Published in final edited form as:
Arthritis Care Res (Hoboken). 2014 March ; 66(3): 395–403. doi:10.1002/acr.22162.

Psychometric Properties of the Foot and Ankle Outcome Score in a Community-Based Study of Adults with and without Osteoarthritis

Yvonne M. Golightly, PT, PhD[1,2], **Robert F. DeVellis, PhD**[2,4], **Amanda E. Nelson, MD, MSCR**[2,5], **Marian T. Hannan, DSc, MPH**[6,7], **L. Stefan Lohmander, MD, PhD**[8,9], **Jordan B. Renner, MD**[10], and **Joanne M. Jordan, MD, MPH**[1,2,5,11]

[1]Department of Epidemiology, University of North Carolina, Chapel Hill, NC, USA

[2]Thurston Arthritis Research Center, University of North Carolina, Chapel Hill, NC, USA

[3]Injury Prevention Research Center, University of North Carolina, Chapel Hill, NC, USA

[4]Department of Health Behavior and Health Education, University of North Carolina, Chapel Hill, NC, USA

[5]Department of Medicine, University of North Carolina, Chapel Hill, NC, USA

[6]Institute for Aging Research, Hebrew Senior Life, Boston, MA, USA

[7]Harvard Medical School, Boston, MA, USA

[8]Department of Orthopaedics, Lund University Hospital, Lund University, Sweden

[9]Institute of Sports Science and Clinical Biomechanics and Department of Orthopedics and Traumatology, University of Southern Denmark, Odense, Denmark

[10]Department of Radiology, University of North Carolina, Chapel Hill, NC, USA

[11]Department of Orthopedics, University of North Carolina, Chapel Hill, NC, USA

Abstract

Objective—Foot and ankle problems are common in adults, and large observational studies are needed to advance our understanding of the etiology and impact of these conditions. Valid and reliable measures of foot and ankle symptoms and physical function are necessary for this research. This study examined psychometric properties of the Foot and Ankle Outcome Score (FAOS) subscales (pain, other symptoms, activities of daily living [ADL], sport and recreational function [Sport/Recreation], and foot and ankle related quality of life [QOL]) in a large, community-based sample of African American and Caucasian men and women 50+ years old.

Methods—Johnston County Osteoarthritis Project participants (N=1670) completed the 42-item FAOS (mean age 69 years, 68% women, 31% African American, mean body mass index [BMI]

Corresponding Author: Yvonne M. Golightly, PT, Ph.D., Thurston Arthritis Research Center, University of North Carolina, 3300 Thurston Building, Campus Box #7280, Chapel Hill, NC 27599-7280, Phone (919) 966-0566, FAX (919) 966-1739, golight@email.unc.edu.

Competing Interests: The authors report no conflicts of interest in relation to this work.

31.5 kg/m^2). Internal consistency, test-retest reliability, convergent validity, and structural validity of each subscale were examined for the sample and for subgroups according to race, gender, age, BMI, presence of knee or hip osteoarthritis, and presence of knee, hip or low back symptoms.

Results—For the sample and each subgroup, Cronbach's alphas were 0.95–0.97 (pain), 0.97–0.98 (ADL), 0.94–0.96 (Sport/Recreation), 0.89–0.92(QOL), and 0.72–0.82 (symptoms). Correlation coefficients were 0.24–0.52 for pain and symptoms subscales with foot and ankle symptoms and 0.30–0.55 for ADL and Sport/Recreation subscales with Western Ontario and McMaster Universities Osteoarthritis Index function subscale. Intraclass correlation coefficients for test-retest reliability were 0.63–0.81. Items loaded on a single factor for each subscale except symptoms (2 factors).

Conclusions—The FAOS exhibited sufficient reliability and validity in this large cohort study.

Keywords

epidemiologic study; foot; ankle; outcome assessment; reliability; validity

---

An association between foot pain and decreased functional abilities has been demonstrated in several large studies (1–8). Foot pain is especially common among older adults, affecting approximately 20–37% of community-dwelling men and women aged 45 years and older (1, 3, 8–10). Ankle pain is somewhat less common at 15% among adults 58 years of age and older (9, 10), but painful ankle conditions, such as osteoarthritis (OA), can significantly impact physical performance (11).

Observational study designs are useful for understanding foot and ankle conditions and their associated risk factors in populations, and for these types of studies, a comprehensive, valid, and reliable outcome measure of foot and ankle symptoms and physical function is a valuable tool. Several instruments have been developed and validated in clinical samples to assess foot and ankle function and disability (12–15), but their psychometric properties have not been thoroughly examined in large population-based studies (16).

The Foot and Ankle Outcome Score (FAOS) consists of 42 items as effect indicators for 5 subscales of pain, other symptoms, activities of daily living [ADL], sport and recreational function [Sport/Recreation], and foot and ankle related quality of life [QOL]). In patient samples, the FAOS was validated among patients 20–60 years of age with lateral ankle instability (14), and the validity (one factor for each subscale) and reliability (Cronbach's alpha >0.7, test-retest intraclass correlations >0.7) of this instrument also have been confirmed among other patient samples with foot and ankle disorders (17–19) (17–21). The FAOS presents with several advantages as a valuable measure for a population-based study. The FAOS content is comparable to three other measures validated among patients with knee and hip OA that are commonly used in large population-based studies: the Knee Injury and Osteoarthritis Outcome Score (KOOS) (22–24), the Hip Injury and Osteoarthritis Outcome Score (HOOS) (25), and the Western Ontario and McMaster Universities (WOMAC) Index of Osteoarthritis (26). Additionally, the FAOS not only has pain and physical function subscales, but also includes subscales regarding other symptoms (e.g.,

swelling, grinding and clicking) and quality of life, two additional categories that are relevant to older adults.

