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# Foot and Ankle Outcome Score (FAOS): Reference Values From a National Representative Sample

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## Abstract

**Background:** The Foot and Ankle Outcome Score (FAOS) is widely used in clinical practice and research. However, FAOS reference values are missing to aid interpretation. This study aimed to establish national record-based reference values for the FAOS.

**Methods:** A national representative sample of 9996 adult Danish citizens was derived from the Danish Civil Registration System. The FAOS questionnaire was sent to all participants, including 2 supplemental questions regarding previous foot and ankle problems and body mass index (BMI). A threshold of 10 FAOS points was predefined as a clinically relevant difference across all 5 subscales.

**Results:** A total of 2759 participants completed the FAOS. Mean age of participants was 60.5 years, and 51% were women. The mean FAOS subscale scores were as follows: pain, 87.1 (95% CI 86.4–87.8); symptoms, 85.1 (95% CI 84.5–85.8); activity of daily living (ADL), 88.9 (95% CI 88.2–89.6); sport and recreation function 78.5 (95% CI 77.4–79.6); and quality of life (QOL), 79.9 (95% CI 79.0–80.9). The mean difference between men and women was small and not clinically relevant (ranged from 0.9 in ADL to 3.4 in QOL). The largest differences in mean scores between age groups ranged from 4.3 in symptoms to 16.4 in sport/rec. Except for the subscale sport/rec, all age-related differences were below the predefined threshold of 10 for clinical relevance. The difference in mean subscale scores between the lowest BMI group (<24.7) and the obese group (>30) ranged from 19.6 in ADL to 39.1 in sport/rec.

**Conclusion:** We found in our population that BMI severely impacted FAOS scores. We recommend using BMI-specific reference FAOS values. Separate FAOS reference values for men and women appear not needed. Stratifying reference values for age is likely not needed except for the subscale sport and recreation function.

**Level of evidence:** Level III, cohort study.

**Keywords:** FAOS, foot, ankle, reference data, normative data

## Introduction

General and body region-specific patient-reported instruments have become a central part of investigating outcomes of foot and ankle disorders in both clinical practice and research.<sup>7,11</sup>

In orthopaedic foot and ankle clinical practice, the use of body-region specific patient-reported outcome instruments are widely used to capture the baseline status of a patient and to describe the change in patient-reported status following treatment.<sup>7</sup> Foot and ankle specific patient-reported

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instruments tend to be more sensitive to capture the status of a foot and ankle complaint compared to the more general patient-reported instruments.<sup>20</sup>

The Foot and Ankle Outcome Score (FAOS) is a body-region specific patient-reported questionnaire developed in 2003. The aim of FAOS is to assess the patients' own perception of their foot- and ankle-related problems.<sup>3</sup> The psychometric properties of the FAOS have demonstrated high validity, reliability, and responsiveness.<sup>5,8</sup>

FAOS is commonly used in clinical practice to capture the patient-reported status of a patient and as a research instrument investigating the foot- and ankle-specific change to surgical or nonsurgical treatment.<sup>15,21</sup> The FAOS is one of the most used patient-report instruments in the foot and ankle literature and is the preferred instrument of many orthopaedic surgeons.<sup>21</sup> Despite the common use, there are still no large population-based reference data set to allow for a comparison and aid interpretation of the scores. Such reference values would offer a much-needed reference for clinicians to discuss posttreatment outcomes that may be dependent on patient characteristics.<sup>10</sup>

This study aimed to establish national record-based reference values for the 5 subscales of FAOS (pain, symptoms, activity of daily living [ADL], function in sport and recreation (sport/rec), and quality of life [QOL]), based on a randomly selected national sample of adults across age and sex strata.

## Methods

### Study Design

The study design was a national record-based cohort study establishing reference values for the FAOS.

