Original article
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Russian versions of FADI and FAAM for preoperative and postoperative assessment of the foot function

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Abstract

Introduction Self-administered questionnaire recommended by international orthopaedic community is a practical instrument for use in pathological conditions related to the foot and ankle.

The objective was to validate the Russian-language versions of the FADI and FAAM questionnaires to be filled out by orthopaedic patients with forefoot disorders before and after surgical treatment.

Material and methods The study included 100 adult patients with forefoot disorders to be surgically treated. The average age of the patients was 52 ± 12.1 years with 97 % being females and 26 % being athletes. The patients completed the FADI and FAAM questionnaires preoperatively and at 2 months after surgery and they were requested to fill out the SF-36 questionnaire and the LEFS scale preoperatively.

Results The Cronbach's α value was 0.91 for activities of daily living and 0.94 for sports measured with both questionnaires. The reproducibility of the questionnaires was demonstrated by high ICC values (⩾ 0.992) and no changes (ES < 0.01) in stable patients. Satisfactory construct validity was confirmed by significant correlations in activities of daily living and sports activities; criterion validity was confirmed by the dorsiflexion angle in the MCP1 and the daily ($p < 0.001$) and sports activities ($p < 0.05$). Convergent validity of the FADI and FAAM was identified with correlations measured with SF-36 and LEFS. Patients with moderate/severe impairment in range of motion had worse functional status scored with the FADI and FAAM as compared with those who had no/mild impairment. A significant improvement was seen postoperatively in non-athletes ($p < 0.001$). Sports activity significantly improved postoperatively in athletes ($p < 0.05$).

Discussion A limitation of the study includes the sample consisting mostly of patients with one type of orthopaedic pathology (valgus foot). Another limitation is that the majority of patients were females, and the patients were treated in the same health care facility. We can conclude that in the future it would be advisable to test the Russian versions of the FADI and FAAM questionnaires in patients with other foot pathologies and to conduct multicenter studies using these questionnaires.

Conclusion The FADI and FAAM scores measured in the Russian population showed greater sensitivity to changes in the foot/ankle joint in individuals who had indications for surgical treatment for a foot condition.

Keywords: foot pathology, functional disorders, surgical treatment, questionnaires, FADI, FAAM, validation

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INTRODUCTION

Patient's opinion of musculoskeletal pathology affecting his/her daily activity and quality of life is essential for evaluation of surgical outcomes of orthopaedic patients [1, 2]. Reporting patient-reported outcome measure is included in the international recommendations for the management of patients with musculoskeletal disorders [3]. Functional disorders of the foot and ankle and associated limitations can be assessed by the patient using specially designed questionnaires [4]. There are questionnaires that are recommended by the international orthopaedic community for assessing foot and/or ankle joint in different conditions including those during surgical interventions, for use in clinical studies and clinical practice [5–7]. These instruments include the Foot and Ankle Disability Index (FADI) and the Foot and Ankle Ability Measure (FAAM) [8, 9]. Both questionnaires are characterized by good psychometric parameters and are widely used abroad for research and practical purposes to evaluate patient condition and assess the effectiveness of treatment. An important advantage of these tools is that they consider aspects necessary for sports performance and can be applied to athletes. There were Russian versions of the FAAM and FADI questionnaires [10]. In accordance with international recommendations [11, 12] the development of a new language version of the questionnaire to be used in a new language environment is associated with a validation procedure to assess the psychometric properties of the instrument and test it in a population of patients with a specific pathology. The Russian versions of the FAAM and FADI questionnaires to be tested in patients with foot pathology to be surgically treated will create an evidence-based practice for evaluation of the effectiveness of surgical orthopaedic intervention.

The **objective** was to validate the Russian-language versions of the FADI and FAAM questionnaires and test them in orthopaedic patients before and after surgical treatment of forefoot pathology.