The purpose of this study was to determine psychometric qualities (i.e., internal consistency, test-retest reliability, convergent validity, and structural validity) of the FAOS subscales in a large observational study of people sampled from a community without regard to foot or ankle problem status: the Johnston County Osteoarthritis Project (JoCo OA). Study investigators for JoCo OA had specifically chosen to examine the FAOS because other similar instruments for the hip and knee were being collected and analyzed in this cohort (WOMAC, KOOS, and HOOS) and a comparable instrument for foot and ankle conditions was desired. However, to justify the use of the FAOS in a new way as a measure in a population-based sample, psychometric properties needed to be investigated. Internal consistency, convergent validity, and structural validity were tested in the whole cohort. To assess test-retest reliability, new data were collected for 40 participants randomly sampled from the parent study.

METHODS

Study Participants

Existing data were available for 1,670 participants from JoCo OA who completed the FAOS during the second follow-up assessment from November 2006–November 2010. At this visit, all participants were 50+ years old. As one of the largest ongoing community-based prospective studies of OA and other musculoskeletal disorders, the sample size of JoCo OA was more than adequate for conducting factor analysis of the FAOS since most expert recommendations suggest at least 200 to 300 observations (27, 28). Furthermore, at least 87% of participants in JoCo OA have a foot or ankle problem (over 1/4 with pain, aching or stiffness in the foot or ankle and over 80% with foot and ankle disorders, like hallux valgus or lesser toe deformities) (3, 29). Examining the FAOS in the entire cohort seemed appropriate due to the high occurrence of foot and ankle problems and because our objective was for scientific purposes in a large observational study. JoCo OA includes civilian, non-institutionalized adults residing in six townships in Johnston County, North Carolina who were 45+years old at enrollment. Probability sampling was used to recruit participants into the study, and African Americans were oversampled to allow for disease comparisons by race.

To assess test-retest reliability of the FAOS, new data were collected. A sample size of 40 was set to detect a statistically significant correlation coefficient of at least 0.30, well below a minimally acceptable reliability coefficient (e.g., 0.70). Forty participants randomly sampled from the parent study (JoCo OA) were invited to participate, enrolled, and consented in a separate investigation during February and March 2012.

Foot and Ankle Outcome Score

The English version of the FAOS was used. The FAOS is a 42-item questionnaire divided into 5 subscales (pain [9 items], other symptoms [7 items], ADL [17 items], Sport/Recreation [5 items], and QOL [4 items]) (14). Each question is scored on a 5-point Likert

scale from 0–4 (none, mild, moderate, severe, and extreme problems). Scores are calculated for each subscale by summing the total score of each subscale and dividing it by the possible maximum score of the subscale. The normalized score is transformed to a scale of 0–100(100 = no problems, 0 = extreme problems. According to the FAOS manual, if one or two values are missing on a subscale, the missing values are substituted with the average value for the subscale. If more than two items are missing, no subscale score is calculated. For the present analyses, if more than one item was missing on the QOL subscale (a 4 item scale), a subscale score was not calculated.

The initial administration of the FAOS occurred during the regularly-scheduled in-person interview portion of JoCo OA during 2006–2010, and trained interviewers asked the questions to accommodate the range of literacy levels in this cohort. The interviewers were trained to read the items and responses as written. Participants were asked to respond to the FAOS questions based on their most affected foot and ankle. The test-retest reliability of the FAOS occurred at a separate time, and the questionnaire was administered by trained interviewers by telephone two times two weeks apart. A two week interval was selected because it was short enough to minimize changes in symptoms over time but thought to be long enough to reduce the influence of the first administration on the second administration.

Foot and Ankle Symptoms

Participants in the parent study completed an interviewer-administered questionnaire in which they answered “Yes” or “No,” separately for their right and left feet and ankles, to the question: “On most days, do you have pain, aching, or stiffness in your right/left foot/ankle?” Participants who answered affirmatively to the symptoms question for at least one foot were considered to have foot symptoms and for at least one ankle were considered to have ankle symptoms.

Measurement of Physical Function

Self-reported functional status was measured using the physical function subscale of the WOMAC for the worst hip or knee (26). Although the WOMAC was designed for hip and knee problems and not foot or ankle, the WOMAC-function subscale was the most similar to the FAOS ADL and Sport/Recreation subscales of the functional status questionnaires collected in JoCo OA. The possible scores range from 0 (no difficulty) to 68 (extreme difficulty). The WOMAC function subscale has high internal consistency (Cronbach’s alpha of 0.90 or higher) (26, 30, 31) and good convergent validity with similar function constructs (32), and its factor structure has been supported in studies of individuals with hip or knee OA (33, 34).

Comorbid Musculoskeletal Conditions

Knee, Hip, and Low Back Symptoms—Participants in the parent study and in the test-retest reliability study were asked: “On most days, do you have pain, aching or stiffness in your [left/right] [knee/hip/low back]?” Participants were considered to have knee, hip or low back symptoms if they answered affirmatively.

