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# Normative data of the Visual Analogue Scale Foot and Ankle (VAS FA) for pathological conditions

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ARTICLE INFO	A B S T R A C T
Article history: Received 21 January 2010 Received in revised form 7 April 2010 Accepted 4 May 2010	Background: The purpose of this study was to analyze the Visual Analogue Scale Foot and Ankle (VAS FA) in patients to obtain normative data for pathological conditions. Methods: The VAS FA was consecutively obtained in a foot and ankle outpatient clinic. The score results were categorized into different pathological foot and ankle conditions.
Keywords: Visual Analogue Scale Foot and Ankle (VAS FA) Normative data Standard Validation Outcome assessment	<i>Results:</i> 414 patients were evaluated. Overall scores and score categories of all pathology groups differed from non-pathological data ( $n = 121$ ). Within the different groups, no score differences occurred. Score standards were defined for these groups with sufficient statistical power (>.8): isolated Hallux valgus, Hallux valgus and claw toes, forefoot other pathology, midfoot other pathology, hindfoot pathology and ankle deformity. No standards were defined for other pathology groups. <i>Conclusions:</i> The obtained data is normative for different pathological conditions of the earlier validated VAS FA. The obtained data is normative for different pathological conditions of the earlier validated FA. This data could serve as a basis for assessment patient scoring before, during and after treatment
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#### 1. Introduction

The Visual Analogue Scale Foot and Ankle Surgery (VAS FA) has recently been validated on healthy subjects [1]. However, normative data of the validated VAS FA for *pathological* conditions have been missing so far [2–6]. The only validated score for *different pathological* conditions is the Short Form 36 (SF 36) which is not foot and ankle specific [7,8]. As far as we know, specific data for *different* foot and ankle pathologies have not been defined with any scoring system so far despite several efforts [5,6,9–11]. The purpose of this study was to analyze the VAS FA in patients to obtain normative validated foot and ankle specific data for pathologic conditions. This data may serve as a basis for more specific assessment than with the SF36. We hypothesized that different pathological foot and ankle conditions show different scores and score categories.

#### 2. Methods

The VAS FA was obtained consecutively from patients of a foot and ankle outpatient clinic. The score results were categorized into

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*E-mail address:* martinus.richter@klinikum-coburg.de (M. Richter). *URL:* http://www.fusschirurgie-coburg.de different pathologic foot and ankle conditions and further analyzed (see below).

#### 2.1. Visual Analogue Scale Foot and Ankle (VAS FA) [1]

The Visual Analogue Scale Foot and Ankle with the following features was used: a questionnaire based on 20 questions requiring purely subjective answers; three different question categories (pain, n = 4 questions; function, n = 11; other complaints n = 5); Visual Analogue Scale (VAS) based rating; computerized evaluation. For each question a VAS-value from 0 to 100 points is possible. The total value for the entire score (all 20 questions answered) is therefore 0-2000 points. This total value is then divided by 20, resulting in a possible total score ranging from 0 to 100 points. To obtain the result from the single categories the total values from the category questions are divided by the number of questions (function, 11; pain, 4; other complaints, 5). The different number of questions for the categories was determined to consider function, pain and other complaints with various importances. Since more questions are included for function (n = 11) than for pain (n = 4)and other complaints (n = 5), function is weighed higher for the final score than pain or other complaints.

In case of missing answers, the results of the entire score or the categories can still be obtained by dividing the total point value by the number of remaining questions. Whether, for example, one question is missing in each category (pain, function, other

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complaints), the total value of the 17 remaining questions (ranging from 0 to 1700 points) is divided by 17 to obtain the entire score. For the categories (pain, function, other complaints), the total category values of the remaining 3/10/4 questions is divided by 3/10/4 to obtain the score category results.

The German score version was used for this study.

The score was evaluated by hand and computerized. The method by hand was performed with a transparent template that was placed on the score form and allowed a reading of the point values of the single questions. The values were then entered into a personal computer using a spreadsheet based (Excel<sup>TM</sup>, Microsoft Inc.) result-calculation instrument which enabled a calculation of the entire score result and the category results.

#### 2.2. Inclusion criteria

All patients from a foot and ankle outpatient clinic irrespective their diagnosis and their treatment between September 1, 2006 and August 31, 2009 were included.

#### 2.3. Exclusion criteria

Patients without pathological foot and/or ankle condition were excluded. Patients with missing answers were excluded from the further evaluation.

#### 2.4. Study protocol

After the patient had arrived at the foot and ankle clinic, a secretary handed over the VAS FA. The patient completed the form in the waiting area. The sheets were then collected by the secretary after the assessment by the foot and ankle surgeons (JS, SZ, MR). The analysis of the scores including the different score categories were performed with the described computerized method by one of the authors (JS). Under consideration of the earlier approved intra- and interobserver reliability, only one investigator analyzed the scores [1].

#### 2.5. Grouping

The patients were grouped as follows:

- forefoot/isolated Hallux valgus,
- forefoot Hallux valgus and claw toes,
- forefoot others,
- midfoot deformity,
- midfoot others,
- hindfoot varus deformity,
- hindfoot valgus deformity,
- hindfoot others,
- ankle deformity,
- ankle instability,
- flatfoot,
- cavus foot,
- other pathology.

The grouping was performed by the foot and ankle surgeons (JS, SZ, MR) who assessed the patients in the foot and ankle clinic. One single surgeon defined the grouping for each patient. The inter- or intraobserver reliability of the grouping was not analyzed. 121 subjects from an earlier study without pathology served as control group [1].

#### 2.6. Statistical analysis

The VAS FA and demographic data were analyzed and compared between groups (One-way ANOVA and Post Hoc Scheffe test). Before the ANOVA test, the distribution of the data was checked and normal distribution for all tested groups was confirmed. The definition of a standard was considered to be possible if no statistical differences within one group was found (one sample *t*-test with confidence interval 95% and the average value as test value, p > 0.05), and if the power of this special analysis was adequate (>0.8). The score standard was defined as the range between mean value minus standard deviation and mean value plus standard deviation. This range could not exceed 100 points by definition.

#### 3. Results

422 patients were initially included. In 8 cases (2%), less than 20 questions were answered, and these patients were excluded from the further evaluation. The FAS FA was completely answered in 414 cases (98.1%). In 20 of those cases (4.8%), words were additionally written on the VAS FA sheet, and these words were ignored for the further evaluation.

The mean age of the 414 further evaluated cases was 51.6 years ( $\pm$ 15.6), 147 (35.5%) were male and 267 (64.5%) were female. The average scores of the entire group were as follows: overall 55.0 ( $\pm$ 21.6), pain 45.5 ( $\pm$ 25.9), function 56.9 ( $\pm$ 24.6) and other complaints 58.9 ( $\pm$ 23.7).

#### 3.1. Groups

The patients were grouped as follows: isolated Hallux valgus, n = 80 (19.3%); Hallux valgus with claw toes, n = 46 (11.1%); forefoot others, n = 58 (14.0%); midfoot deformity, n = 9 (2.2%); midfoot others, n = 42 (10.1%); hindfoot others, n = 54 (13.0%); ankle deformity, n = 68 (16.4%); ankle instability, n = 8 (1.9%); flatfoot, n = 11 (2.7%); cavus foot, n = 15 (3.6%), other pathology, n = 23 (5.6%). The control group comprised 121 cases (mean age, 31.4 years (±10.4), 63 (52.1%) were male, 58 (47.9%) were female). No patients were assigned to groups hindfoot varus or hindfoot valgus. Table 1 shows score results of the different groups, and Fig. 1a–d boxplots of the scores of the different groups.

#### 3.2. Statistical analysis

#### 3.2.1. Demographic data

Age and gender differed between groups overall (One-way ANOVA each p < .001). The Post Hoc Scheffe test showed age differences between the control group and all pathology groups (each p < .05) except ankle instability, flatfoot and cavus foot but no age differences between pathology groups. The Post Hoc Scheffe test showed gender differences between all groups (each p < .05).

#### 3.2.2. Scores

The scores and score categories differed between all groups (One-way ANOVA each p < .001). Table 2 shows the results of the Post Hoc Scheffe test of the score differences. Overall scores, pain and function categories differed between control group and all pathology groups (each p < .05). Other complaints category did not differ between control group and all pathology groups except ankle deformity, flatfoot, cavus foot and other pathology (each  $p \ge .05$ ). The overall scores and all score categories did not differ between different pathology groups (each  $p \ge .05$ ).

