Sport and Exercise Medicine Research Centre, La Trobe University, Bundoora, Victoria, Australia

^g The Australian Ballet, Southbank, Victoria, Australia

^h Victorian Institute of Sport, Albert Park, Victoria, Australia

ARTICLE INFO

Handling Editor: Dr L Herrington

Keywords:

Achilles
Tendinopathy
TENDINS-A
FAOS
VISA-A

ABSTRACT

Objective: Determine the capacity of individual items on the Tendinopathy Severity Assessment – Achilles (TENDINS-A), Foot and Ankle Outcome Score (FAOS), and Victorian Institute of Sports Assessment – Achilles (VISA-A) to differentiate patients with mild and severe tendon-related disability in order to provide clinicians the best questions when they are consulting patients with Achilles tendinopathy.

Design: Cross-sectional.

Participants: Seventy participants with Achilles tendinopathy (61.4% mid-portion only, 31.4% insertional only, 7.2% both).

Outcome measures: The discrimination index was determined for each TENDINS-A, FAOS, and VISA-A item to determine if items could discriminate between mild and severe disability. A Guttman analysis for polytomous items was conducted.

Results: All 62 items from the TENDINS-A, FAOS, and VISA-A were ranked with the best items relating to pain with physical tendon loading, time for pain to settle following aggravating activities and time for the tendon to 'warm-up' following inactivity.

Conclusions: Pain with loading the Achilles tendon, time for pain to settle following aggravating activity, as well as time taken for the tendon symptoms to subside after prolonged sitting or sleeping are the best questions indicative of the severity of disability in patients with Achilles tendinopathy. These questions can assist clinicians with assessing baseline severity and monitoring treatment response.

1. Introduction

Achilles tendinopathy presents as localised tendon pain with mechanical loading that is associated with impaired function (Scott et al., 2020). Achilles tendinopathy is problematic for both athletic and non-athletic populations, (de Jonge et al., 2011; Wang et al., 2022) and represents a significant personal (Ceravolo et al., 2020) and societal burden (Sleeswijk Visser et al., 2021).

Effectively determining the severity of a patient's disability [being one of the core domains of tendinopathy (Vicenzino et al., 2019)] is a key objective of the clinical assessment (Petersen et al., 2021). However, healthcare providers are often time-poor, and efficiency is needed to obtain the most important information from patients. Despite this, there is no research that provides clinicians with clear information on the questions that are the most valuable to utilise to identify the severity in disability of Achilles tendinopathy. Clinicians are met with a significant clinical

* Corresponding author: Edith Cowan University, 270 Joondalup Drive, Joondalup, Western Australia, Australia.

E-mail address: m.murphy@ecu.edu.au (M.C. Murphy).

<https://doi.org/10.1016/j.ptsp.2024.03.005>

Received 22 January 2024; Received in revised form 27 March 2024; Accepted 28 March 2024

Available online 5 April 2024

1466-853X/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

challenge – deciding, without clear evidence, the questions to best differentiate patients with mild versus severe disability.

Established methodology within the social sciences, education and test assessment may reveal the way forward for clinicians and address this critical question. While components of this methodology are often utilised within Sports Medicine and Physiotherapy, specifically for psychometric analysis of Patient Reported Outcome measures (PROMS) (Comins et al., 2021; Conceicao et al., 2016); in education methods to determine questions (which we will refer to as ‘Items’) within an examination or test that delineate low versus high performing students have been used for decades (Hales, 1972). Applied clinically, the method involves: (Scott et al., 2020) quantifying the relative difficulty of each Item (termed ‘facility’), grouping test-takers (i.e., ‘patients’) into tertiles based on overall severity, and, identifying those Items that clearly differentiate the low versus high score tertiles (Andrich & Marais, 2019). Translated clinically: Patients can first be grouped into mild, moderate and severe tendon-related disability, and then the Items from the subjective history that are best able to discriminate the patients with mild and severe disability can be determined. Importantly, Items that lack discriminative capacity (and may have limited clinical utility) can also be identified from this approach.

Several outcome measures evaluating the severity of disability associated with Achilles tendinopathy exist. Most recently the Tendinopathy Severity Assessment- Achilles (TENDINS-A) (Murphy et al., 2023, 2024) has been developed (being the most methodologically robust). However, the Foot and Ankle Outcome Score (FAOS) (Roos et al., 2001) and Victorian Institute of Sport Assessment- Achilles (VISA-A) (Robinson et al., 2001) have been used frequently in literature (Grävare Silbernagel et al., 2022). The availability of many different PROMS may reduce clarity for healthcare providers, and it is not always possible to administer a PROM for all patients (e.g., on the sidelines of a sporting setting or people who have impaired reading or writing). This then prompts the question: How can we select the Items that are best able to differentiate the severity of Achilles tendinopathy? This critical question can guide contemporary practice and is currently unknown.