Knee and Hip Osteoarthritis—All participants in the parent study completed bilateral posteroanterior fixed-flexion radiography of the knees in weight bearing. Women 50+ years old and all men completed supine anteroposterior pelvic radiography. Knee and hip radiographs were rated by a single muscuoloskeletal radiologist using the Kellgren-Lawrence (K-L) radiographic atlas (35). Interrater and intrarater reliability for the radiologist were 0.9 (weighted kappa) and 0.9 (kappa), respectively (36). K-L grades were assigned: 0 for no features of OA, 1 for a minute radiographic osteophyte of doubtful pathologic significance, 2 for an osteophyte without joint space narrowing, 3 for a moderate decrease of joint space, and 4 for severe joint space narrowing with subchondral bone sclerosis (37). Foot pain and radiographic OA in areas other than the foot have been associated in previous studies (4, 6).

Demographic and Clinical Characteristics

The following participant characteristics were examined: gender; race (African American or Caucasian); age (continuous variable in years); and body mass index at baseline (BMI: continuous variable calculated as weight in kilograms/height in meters squared). Height without shoes was measured in centimeters, and weight was measured in kilograms.

Analyses

To confirm measurement properties, relevant recommendations of **CO**nsensus-based **S**tandards for the selection of health **M**easurement **In**struments (COSMIN) were followed to examine each FAOS subscale in the whole sample and by subgroup (race; gender; age; presence of knee or hip OA; presence of knee, hip, or low back symptoms; and obesity). SAS 9.2 (Cary, NC) was used for all analyses.

Reliability

Internal Consistency: Cronbach's alpha coefficient was used to assess the internal consistency of each FAOS subscale, using raw data only without imputation for missing values. Cronbach's alpha coefficient determines how well individual terms measure the same characteristic (38) with a coefficient of >0.70 indicating a strong correlation, 0.3–0.7 a moderate correlation, and <0.3 a weak correlation (39). To confirm findings for the whole cohort, a post hoc sensitivity analysis was conducted to determine the internal consistency in those with: 1) foot or ankle symptoms (pain, aching, or stiffness, n=432) and 2) foot or ankle problems (symptoms or disorders, n= 1443).

Test-retest Reliability: An intraclass correlation coefficient (ICC) was calculated for each subscale (using raw data without imputation) to assess test-retest reliability. ICCs of <0.3 were considered to indicate poor agreement, 0.3–0.7 moderate agreement, and >0.7 strong agreement.

Validity

Convergent Validity: Spearman's correlation coefficients were calculated to assess correlations of the symptoms and pain subscale scores with foot and ankle symptoms and the ADL and Sport/Recreation subscales (using imputed data) with the function subscale of

WOMAC. Correlation coefficients were classified as weak (<0.3), moderate (0.3–0.7) and strong (>0.7). A post hoc sensitivity analysis was conducted to determine the validity among those with foot or ankle problems (symptoms or disorders, n= 1443).

Structural Validity: Factor analyses (SAS Proc Factor, with unities retained along the diagonal) of items from each FAOS subscale (using raw data) were conducted for the whole sample to confirm the structure of the instrument. Next, analyses were stratified by race (African American and Caucasian); gender; age (55–64, 65+ years); presence of knee or hip OA; presence of knee, hip, or low back symptoms; and BMI (<25.0, 25.0–29.9, 30.0+ kg/m^2). Eigenvalues were calculated to determine the proportion of information provided by a factor (40). An eigenvalue divided by the sum of item variances estimates the extent to which a factor captures the information present in the original items. Since a subscale was intended to represent one underlying construct, each subscale was expected to have only a one factor solution.

RESULTS

Study Participants

FAOS data were available for 1670 participants in the parent study. The study sample was 68% women and 31% African American with a mean age of 68.6 years (standard deviation [SD] =9.1, median=67.6, range=50–95) and mean BMI of 31.5 kg/m^2 (SD=7.2; Table 1). Of the participants with foot and ankle symptoms data (N=1449), 24.3% had foot symptoms and 15.5% had ankle symptoms. The WOMAC function subscale scores were skewed, with most participants reporting no difficulty (N=1587; mean=13, SD=16, median=5, range 0–68).

The 40 participants in the test-retest reliability study were 78% women and 35% African American with a mean age of 71 years. This sample had a slightly older mean age than the parent study and had a larger proportion of women and African Americans, but these characteristics were not statistically different (mean age p=0.40, gender p=0.20, race p=0.07). These participants completed the FAOS on average 14.0 days apart (standard deviation=0.65, range 11.0–15.0 days). All participants reported consistent presence or absence of foot or ankle symptoms at baseline and at 2 weeks, and presence or absence of symptoms was consistent at the hips for 30 participants, at the knees for 25 participants, and in the low back for 29 participants.

Foot and Ankle Outcomes Score

Missing Data and Imputation—Complete data were missing for 94 participants (5.6%) on the pain subscale, and item values were imputed for 65 participants with missing ≤2 pain items. For the symptoms subscale, 25 (1.5%) participants were missing data, and values were imputed for all. One item from the ADL subscale (A8. “Going shopping”) was unintentionally excluded during the home interview of the parent study for all 1670 participants, leaving 16 items available for analyses of this subscale. Item values were imputed for 1609 participants who were missing this item and no more than one other item. For the Sports/Recreation subscale, 262 (15.7%) participants were missing data, and values

were imputed for 46 participants. For the QOL subscale, 47 (2.8%) were missing data, and values were imputed for 9 participants missing 1 item. No data were missing for test-retest reliability study participants.