When grouping groups into forefoot (groups isolated Hallux valgus, Hallux valgus with claw toes, forefoot others, n = 184), midfoot (groups midfoot deformity, midfoot others, n = 51), ankle/ hindfoot (groups hindfoot others, ankle deformity, ankle instability, n = 130) and other pathology (groups flatfoot, cavus foot, other pathology, n = 49), the scores and score categories differed between all groups (One-way ANOVA each p < .001). The Post Hoc Scheffe test of the score differences showed differences

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#### Table 1

VAS FA for different pathology groups and control group, and defined standards. \* No standard definition because power of statistical analysis <.8 [1].

No pathology (Control group) n = 121         Overall score prine prine (finite complaints)         45.7 (finite complaints)         100.0 (finite complaints)         45.7 (finite complaints)         100.0 (finite complaints)         45.8 (finite complaints)         82.5 (finite complaints)         100.0 (finite complaints)         45.8 (finite complaints)         82.5 (finite complaints)         82.5 (finite complaints)         100.0 (finite complaints)         93.0 (finite complaints)         64.0 (finite complaints)         45.0 (finite complaints)         45.0 (finit	Pathology	Score category	Minimum	Maximum	Mean	Standard deviation	Defined standard
Pain Other complaints         Pain 33.1 0ther complaints         Pain 33.1 0000         Pion 33.1 0000         Pion 33.1 0000         Pion 35.4         Pion 33.1 0000         Pion 35.4         Pion 33.1 0000         Pion 35.4         Pion 32.1         Pion 35.4         Pion 35.4 <t< td=""><td>No pathology (Control group) <math>n = 121</math></td><td>Overall score</td><td>45.7</td><td>100.0</td><td>94.5</td><td>8.2</td><td>86.3-100</td></t<>	No pathology (Control group) $n = 121$	Overall score	45.7	100.0	94.5	8.2	86.3-100
Function         33.1         100         95.6         7.8         8.8         865-100           Isolated Hallux valgus n=80         Overall score         20.7         90.0         64.0         15.9         24.0         25.6           Hallux valgus and daw toes n=46         Overall score         3.8         97.1         57.6         7.8         21.2         24.6         28.0           Hallux valgus and daw toes n=46         Overall score         3.8         97.1         57.6         57.8         3.2         21.2         24.6         59.0           Forefoot other pathology n=58         Overall score         0         96.1         59.9         24.5         33.9-86.8           Midfoot deformity n=9         Pain         0         100.0         67.2         21.0         24.2         21.0         24.2         23.0-84.8           Midfoot deformity n=9         Pain         0         100.0         67.3         22.3         24.4         28.5         27.5         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7         28.7		Pain	46.0	100.0	92.5	10.1	82.4-100
Other complaints         35.4         90.0         75.6         7.4         682-830           Isolated Hallux valgus n=80         Pari ion         20 7         99.0         61.6         21 2         426.7.76.9           Pari ion         10.0         100.0         65.7         21.3         426.7.76.9           Hallux valgus and claw toes n=46         Overall score         38         97.1         75.6         23.8         33.9.81.4           Foreford other pathology n=58         Overall score         0         96.1         59.9         20.7         332.80.6           Foreford other pathology n=58         Overall score         0         96.1         59.9         20.7         332.80.6           Midfoot other pathology n=42         Overall score         0         99.1         23.3         26.4         7.9.85.0           Midfoot other pathology n=42         Overall score         0         99.2         53.3         26.4         7.9.85.0           Midfoot other pathology n=42         Overall score         0         99.5         53.8         21.5         22.3.78.85.0           Midfoot other pathology n=54         Overall score         13.3         7.64         7.62         3.9.8         7.64         7.62         3.9.8         7.6		Function	33.1	100.0	95.4	8.8	86.5-100
Isolated Hallux valgus n=80         Overall score Particion Function Particion Parti		Other complaints	35.4	80.0	75.6	7.4	68.2-83.0
Pain         0         998         518         251         267-769           Other complaints         9.0         100.0         67.5         19.7         46.6 = 85.0           Halux valus and daw toes n= 40         Overall score         3.8         97.1         56.7         23.8         33.9 = 14.4           Forefoot other pathology n=58         Overall score         0         96.1         59.9         20.7         22.6         33.9 = 6.8           Forefoot other pathology n=58         Overall score         0         95.1         53.3         24.7         28.6 = 7.8.1           Midfoot deformity n = 9         Overall score         0         99.2         61.4         23.6         73.9 = 8.0.6           Midfoot other pathology n = 42         Overall score         0         99.3         53.3         26.4         *           Midfoot other pathology n = 42         Overall score         0         99.3         53.3         26.4         *           Midfoot other pathology n = 42         Overall score         10.0         91.0         26.8         12.4         92.8         23.5         12.4         14.2 = 6.2         13.5         12.4         14.2 = 6.2         12.4         12.5         12.4         12.4         12.4	Isolated Hallux valgus $n = 80$	Overall score	20.7	99.0	64.0	18.9	45.0-82.9
Function         14.0         100.0         67.5         11.2         66.8-80.           Halux valgus and claw toes n=46         Overall score         3.8         97.1         57.6         23.8         33.9-81.4           Halux valgus and claw toes n=46         Overall score         3.8         97.1         57.6         23.8         33.9-81.4           Forefore other pathology n=58         Overall score         0         94.8         59.9         0.07         39.2-86.6           Pain         0         100.0         62.2         2.10         41.2-83.2           Midfoot other pathology n=58         Overall score         0         99.3         53.3         26.4         -*           Midfoot other pathology n=5         Overall score         0         99.5         5.2         94.4         -*         32.8         14.2-83.2         14.2-83.2           Midfoot other pathology n=42         Overall score         12.4         96.5         3.8         2.15         2.23-75.4           Midfoot other pathology n=54         Overall score         13.3         97.8         51.6         22.0         20.4         22.8-82.5         23.4         14.7-66.1         22.0         23.8-82.5         23.8         22.8         23.8         22.8	-	Pain	0	99.8	51.8	25.1	26.7-76.9
Other complaints         9.0         100.0         65.7         19.7         46.1-85.4           Hallux valgus and claw toes n=46         Overall score princion         3.8         97.1         57.6         22.8         32.0-81.4           Forefoot other pathology n=58         Overall score princion         0         96.1         99.9         20.7         32.8-86.8           Midfoot other complaints         0         99.2         61.4         22.6         37.9-86.8           Princion         0         99.2         61.4         22.6         37.9-86.8           Midfoot deformity n=9         Overall score princion         0         99.2         53.3         26.4         -2.8           Midfoot other pathology n=42         Overall score princion         0         99.5         52.9         34.4         -2.8		Function	14.0	100.0	67.8	21.2	46.6-89.0
Halux valgus and claw toes n=46       Overall score       3.8       97.1       7.76       23.8       332-814         Forefoot other pathology n=58       Other complaints       3.0       100.0       66.4       26.4       332-86.6         Forefoot other pathology n=58       Pain       0       96.1       59.9       20.7       32-80.6         Midfoot deformity n=9       Overall score       0       93.3       53.3       24.4       372-85.0         Midfoot other pathology n=58       Overall score       0       93.3       53.3       26.4       *         Midfoot deformity n=9       Overall score       100.0       95.5       22.9       34.4       *         Midfoot other pathology n=42       Overall score       12.4       96.5       53.8       21.5       32.7.6.6         Pain       0       95.5       24.8       34.4       *       36.6       12.9       39.5         Midfoot other pathology n=42       Overall score       7.0       100.0       66.1       22.0       39.5       32.9         Midfoot other pathology n=54       Overall score       13.3       97.8       52.6       17.9       34.7.70.5       34.7.62         Pain       0       97.8       1		Other complaints	9.0	100.0	65.7	19.7	46.1-85.4