The aim of this study was to determine the capacity of Items on the TENDINS-A, FAOS, and VISA-A to differentiate patients with mild and severe tendon-related disability in order to provide clinicians the best questions to ask when they are consulting patients with Achilles tendinopathy.

1.1. Objective

Determine the questions from the TENDINS-A, FAOS, and VISA-A best able to distinguish mild and severe disability in patients with Achilles tendinopathy.

2. Methods

2.1. Study design

This cross-sectional study was embedded within a larger cohort study to assess the construct validity and the reliability of the TENDINS-A (Murphy et al., 2024), of which data collection is still ongoing and contributing to a larger database. This study represents a secondary analysis of data collected within the larger TENDINS-A cohort (Murphy et al., 2024) with the data for this study collected from January 2023 to May 2023.

2.2. Ethical approvals

This research was approved by the University of Notre Dame Australia Human Research Ethics Committee (ID: 2022-175F) and all participants gave informed, electronic consent.

2.3. Participants and setting

A network of clinicians (e.g., orthopaedic surgeons and physiotherapists) and researchers identified people with Achilles tendinopathy (both insertional and mid-portion) and provided them our Qualtrics survey. The survey was provided to participants via either a web-link or a Quick Response (QR) code. We restricted inclusion to participants who were >18 years old, were able to read the English language, and reported pain in the region of the Achilles tendon based on a pain map. The locations of pain that could be selected are detailed in Rio et al., 2024. Pain localisation to the Achilles tendon using a pain map is strongly associated with a clinical diagnosis of Achilles tendinopathy (Sleeswijk Visser et al., 2022) and is used as inclusion methodology in existing studies (Chen et al., 2023).

2.4. Outcome measures

We provided all outcome measures to participants within a single Qualtrics survey (as reported elsewhere (Murphy et al., 2024)) and outcomes were provided in the following order: participant characteristics, TENDINS-A, FAOS, VISA-A.

2.4.1. Participant characteristics

Participants reported their age (years), sex (male, female, intersex), height (centimetres), weight (kilograms), ethnicity, country of residence, languages other than English spoken by the participant, whether the participant performed moderate to vigorous physical activity most days (yes, no), highest level of education, work status and total household income.

2.4.2. TENDINopathy severity assessment – Achilles

The 13-Item TENDINS-A was provided to participants as the first PROM within the survey. This PROM was scored between 0 and 100, with ‘0’ representing a perfect score and ‘100’ representing complete disability (Murphy et al., 2023). The TENDINS-A is the only PROM for Achilles tendinopathy with acceptable content validity, structural validity, and reliability (Murphy et al., 2023, 2024).

2.4.3. Foot and Ankle Outcome Score

The 42-Item FAOS (Golightly et al., 2014) was performed following the TENDINS-A, which has subscales for symptoms, pain, activities of daily living, sport and quality of life, was performed following the TENDINS-A. A score of ‘0’ represented a perfect score, with higher scores representing increased levels of disability (Golightly et al., 2014). The FAOS has never been validated in an Achilles tendinopathy population.

2.4.4. Victorian Institute of Sport Assessment – Achilles

The 8-Item VISA-A (Robinson et al., 2001) was performed after the FAOS. The VISA-A items are inversely scored when compared to the TENDINS-A and FAOS items: A score of ‘100’ represented a perfect score and a score of ‘0’ represented complete disability (Robinson et al., 2001). The VISA-A is reliable (Robinson et al., 2001), but its content and structural validity is lacking (Korakakis et al., 2021a, 2021b).

2.5. Power calculation

A sample of convenience was used for this study, with the robustness of our sample size informed by the COnsensus-based Standards for the selection of health Measurement INstruments (COSMIN) guidelines (Gagnier et al., 2021). As the current study is descriptive, formal power calculations are not able to be performed. Hence the decision to extract data for this study from the TENDINS-A database was based upon having a minimum of 65 participants. This equates to five participants from each of the 13 TENDINS-A items, which would be considered acceptable for classical test theory validation. The database was monitored fortnightly and when >65 participants had completed the Qualtrics Survey,

the entire dataset was extracted.