The Danish Data Protection Agency approved the study (J. nr. 2021 Id: 114). The reporting of the study complies with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.<sup>19</sup>

### Data Retrieval

At birth or immigration to Denmark, a Civil Registration Number (CPR) is given to all residents and registered in the Civil Registration System. Prospective information regarding emigration and death is recorded in this registry.<sup>9</sup> The Civil Registration System includes individual information of the complete population of Denmark.<sup>9</sup>

Participants were invited to participate in the study using the online mailing system E-boks. E-boks is mandatory for almost all adult Danish citizens and is connected to the Civil Registration System. The invitation includes an online link to the FAOS questionnaire and contact information for the research group for questions. After finishing the FAOS questionnaire, participants were asked to submit their height

and weight. Furthermore, 1 supplemental question was asked: Within the last 5 years, have you been in contact with a health professional because of a foot or ankle problem? Answer: yes/no.

In case of no response within 14 days, participants received a second and final request by E-boks.

### Study Population

A representative sample of 9996 citizens of Denmark over the age of 18 years was derived from the Danish Civil Registration System. The population of Denmark constituted 5.8 million citizens by 2022. Excluded were all participants without online contact information (E-boks) (Figure 1).

The sample was selected based on 7 predefined age groups (18-29, 30-39, 40-49, 50-59, 60-69, 70-79,  $\geq 80$ ) and an equal sex distribution across the 7 predefined age groups.

Based on an expected response rate of 30%, a sample of 9996 citizens was included to allow adequate power for subgroup analyses based on both age and sex.

### Foot and Ankle Outcome Score

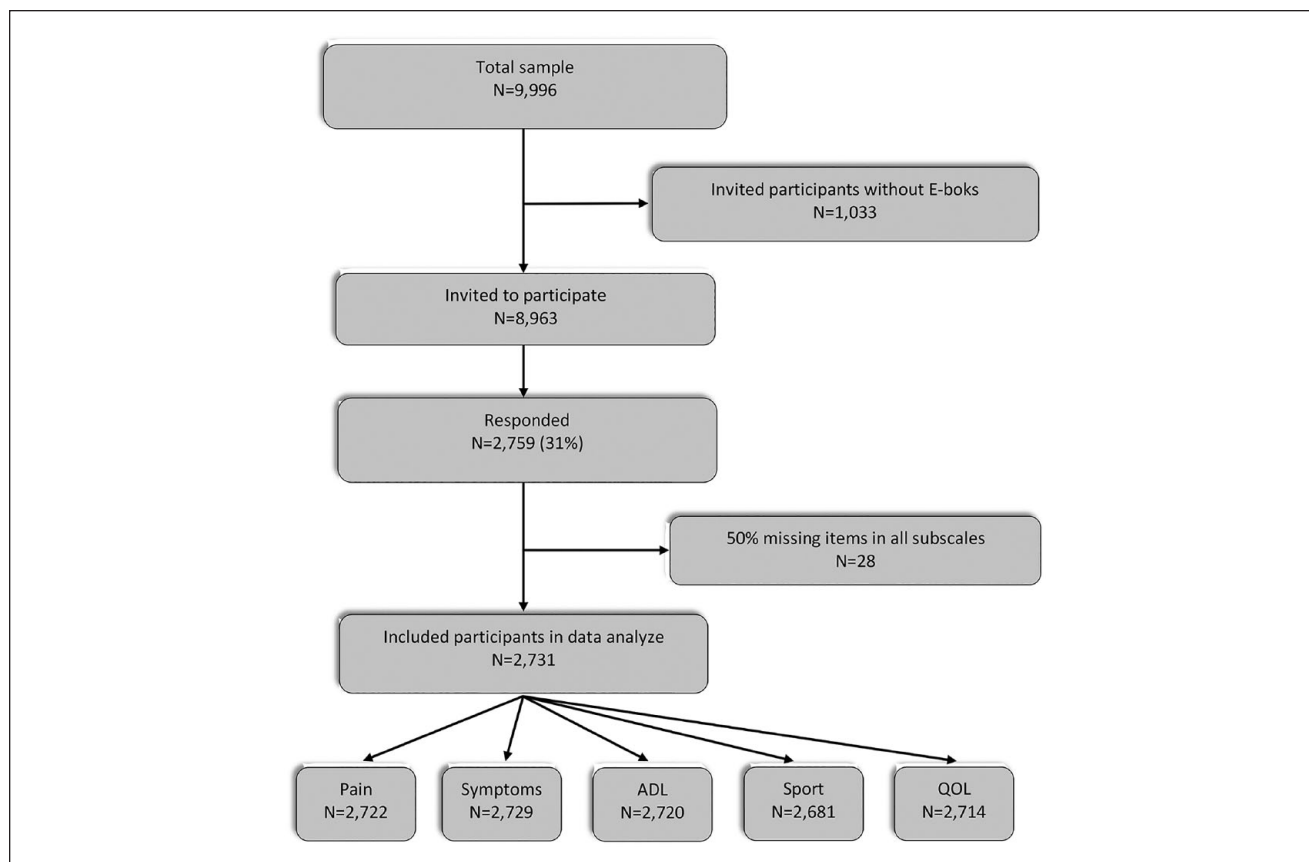
The FAOS is a patient-reported foot- and ankle-specific questionnaire including 42 items in 5 subscales evaluating pain, symptoms, function of daily living (ADL), function in sport and recreation (sport/rec), and quality of life (QOL).<sup>3</sup> At present, the FAOS is available in 20 languages.<sup>3</sup> The outcome of FAOS is calculated based on a standardized scoring algorithm given a score between 0 and 100 for each of the 5 subscales. A score of 100 indicates the best possible results and 0 the worst outcome. The FAOS is freely available for academic users at <https://eprovide.mapi-trust.org>.