Distribution—Distributions of each FAOS subscale scores were similarly skewed for the whole sample and by subgroup (Table 1). Fewer than 1% of participants had the lowest score (worst outcome) on the pain, symptoms, ADL, and QOL subscales, while 6.9% had the lowest score on the Sports/Rec subscale. The highest score (no problems) was reported by 48.9% of participants for the pain subscale, 36.0% for the symptoms subscale, 60.7% for the ADL subscale, 48.6% for the Sport/Recreation subscale, and 51.9% for the QOL subscale.

Internal Consistency

Internal consistency was high for the whole sample and across subgroups for the pain (Cronbach's alphas = 0.95–0.97), ADL (0.97–0.98), Sport/Recreation (0.94–0.96), and QOL (0.89–0.92) subscales (Table 2). The internal consistency was somewhat lower for the symptoms subscale (0.72–0.82). After determining the factor structure of each subscale (see Structural Validity below), the internal consistency was examined for two factors on the symptoms subscale, and Cronbach's alphas were 0.81 for Symptoms Factor 1 and 0.88 for Symptoms Factor 2. A sensitivity analysis of those with foot or ankle symptoms (n=432) and those with foot or ankle problems (n= 1443) revealed similar Cronbach's alphas (data not shown).

Test-Retest Reliability

The ICCs comparing the administration of the questionnaire at two time points two weeks apart indicated high reliability for the ADL (0.81), pain (0.80), and QOL (0.78) subscales and somewhat lower agreement for the Sport/Recreation (0.68) and symptoms (0.63) subscales. ICCs were 0.85 for Symptoms Factor 1 and 0.23 for Symptoms Factor 2.

Convergent Validity

Pain (r=0.26–0.52) and symptoms subscales (r=0.24–0.45) were moderately correlated with foot and ankle symptoms (r = 0.25 to 0.55), and ADL (r=0.39–0.55) and Sport/Recreation subscales (r=0.30–0.49) were moderately correlated with the WOMAC function subscale (Table 3). A sensitivity analysis of those with foot or ankle problems (n= 1443) estimated similar Cronbach's alphas (data not shown).

Structural Validity

All items loaded on a single factor for the pain, ADL, Sport/Recreation, and QOL subscales (Table 4). For the symptoms subscale, all but two range of motion items (straightening and bending the foot/ankle fully) loaded on a single factor (Table 4), resulting in a two factor solution (Symptoms Factors 1 and 2). Results were similar for all subgroups according to race, gender, age BMI, and lower extremity symptoms and OA for each subscale (Table 2).

DISCUSSION

The results of this study demonstrated high internal consistency of the FAOS subscales, high test-retest reliability for three subscales, and a one-factor structure for four subscales in this large cohort and across subgroups. The convergent validity was moderate.

Both the sample and the method of administration of the FAOS differed in this study compared to the original study by Roos et al (14). In the original study, Swedish patients 20–60 years old with lateral ankle instability read and completed the instrument on their own. JoCo OA participants were generally older and the presence and type of foot and ankle problems varied. A trained interviewer read the FAOS items and responses to each participant as a consistent method of data collection to accommodate a range of literacy levels. Despite these differences, psychometric properties were largely similar between these two studies.

Participants in the test-retest reliability study reported stable presence or absence of foot and ankle symptoms, but presence or absence of knee, hip, and low back symptoms varied for some individuals over the 2 week interval. Variability in lower body symptoms may have influenced subscale scores, yet the test-retest reliability was acceptable with moderate to high correlation coefficients for all subscales.

Correlations were moderate for pain and symptoms subscales with foot and ankle symptoms and ADL and Sport/Recreation subscales with WOMAC function. The measures available in our existing data in the parent study (foot and ankle symptoms questions and WOMAC function for knees and hips) were similar to the constructs of the FAOS subscales, but there were differences (e.g., WOMAC function was for knees and hips and not feet or ankles) that limited our ability to rigorously test the construct validity, possibly contributing to moderate correlation coefficients. Considering these differences in construct, the FAOS subscales appear to reflect their intended concepts. A comparable quality of life measure was not available in the existing JoCo OA data, and accordingly, convergent validity of the QOL subscale could not be confirmed in this study.

Overall, a one factor solution for each FAOS subscale is appropriate in this sample, as reported in the original FAOS study (14), suggesting that each subscale represents a single, intended concept. In both studies, two items did not load on the first factor for a particular subscale, indicating they were not strongly related to the concept of interest, but these items differed for each study. Two pain items in the original study related to pain in non-weight bearing positions (sitting or lying or at night) loaded onto a second factor rather than being related to the same underlying factor of the other pain items, which the authors suggested may show that these positions are not problematic for patients after lateral ankle reconstruction. In the present study, two items from the other symptoms subscale related to range of motion (straightening and bending the foot/ankle fully) loaded onto a second factor, suggesting they were not strongly associated with the same concept as the other symptoms items. This subscale also had a lower internal consistency than the other subscales, which appeared to be driven by these two items. Administering the FAOS by trained interviewer rather than self-administration of the instrument may have contributed to confusion in