2.6. Statistical analysis

2.6.1. Descriptives

Participant characteristics were reported using descriptive statistics. We quantified the degree of disability using the total score of the TENDINS-A [that was developed in accordance with international guidelines (Gagnier et al., 2021)], since it is the only existing PROM that is reliable and validated for Achilles tendinopathy (Korakakis et al., 2021a, 2021b; Murphy et al., 2023, 2024).

2.6.2. Discrimination index

The discrimination index (Mokkink et al., 2010) assessed whether an Item (i.e., question) could discriminate between mild and severe Achilles tendinopathy disability. Specifically, we quantified: (a) the Item facility (person score divided by total possible score per Item); and, (b) discrimination index (Andrich & Marais, 2019; Guttman & Kalish, 1956). A Guttman analysis for polytomous Items was conducted and ordered within a table.

The sample was split into tertiles (three groups) based on overall TENDINS-A score severity. The split would have been equal except for an overlap of identical scores in people from the mild and moderate groups, so the same scores from the mild group were included within the moderate group. The mean facility per tertile for each Item (i.e., PROM question) was calculated, as was the discrimination index by subtracting the mild tertile score from the severe tertile score (Andrich & Marais, 2019). The discrimination for all Items was then ordered from highest (representing best capacity to discriminate) to lowest (representing worst capacity to discriminate).

3. Results

3.1. Participant characteristics

We included 70 participants [Mild disability (n = 22); moderate disability (n = 24); severe disability (n = 24)] with self-reported Achilles tendinopathy (61.4% mid-portion only, 31.4% insertional only, 7.2% both) and a mean (SD) TENDINS-A score of 42.5 (25.4). Participants were a mean (SD) age of 42.8 (13.4) years, height of 174.7 (11.7) cm and weight of 82.7 (19.4) kg with 70% performing moderate to vigorous physical activity most days. Other participant characteristics are presented in Table 1.

3.2. Item discrimination capacity

The discrimination index for all Items was calculated and ranked in descending order from 1 to 62 (Appendix A). Capacity to differentiate between disability tertiles was clearly demonstrated. The top ten best performing Items are presented in Fig. 1 and were.

1. Numerical rating scale of pain with single leg hopping.
2. Numerical rating scale of pain with double leg jumping.
3. How many single leg hops able to be completing without pain.
4. Time taken for pain to subside following aggravating activities (minutes).
5. Numerical rating scale of pain with single leg calf raise.
6. Numerical rating scale of pain with double leg calf raise.
7. Time taken for stiffness/symptoms to subside following waking (minutes).
8. Time taken for stiffness/symptoms to subside following prolonged sitting (minutes).
9. The degree of reduction in physical activity from pre-injury levels.
10. Difficulty in completing running in the past week.

Table 1
Summary of participant characteristics.

Variable	Variable (sub variable)	N (%)	
Sex	Male	36 (51.4)	
	Female	34 (48.6)	
Tendinopathy location	Insertional only	22 (31.4)	
	Mid-portion only	43 (61.4)	
	Both	5 (7.2)	
Geographical location	Australia	63 (90.0)	
	United Kingdom	3 (4.3)	
	United States of America	2 (2.9)	
	Italy	1 (1.4)	
	Netherlands	1 (1.4)	
Multilingual	Yes	19 (27.1)	
	No	51 (72.9)	
English first language (for those persons multi-lingual)	Yes	15 (78.9)	
	No	4 (21.1)	
Ethnicity	Australian	47 (67.1)	
	European	11 (15.7)	
	Asian	2 (2.8)	
	Indian	2 (2.9)	
	North American	2 (2.9)	
	New Zealander	1 (1.4)	
	Other	4 (5.7)	
	Decline to answer	1 (1.4)	
	Physical activity	MVPA most days	49 (70.0)
		No MVPA most days	21 (30.0)
Education	Less than high school	3 (4.3)	
	High school graduate	10 (1.43)	
	Bachelors degree	32 (45.7)	
	Masters degree	16 (22.9)	
	Doctoral degree	5 (7.1)	
	Professional degree (JD, MD)	4 (5.7)	
Employment	Full time	46 (65.7)	
	Part time	11 (15.7)	
	Home maker	1 (1.4)	
	Student	7 (10.0)	
	Retired	3 (4.3)	
	Other	2 (2.9)	
Income	Less than 30,000 AUD	4 (5.7)	
	30,000–49,999 AUD	1 (1.4)	
	50,000–79,999 AUD	7 (10.0)	
	80,000–99,999 AUD	7 (10.0)	
	100,000–149,999 AUD	16 (22.9)	
	150,000–199,999 AUD	12 (17.1)	
	Greater than 200,000 AUD	21 (30.0)	
	Declined to answer	2 (2.9)	

Abbreviations: n = number; % = percentage; MVPA = moderate to vigorous physical activity; JD = Juris Doctor; MD = medical doctor; AUD = Australian Dollars; TENDINS-A = Tendinopathy Severity Assessment – Achilles.