Pain Other complaints         0         100.0         46.7         25.9         20.8-7.2.6           Forefoot other pathology n=58         Overall score Pain         0         96.1         59.9         20.7         39.2-80.6           Forefoot other pathology n=58         Overall score Pain         0         90.1         59.9         20.7         39.2-80.6           Midfoot deformity n=9         Overall score Pain         0         99.2         61.4         23.6         37.9-85.0           Midfoot other omplaints         0         99.3         53.3         26.4         *           Midfoot other pathology n=42         Overall score Pain         0         99.5         52.9         34.4           Midfoot other pathology n=42         Overall score Pain         0         100.0         46.8         28.3           Midfoot other pathology n=42         Overall score         13.3         97.8         32.6         17.9         34.7-70.5           Pain         0         100.0         46.1         22.0         39.5-83.6         14.7         24.9         30.5         25.6         17.9         34.7-70.5         17.9         34.7-70.5         17.9         34.7-70.5         17.9         34.7-70.5         17.9         34.7-70.5         1	Hallux valgus and claw toes $n=46$	Overall score	3.8	97.1	57.6	23.8	33.9-81.4
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Other complaints         0         1000         62.2         21.0         41.2-83.2           Midfoot deformity n=9         Oreall score Pain         0         93.5         52.9         54.4         *           Midfoot other pathology n=42         Overall score Pain         12.4         96.5         53.8         21.5         52.3-75.4           Midfoot other pathology n=42         Overall score         12.4         96.5         53.8         21.5         52.3-75.4           Midfoot other pathology n=42         Overall score         12.4         96.5         53.8         21.5         52.3-75.4           Midfoot other pathology n=54         Overall score         13.3         97.8         52.6         17.9         34.7-70.5           Pain         0         97.3         53.1         20.4         23.6-73.5         26.6-73.5           Other complaints         19.8         100.0         61.5         22.6         73.5         10.0         42.3         25.6         73.5         26.6-73.5         26.6-73.5         26.7         16.7-68.0         20.6-73.5         20.6         25.0         26.7         26.7         26.7         26.7         26.7         26.7         26.7         26.7         26.7         26.7         26.7<		Function	0	99.2	61.4	23.6	37.9-85.0
Midfoot deformity n=9         Overall score Pain         0         93.3         53.3         26.4         *           Midfoot other pathology n=42         Overall score Pain         12.4         96.5         53.8         21.5         32.3-75.4           Midfoot other pathology n=42         Overall score Pain         12.4         96.5         53.8         21.5         32.3-75.4           Midfoot other pathology n=54         Overall score         13.3         97.8         41.0         23.1         17.5-63.1           Pain         0         97.8         41.0         23.1         17.5-63.1         23.6-73.5           Function         0.8         97.8         41.0         23.1         17.5-64.1         23.6-73.5           Ankle deformity n=68         Overall score         7.5         100.0         49.0         21.9         27.1-70.9           Pain         2.3         100.0         45.0         24.9         30.0-73.9         25.6         7.9         16.7-68.0         26.6-72.9         27.1-70.9         16.7-68.0         26.6-72.9         27.1-70.9         16.7-68.0         26.6-72.9         21.6         7.6-72.9         25.0         24.9         30.0-73.9         25.0         25.6         25.9         21.9         20.6-73.9<		Other complaints	0	100.0	62.2	21.0	41.2-83.2
Pain Function         0 Function         995 0         52.9 83.0         34.4 28.3           Midfoot other pathology n=42         Overall score Function         12.4 0         96.5 0         53.8 46.8         21.5 22.3         32.3-75.4 22.4 29.8-82.5 20.0           Hindfoot other pathology n=54         Overall score Pain         13.3 0.7         97.8 97.8         52.6 41.0         17.9 22.0         34.7-66.2 29.8-82.5 20.0           Ankle deformity n=68         Overall score Function         13.3 9.7         97.8 41.0         23.1 20.4         23.6-73.5 21.0         34.7-70.5 21.0           Ankle deformity n=68         Overall score Function         7.5 0.0         100.0         49.0 49.0         21.9 22.5         27.1-70.9 27.6-76.2 24.9           Ankle instability n=8         Overall score Function         22.5 0.0         100.0         49.0 45.6         21.9 30.0-79.9         *           Flatfoot n=11         Overall score Pain         22.5 2.7         79.1 1.8         48.1 28.2         20.9 2.2         *           Cavus foot n=15         Overall score Pain         2.5 2.7         75.9 2.0         45.9 2.1         19.1 2.2         *           Other complaints         0         100.0         54.9 2.2         21.9 2.2         *         *           Cavus foot n=15         Overall score Pain	Midfoot deformity $n = 9$	Overall score	0	93.3	53.3	26.4	*
Function Other complaints         0         100.0 100.0         7.1 46.8         32.8 28.3           Midfoot other pathology n=42         Overall score Pain Other complaints         12.4 9.0         96.5 10.00         53.8 40.4         21.5 25.8         32.3-75.4 29.8           Hindfoot other pathology n=54         Overall score Pain         13.3 0.0         97.8 9.0         52.6 77.8         17.9 41.0         34.7-70.5 23.1           Ankle deformity n=68         Overall score Pain         7.5 0.0         19.8         100.0         49.0 61.5         21.0         40.5-82.5           Ankle instability n=8         Overall score Pain         7.5 0.0         19.8         100.0         49.0 49.2         22.6 2.6         25.6-72.9 30.0-79.9           Ankle instability n=8         Overall score Pain         2.2 10.0         7.7 10.0         48.1 42.7         24.1 24.1         *           Flatfoot n=11         Overall score Pain         2.1 2.1         76.2         40.8         17.8 17.3         *           Gauss foot n=15         Overall score Pain         2.1 2.1         76.2         40.8         17.8 17.3         *           Other complaints         2.7         79.1 10.0         45.9         19.1         *           Flatfoot n=11         Overall score Pain         2.1 2.1	·	Pain	0	99.5	52.9	34.4	
Other complaints         0         83.0         46.8         28.3           Midfoot other pathology n=42         Overall score Punction Other complaints         12.4         96.5         53.8         21.5         32.3-75.4           Pain         0         100.0         46.4         25.8         14.7-66.2         29.8-82.5           Other complaints         14.8         100.0         61.6         22.0         39.5-83.6           Hindfoot other pathology n=54         Overall score Pain         0         97.8         51.6         17.9         34.7-70.5           Pain         0         97.8         51.0         23.1         17.9-64.1         32.6-73.5           Other complaints         19.8         100.0         61.5         21.0         40.5-82.5           Ankle deformity n=68         Overall score         7.5         100.0         49.0         21.9         27.1-70.9           Pain         2.3         100.0         45.0         24.9         30.0-79.9         30.0-79.9           Ankle deformity n=68         Overall score         7.5         100.0         49.2         23.6         25.6-72.9           Other complaints         0         100.0         54.9         32.9         -         -		Function	0	100.0	57.1	32.8	