responding to these items in the present study. To prevent any variation in the way that questions were asked, the interviewers were instructed to read the items and responses as they were written and not offer further clarification, only repeating the question if the participant asked or did not understand. The two range of motion items are reversed in wording to reflect normal to abnormal range of motion, while answer options for the other 40 items range from lack to presence of adverse symptoms or disability. When viewed, responses for all 42 items progress from no pain or problems to extreme difficulty. When these responses are heard without visual information, participants may continue to answer these two items in a similar pattern to how they answered previous questions and may incorrectly state their ability to straighten or bend their foot or ankle. Observing the test-retest data for the 40 participants may provide some support for this hypothesis. Their responses to each item of the FAOS symptoms subscale stayed fairly constant across the two week period, shifting no more than a point or two, but for the two range of motion symptoms items (Symptoms Factor 2), responses reversed from one end of the response scale to the other (i.e., from “always” to “never” or from “never” to “always”) in 6 (15%) of the participants. It is unlikely that the participants truly experienced that dramatic of a change in these two symptoms items over two weeks, especially since their other symptoms remained relatively stable. Performance of this subscale may improve if interviewers alert participants to the difference in these items and the available answer options.

Important strengths of the present study are that it is community-based and includes a large sample of African American and Caucasian men and women 50+ years of age with data on foot, ankle, knee, hip, and low back symptoms and knee and hip OA. This allowed for comparisons of the performance of the FAOS across differing subgroups, and the results showed the consistency of the instrument. Furthermore, the sample included participants with a variety of foot and ankle conditions, as well as no pain and disorders, and this may support the generalization of the FAOS. This large study was well-powered to assess the properties of the FAOS in an observational study. A limitation is that this study did not ask the FAOS separately based on laterality (left and right), and data collected were based on the most affected foot and ankle. This may have minimized the strength of the correlation coefficients observed in the analysis of construct validity. In response to this limitation, during the latest wave of data collection (beginning 2013) in JoCo OA, the FAOS is being collected separately for the left and right sides. The FAOS was not asked separately for the foot and the ankle in this study because foot and ankle joints are not biomechanically independent, and subsequently, symptoms and dysfunction within this joint complex would both affect physical function and quality of life in a similar fashion. For the test-retest reliability study, symptoms may have varied depending on whether they were acute or chronic, and we do not have data to determine the chronicity of foot and ankle conditions in this study or in the parent study. Although the two week period was carefully selected to reduce recall of answers, symptoms may not have remained stable during this time and thus affected the ICCs.

In summary, the FAOS is a valid and reliable measure in this community-based OA study, although factor structure of one underlying concept was not replicated for the symptoms subscale (perhaps because of mode of administration of the questionnaire). These findings should be confirmed in other large, population-based observational studies, and future

research should determine whether interviewers alerting participants to the differences in the two range of motion symptoms items (Symptoms Factor 2) affects the internal consistency and factor structure of the FAOS symptoms subscale.

Acknowledgments

Funding: Golightly: Arthritis Foundation Postdoctoral Fellowship Award and National Center for Advancing Translational Sciences/ National Institutes of Health (NIH), through Grant KL2TR000084; Hannan/ Jordan: Framingham Foot Biomechanics Study, National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS) RO1 AR047853; Nelson: American College of Rheumatology-Research and Education Foundation Clinical Investigator Fellowship Award and NIH K23 AR061406; Jordan/Renner: Centers for Disease and Prevention Control /Association of Schools of Public Health S043, S3486.

We are grateful to the participants and staff of JoCo OA for their hard work and dedication to this research.

References

1. Benvenuti F, Ferrucci L, Guralnik JM, Gangemi S, Baroni A. Foot pain and disability in older persons: an epidemiologic survey. J Am Geriatri Soc. 1995; 43:479–84.
2. Bowling A, Grundy E. Activities of daily living: changes in functional ability in three samples of elderly and very elderly people. Age Ageing. 1997; 26:107–14. [PubMed: 9177667]
3. Golightly YM, Hannan MT, Shi XA, Helmick CG, Renner JB, JMJ. Association of foot symptoms with self-reported and performance-based measures of physical function: The Johnston County Osteoarthritis Project. Arthritis Care Res. 2011; 63(5):654–9.
4. Gorter KJ, Kuyvenhoven MM, DeMelker RA. Nontraumatic foot complaints in older people: a population-based survery of risk factors, mobility, and well-being. J Am Podiatr Med Assoc. 2000; 90:397–402. [PubMed: 11021051]
5. Keysor JJ, Dunn JE, Link CL, Badlissi F, Felson DT. Are foot disorders associated with functional limitation and disability among community-dwelling older adults? J Aging Health. 2005; 17:734–52. [PubMed: 16377770]
6. Leveille SG, Guralnik JM, Ferrucci L, Hirsch R, Simonsick E, Hochberg MC. Foot pain and disability in older women. Am J Epidemiol. 1998; 148:657–65. [PubMed: 9778172]
7. Menz HB, Morris ME. Determinants of disabling foot pain in retirement village residents. J Am Podiatr Med Assoc. 2005; 95:573–9. [PubMed: 16291849]
8. Menz HB, Tiedemann A, Kwan MMS, Plumb K, Lord SR. Foot pain in community-dwelling older people: an evaluation of the Manchester Foot Pain and Disability Index. Rheumatology. 2006; 45:863–7. [PubMed: 16449369]
9. Dunn JE, Link CL, Felson DT, Crincoli MG, Keysor JJ, McKinlay JB. Prevalence of foot and ankle conditions in a multiethnic community sample of older adults. Am J Epidemiol. 2004; 159:491–8. [PubMed: 14977645]
10. Adamson J, Ebrahim S, Dieppe P, Hunt K. Prevalence and risk factors for joint pain among men and women in the West of Scotland Twenty-07 study. Ann Rheum Dis. 2006; 65(4):520–4. [PubMed: 16126799]
11. McDaniel G, Renner JB, Sloane R, Kraus VB. Association of knee and ankle osteoarthritis with physical performance. Osteoarthritis Cartilage. 2011; 19(6):634–8. [PubMed: 21310252]
12. Garrow AP, Papageorgiou AC, Silman AJ, Thomas E, Jayson MIV, Macfarlane GJ. Development and validation of a questionnaire to assess disabling foot pain. Pain. 2000; 85:107–13. [PubMed: 10692609]
13. Hale SA, Hertel J. Reliability and sensitivity of the Foot and Ankle Disability Index in subjects with chronic ankle instability. J Athl Train. 2005; 40:35–40. [PubMed: 15902322]
14. Roos EM, Brandsson S, Karlsson J. Validation of the foot and ankle outcome score for ankle ligament reconstruction. Foot Ankle Int. 2001; 22:788–94. [PubMed: 11642530]
15. Rozzi SL, Lephart LM, Sterner R, Kuligowski L. Balance training for persons with functionally unstable ankles. J Orthop Sports Phys Ther. 1999; 29:478–86. [PubMed: 10444738]