Overlap between Items on the different scales was identified (One and Three; Nine and Ten). As a result, we pooled Items that were clinically similar to generate the most important clinical Items to consider for determining Achilles tendinopathy severity, which are presented

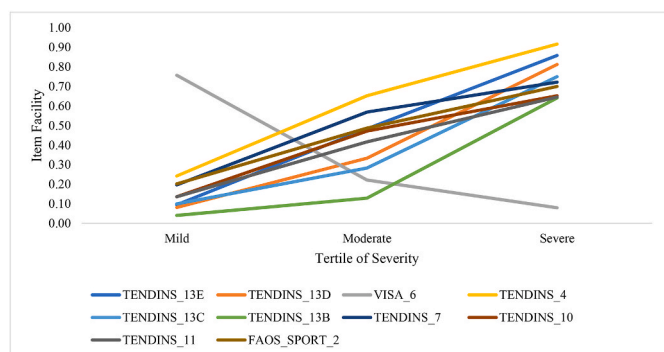


Fig. 1. Discriminatory capacity of the top ten ranked Items based on their Item facility per disability severity tertile. Note the VISA-A Question Six is in the opposite direction due to reverse scoring.

within Fig. 2.

4. Discussion

Our study is the first to identify the top-ten most useful clinical questions to ask patients to subjectively determine the severity of disability in patients with Achilles tendinopathy. When accounting for clinically similar questions, we were then able to generate eight important Items to guide healthcare providers. Specifically, pain with loading the Achilles tendon, the time taken for pain to settle following aggravating activity, and the time taken for the tendon symptoms to subside after prolonged sitting or sleeping should form the clinical basis for delineating mild versus severe tendinopathy. Another important clinical finding was that there are several notable questions that are extremely poor indicators of severity: whether patients have Achilles tendon stiffness, pain at rest or pain during activities of daily living.

Must-ask questions identified in the current study should form the basis of a confident clinical assessment and diagnosis. These questions provide clinical avenues for monitoring treatment response over time as well. Critically, our study also demonstrated a clear increase in the discriminatory capacity of pain with mechanical loading as Achilles tendon strain (Demangeot et al., 2023) increased. For example, jumping tasks had superior discriminatory capacity than calf raise tasks, and single leg tasks had better discriminatory capacity than double leg tasks.

These findings are consistent with our current understanding of Achilles tendinopathy and reflect approaches utilised objectively [e.g., progressive load testing batteries (Bradford et al., 2021)] whereby we typically expect pain associated with Achilles tendinopathy to increase with rising mechanical tendon loads. Additionally, these provocation tests were recently identified as prognostic indicator of the progression of symptom severity (Mulder et al., 2023). This also aligns with existing rehabilitation and reconditioning models that support stretch-shortening cycle loading should be introduced last (Cook & Docking, 2015; Sancho et al., 2019).

It is perhaps unsurprising that the questions identified as being the most important to distinguish tendinopathy severity relate to pain with mechanical loading, which is known to drive tendinopathy symptoms. These features are long established as clinically important when evaluating patients with Achilles tendinopathy (Cook et al., 2016; Cook & Purdam, 2009). Alternatively, questions related to the presence of stiffness and activities of daily living had poor discriminatory capacity. Questions focusing on these features of a patient’s presentation cannot be recommended to monitor Achilles tendinopathy severity based on this study. These findings may have significant practical implications in settings where serial monitoring is conducted. For example, in elite sport the symptoms associated with Achilles tendinopathy must be determined in an efficient and accurate fashion – often on a daily basis. This information is then used as part of contemporary prevention to avoid exacerbations and subsequently mitigate the time loss from training and matches.

4.1. Perspective

It is fundamental clinically that any question we ask a patient is for a specific purpose. Typically, this would include questions to determine whether someone has a health condition (i.e., differential diagnosis), as well as questions to determine the severity of the health condition. Our study focussed on the latter. For example, the presence or absence of stiffness has poor discriminatory capacity between people with mild and severe disability and scored poorly in our study. However, this question may have clinical utility in initial assessment and diagnosis. Furthermore, our study does not mean that other questions should not be asked as they are likely important in patient management (e.g., you would also need to determine the most aggravating activities for the patient in front of you), just that questions identified in this study provide the best



Fig. 2. Important items to consider quantifying when someone presents with Achilles tendinopathy.