Midfoot other pathology $n=42$ Overall score Pain (12,4)12,4 96,596,5 53,821,5 21,532,3-75,4 32,3-82,5Hindfoot other pathology $n=54$ Overall score Pain (14,8)13,3 9,697,8 9,7352,6 31,117,9 22,134,7-70,5 32,3,1Ankle deformity $n=68$ Overall score Pain (14,7,7,6)7,5 19,6100,040,4 42,325,7 21,032,6-73,5 42,1Ankle deformity $n=68$ Overall score Pain (14,7,7,6)7,5 19,3100,049,0 42,325,7 21,016,7-86,0 21,9Ankle instability $n=8$ Overall score Pain (14,7,7,6)22,579,1 10,048,1 42,220,9 23,625,6-72,9 23,6Flatfoot $n=11$ Overall score Pain (14,7,7,1,7,2,7,7,4,1,4,2,2,3,2,4,2,4,1,4,2,2,3,2,4,3,4,4,2,3,4,4,2,3,4,4,2,3,4,4,3,4,4,2,3,4,4,4,3,4,4,3,4,4,3,4,4,4,3,4,4,4,4		Other complaints	0	83.0	46.8	28.3	
Pain Function Other complaints0100.040.425.8147-66.2Hindfoot other pathology $n=54$ Overall score Pain Other complaints13.397.852.617.934.7-70.5Hindfoot other pathology $n=54$ Overall score Pain Other complaints13.397.852.617.934.7-70.5Ankle deformity $n=68$ Overall score Pain Other complaints7.5100.049.021.927.1-70.9Ankle deformity $n=68$ Overall score Pain Pain Other complaints7.5100.049.021.927.1-70.9Ankle instability $n=8$ Overall score Pain Other complaints7.9100.042.325.716.7-68.0Ankle instability $n=8$ Overall score Pain Other complaints22.579.148.120.9*Ankle instability $n=8$ Overall score Pain Pain Other complaints22.579.148.120.9*Flatfoot $n=11$ Overall score Pain Other complaints22.176.240.817.8*Overall score Pain Other complaints27.792.043.228.2*Cavus foot $n=15$ Overall score Pain Other complaints75.945.919.1*Other complaints Other complaints27.775.945.919.1*Pain Function Other complaints9.171.333.919.7*Function Other complaints9.171.333.919.7*P	Midfoot other pathology $n = 42$	Overall score	12.4	96.5	53.8	21.5	32.3-75.4
Image: Participant of the complaints $7.0$ (14.8) $100.0$ (100.0) $56.1$ $61.6$ $26.4$ (22.0) $298-82.5$ (39.5-83.6)Hindfoot other pathology n=54Overall score (100.0) $13.3$ (100.0) $97.8$ (100.0) $52.6$ (100.0) $17.9$ (100.0) $14.9$ (100.0) $17.9$ (100.0)Ankle deformity n=68Overall score (100.0) $7.5$ (100.0) $100.0$ $42.3$ (23.0) $25.7$ (24.0) $16.7-68.0$ (25.6-72.9)Ankle instability n=8Overall score (100.0) $25.7$ (100.0) $100.0$ $49.2$ (23.6) $23.6$ (25.6-72.9)Ankle instability n=8Overall score (100.0) $22.4$ (100.0) $79.3$ $45.6$ (19.1) $30.0-79.9$ Flatfoot n=11Overall score (100.0) $22.4$ (100.0) $73.0$ $45.6$ (19.1) $30.0-79.9$ Flatfoot n=15Overall score (100.0) $22.4$ (100.0) $73.0$ $45.6$ (19.1) $30.0-79.9$ Cavus foot n=15Overall score (100.0) $22.4$ (100.0) $73.0$ $32.6$ (100.0) $30.0-79.9$ Other complaints (100.0) $22.4$ (100.0) $73.3$ $28.6$ $30.0-79.9$ Cavus foot n=15Overall score (100.0) $15.2$ (100.0) $75.9$ $45.9$ (100.0) $19.7$ (100.0)Other complaints (100.0) $38.3$ (100.0) $73.3$ (100.0) $39.9$ $30.0-79.9$ Other complaints (100.0) $39.3$ $31.7$ (100.0) $31.3$ $31.6$ $30.0-79.9$ Other complaints (100.0) <t< td=""><td>1 00</td><td>Pain</td><td>0</td><td>100.0</td><td>40.4</td><td>25.8</td><td>14.7-66.2</td></t<>	1 00	Pain	0	100.0	40.4	25.8	14.7-66.2
Other complaints14.8100.061.622.039.5-83.6Hindfoot other pathology $n=54$ Overall score Pain Punction Other complaints13.3 097.8 97.852.6 97.317.9 23.134.7-70.5 17.9-64.1 23.1Ankle deformity $n=68$ Overall score Pain Pain Pain Pain Pain Pain Complaints7.5 6.7100.040.0 42.3 23.621.9 27.1-70.9 23.627.1-70.9 23.6Ankle deformity $n=68$ Overall score Pain Pain Complaints7.5 0.00100.042.3 42.325.7 27.1-70.9 16.7-68.027.1-70.9 23.6Ankle instability $n=8$ Overall score Pain Pain Complaints22.5 0.10.079.1 100.048.1 42.7 45.620.9 45.9Ankle instability $n=8$ Overall score Pain Pain Cother complaints22.1 076.2 100.040.8 42.617.8 42.1Flatfoot $n=11$ Overall score Pain Cother complaints22.1 075.945.6 21.019.1Flatfoot $n=15$ Overall score Pain Pain Cother complaints75.945.9 21.019.1 43.2* 21.7Cavus foot $n=15$ Overall score Pain Pain Pain Cother complaints75.975.945.9 25.919.1 23.7* 23.7Other pathology $n=23$ Overall score Pain 		Function	7.0	100.0	56.1	26.4	29.8-82.5
Hindfoot other pathology $n = 54$ Overall score Pain13.3 0 9 9697.8 97.852.6 41.0 23.117.9 23.1Ankle deformity $n = 68$ Overall score Pain7.5 2.3100.049.0 42.321.9 25.727.1-70.9 16.7-68.0 25.6Ankle deformity $n = 68$ Overall score Pain7.5 6.7100.049.0 42.321.9 25.727.1-70.9 16.7-68.0 25.6Ankle instability $n = 8$ Overall score Pain2.5 6.779.1 100.048.1 45.620.9 21.9Ankle instability $n = 8$ Overall score Pain22.5 10.579.1 100.048.1 45.620.9 21.9Ankle instability $n = 8$ Overall score Pain22.5 22.479.1 70.048.1 45.620.9 21.9Flatfoot $n = 11$ Overall score Pain22.1 2.5762.240.8 45.617.8 21.9Cavus foot $n = 15$ Overall score Pain15.2 9.375.945.9 45.919.1 23.7Cavus foot $n = 15$ Overall score Pain15.2 9.375.9 75.945.9 45.919.1 19.1Other complaints0.0 21.7 74.133.9 45.219.1 23.7Other complaints9.3 9.3 71.333.9 33.919.7 19.7Overall score Pain15.2 9.375.9 71.345.9 33.919.1 19.7Other complaints9.3 9.3 71.323.4 33.919.7 19.7Other complaints9.3 9.3 71.373.3 33.9 <td< td=""><td></td><td>Other complaints</td><td>14.8</td><td>100.0</td><td>61.6</td><td>22.0</td><td>39.5-83.6</td></td<>		Other complaints	14.8	100.0	61.6	22.0	39.5-83.6
Pain Function0 9.697.8 97.341.0 53.123.1 20.417.9-64.1 32.6-73.5Ankle deformity $n = 68$ Overall score Pain 2.37.5100.049.021.927.1-70.9Ankle deformity $n = 68$ Overall score Function 0.677.5100.042.325.716.7-68.0Ankle instability $n = 8$ Overall score Pain Pain 100022.579.148.120.9*Ankle instability $n = 8$ Overall score Pain Pain 100022.579.148.120.9*Ankle instability $n = 8$ Overall score Pain Pain Pain Pain Pain 100.022.473.045.619.1Overall score Pain Pa	Hindfoot other pathology $n = 54$	Overall score	13.3	97.8	52.6	17.9	34.7-70.5
Function Other complaints9.6 19.897.3 100053.1 61.520.4 21.032.6-73.5 405-82.5Ankle deformity $n = 68$ Overall score Pain Other complaints7.5 0.0100.0 49.049.0 49.221.9 25.727.1-70.9 167-68.0 25.0Ankle instability $n = 8$ Overall score Pain Pain 19.522.5 19.579.1 100.048.1 42.720.9 24.930.0-79.9Ankle instability $n = 8$ Overall score Pain Other complaints22.4 073.0 100.045.6 45.619.1 19.1Flatfoot $n = 11$ Overall score Pain Other complaints22.1 076.2 20.040.8 20.917.8 20.0Flatfoot $n = 15$ Overall score Pain Other complaints21.7 2.5 0.2075.9 20.043.2 20.228.2Cavus foot $n = 15$ Overall score Pain Other complaints15.2 9.075.9 20.045.919.1 20.1Other pain Pain Other complaints3.8 9.068.642.418.9Other complaints 09.0100.047.3 43.225.3Cavus foot $n = 15$ Overall score Pain Other complaints11.8 9.0100.047.3 43.225.3Other pain Pain Other complaints9.0100.047.3 43.225.3*Other complaints Other complaints9.2 9.2100.047.3 51.325.3*		Pain	0	97.8	41.0	23.1	17.9-64.1
Other complaints19.8100.061.521.040.5-82.5Ankle deformity n=68Overall score Pain Function Other complaints7.5100.049.021.927.1-70.9Ankle instability n=8Overall score Pain Cuther complaints2.579.148.120.93079.9Ankle instability n=8Overall score Pain Pain Other complaints22.579.148.120.9*Ankle instability n=8Overall score Pain Other complaints22.473.045.619.1*Flatfoot n=11Overall score Other complaints22.176.240.817.8*Pain Pain Pain Pain Pain Other complaints27.774.144.217.3*Cavus foot n=15Overall score Pain Pain Pain Other complaints15.275.945.919.1*Other complaints9.068.642.418.9***Other complaints9.068.642.418.9**Other complaints9.068.642.418.9**Other complaints9.0100.047.325.3**Other complaints9.2100.047.325.3**Other complaints9.2100.047.022.9**Other complaints9.2100.047.325.3**Other complaints9.2100.047.432.1* <td< td=""><td></td><td>Function</td><td>9.6</td><td>97.3</td><td>53.1</td><td>20.4</td><td>32.6-73.5</td></td<>		Function	9.6	97.3	53.1	20.4	32.6-73.5
Ankle deformity $n=68$ Overall score Pain Function Other complaints7.5 2.3 0100.0 100.049.0 42.3 42.3 42.3 42.3 25.727.1-70.9 16.7-68.0 25.6 25.6-72.9 30.0Ankle instability $n=8$ Overall score Pain Pain Other complaints22.5 079.1 81.8 42.7 48.1 19.548.1 42.7 48.1 42.920.9 48.1Flatfoot $n=11$ Overall score Pain Other complaints22.4 073.0 100.045.6 45.619.1 32.9Flatfoot $n=11$ Overall score Pain Pain 21.721.7 74.1 74.1 44.277.3 45.6* 42.9Cavus foot $n=15$ Overall score Pain Pain 015.2 92.075.9 45.945.9 19.1 43.2* 42.2Cavus foot $n=15$ Overall score Pain Pain 9.015.2 9.075.9 45.945.9 19.1 43.2* 42.2Other complaints Pain 9.09.0 68.642.418.9* 44.2Other complaints Pain Pain Other complaints9.0 9.068.642.418.9Other complaints Pain Pain Other complaints9.0100.0 68.647.3 42.425.3 43.9* 44.2Other complaints Pain Pain Pain Other complaints11.8 9.0100.0 47.3 47.845.9* 44.2Other complaints Pain Pain Pain Other complaints 9.2100.047.3 47.325.3 25.3* 4		Other complaints	19.8	100.0	61.5	21.0	40.5-82.5