MATERIAL AND METHODS

The study was performed at the trauma department No. 2 of the High Medical Technologies Clinic named after N.I. Pirogov St. Petersburg State University (the study protocol was approved by the Biomedical Ethics Committee, protocol No. 07/22 dated 07/07/2022). The study included patients aged ⩾ 18 years with foot and/or ankle pathology who had indications for surgical treatment. Patients with cognitive impairment, which could prevent adequate completion of the questionnaires, were not included in the study. The patients signed informed consent prior to the research. The patients completed the FADI and FAAM questionnaires, the SF-36 general quality of life questionnaire and the Lower Extremity Functional Scale (LEFS) preoperatively. Some patients completed the FADI and FAAM twice before surgery, one day apart, to assess the reproducibility of the questionnaires. The patients completed the FADI and FAAM questionnaires at two months of surgery. The FADI questionnaire is developed to assess physical function for individuals with foot and ankle related impairments [11]. It consists of two subscales: the main part contains 26 items, divided into two scales: 22-item Activities of Daily Living subscale and 4-item pain subscale. The 8-item Sports subscale assesses more difficult tasks that are essential to sport (FADI-Sport). Each item is scored on a 5-point Likert scale (4 to 0) from 'no difficulty at all' to 'unable to do'. The maximum score on the daily activity scale is 104. The maximum score on the sports activity subscale is 32. The Sports Activity Scale also includes separate questions about the current level of functional status during sports (a score of 100 indicates the condition before the onset of problems with the foot and ankle, '0' means inability to perform normal daily activities) and the level of functional status at present (includes 4 options: normal, almost normal, reduced, significantly reduced level). The FAAM questionnaire was developed based on the FADI questionnaire. It is a region-specific tool for comprehensive assessment of the functioning of the foot and ankle joint in patients with a variety of disorders [12–15]. The questionnaire includes two scales evaluating daily activity (21 items, similar to the FADI items) and sports activity (8 items, similar to the FADI items). Five questions included in the FADI Activities of Daily Living scale are missing: a question about foot/ankle function during sleep and four questions about pain. The patient evaluates the current level of functional status performing normal daily activities on a scale from 0 to 100 scores.

The RAND 36-item Health Survey is comprised of 36 items that assess eight health concepts: physical functioning (PF), role limitations caused by physical health problems (RLPHP), role limitations caused by emotional problems (RLEP), social functioning (SF), emotional well-being (EWB), energy/fatigue (E/F), pain (P), general health perceptions (GHP). Each item is scored on a 0 to 100 scale so that the lowest and highest possible scores are set 0 and 100, respectively [16]. The LEFS contains 20 items to rate the degree of difficulty in performing different physical activities due to problems in the lower extremities; a 5-point scale is used, from 0 (extreme difficulty/unable to perform activity) to 4 (no difficulty). The total score ranges from 0 to 80, with higher scores indicating better function [17].

The reliability, validity and sensitivity of the Russian versions of the FADI and FAAM were analyzed for assessment of the psychometric properties. The reliability of the questionnaires was determined by calculating Cronbach's α coefficient for assessment of the internal consistency and the reproducibility identified with the test-retest method. Correlations were determined between the scores of the daily and sports activity scales of the FADI and FAAM questionnaires for assessment of the construct validity. For criterion validity, correlations of the FADI and FAAM scores were assessed with the dorsiflexion angle (DA) in the 1st metatarsophalangeal joint (MTP1). Discriminant validity analysis was performed using the "known groups" method based on comparison of the FADI and FAAM scores in groups of patients with no impairment in the range of motion, mild impairment, and with impaired range of motion of moderate or severe severity measured with the DF angle in MTP1. Convergent validity was assessed by correlations of the FADI and FAAM scores and the SF-36 and LEFS scores.

Effect size of changes on questionnaire scales were determined preoperatively and at two months of surgery to examine sensitivity to changes. As part of testing the Russian versions of FADI and FAAM, changes in the postoperative scores were compared with preoperative values in athletes and non-athletes. The applicability of the Russian versions of FADI and FAAM for the focal patient population was determined based on the understandability and ease of filling out the questionnaires, and the quality of completion. The study included 100 orthopaedic patients with a forefoot condition. Table 1 presents general characteristics of the sample. The majority of patients were females (97 %). The mean age was 52 years (20÷73). Hallux valgus was the main diagnosis in 98 %. Pathology of the foot was diagnosed in 47 % on the right and in 53 % on the left.