16. Riskowski J, Hagedorn T, Hannan MT. Measures of foot function, foot health, and foot pain. Arthritis Care Res. 2011; 63(S11):S229–39.
17. Karatepe AG, Günaydin R, Kaya T, Karlibaş U, Özbek G. Validation of the Turkish version of the foot and ankle outcome score. Rheumatol Int. 2009; 30(2):169–73. [PubMed: 19370349]
18. Negahban H, Mazaheri M, Salavati M, Sohani SM, Askari M, Fanian H, et al. Reliability and validity of the foot and ankle outcome score: a validation study from Iran. Clin Rheumatol. 2010; 29(5):479–86. [PubMed: 20140474]
19. Chen L, Lyman S, Do H, Karlsson J, Adam SP, Young E, et al. Validation of foot and ankle outcome score for hallux valgus. Foot Ankle Int. 2012; 33(12):1145–55. [PubMed: 23199868]
20. van den Akker-Scheek ISA, Reininga IH, Stevens M. Reliability and validity of the Dutch version of the foot and ankle outcome score (FAOS). BMC Musculoskelet Disord. 2013; 14:183. [PubMed: 23758917]
21. Mani SBBH, Nair P, Chen L, Do HT, Lyman S, Deland JT, Ellis SJ. Validation of the Foot and Ankle Outcome Score in Adult Acquired Flatfoot Deformity. Foot Ankle Int. 2013 [Epub ahead of print].
22. Roos EM, Roos H, Ekdahl C, Lohmander LS. Knee injury and Osteoarthritis Outcome Score (KOOS) - validation of a Swedish version. Scand J Med Sci Sports. 1998; 8:439–48. [PubMed: 9863983]
23. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Knee Injury and Osteoarthritis Outcome Score (KOOS)--development of a self-administered outcome measure. J Orthop Sports Phys Ther. 1998; 28:88–96. [PubMed: 9699158]
24. Roos EM, Lohmander LS. The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. Health Qual Life Outcomes. 2003; 1:64. [PubMed: 14613558]
25. Nilsdotter AK, Lohmander LS, Klassbo M, Roos EM. Hip disability and osteoarthritis outcome score (HOOS)--validity and responsiveness in total hip replacement. BMC Muculoskelet Disord. 2003; 4:10.
26. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol. 1988; 15:1833–40. [PubMed: 3068365]
27. Guadgnoli E, Velicer WF. Relation of sample size to the stability of component patterns. Psychol Bull. 1988; 103(2):265–75. [PubMed: 3363047]
28. Tabachnick, BG.; Fidell, LS. Using multivariate statistics. 5. Boston: Allyn and Bacon; 2007.
29. Golightly YM, Hannan MT, Dufour AB, Jordan JM. Racial differences in foot disorders and foot type. Arthritis Care Res. 2012; 64(11):1756–9.
30. Dunbar MJ, Robertsson O, Ryd L, Lindgren L. Appropriate questionnaires for knee arthroplasty: results of a survey of 360 patients from the Swedish knee arthroplasty registry. J Bone Joint Surg Am. 2001; 83:339–44.
31. McConnell S, Kolopack P, Davis AM. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): a review of its utility and measurement properties. Arthritis Rheum. 2001; 45(5):453–61. [PubMed: 11642645]
32. Brazier JE, Harper R, Munro J, Walters SJ, Snaith ML. Generic and condition-specific outcome measures for people with osteoarthritis of the knee. Rheumatology (Oxford). 1999; 38(9):870–7. [PubMed: 10515649]
33. Angst F, Ewert T, Lehmann S, Aeschlimann A, Stucki G. The factor subdimensions of the Western Ontario and McMaster Universityies Osteoarthritis Index (WOMAC) help to specify hip and knee osteoarthritis. A prospective evaluation and validation study. J Rheumatol. 2005; 32:1324–30. [PubMed: 15996072]
34. Wolfe F, Kong SX. Rasch analysis of the Western Ontario MacMaster questionnaire (WOMAC) in 2205 patients with osteoarthritis, rheumatoid arthritis, and fibromyalgia. Ann Rheum Dis. 1999; 58(9):563–8. [PubMed: 10460190]
35. Jordan JM, Helmick CG, Renner JB, Luta G, Dragomir AD, Woodard J, et al. Prevalence of knee symptoms and radiographic and symptomatic knee osteoarthritis in African Americans and