Legend: Domain ONE (pain with loading the Achilles tendon): Items 1, 2, 3, 4 and 8. Domain TWO (time for pain to settle following aggravating activity): Item 5. Domain THREE (time taken for the tendon symptoms to subside after prolonged sitting or sleeping): Items 6 and 7.

capacity to differentiate the degree of severity.

4.2. Limitations

The sample of participants within the study are well diversified with acceptable split for sex, physical activity levels, education levels, work status and household income. However, the sample is skewed towards Australian residents and people identifying with an “Australian” ethnicity. Thus, with all TENDINS-A, FAOS and VISA-A questions used within this study being in English, these results may not be generalisable to all languages or regions. However, as the TENDINS-A (which was used to group into disability tertiles) does not appear to demonstrate differences based on sex, age or whether a person is bilingual and has no floor or ceiling effects based on physical activity level we do not expect significant demographic differences.

Another potential limitation is that the standard items in the questionnaires might not adequately capture the personal context in the clinical setting. From a clinical perspective, it would not be of additional value to let the patient perform pain-provoking single leg hopping or jumping tests if the level of pain on double leg calf raises is already very high. This emphasizes a personalised approach when using the presented top items for clinical practice. The authors also would like to stress that time taken symptoms to subside is more valuable with a specific context. In the clinical setting, patients might find it easier to answer these questions when the type and amount of physical activity is specifically addressed and monitored in similar circumstances. Finally, as outlined in the TENDINS-A, when asking patients about changes in their activity levels following their tendinopathy you must make it specific to the aggravating loads experienced by the patient as these loads likely to differ between people. These limitations emphasize that the number of identified ‘must-ask’ questions in the clinical setting can be further reduced based on patient needs and context.

5. Conclusion

Pain with loading the Achilles tendon, time for pain to settle

Appendix A. Ranking of items best capable of discriminating mild and severe Achilles tendinopathy disability

	Mild Disability Mean Facility	Moderate Disability Mean Facility	Severe Disability Mean Facility	Discrimination Index	Ranking
TENDINS_13E	0.095	0.483	0.858	0.763	1
TENDINS_13D	0.082	0.333	0.813	0.731	2
VISA_6	0.757	0.222	0.080	0.677	3
TENDINS_4	0.242	0.653	0.917	0.674	4
TENDINS_13C	0.100	0.283	0.750	0.650	5
TENDINS_13B	0.041	0.129	0.642	0.601	6
TENDINS_7	0.197	0.569	0.722	0.525	7
TENDINS_10	0.136	0.472	0.653	0.516	8
TENDINS_11	0.136	0.417	0.646	0.509	9
FAOS_SPORT_2	0.202	0.488	0.700	0.498	10
FAOS_Pain_3	0.125	0.304	0.600	0.475	11
FAOS_QoL_2	0.104	0.383	0.575	0.471	12
TENDINS_13A	0.045	0.038	0.513	0.467	13
FAOS_QoL_4	0.146	0.367	0.600	0.454	14
VISA_2	0.871	0.565	0.420	0.451	15
FAOS_SPORT_3	0.202	0.513	0.650	0.448	16
VISA_8	0.563	0.352	0.129	0.435	17
FAOS_Pain_2	0.107	0.261	0.533	0.426	18
VISA_4	0.848	0.557	0.427	0.421	19
TENDINS_3	0.227	0.347	0.639	0.412	20
VISA_7	0.671	0.530	0.267	0.405	21
FAOS_Pain_5	0.262	0.554	0.667	0.405	22
VISA_5	0.805	0.570	0.407	0.398	23
FAOS_Pain_4	0.190	0.413	0.583	0.393	24
FAOS_Pain_9	0.298	0.511	0.683	0.386	25
FAOS_QoL_3	0.146	0.383	0.525	0.379	26
FAOS_Pain_1	0.155	0.435	0.517	0.362	27

(continued on next page)

following aggravating activity, as well as time taken for the tendon symptoms to subside after prolonged sitting or sleeping are the best questions indicative of the severity of disability in patients with Achilles tendinopathy. These questions can assist clinicians with assessing baseline severity and monitoring treatment response.

Patient consent statement

All participants gave informed, electronic consent.

Ethics approval statement

This research was approved by the University of Notre Dame Australia Human Research Ethics Committee (ID: 2022-175F).