The mean (standard deviation) preoperative DF angle in MCP1 was 38.9° ± 19.9° (range 0÷70°. Impaired range of motion in the MCP1 was

Table 1

Characteristics of patients

Description		Value
Gender, %	Male	3
	Female	97
Age	Mean, standard deviation	52 ± 12.1
	Median (interquartile range)	55 (42.8; 61.3)
	Range	20–73
Marital status, %	Married	71
	Single	8
	Divorced	6
	Widow	15
Education, %	Higher	56
	Secondary special	26
	Secondary	12
	Incomplete secondary	6
Employment, %	Employed	70
	Student	1
	Unemployed	29
Going in for sports, %	Yes	74
	No	26
Disability, %	There is	98
	There is, among them:	2
	Grade 2	1
	Grade 3	1
Comorbidity, %	None	15
	There is	85
Principal diagnosis, %	Hallux valgus	98
	Hallux rigidus	2
The side involved, %	Right	47
	Left	53

classified as mild in 17 %, moderate in 13 % and severe in 27 %. No impairment was detected in 43 % of patients. The mean preoperative LEFS foot function scored 60.8 ± 16.7. Professional athletes made up a quarter (26 %) of the sample and represented the following sports: running (n = 5), cycling (n = 5), skiing (n = 4), dancing (n = 4), swimming (n = 4), table tennis (n = 2), track and field athletics (n = 2), equestrian (n = 1), football (n = 1).

Statistical analysis Quantitative data were presented as mean and standard deviation, M ± SD. Qualitative data were described by absolute and relative frequencies of occurrence, n (%). The nature of the data distribution was determined using the Shapiro – Wilk test. A comparison test for two samples — the Student t-test or its non-parametric analogue — the Mann - Whitney test was used to compare two unrelated groups. The Student's t test or the paired nonparametric Wilcoxon signed rank test was used to compare two related groups. The intraclass correlation coefficient (ICC) was used to assess the relationship between variables at two points of questionnaire completion with the test-retest method. Spearman's r correlations were used to assess associations between continuous variables. The strength of a correlation was measured with r:and considered weak at $0.1 < r < 0.39$; as moderate at $0.4 \leqslant r < 0.69$ and strong at $r \geqslant 0.7$ [18]. Cronbach's α coefficient was calculated for assessment of the internal consistency of the questionnaire. Effect sizes (ES) were determined to examine changes in scores over time. The effect size was considered small with ES = 0.2–0.5, as medium with ES = 0.5–0.8 and large with ES > 0.8 [19]. All tests were two-sided, differences between groups were considered statistically significant at $p < 0.05$. Statistical analysis was performed using SPSS 23.0 software.

RESULTS

Psychometric properties of Russian versions of FADI and FAAM

Reliability

The Cronbach's α coefficient was identical and amounted to 0.91 for the FADI and FAAM daily activity and to 0.94 for sports. The reproducibility assessment showed no change in activities of daily living (FADI: (79.2 ± 16.6) vs. (79.3 ± 16.7); ES = 0.008; FAAM: (83.9 ± 14.4) vs. (84 .1 ± 14.0); ES = 0.008), as well as sports activity (68.8 ± 24.5) versus (68.8 ± 24.0); ES < 0.001 with both questionnaires repeated by patients in stable condition. The intraclass correlation coefficient ICC indicator was 0.999 (95 % CI: 0.997–0.999; $p < 0.001$) for the FADI daily activities, 0.992 (95 % CI: 0.980–0.997; $p < 0.001$) for the FAAM daily activities, 0.999 (95 % CI: 0.998–1.000; $p < 0.001$) for sports when the FADI and FAAM questionnaires were first completed and then refilled. In general, both questionnaires were characterized by good internal consistency and reproducibility indicating acceptable reliability of the Russian versions.

Validity

The correlation coefficient Spearman's r of the activity of daily living and sports was 0.470 (95 % CI: 0.301–0.610, $p < 0.001$) as measured with FADI and 0.482 (95 % CI: 0.315–0.620, $p < 0.001$) as determined with FAAM. The data indicate satisfactory construct validity of both questionnaires. Statistically significant positive correlations were established for the FADI and FAAM scores of activities of daily living, for sports with the value of the DF angle in the MCP1. The correlation coefficient Spearman's r was 0.388 (95 % CI: 0.208–0.543, $p < 0.001$) for the FADI daily activity score and the TC angle in MCP1, 0.403 (95 % CI: 0.224– 0.555, $p < 0.001$) for the FAAM daily activity score and the DF angle in MCP1 and 0.227 (95 % CI: 0.032–0.406, $p = 0.023$) for sports and the DF angle in MCP1. Table 2 presents Spearman's r correlation coefficients for the FADI and FAAM daily activity scores, the SF-36 sports activity scores and the LEFS total score.