Pain Function Other complaints2.3100.042.325.716.7-68.0Function Other complaints6.7100.049.223.625.6-72.9Ankle instability $n=8$ Overall score Pain Other complaints22.579.148.120.9*Ankle instability $n=8$ Overall score Pain Other complaints22.473.045.619.1Function Other complaints22.473.045.619.1*Flatfoot $n=11$ Overall score Pain Other complaints22.176.240.817.8*Pain Pain Other complaints2.1.774.144.217.3*Cavus foot $n=15$ Overall score Pain Other complaints15.275.945.919.1*Other complaints9.068.642.418.9**Other complaints9.068.642.418.9*Other complaints9.0100.047.325.3*Other complaints9.2100.044.432.1*Pain Pain Pain Other complaints9.2100.047.325.3*Other complaints9.2100.047.325.3*Other complaints9.2100.047.325.3*Other complaints9.2100.047.325.3*Other complaints9.2100.051.324.8*Other complaints9.2100.051.324.	Ankle deformity $n = 68$	Overall score	7.5	100.0	49.0	21.9	27.1-70.9
Function Other complaints $6.7$ 0 $100.0$ $49.2$ $5.0$ $23.6$ $24.9$ $25.6-72.9$ $30.0-79.9$ Ankle instability n=8Overall score Pain Tunction $22.5$ $22.4$ $79.1$ $73.0$ $48.1$ $45.6$ $19.1$ $20.9$ *Flatfoot n=11Overall score Pain Other complaints $22.1$ $0$ $76.2$ $100.0$ $40.8$ $54.9$ $78.9$ $32.9$ Flatfoot n=15Overall score Pain Pain $21.7$ $27.1$ $74.1$ $44.2$ $44.2$ $17.3$ $28.2$ Cavus foot n=15Overall score Pain $21.7$ $75.9$ $21.7$ $45.9$ $28.2$ $91.1$ $28.2$ Cavus foot n=15Overall score Pain $9.3$ $71.3$ $71.3$ $33.9$ $39.1$ $9.7$ Other complaints $9.0$ $68.6$ $42.4$ $18.9$ Other complaints $9.0$ $68.6$ $42.4$ $18.9$ Other complaints $9.0$ $68.6$ $42.4$ $18.9$ Other complaints $9.2$ $100.0$ $47.3$ $42.4$ $25.3$ $29.9$ Other complaints $9.2$ $100.0$ $47.3$ $42.4$ $25.3$		Pain	2.3	100.0	42.3	25.7	16.7-68.0
Other complaints0100.055.024.930.0-79.9Ankle instability $n=8$ Overall score Pain22.579.148.120.9*Pain19.581.842.724.1**Function22.473.045.619.1*Other complaints0100.054.932.9*Flatfoot $n=11$ Overall score Pain22.176.240.817.8*Pain2.562.026.921.9**Function21.774.144.217.3*Other complaints2.792.043.228.2*Cavus foot $n=15$ Overall score15.275.945.919.1*Pain9.371.333.919.7**Pain9.368.642.418.9**Other complaints9.068.642.418.9*Other complaints9.0100.047.325.3*Other complaints9.2100.047.029.9*		Function	6.7	100.0	49.2	23.6	25.6-72.9
Ankle instability $n=8$ Overall score Pain22.579.148.120.9*Pain19.581.842.724.1*Function22.473.045.619.1Other complaints0100.054.932.9*Flatfoot $n=11$ Overall score22.176.240.817.8*Pain2.562.026.921.9**Function21.774.144.217.3*Other complaints2.792.043.228.2*Cavus foot $n=15$ Overall score15.275.945.919.1*Pain9.371.333.919.7**Pain9.371.333.919.7*Other complaints9.068.642.418.9*Other complaints9.068.642.418.9*Other complaints9.2100.047.325.3*Other complaints9.2100.047.029.9*Other complaints9.2100.051.324.8*		Other complaints	0	100.0	55.0	24.9	30.0-79.9
Pain19.581.842.724.1Function22.473.045.619.1Other complaints0100.054.932.9Flatfoot $n = 11$ Overall score22.176.240.817.8Pain2.562.026.921.9Function21.774.144.217.3Other complaints2.792.043.228.2Cavus foot $n = 15$ Overall score15.275.945.919.1Pain9.371.333.919.7Function3.885.551.123.7Other complaints9.068.642.418.9Other complaints0100.044.432.1Other complaints0100.044.432.1Other complaints9.2100.051.324.8	Ankle instability $n=8$	Overall score	22.5	79.1	48.1	20.9	*
Function Other complaints $22.4$ 0 $73.0$ $100.0$ $45.6$ $54.9$ $19.1$ $32.9$ Flatfoot $n = 11$ Overall score Pain Function Other complaints $22.1$ $2.5$ $76.2$ $62.0$ $26.9$ $40.8$ $21.9$ $17.8$ $44.2$ $*$ $17.3$ Cavus foot $n = 15$ Overall score Pain Other complaints $2.7$ $92.0$ $43.2$ $28.2$ Cavus foot $n = 15$ Overall score Pain Pain Other complaints $9.3$ $9.0$ $71.3$ $68.6$ $33.9$ $19.7$ $23.7$ Other pathology $n = 23$ Overall score Pain Other complaints $9.0$ $68.6$ $42.4$ $18.9$ Other pathology $n = 23$ Overall score Pain Other complaints $9.2$ $100.0$ $47.3$ $47.0$ $25.3$ $29.9$ Other complaints $9.2$ $100.0$ $47.0$ $29.9$ $29.9$		Pain	19.5	81.8	42.7	24.1	
Other complaints         0         100.0         54.9         32.9           Flatfoot n = 11         Overall score Pain         22.1         76.2         40.8         17.8         *           Pain         2.5         62.0         26.9         21.9         *         *           Function         21.7         74.1         44.2         17.3         *         *           Other complaints         2.7         92.0         43.2         28.2         *         *           Cavus foot n = 15         Overall score         15.2         75.9         45.9         19.1         *           Pain         9.3         71.3         33.9         19.7         *         *           Function         3.8         85.5         51.1         23.7         *         *           Other complaints         9.0         68.6         42.4         18.9         *           Other complaints         9.0         100.0         47.3         25.3         *           Pain         0         100.0         47.0         29.9         *           Other complaints         9.2         100.0         51.3         24.8         *		Function	22.4	73.0	45.6	19.1	
Flatfoot $n = 11$ Overall score Pain Function Other complaints22.176.240.817.8*Pain 		Other complaints	0	100.0	54.9	32.9	
Pain2.562.026.921.9Function21.774.144.217.3Other complaints2.792.043.228.2Cavus foot $n = 15$ Overall score15.275.945.919.1Pain9.371.333.919.7Function3.885.551.123.7Other complaints9.068.642.418.9Other pathology $n = 23$ Overall score11.8100.047.325.3*Pain0100.044.432.1*100.047.029.9Other complaints9.2100.051.324.8*	Flatfoot $n = 11$	Overall score	22.1	76.2	40.8	17.8	*
Function $21.7$ $74.1$ $44.2$ $17.3$ Other complaints $2.7$ $92.0$ $43.2$ $28.2$ Cavus foot $n=15$ Overall score $15.2$ $75.9$ $45.9$ $19.1$ *Pain $9.3$ $71.3$ $33.9$ $19.7$ *Function $3.8$ $85.5$ $51.1$ $23.7$ Other complaints $9.0$ $68.6$ $42.4$ $18.9$ Other pathology $n=23$ Overall score $11.8$ $100.0$ $47.3$ $25.3$ *Pain $0$ $100.0$ $44.4$ $32.1$ *Function $5.6$ $100.0$ $47.0$ $29.9$ Other complaints $9.2$ $100.0$ $51.3$ $24.8$		Pain	2.5	62.0	26.9	21.9	
Other complaints $2.7$ $92.0$ $43.2$ $28.2$ Cavus foot $n = 15$ Overall score $15.2$ $75.9$ $45.9$ $19.1$ *Pain $9.3$ $71.3$ $33.9$ $19.7$ Function $3.8$ $85.5$ $51.1$ $23.7$ Other complaints $9.0$ $68.6$ $42.4$ $18.9$ Other pathology $n = 23$ Overall score $11.8$ $100.0$ $47.3$ $25.3$ *Pain $0$ $100.0$ $44.4$ $32.1$ *Function $5.6$ $100.0$ $47.0$ $29.9$ Other complaints $9.2$ $100.0$ $51.3$ $24.8$		Function	21.7	74.1	44.2	17.3	
Cavus foot n=15       Overall score       15.2       75.9       45.9       19.1       *         Pain       9.3       71.3       33.9       19.7         Function       3.8       85.5       51.1       23.7         Other complaints       9.0       68.6       42.4       18.9         Other pathology n=23       Overall score       11.8       100.0       47.3       25.3       *         Pain       0       100.0       44.4       32.1       *       *       *         Pain       0       100.0       47.0       29.9       *       *       *         Other complaints       9.2       100.0       51.3       24.8       *		Other complaints	2.7	92.0	43.2	28.2	
Pain9.371.333.919.7Function3.8 $85.5$ $51.1$ $23.7$ Other complaints9.0 $68.6$ $42.4$ $18.9$ Other pathology $n=23$ Overall score $11.8$ $100.0$ $47.3$ $25.3$ *Pain0 $100.0$ $44.4$ $32.1$ Function $5.6$ $100.0$ $47.0$ $29.9$ Other complaints $9.2$ $100.0$ $51.3$ $24.8$	Cavus foot $n = 15$	Overall score	15.2	75.9	45.9	19.1	*
Function $3.8$ $85.5$ $51.1$ $23.7$ Other complaints $9.0$ $68.6$ $42.4$ $18.9$ Other pathology $n=23$ Overall score $11.8$ $100.0$ $47.3$ $25.3$ *Pain $0$ $100.0$ $44.4$ $32.1$ Function $5.6$ $100.0$ $47.0$ $29.9$ Other complaints $9.2$ $100.0$ $51.3$ $24.8$		Pain	9.3	71.3	33.9	19.7	
Other complaints         9.0         68.6         42.4         18.9           Other pathology n=23         Overall score         11.8         100.0         47.3         25.3         *           Pain         0         100.0         44.4         32.1         *           Function         5.6         100.0         47.0         29.9         *           Other complaints         9.2         100.0         51.3         24.8		Function	3.8	85.5	51.1	23.7	
Other pathology n=23         Overall score         11.8         100.0         47.3         25.3         *           Pain         0         100.0         44.4         32.1         *           Function         5.6         100.0         47.0         29.9           Other complaints         9.2         100.0         51.3         24.8		Other complaints	9.0	68.6	42.4	18.9	
Pain0100.044.432.1Function5.6100.047.029.9Other complaints9.2100.051.324.8	Other pathology $n = 23$	Overall score	11.8	100.0	47.3	25.3	*
Function5.6100.047.029.9Other complaints9.2100.051.324.8		Pain	0	100.0	44.4	32.1	
Other complaints         9.2         100.0         51.3         24.8		Function	5.6	100.0	47.0	29.9	
		Other complaints	9.2	100.0	51.3	24.8	