Funding

Not applicable.

CRediT authorship contribution statement

Myles C. Murphy: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Brady Green:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Igor Sancho Amundarain:** Writing – review & editing, Writing – original draft. **Robert-Jan de Vos:** Writing – review & editing, Writing – original draft, Data curation. **Ebonie K. Rio:** Writing – review & editing, Writing – original draft, Supervision, Data curation, Conceptualization.

Declaration of competing interest

The authors declare no competing interests.

(continued)

	Mild Disability Mean Facility	Moderate Disability Mean Facility	Severe Disability Mean Facility	Discrimination Index	Ranking
FAOS_Pain_8	0.107	0.227	0.464	0.357	28
VISA_3	0.829	0.704	0.473	0.355	29
FAOS_Pain_6	0.131	0.141	0.467	0.336	30
FAOS_SPORT_1	0.083	0.250	0.417	0.333	31
FAOS_Syptoms_1	0.071	0.413	0.400	0.329	32
FAOS_ADL_16	0.083	0.272	0.411	0.327	33
FAOS_ADL_15	0.107	0.250	0.433	0.326	34
FAOS_ADL_14	0.095	0.359	0.417	0.321	35
FAOS_Pain_7	0.083	0.174	0.400	0.317	36
FAOS_SPORT_4	0.119	0.298	0.433	0.314	37
FAOS_ADL_4	0.060	0.152	0.367	0.307	38
FAOS_QoL_1	0.429	0.685	0.734	0.306	39
FAOS_Syptoms_6	0.298	0.435	0.600	0.302	40
FAOS_ADL_8	0.071	0.185	0.367	0.295	41
FAOS_Syptoms_7	0.179	0.348	0.450	0.271	42
FAOS_ADL_1	0.038	0.152	0.300	0.263	43
FAOS_ADL_6	0.048	0.130	0.304	0.256	44
FAOS_SPORT_5	0.113	0.205	0.357	0.245	45
TENDINS_6	0.636	0.833	0.875	0.239	46
FAOS_ADL_3	0.060	0.152	0.283	0.224	47
FAOS_ADL_17	0.026	0.098	0.233	0.207	48
FAOS_Syptoms_5	0.095	0.098	0.300	0.205	49
TENDINS_8	0.591	0.875	0.792	0.201	50
FAOS_ADL_5	0.036	0.130	0.233	0.198	51
FAOS_ADL_2	0.048	0.163	0.232	0.185	52
FAOS_Syptoms_3	0.119	0.159	0.300	0.181	53
FAOS_ADL_10	0.048	0.065	0.200	0.152	54
FAOS_ADL_13	0.036	0.054	0.183	0.148	55
FAOS_Syptoms_4	0.083	0.065	0.217	0.133	56
FAOS_ADL_12	0.048	0.065	0.167	0.119	57
FAOS_ADL_11	0.048	0.071	0.150	0.102	58
FAOS_ADL_9	0.025	0.054	0.117	0.092	59
FAOS_ADL_7	0.036	0.065	0.117	0.081	60
FAOS_Syptoms_2	0.345	0.413	0.333	-0.012	61
VISA_1	0.567	0.687	0.580	-0.013	62