Table 2

Correlations between FADI and FAAM scales, SF-36 and LEFS scales

Scale	Total LEFS score	PF	RLPHP	P	GHP	E/F	SF	RLEP	EWB
FADI Activities of Daily Living	0.531**	0.532**	0.430**	0.471**	0.393**	0.460**	0.414**	0.274*	0.316**
FAAM Activities of Daily Living	0.581**	0.557**	0.463**	0.492**	0.432**	0.334**	0.406**	0.234*	0.226*
Sports	0.441**	0.437**	0.369**	0.399**	0.193	0.227*	0.291**	0.214*	0.174

Note: * correlation coefficients are statistically significant at $p < 0.05$; **correlation coefficients are statistically significant at $p \leqslant 0.001$. Health concepts measured with SF-36: PF, physical functioning; RLPHP, role limitations caused by physical health problems; *P*, pain; GHP, general health perceptions; E/F, energy/fatigue; SF, social functioning; RLEP, role limitations caused by emotional problems; EWB, emotional well-being.

Statistically significant correlations of moderate or weak strength were obtained for the scores of both questionnaires and the total LEFS score and for the SF-36 score. In general, the findings indicated acceptable criterion and convergent validity of the Russian versions of the FADI and FAAM questionnaires. Using the "known groups" method, statistically significant differences in the activities of daily living and sports measured with FADI and FAAM were demonstrated in the group of patients with no impairment and mild impairments in the range of motion in the MCP1 compared to the group of patients with moderate and severe impairment in the range of motion in the MCP1 (Fig. 1).

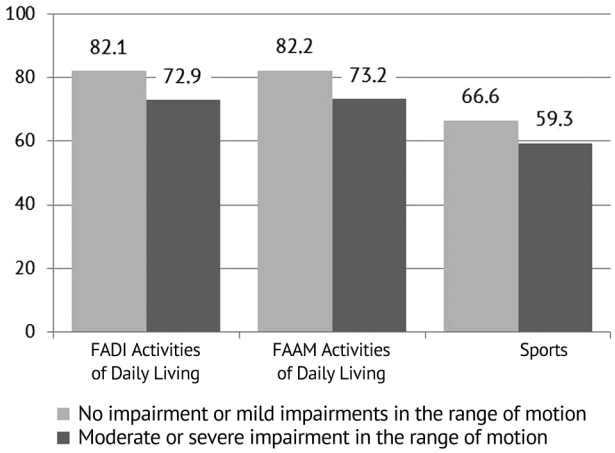

Fig. 1 The mean scores of the activities of daily living and sports measured with the FADI and FAAM questionnaires in patients with varying degrees of impairment in range of motion based on the DF angle in the MCP joint

Patients with moderately and severely impaired range of motion had lower ADL scores (worse foot condition) than those with no or mild impairment in the range of motion (FADI: (72.9 ± 14.5) vs. (82. 1 ± 10.2), $p < 0.001$; FAAM: (73.2 ± 14.9) vs. (82.2 ± 10.9), $p = 0.001$). There were no statistical differences between the groups on the sports activity scale. The findings indicated good discriminant validity of the ADL of the Russian versions of FADI and FAAM.

Sensitivity

Changes in ADL and sports of the FADI and FAAM questionnaires were analyzed at 2 months of surgery and compared with preoperative values (Table 3). There was a significant improvement in the scores of both questionnaires postoperatively ($p < 0.001$). Changes in the FADI and FAAM ADL scores corresponded to a moderate ES effect size (0.403 and 0.443) and to a larger effect size (0.781) for the sports.

Table 3

Mean scores of ADL and sports measured with the FADI and FAAM questionnaires completed preoperatively and postoperatively

Scales	Pre-op		At 2 months		*p*	ES
	mean	Standard deviation	mean	Standard deviation		
FADI Activities of Daily Living	78.44	12.86	83.63	3.63	< 0.001	0.403
FAAM Activities of Daily Living	78.60	13.32	84.50	4.63	< 0.001	0.443
Sports	63.69	22.83	81.53	7.30	< 0.001	0.781

Therefore, the Russian versions of FADI and FAAM were highly sensitive to postoperative changes in the foot.