Caucasians: the Johnston County Osteoarthritis Project. J Rheumatol. 2007; 34(1):172–180. [PubMed: 17216685]

36. Jordan JM, Linder GF, Renner JB, Fryer JG. The impact of arthritis in rural populations. Arthritis Care Res. 1995; 8:242–250. [PubMed: 8605262]
37. Kellgren, JH.; Lawrence, JS. The epidemiology of chronic rheumatism, atlas of standard radiographs. Oxford: Blackwell Scientific; 1963.
38. Cronbach LJ. Coefficient alpha and the internal structure of tests. Pyschometrika. 1951; 16:297–333.
39. Gertsman, BB. Basic Biostatistics: Statistics for Public Health Practice. Sudbury, Canada: Jones & Bartlett; 2008.
40. DeVellis, RF. Scale Development: Theory and Applications. 2. Thousand Oakes, California: Sage Publications, Inc; 2003.

SIGNIFICANCE AND INNOVATIONS

- Foot- and ankle-related pain and disorders are common among adults 50 years of age and older, and they may be important risk factors for disability and falls.
- Valid and reliable measures of foot- and ankle-related symptoms and physical function are needed in large observational studies aimed at understanding pain and disorders of the foot and ankle.
- The Foot and Ankle Outcome Score (FAOS) demonstrates acceptable reliability and validity in a large cohort of adults 50+ years old without differences in psychometric properties by age, race, gender, obesity, knee/hip osteoarthritis status, or pain status of the low back, hip, and knee.

Arthritis Care Res (Hoboken). Author manuscript; available in PMC 2015 March 01.

Table 1

Sample Characteristics of Sample (N=1670)

	n/N	%
African American:	521/1670	31.2
Women:	1129/1670	67.6
Age		
50–65 years:	678/1670	40.6
65–95 years:	992/1670	59.4
BMI		
13–25 kg/m^2:	252/1658	15.2
25–30:	545/1658	32.9
30–78:	861/1658	51.9
Knee Symptoms:	651/1644	39.6
Hip Symptoms:	495/1644	30.1
Low Back Symptoms:	598/1449	41.3
Knee Osteoarthritis:	712/1578	45.1
Hip Osteoarthritis:	646/1594	40.5

	Mean (SD)	Median (range)
FAOS Subscale Scores [*]:		
Pain (n=1641):	86 (20)	97 (8–100)
Symptoms (n=1670):	87 (16)	93 (7–100)
ADL [†] (n=1609):	95 (10)	100 (48–100)
Sports/Rec [‡] (n=1454):	74 (34)	95 (0–100)
QOL [§] (n=1632):	83 (23)	100 (0–100)

[*] Score of 100 indicates no problems and 0 indicates extreme problems. Scores for each subscale were calculated using imputed values in cases where one or two values were missing on a given subscale.

[†] Activities of Daily Living

[‡] Sports and Recreational Function

[§] Foot and Ankle-Related Quality of Life

Table 2

Factor scores (Eigenvalues*) and internal consistency (Cronbach's alpha) of FAOS Subscales in whole sample and across subgroups.

Subscale	Factor	Number of Items	Eigenvalues		Cronbach's Alpha	
			Whole Sample	Across Subgroups (range)	Whole Sample	Across Subgroups (range)
Pain	1	9	6.9	6.5–7.1	0.96	0.95–0.97
Symptoms	1	5	3.0	2.6–3.2	0.81	0.76–0.82
	2†	2	1.9	1.8–2.1	0.88	0.83–0.90
ADL	1	17	12.5	11.4–12.9	0.98	0.97–0.98
Sport/Recreation	1	5	4.3	4.1–4.4	0.96	0.94–0.96
QOL	1	4	3.2	3.0–3.2	0.91	0.89–0.92

*Proportion of total information within a factor =eigenvalue / sum of item variances

†Two range of motion items: S4. Can you straighten your foot/ankle fully? and S5. Can you bend your foot/ankle fully?

Table 3

Convergent validity of FAOS subscales (Spearman's correlation coefficients).

Comparison Measure	Subscale	Whole Sample*	Across Subgroups (range)*
Foot Symptoms	Pain	0.49	0.39–0.52
	Other Symptoms	0.37	0.24–0.45
Ankle Symptoms	Pain	0.41	0.26–0.45
	Other Symptoms	0.37	0.26–0.43
WOMAC† Function Subscale	ADL	0.52	0.36–0.55
	Sport/Recreation	0.45	0.30–0.49

*All correlation coefficients $p<0.001$.

†WOMAC=Western Ontario & McMaster Universities Osteoarthritis Index

Table 4

Loadings of individual items by FAOS subscale for whole sample.