### Statistical Analysis

The FAOS outcomes were given as mean, median, SD, 95% CIs, minimum, maximum, and number in each age group. If the number of missing values in the FAOS items were more than 50% in each subscale, the result of the subscale was omitted, in accordance with the FAOS scoring manual.<sup>3</sup>

Continuous variables are reported by mean and SD, and categorical variables by frequencies. A 2-way analysis of variance (ANOVA) was used to analyze difference between predefined age groups and sex. If significant ANOVA factors or interactions were found, multiple pairwise analyses with post hoc test (Bonferroni) corrections were used.

One-way ANOVA was used to analyze difference between FAOS subscale scores and reporting of foot or ankle problems (yes/no) and between body mass index (BMI) groups (18-24.9, 25-29.9, 30-34.9, 35-39.9, 40-44.9, and  $>45$ ), where BMI  $>30$  indicates obesity. If significant ANOVA factor was found, multiple pairwise analyses with post hoc test (Bonferroni) corrections were used.



**Figure 1.** Detailed flow of the study. N, number.

Response vs nonresponse was tested regarding age by the unpaired *t* test and sex by the  $\chi^2$  test. A *P* value of  $<.05$  was considered significant. The statistical analysis was performed by Stata (version 27).

Thresholds for minimal clinically relevant improvement for the 5 FAOS subscales ranges from 5 to 22 points.<sup>2,8,16,17</sup> In this study, we considered a threshold of 10 for all FAOS subscales to represent the cutoff point for the analysis of clinical relevance, regardless of subscale.

## Results

A total of 9996 participants were included in the study population. Because of exemption from the E-boks system, 1033 participants were excluded. A total of 2759 participants completed the FAOS questionnaire (response rate 31%). A detailed study flow is presented in Figure 1.

### FAOS Subscale Scores

The FAOS subscale scores for the total sample and stratified by age and sex are given in Tables 1 and 2 and Figure 2.

### Patient-Reported Foot and Ankle Problems Within the Past 5 Years

Foot and ankle problems during the last 5 years were reported by 622 (23%) participants. The mean age of participants reporting a foot and ankle problem was 60.0 years, and 63% were women. These characteristics are similar to the total sample with a mean age of 60.5 years and 51% women.

Participants who reported a foot and ankle problem had worse FAOS mean subscale scores. The difference in mean subscale scores between participants with and without a patient-reported foot and ankle problem ranged from 15.4 in symptoms to 30.3 in QOL (Table 3).

### FAOS Subscale Scores Divided by Age and Sex

The age- and sex-specific mean subscale scores are given in Table 2 and Figure 2.