between pathology groups, for example forefoot ankle/hindfoot regarding overall score, and categories pain and function (Table 3).

Within the different groups, no score differences (overall score or score categories) occurred (one sample *t*-test with confidence interval 95% and the average value as test value, each  $p \ge .05$ ). The power of this analysis was >.8 for the 7 groups no pathology (control group), isolated Hallux valgus, Hallux valgus and claw toes, forefoot other pathology, midfoot other pathology, hindfoot pathology and ankle deformity. Score standards were defined for these groups (Table 1).

#### 4. Discussion

American Orthopaedic Foot and Ankle Society (AOFAS) score is the mostly used score for foot and ankle shown by the high number of hits when entering the term "aofas score" into the PubMed<sup>®</sup>search engine in the World-Wide-Web (National Library of Medicine) [1,2,4,6,9,12,13]. However, this score is problematic due to significant flaws as follows. The score is not validated despite several attempts [2,6,9,14], cannot be obtained if answers are missing, and contains problematic pseudo-objective assessment [1]. To assess a walking distance in blocks, to specify joint stability as "stable" or "definitely instable", to define gait abnormality as "none, slight", "obvious" or "marked", or to classify alignment as "good, plantigrade, well aligned", "fair, plantigrade, some degree of...malalignment" or "poor, nonplantigrade, severe malalignment" are some examples for non- or pseudo-objective assessment of the AOFAS-score [1].

The Ankle Osteoarthritis Score (*AOS*) is an instrument that was developed for the assessment of pain in patients with ankle



Fig. 1. (a-d) Boxplots of scores and score categories of different groups (a, overall; b, pain; c, function; d, other complaints).

osteoarthritis [15,16]. The score demonstrated a high "vulnerability" regarding other musculoskeletal problems than at the ankle resulting in a questionable specificity for foot and ankle disorders [1,15].

The Foot Function Index (*FFI*) was correlated with the SF36 for validation [10,17–19]. The correlation coefficients ranged from 0.10 to -0.69 for the different domains disability (0.23 to -0.69), activity limitation (-0.26 to -0.64) and pain (-0.10 to -0.61) [17].

Despite the conclusions of SooHoo et al. that these levels of correlation support the FFI as a valid measure, it is clear that a correlation coefficient smaller than 0.5 (or greater than -0.5 for negative correlation) does not represent a sufficient correlation allowing a successful validation [1,10,17,20].

The validation process of the Foot and Ankle Outcome Score (*FAOS*) was reported by Roos et al. [11]. The FAOS is an adaptation of the Knee Injury and Osteoarthritis Outcome Score intended to

#### Table 2

Result of Post Hoc Scheffe test from One-way ANOVA of scores (p < .001) of different single groups. All lines with only non-significant values not shown (complete table in Appendix B).

Test group 1	Test group 2	Overall	Pain	Function	Other
No pathology (Control group) <i>n</i> = 121	Isolated Hallux valgus	<.001	<.001	<.001	.406
	Hallux valgus and claw toes	<.001	<.001	<.001	.035
	Forefoot other pathology	<.001	<.001	<.001	.108
	Midfoot deformity	<.001	.010	.005	.113
	Midfoot other pathology	<.001	<.001	<.001	.186
	Hindfoot other pathology	<.001	<.001	<.001	.080
	Ankle deformity	<.001	<.001	<.001	<.001
	Ankle instability	<.001	<.001	<.001	.727
	Flatfoot	<.001	<.001	<.001	.008
	Cavus foot	<.001	<.001	<.001	<.001
	Other pathology	<.001	<.001	<.001	.004
Isolated Hallux valgus $n = 80$	Ankle deformity	.017	.851	.004	.495

#### Table 3

Result of Post Hoc Scheffe test from One-way ANOVA of scores (p < .001) of groups forefoot (isolated Hallux valgus, Hallux valgus with claw toes, forefoot others, n = 184), midfoot (midfoot deformity, midfoot others, n = 51), ankle/hindfoot (hindfoot others, ankle deformity, ankle instability, n = 130) and other pathology (flatfoot, cavus foot, other pathology, n = 49).