Subscale	Item	Question						Factor 1	Factor 2
Pain	P1	How often do you experience foot/ankle pain?	Never	Monthly	Weekly	Daily	Always	0.82	--
		What amount of foot/ankle pain have you experienced the last week during the following activities?							
	P2	Twisting/pivoting on foot/ankle?	None	Mild	Moderate	Severe	Extreme	0.88	--
	P3	Straightening foot/ankle fully?	None	Mild	Moderate	Severe	Extreme	0.89	--
	P4	Bending foot/ankle fully?	None	Mild	Moderate	Severe	Extreme	0.91	--
	P5	Walking on a flat surface?	None	Mild	Moderate	Severe	Extreme	0.88	--
	P6	Going up or down stairs?	None	Mild	Moderate	Severe	Extreme	0.91	--
	P7	At night while in bed?	None	Mild	Moderate	Severe	Extreme	0.83	--
	P8	Sitting or lying?	None	Mild	Moderate	Severe	Extreme	0.84	--
	P9	Standing upright?	None	Mild	Moderate	Severe	Extreme	0.91	--
Symptoms	S1	Do you have swelling in your foot/ankle?	Never	Rarely	Sometimes	Often	Always	0.66	0.12
	S2	Do you feel grinding, hear clicking or any other type of noise when your foot/ankle moves?	Never	Rarely	Sometimes	Often	Always	0.67	0.12
	S3	Does your foot/ankle catch or hang up when moving?	Never	Rarely	Sometimes	Often	Always	0.74	0.20
	S4	Can you straighten your foot/ankle fully?	Always	Often	Sometimes	Rarely	Never	0.21	0.94
	S5	Can you bend your foot/ankle fully?	Always	Often	Sometimes	Rarely	Never	0.22	0.94
	S6	How severe is your foot/ankle stiffness after first waking in the morning?	None	Mild	Moderate	Severe	Extreme	0.85	0.21
	S7	How severe is your foot/ankle stiffness after sitting, lying, or resting later in the day?	None	Mild	Moderate	Severe	Extreme	0.85	0.22
ADL *		*For each of the following activities please indicate the degree of difficulty you have experienced in the last week due to your foot/ankle.*							
	A1	Descending stairs?	None	Mild	Moderate	Severe	Extreme	0.89	--
	A2	Ascending stairs?	None	Mild	Moderate	Severe	Extreme	0.90	--
	A3	Rising from sitting?	None	Mild	Moderate	Severe	Extreme	0.92	--
	A4	Standing?	None	Mild	Moderate	Severe	Extreme	0.89	--
	A5	Bending to floor/pick up an object?	None	Mild	Moderate	Severe	Extreme	0.90	--

Subscale	Item	Question						Factor 1	Factor 2
	A6	Walking on a flat surface?	None	Mild	Moderate	Severe	Extreme	0.89	--
	A7	Getting in/out of car?	None	Mild	Moderate	Severe	Extreme	0.92	--
	A9	Putting on socks/stockings?	None	Mild	Moderate	Severe	Extreme	0.89	--
	A10	Rising from bed?	None	Mild	Moderate	Severe	Extreme	0.90	--
	A11	Taking off socks/stockings?	None	Mild	Moderate	Severe	Extreme	0.89	--
	A12	Lying in bed (turning over, maintaining hip position)?	None	Mild	Moderate	Severe	Extreme	0.86	--
	A13	Getting in/out of bath?	None	Mild	Moderate	Severe	Extreme	0.86	--
	A14	Sitting?	None	Mild	Moderate	Severe	Extreme	0.85	--
	A15	Getting on/off toilet?	None	Mild	Moderate	Severe	Extreme	0.85	--
	A16	Heavy domestic duties?	None	Mild	Moderate	Severe	Extreme	0.83	--
	A17	Light domestic duties?	None	Mild	Moderate	Severe	Extreme	0.88	--
Sport/Recreation†	*The questions should be answered thinking of what degree of difficulty you have experienced during the last week due to your foot/ankle.*								
	SP1	Squatting?	None	Mild	Moderate	Severe	Extreme	0.94	--
	SP2	Running?	None	Mild	Moderate	Severe	Extreme	0.95	--
	SP3	Jumping?	None	Mild	Moderate	Severe	Extreme	0.94	--
	SP4	Twisting/pivoting on your injured foot/ankle?	None	Mild	Moderate	Severe	Extreme	0.86	--
	SP5	Kneeling?	None	Mild	Moderate	Severe	Extreme	0.92	--
QOL‡	Q1	How often are you aware of your foot/ankle problem?	Never	Monthly	Weekly	Daily	Constantly	0.90	--
	Q2	Have you modified your life style to avoid potentially damaging activities to your foot/ankle?	Not at all	Mildly	Moderately	Severely	Totally	0.83	--
	Q3	How much are you troubled with lack of confidence in your foot/ ankle?	Not at all	Mildly	Moderately	Severely	Extremely	0.90	--
	Q4	In general, how much difficulty do you have with your foot/ankle?	None	Mild	Moderate	Severe	Extreme	0.94	--

*Activities of Daily Living

†Sports and Recreation Function

‡Foot and Ankle-Related Quality of Life

Arthritis Care Res (Hoboken). Author manuscript; available in PMC 2015 March 01.