The sex-specific subscale scores showed only small differences between men and women, ranging from 0.9 in ADL to 3.4 in QOL (Figure 2). Differences between age group-specific mean subscale scores ranged from 4.3 in the

**Table 1.** FAOS Subscale Scores.

Score	FAOS Subscale				
	Pain	Symptoms	ADL	Sport/rec	QOL
Mean	87.1	85.1	88.9	78.5	79.9
SD	18.7	17.1	17.8	28.8	24.9
95% CI	86.4-87.8	84.5-85.8	88.2-89.6	77.4-79.6	79.0-80.9
Median	97	90	99	95	94
Min	6	5	4	0	0
Max	100	100	100	100	100
Number	2722	2729	2720	2681	2714

Abbreviations: ADL, activities of daily living; FAOS, Foot and Ankle Outcome Score; QOL, quality of life.

subscale symptoms between the age groups 30-39 years and 50-59 years to 16.4 in the subscale sport/rec between the age groups 30-39 years and  $\geq 80$  years (Table 2).

Considering the predefined threshold of 10 points for clinical relevance, a comparison between all the 5 subscales and age groups (21 groups compared) showed age-specific clinically relevant differences in mean scores in 3 of the 21 possible comparisons for the subscale sport/rec (Table 2).

### FAOS Subscale Scores Divided by BMI

The patient-reported BMI of participants was on average 26.6 ( $\pm 5.2$ ). Obese participants (reporting a BMI of  $\geq 30$ ) accounted for 19% (n=538). The mean age of obese participants was 59.2 years, and 56% were women compared to the total sample with a mean age of 60.5 years and 51% women.

The association between the predefined BMI groups and the mean FAOS subscale scores are presented in Table 4. Higher BMI scores were associated with lower (worse) FAOS subscale scores and was especially pronounced in the subscales pain, sport/rec, and QOL. The difference in mean subscale scores between the lowest BMI group ( $< 24.7$ ) and obese BMI groups ( $> 30$ ) ranged from 19.6 in ADL to 39.1 in sport/rec.

## Discussion

This study is the first to report national reference values for the widely used Foot and Ankle Outcome Score. Results indicated that FAOS mean subscale scores can be used without stratification for age and sex in most cases. However, the subscale sport/rec demonstrated clinically relevant age-dependent differences for 3 of 21 age group comparisons. Furthermore, obese patients (BMI  $> 30$ ) demonstrated clinically worse reference values for all the FAOS subscales, indicating the importance of considering BMI-stratified FAOS reference values when evaluating the subscale scores of obese patients in the clinic.