Test group 1	Test group 2	Overall	Pain	Function	Other
No pathology (Control group), $n = 121$	Forefoot	<.001	<.001	<.001	<.001
	Midfoot	<.001	<.001	<.001	<.001
	Ankle/Hindfoot	<.001	<.001	<.001	<.001
	Other pathology	<.001	<.001	<.001	<.001
Forefoot, $n = 184$	Midfoot	.193	.255	.276	.805
	Ankle/Hindfoot	<.001	.016	<.001	.251
	Other pathology	<.001	.008	<.001	<.001
Midfoot, $n = 51$	Ankle/Hindfoot	.887	1	.621	.997
	Other pathology	.295	.850	.388	.062
Ankle/Hindfoot, <i>n</i> = 130	Other pathology	.636	.845	.953	.037

evaluate symptoms and functional limitations related to the foot and ankle [11]. The FAOS was tested in 213 subjects for follow-up of ankle ligament reconstruction. Factors such as content validity, dimensionality, construct validity, score distribution, internal consistency and test retest reliability were analyzed and correct validation was concluded [11]. The described validation process is sound but only one specific pathology and no control groups were assessed. This calls into question if the FAOS may be valid for other foot and ankle pathologies.

A literature search revealed no publications dealing with validation of a foot and ankle specific score. Consequently, no validated data is available for pathological conditions also. The goal of our study was to use the previously validated foot and ankle specific VAS FA for assessment of a sufficient number of patients to define standards for different pathological conditions.

#### 4.1. Findings

The scores and score categories differed when comparing all groups including the control group. The scores and score categories differed between the control group and all different pathologies except the category other complaints, i.e. the category other complaints was normal or healthy or physiologic. The overall scores and all score categories did not differ between different pathology groups. Thus the different pathologies do not show different scores or score patterns as initially suspected. However, when pooling some of the groups into forefoot (groups isolated Hallux valgus, Hallux valgus with claw toes, forefoot others), midfoot (groups midfoot deformity, midfoot others), ankle/hindfoot (groups hindfoot others, ankle deformity, ankle instability) and other pathology (groups flatfoot, cavus foot, other pathology), the Post Hoc Scheffe test of the score differences showed differences between pathology groups, for example forefoot versus ankle/hindfoot regarding overall score, and categories pain and function. This effect is probably caused by the higher case numbers in each group and the lower number of groups and not by greater differences between the groups. However, based on the overlapping of the scores for the different pathologies without pooling groups together, we put more focus on the definition of standards instead a detection of specific pathologies by the specific score pattern as initially intended. One of the tasks of this study that could be completed successfully was to define standards for different pathologies. Within the different groups, no score differences (overall score or score categories) occurred and the power of this analysis was sufficient for 6 groups (isolated Hallux valgus, Hallux valgus and claw toes, forefoot other pathology, midfoot other pathology, hindfoot pathology and ankle deformity). Consequently, score standards were defined for these groups as the range between mean value minus standard deviation and mean value plus standard deviation. This range could not exceed 100 points by definition of course. This definition had been performed by subjective intention. We choose the range of  $\pm$ one standard deviation which includes 68.3% of all individuals and we found that this would be a sufficient range for a standard. Another possibility would be a range of  $\pm$ two standard deviations which includes 95.4% of all individuals. We found that a range of more than 95% would include almost everyone or in other words too many subjects that are not standard. But again, this determination was subjectively and not based on statistical calculations. Within the current step for validation, subjects with missing answers were excluded from the evaluation as done before for the healthy subjects [1]. The score allows the calculation of the total and categories results with missing answers as described above. It was our strategy for validation to validate the score without missing answers for healthy subject and pathological situations first, and later with missing answers.

#### 4.2. Weaknesses

We are aware of some weaknesses of the study such as potential problematic grouping and complex statistical analysis. The grouping was performed by the surgeons from the foot and ankle outpatient clinic. This grouping was based on the clinical assessment, radiographic findings and pedographic measurements. However, this grouping process was not clearly objective but also subjective. Consequently, the entire analysis is based on partly subjective assessment. However, the same partly subjective assessment is also the basis for foot and ankle surgery in general. No patients were assigned to groups hindfoot varus or hindfoot valgus. This was initially surprising because these groups were defined on the basis of subjective experience when thinking of the cohort of patients that would be available for inclusion. However, all patients with hindfoot varus or valgus (n = 38) showed also an equinus-like deformity at the ankle which resulted in assignment to the group hindfoot other pathology and not to the groups with isolated hindfoot varus or valgus.

Another potential weakness is the complex statistical analysis. Our goal was to define specific overall score patterns and specific score category patterns for each pathology group, i.e. a standard score points pattern. We could not define this specific pattern but could compare the scores and score categories between groups. The problem in using a One-way ANOVA analysis when comparing different groups is that differences could be over estimated when not also using a Post Hoc test. The same is true for our analysis with very low *p*-values for the One-way ANOVA test and much higher or even non-significant *p*-values for the Post Hoc test.

Another shortcoming is the control group. Age and gender differed between most of the pathology groups and between the pathology groups and the control group. When strictly respecting the principle of a control group, a matched and different control group for all different pathology groups would have been needed. We are aware of this requirement. Still, we defined only one single control group with healthy feet for all comparisons because of the feasibility of this approach and the extreme and unfeasible effort of having matched control groups for all different pathology groups. In the literature this principle is followed with few exceptions when assessing different pathological conditions. In conclusion, we found that for our purpose one control group for all different pathology groups would be sufficient despite the age and gender differences between some groups.

In conclusion, the overall scores and score categories scores differed between the control group and all different pathologies except the category other complaints. The overall scores and all score categories scores did not differ between different pathology groups. Thus the different pathologies do not show different overall scores or category score patterns as initially suspected. The obtained data is normative for different pathologic conditions of the earlier validated VAS FA. This data could serve as a basis for assessment patient scoring before, during and after treatment which has to then to be proved by ongoing research.

#### Acknowledgement

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## Appendix A. VAS FA for different pathology groups and control group<sup>1</sup>, and defined standards

Links for download.

Instruction: German version English version	http://www.foot-trauma.org/de/vasd.htm http://www.foot-trauma.org/uk/vase.htm
Score form:	
German version	http://www.foot-trauma.org/dokumente/vasfad.pdf
English version	http://www.foot-trauma.org/dokumente/vasfaea4.pdf
(DIN-A4-format)	
English version	http://www.foot-trauma.org/dokumente/vasfael.pdf
(letter format)	
Template/Gauche for evalue	ition by hand:
German version	http://www.foot-trauma.org/dokumente/messd.pdf
English version	http://www.foot-trauma.org/dokumente/messea4.pdf
(DIN-A4-format)	
English version	http://www.foot-trauma.org/dokumente/messel.pdf
(letter format)	

Result-Calculation Instrument for evaluation by hand:

 German version
 http://www.foot-trauma.org/dokumente/xvasfad.xls

 English version
 http://www.foot-trauma.org/dokumente/xvasfae.xls

#### Appendix B. Result of Post Hoc Scheffe test from One-way ANOVA (p < .001)

Test group 1	Test group 2	Overall	Pain	Function	Other
No pathology (Control group) $n = 121$	Isolated Hallux valgus	<.001	<.001	<.001	.406
	Hallux valgus and claw toes	<.001	<.001	<.001	.035
	Forefoot other pathology	<.001	<.001	<.001	.108
	Midfoot deformity	<.001	.010	.005	.113
	Midfoot other pathology	<.001	<.001	<.001	.186
	Hindfoot other pathology	<.001	<.001	<.001	.080
	Ankle deformity	<.001	<.001	<.001	<.001
	Ankle instability	<.001	<.001	<.001	.727
	Flatfoot	<.001	<.001	<.001	.008
	Cavus foot	<.001	<.001	<.001	<.001
	Other pathology	<.001	<.001	<.001	.004
Isolated Hallux valgus $n = 80$	Hallux valgus and claw toes	.985	1	.980	.993
	Forefoot other pathology	1	1	.990	1
	Midfoot deformity	.995	1	.998	.793
	Midfoot other pathology	.716	.812	.689	1
	Hindfoot other pathology	.388	.781	.165	1
	Ankle deformity	.017	.851	.004	.495
	Ankle instability	.921	1	.719	.998
	Flatfoot	.203	.404	.376	.370
	Cavus foot	.397	.735	.730	.116
	Other pathology	.232	.999	.111	.611
Hallux valgus and claw toes $n = 46$	Forefoot other pathology	1	.998	1	1
	Midfoot deformity	1	1	1	.991
	Midfoot other pathology	1	.999	1	1
	Hindfoot other pathology	.999	1	.992	1
	Ankle deformity	.885	1	.758	1
	Ankle instability	.999	1	.986	1
	Flatfoot	.790	.822	.925	.889
	Cavus foot	.957	.981	.998	.702
	Other pathology	.946	1	.872	.995