References

- Andrich, D., & Marais, I. (2019). *A course in Rasch measurement theory: Measuring in the educational, social and health sciences*. Singapore: Springer Nature Singapore Pte Ltd.
- Bradford, B., Rio, E., Murphy, M., Wells, J., Khondoker, M., Claarke, C., ... Chester, R. (2021). Immediate effects of two isometric calf muscle exercises on mid-portion Achilles tendon pain. *International Journal of Sports Medicine*, 42(12), 1122–1127.
- Ceravolo, M. L., Gaida, J. E., & Keegan, R. J. (2020). Quality-of-Life in Achilles tendinopathy: An exploratory study. *Clinical Journal of Sport Medicine: Official Journal of the Canadian Academy of Sport Medicine*, 30(5), 495–502.
- Chen, W., Cloosterman, K. L. A., Bierma-Zeinstra, S. M. A., van Middelkoop, M., & de Vos, R. J. (2023). Epidemiology of insertional and midportion Achilles tendinopathy in runners: A prospective cohort study. *Journal of sport and health science*.
- Comins, J., Siersma, V., Coupe, C., Svensson, R. B., Johansen, F., Malmgaard-Clausen, N. M., & Magnusson, S. P. (2021). Assessment of content validity and psychometric properties of VISA-A for Achilles tendinopathy. *PLoS One*, 16(3), Article e0247152.
- Conceicao, C. S., Neto, M. G., Neto, A. C., Mendes, S. M., Baptista, A. F., & Sa, K. N. (2016). Analysis of the psychometric properties of the American orthopaedic foot and ankle society score (AOFAS) in rheumatoid arthritis patients: Application of the Rasch model. *Revista Brasileira de Reumatologia*, 56(1), 8–13.
- Cook, J., & Docking, S. (2015). "Rehabilitation will increase the 'capacity' of your ... insert musculoskeletal tissue here..." Defining 'tissue capacity': A core concept for clinicians. *British Journal of Sports Medicine*, 49(23), 1484–1485.
- Cook, J. L., & Purdam, C. R. (2009). Is tendon pathology a continuum? A pathology model to explain the clinical presentation of load-induced tendinopathy. *British Journal of Sports Medicine*, 43(6), 409–416.
- Cook, J. L., Rio, E., Purdam, C. R., & Docking, S. I. (2016). Revisiting the continuum model of tendon pathology: What is its merit in clinical practice and research? *British Journal of Sports Medicine*, 50(19), 1187–1191.
- de Jonge, S., van den Berg, C., de Vos, R. J., van der Heide, H. J., Weir, A., Verhaar, J. A., ... Tol, J. L. (2011). Incidence of midportion Achilles tendinopathy in the general population. *British Journal of Sports Medicine*, 45(13), 1026–1028.
- Demangeot, Y., Whiteley, R., Gremeaux, V., & Degache, F. (2023). The load borne by the Achilles tendon during exercise: A systematic review of normative values. *Scandinavian Journal of Medicine & Science in Sports*, 33(2), 110–126.
- Gagnier, J. J., Lai, J., Mokkink, L. B., & Terwee, C. B. (2021). COSMIN reporting guideline for studies on measurement properties of patient-reported outcome measures. *Quality of Life Research*, 30(8), 2197–2218.
- Golightly, Y. M., Devellis, R. F., Nelson, A. E., Hannan, M. T., Lohmander, L. S., Renner, J. B., & Jordan, J. M. (2014). Psychometric properties of the foot and ankle outcome score in a community-based study of adults with and without osteoarthritis. *Arthritis Care & Research*, 66(3), 395–403.
- Grävare Silbernagel, K., Malliaras, P., de Vos, R.-J., Hanlon, S., Molenaar, M., Alfredson, H., ... Vicenzino, B. (2022). ICON 2020—international scientific tendinopathy symposium consensus: A systematic review of outcome measures reported in clinical trials of Achilles tendinopathy. *Sports Medicine*. Auckland, NZ, 52(3), 613–641.
- Guttman, N., & Kalish, H. I. (1956). Discriminability and stimulus generalization. *Journal of Experimental Psychology*, 51(1), 79–88.
- Hales, L. W. (1972). Method of obtaining the index of discrimination for item selection and selected test characteristics: A comparative study. *Educational and Psychological Measurement*, 32(4), 929–937.
- Korakakis, V., Kotsifaki, A., Stefanakis, M., Sotiralis, Y., Whiteley, R., & Thorborg, K. (2021a). Evaluating lower limb tendinopathy with Victorian Institute of sport assessment (VISA) questionnaires: A systematic review shows very-low-quality evidence for their content and structural validity-part I. *Knee Surgery, Sports Traumatology, Arthroscopy*, 29(9), 2749–2764.
- Korakakis, V., Whiteley, R., Kotsifaki, A., Stefanakis, M., Sotiralis, Y., & Thorborg, K. (2021b). A systematic review evaluating the clinimetric properties of the Victorian Institute of Sport Assessment (VISA) questionnaires for lower limb tendinopathy shows moderate to high-quality evidence for sufficient reliability, validity and responsiveness—part II. *Knee Surgery, Sports Traumatology, Arthroscopy*.
- Mokkink, L. B., Terwee, C. B., Patrick, D. L., Alonso, J., Stratford, P. W., Knol, D. L., ... de Vet, H. C. W. (2010). The COSMIN study reached international consensus on taxonomy, terminology, and definitions of measurement properties for health-related patient-reported outcomes. *Journal of Clinical Epidemiology*, 63(7), 737–745.
- Mulder, C. F. L., van der Vlist, A. C., van Middelkoop, M., van Oosterom, R. F., van Veldhoven, P. L. J., Weir, A., & Verhaar, J. A. N. (2023). Do physical tests have a prognostic value in chronic midportion Achilles tendinopathy? *Journal of Science and Medicine in Sport*, 26(8), 421–428.
- Murphy, M. C., McCleary, F., Hince, D., Chimenti, R. L., Chivers, P. T., Vosseller, J. T., ... Rio, E. (2024). TENDINopathy Severity assessment – Achilles (TENDINS-A): Evaluation of reliability and validity in accordance with COSMIN recommendations. *British Journal of Sports Medicine, Published Online First*. <https://doi.org/10.1136/bjsports-2023-107741>
- Murphy, M. C., Newsham-West, R., Cook, J., Chimenti, R. L., de Vos, R. J., & Maffulli, N., Malliaras, P., Mkumbuzi, N., Purdam, C., Vosseller, J.T., & Rio, E. (2023). TENDINopathy severity assessment - Achilles (TENDINS-A): Development