### Interpretation of Age and Sex

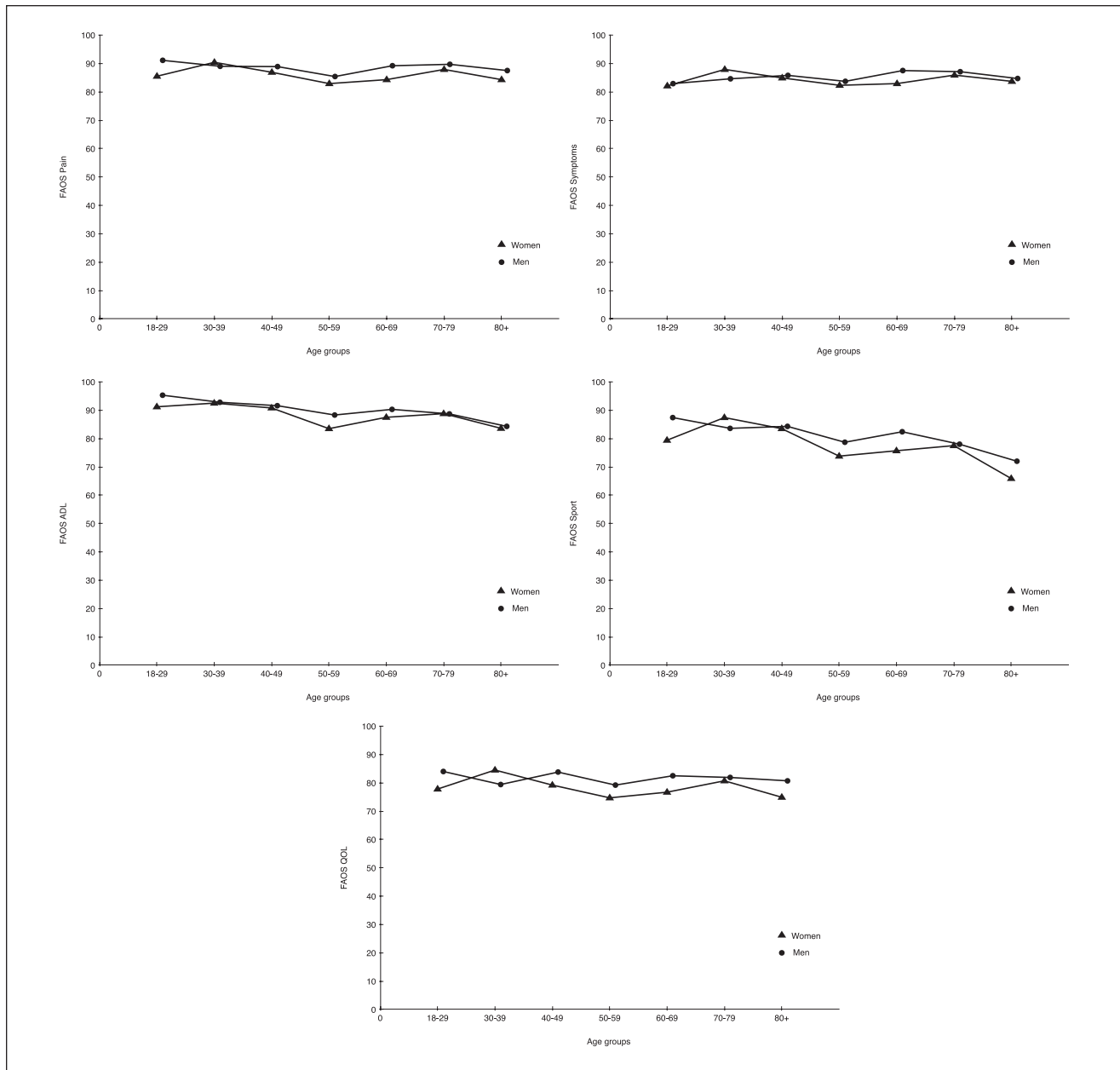
This study showed that women reported statistically significant worse FAOS scores compared with men in most subscales (pain, symptoms, sport/rec, and QOL). The mean difference across FAOS subscales between sex was small (ranged from 0.9 in ADL to 3.4 in QOL) and were below the threshold for clinically relevant difference. Results indicated that FAOS reference values stratified by sex are not needed. Also, statistically significant and small differences were observed between age strata. Except the subscale sport/rec with a maximum mean difference of 16.4, the difference in mean FAOS subscale scores between age strata were small ( $< 8.7$ ) and are unlikely to be important. However, younger age groups evaluated on their ability to perform competitive sports may warrant the use of age appropriate FAOS sport/rec reference values.

This study is the first to report reference values for the FAOS subscale scores. Reference values for other foot and ankle patient-reported instruments have previously been established, and reported comparable results to the present study, with statistically significant and generally small differences between age and sex.<sup>1,13,14</sup>

### Interpretation of BMI

Patient-reported obesity (BMI  $> 30$ ) accounts for 19% of participants in the study population. Higher BMI scores were associated with lower (worse) FAOS subscale scores and were especially pronounced in the subscales pain, sport/rec, and QOL. The mean FAOS subscale difference between the lowest BMI group ( $< 24.7$ ) and the obese BMI groups ( $> 30$ ) ranged from 19.6 in ADL to 39.1 in sport/rec. Considering the predefined threshold of 10 for clinical relevance, our results indicated the importance of considering FAOS reference values stratified by BMI in the interpretation of subscale scores. Such a marked difference between BMI groups is likely multifactorial. FAOS subscales pain, function, and QOL have all reported greater impairment in obese populations.<sup>4,6,18</sup>





**Figure 2.** FAOS subscale scores divided by age groups and sex.

**Table 3.** Mean Differences in FAOS Subscale Scores Between Patients With and Without Self-Reported Foot and Ankle Problems.

FAOS	Mean Difference	95% CI
Pain	20.2	18.7-21.7
Symptoms	15.4	13.9-16.8
ADL	15.8	14.4-17.3
Sport/rec	26.6	24.2-29.0
QOL	30.3	28.4-32.3

Abbreviations: ADL, activities of daily living; FAOS, Foot and Ankle Outcome Score; QOL, quality of life; Sport/rec, sport and recreation.