Appendix B (Continued)

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Test group 1	Test group 2	Overall	Pain	Function	Other
Midfoot other pathology         95         7.74         1         1         1           Hindfoot other pathology         962         701         9.59         1           Ankle deformity         476         7.79         5.09         9.66           Ankle instability         903         1         973         1           Flatfoot         571         338         8.70         6.69           Cavus foot         630         6.58         .993         .405           Other pathology         .759         .996         .755         .938           Midfoot deformity n = 9         Midfoot other pathology         1         .998         1         .997           Hindfoot other pathology         1         .998         .1         .971         .1         .1           Ankle instability         1         .998         .1         .972         .1         .1           Ankle instability         1         .988         .843         .999         .1         .1         .1         .1           Midfoot other pathology         1         .1         .1         .1         .1         .1         .1         .1           Ankle instability         .999         .1<	Forefoot other pathology $n = 58$	Midfoot deformity	1	1	1	.952
Hindfoot other pathology       .962       .701       .959       1         Ankle deformity       .476       .779       .509       .966         Ankle instability       .933       .1       .973       .1         Blatfoot       .511       .338       .870       .6699         Cavus foot       .830       .658       .993       .405         Other pathology       .759       .996       .755       .938         Midfoot deformity n = 9       Midfoot other pathology       .1       .999       .1       .997         Hindfoot other pathology       .1       .998       .843       .999       .1       .968         Ankle deformity       .1       .973       .1       .1       .1       .1       .1         Iddfoot other pathology       .1       .973       .1		Midfoot other pathology	.995	.734	1	1
Ankle deformity       476       .779       .509       .968         Ankle instability       .993       1       .973       1         Flatfoot       .571       .338       .870       .695         Cavus foot       .830       .658       .993       .405         Other pathology       .759       .996       .755       .938         Midfoot deformity n = 9       Midfoot other pathology       1       .998       1       .971         Hindfoot other pathology       1       .998       .1       .975       .938         Ankle deformity       1       .998       .1       .968       .433       .999       .968         Ankle instability       1       1       .973       1       1       .5       .3       .9       .3       .3       .3       .3		Hindfoot other pathology	.962	.701	.959	1
Ankle instability       993       1       973       1         Flatfoot       571       338       870       658         Cavus foot       830       658       993       405         Other pathology       759       996       .755       938         Midfoot deformity n = 9       Midfoot other pathology       1       .998       1       .973         Ankle deformity       1       .998       .1       .968       .1       .968         Ankle deformity       1       .999       1       1       1       .1         Ankle deformity       1       .998       .843       .999       1       .1         Cavus foot       1       .973       1       1       .1       .1       .1         Midfoot other pathology n = 42       Hindfoot other pathology       1       1       .1       .1       .1       .1         Midfoot other pathology n = 42       Hindfoot ther pathology       .999       1       .994       .993         Ankle deformity       1       1       .1       .535       .990       .994       .993         Ankle deformity       1       1       .994       .993       .994       .99		Ankle deformity	.476	.779	.509	.968
Flatfoot         571         338         370         669           Cavus foot         830         658         993         400           Other pathology         759         996         755         938           Midfoot deformity n = 9         Midfoot other pathology         1         998         1         997           Ankle deformity         1         998         1         1         999         1         1           Ankle instability         1         1         1         1         1         1         1           Midfoot other pathology         1         999         1		Ankle instability	.993	1	.973	1
Cavus foot Other pathology         330         658         993         405           Midfoot deformity n = 9         Midfoot other pathology         1         998         1         997           Ankle deformity         1         998         1         998         1         996           Ankle deformity         1         998         1         1         998         1         996           Ankle instability         1         1         1         1         1         1         1           Midfoot other pathology n = 42         Hindfoot other pathology         1		Flatfoot	.571	.338	.870	.699
Other pathology         7.59         9.96         7.755         9.38           Midfoot deformity n = 9         Midfoot other pathology         1         9.998         1         .975           Ankle deformity         1         .998         1         .976         .998         .998           Ankle deformity         1         .999         1         .999         .999         .999         .999         .999         .1         .998         .999         .1         .998         .1         .998         .999         .1		Cavus foot	.830	.658	.993	.405
Midfoot deformity n = 9       Midfoot other pathology       1       .998       1       .971         Hindfoot other pathology       1       .998       1       .968         Ankle deformity       1       1       .998       .1       .968         Ankle deformity       1       1       1       1       .968         Ankle deformity       .998       .843       .999       1       .971         Midfoot other pathology       1       1       1       1       1       1         Midfoot other pathology       1       <		Other pathology	.759	.996	.755	.938
Hindfoot other pathology       1       .998       1       .968         Ankle deformity       1       1       1       1       1         Ankle instability       1       1       1       1       1       1         Hindfoot other pathology       1       1       1       1       1       1       1         Midfoot other pathology       1 <td< td=""><td>Midfoot deformity <math>n = 9</math></td><td>Midfoot other pathology</td><td>1</td><td>.998</td><td>1</td><td>.971</td></td<>	Midfoot deformity $n = 9$	Midfoot other pathology	1	.998	1	.971
Ankle deformity       1       .999       1       1         Ankle instability       1       1       1       1         Flatfoot       .998       .843       .999       1         Cavus foot       1       .973       1       1         Midfoot other pathology       1       1       1       1         Midfoot other pathology       1       1       1       1         Ankle deformity       .999       1       .994       .993         Hindfoot other pathology n = 54       Ankle deformity       .999       1       .994       .974         Hindfoot other pathology n = 54       Ankle deformity       .999       .982       .1       .763         Cavus foot       .999       .982       .982       .1       .763         Cavus foot       .999       .958       .982       .984       .984         Ankle instabil		Hindfoot other pathology	1	.998	1	.968
Ankle instability         1         1         1         1         1           Flatfoot         .998         .843         .999         1           Cavus foot         1         .973         1         1           Midfoot other pathology         1         1         1         1         1           Midfoot other pathology         1         1         1         .993         .994         .993           Ankle instability         .999         1         .994         .993         .994         .993           Ankle instability         .999         1         .994         .993         .994         .993           Ankle instability         .999         1         .994         .993         .994         .785           Cavus foot         .999         .1         .994         .974         .994         .974           Hindfoot other pathology         .999         .1         .994         .945         .949         .949         .949           Ankle instability         .1         .998         .941         .949         .941         .941         .941         .941         .941         .941         .941         .941         .941         .941		Ankle deformity	1	.999	1	1
Flatfort         998         843         999         1           Cavus foot         1         .973         1         1           Midfoot other pathology         1         1         1         1           Midfoot other pathology n = 42         Hindfoot other pathology         1         1         1         1         1         1           Ankle deformity         .999         1         .994         .993         .993         .994         .993           Ankle instability         1         1         1         .994         .993           Ankle instability         1         1         .994         .993           Ankle instability         1         1         .994         .993           Ankle instability         1         1         .994         .993           Hindfoot other pathology         .999         1         .994         .993           Hindfoot other pathology         .999         1         .994         .993           Hindfoot other pathology         .999         .999         .994         .943           Other pathology         1         1         .941         .941           Infatoot         .999         .958		Ankle instability	1	1	1	1
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		Other pathology	1	.956	1	1
Cavus foot, n = 15         Other pathology         1         .999         1         .999	Cavus foot, $n = 15$	Other pathology	1	.999	1	.999

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