- and content validity assessment of a new patient-reported outcome measure for Achilles tendinopathy. *Journal of Orthopaedic & Sports Physical Therapy*, 0(11), 1–16.
- Petersen, E. J., Thurmond, S. M., & Jensen, G. M. (2021). Severity, irritability, nature, stage, and stability (SINSS): A clinical perspective. *Journal of Manual & Manipulative Therapy*, 29(5), 297–309.
- Rio, E. K., Rabusin, C., Munteanu, S., Docking, S. I., Perrot, M., Couch, J., ... Girdwood, M. (2024). Where is your pain? Pain location on loading is different to palpation, imaging and recall location: A study of Achilles tendinopathy research participants. *Journal of Orthopaedic & Sports Physical Therapy*, 54(1), 1–9. <https://doi.org/10.2519/jospt.2023.12131>
- Robinson, J. M., Cook, J. L., Purdam, C., Visentini, P. J., Ross, J., Maffulli, N., ... Khan, K. M. (2001). The VISA-A questionnaire: A valid and reliable index of the clinical severity of Achilles tendinopathy. *British Journal of Sports Medicine*, 35(5), 335–341.
- Roos, E. M., Brandsson, S., & Karlsson, J. (2001). Validation of the foot and ankle outcome score for ankle ligament reconstruction. *Foot & Ankle International*, 22(10), 788–794.
- Sancho, I., Morrissey, D., Willy, R. W., Barton, C., & Malliaras, P. (2019). Education and exercise supplemented by a pain-guided hopping intervention for male recreational runners with midportion Achilles tendinopathy: A single cohort feasibility study. *Physical Therapy in Sport: Official Journal of the Association of Chartered Physiotherapists in Sports Medicine*, 40, 107–116.
- Scott, A., Squier, K., Alfredson, H., Bahr, R., Cook, J. L., Coombes, B., ... Zwerver, J., et al. (2020). ICON 2019: International Scientific Tendinopathy Symposium consensus: Clinical terminology. *British Journal of Sports Medicine*, 54(5), 260–262.
- Sleeswijk Visser, T. S. O., van der Vlist, A. C., van Oosterom, R. F., van Veldhoven, P., Verhaar, J. A. N., & de Vos, R. J. (2021). Impact of chronic Achilles tendinopathy on health-related quality of life, work performance, healthcare utilisation and costs. *BMJ Open Sport Exerc Med*, 7(1), Article e001023.
- Sleeswijk Visser, T. S. O., van Es, E. M., Meuffels, D. E., Verhaar, J. A. N., & de Vos, R. J. (2022). Standardized pain mapping for diagnosing Achilles tendinopathy. *Journal of Science and Medicine in Sport*, 25(3), 204–208.
- Vicenzino, B., de Vos, R.-J., Alfredson, H., Bahr, R., Cook, J. L., Coombes, B. K., Fu, S. N., Silbernagel, K. G., Grimaldi, A., Lewis, J. S., Maffulli, N., Magnusson, S. P., Malliaras, P., Mc Auliffe, S., Oei, E. H. G., Purdam, C., Rees, J. D., Rio, E. K., Scott, A., Speed, C., van den Akker-Scheek, I., Weir, A., Moriatis, J., & Zwerver, J. (2019). ICON 2019—international Scientific Tendinopathy Symposium Consensus: There are nine core health-related domains for tendinopathy (CORE DOMAINS): Delphi study of healthcare professionals and patients. *British Journal of Sports Medicine*, 54(8), 444–451.
- Wang, Y., Zhou, H., Nie, Z., & Cui, S. (2022). Prevalence of Achilles tendinopathy in physical exercise: A systematic review and meta-analysis. *Sports Med Health Sci*, 4(3), 152–159.