### How to Use FAOS Reference Values

The use of FAOS reference values in the clinic may help clinicians establish an expectation level for a specific foot and ankle condition or evaluate the outcomes of conservative or surgical treatment. Moreover, reference values may help to inform the patient of the upper limit of the expected improvement of a treatment and provide a common treatment goal. Age-specific reference values may be of clinical interest when, for example, treating a young active patient presenting with an ankle fracture, and BMI-stratified reference values may be of interest to indicate the expected

**Table 4.** FAOS Subscale Scores by BMI Groups.

BMI Groups	FAOS Pain				FAOS Symptoms				FAOS ADL			
	Mean	95%CI	SD	Number	Mean	95%CI	SD	Number	Mean	95%CI	SD	Number
18-24.9	91.3	90.4-92.2	14.8	1083	88.6	87.7-89.4	14.6	1085	93.3	92.5-94.1	13.3	1082
25-29.9	87.3	86.1-88.4	18.2	990	85.1	84.1-86.2	16.8	991	88.5	87.4-89.6	17.6	990
30-34.9	79.1	76.8-81.4	22.4	371	79.0	77.0-80.9	19.4	371	81.5	79.3-83.7	21.6	371
35-39.9	77.5	73.3-81.7	22.5	112	73.6	69.8-77.5	20.6	113	78.7	74.2-83.1	23.8	112
40-44.9	70.3	61.1-79.6	28.1	38	71.7	64.8-78.7	21.2	38	73.7	64.4-83.0	28.2	38
>45	73.0	56.5-89.6	28.6	14	65.0	49.7-80.4	27.7	15	77.8	61.9-93.7	27.5	14

BMI Groups	FAOS Sport/rec				FAOS QOL			
	Mean	95%CI	SD	Number	Mean	95%CI	SD	Number
18-24.9	85.7	84.3-87.1	22.8	1069	85.5	84.3-86.7	20.7	1081
25-29.9	78.2	76.4-80.0	28.4	982	79.4	77.8-80.9	24.7	990
30-34.9	66.2	62.7-69.6	33.5	365	69.9	67.0-72.9	29.2	370
35-39.9	65.8	59.1-72.4	35.3	110	66.9	61.5-72.3	28.9	112
40-44.9	55.5	43.2-67.9	37.6	38	60.5	50.0-71.0	32.0	38
>45	46.5	23.3-69.8	28.7	13	61.5	42.9-80.2	25.0	13

Abbreviations: BMI, body mass index; ADL, activities of daily living; FAOS, Foot and Ankle Outcome Score; QOL, quality of life; Sport/rec, sport and recreation.

improvement for an obese patient having ankle fusion. Moreover, FAOS reference values are also usable when applied to groups of patients in orthopaedic foot and ankle research. Considering FAOS as the primary outcome in a future randomized controlled study, reference values may support the sample size estimations by indicating expected mean subscale scores and SDs.

### Strength and limitations

The strength of the present study is the inclusion of a national and randomly selected age and sex representative sample of more than 2700 citizens, to establish the first available reference material for the FAOS. We considered a predefined threshold of 10 points for a clinically relevant difference. However, it is well known that the minimal clinically relevant difference varies between foot and ankle disorders, and our cutoff should be interpreted with care. Specific population or conditions may need specific age- and sex-stratified reference values.<sup>2,8,12,16,17</sup> Moreover, national reference values may be of limited use in other countries. Another limitation may be the response rate of 31%. However, no statistically significant difference was observed in age and sex between responders and nonresponders ( $P < .001$ ), reducing the risk of selection bias.

### Conclusion

We report national age- and sex-representative reference values of the Foot and Ankle Outcome Score (FAOS). Our results suggest that FAOS reference values stratified by

sex are not needed. Except for the subscale sport/rec, FAOS reference values stratified by age are unlikely to be of clinical relevance. However, stratifying FAOS reference values by BMI is recommended based on a study of our population.

### Ethical Approval

This is a register-based study. The local Research Ethics Committee has confirmed that no ethical approval is required.

### Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. ICMJE forms for all authors are available online.

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