Testing of Russian versions of FADI and FAAM in orthopaedic patients before and after surgical treatment of forefoot pathology

Testing of the FADI and FAAM questionnaires suggested analysis of changes in the ADL and sports scores, in the postoperative level of the foot functionality associated with ADL and with sports in patients and comparison with preoperative scores. The analysis was performed for the whole sample and separately in athletes and non-athletes (Fig. 2). As seen from the figure, significant improvements were seen on the scales of both questionnaires at 2 months and with additional parameters in the whole sample and in non-athletes. Athletes demonstrated improvement in most parameters and statistically significant changes were established for sports and functional foot scores associated with ADL and sports (Fig. 2).

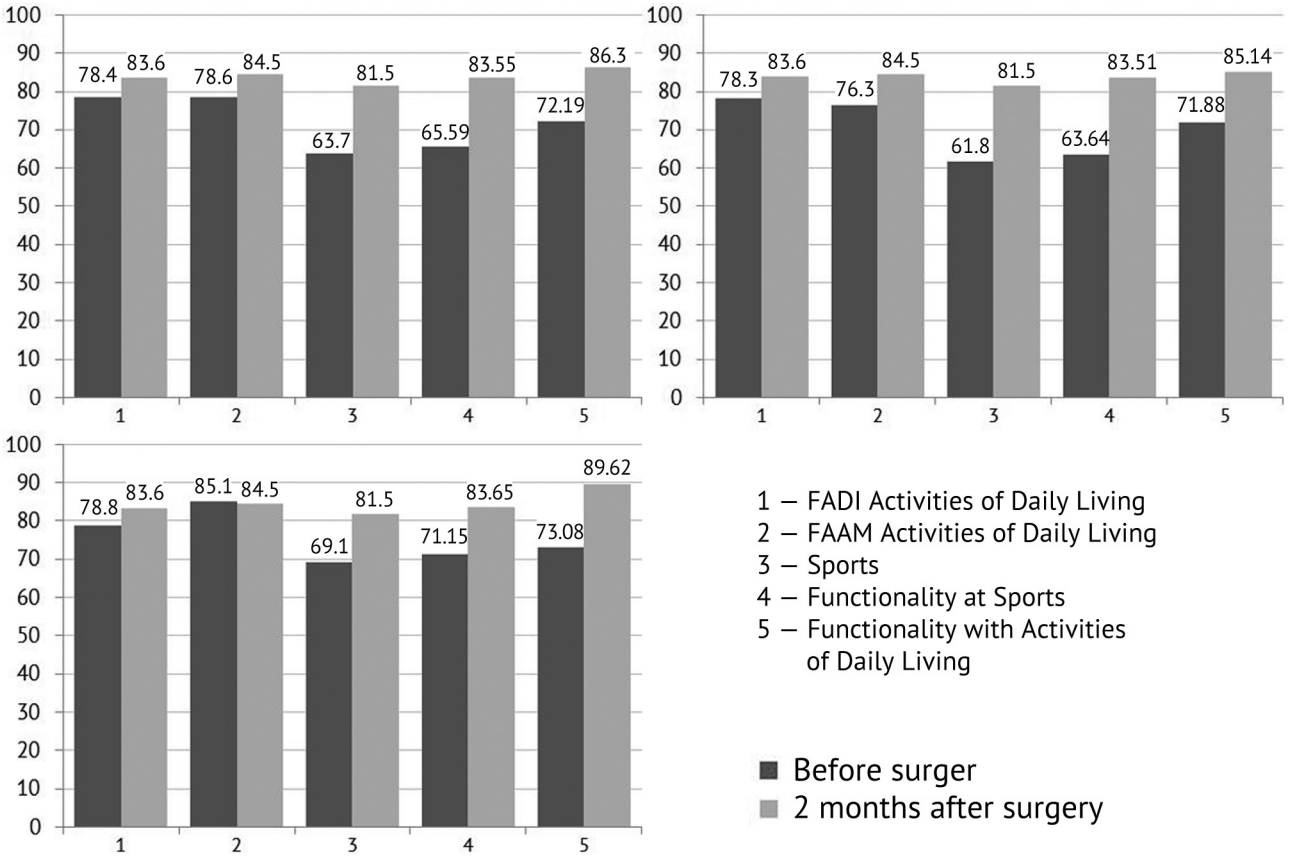

Fig. 2 Mean FADI and FAAM scores for activities of daily living, for sports, average foot function during activities of daily living, during preoperative ADL and at 2 months postoperatively in the total sample (*a*), non-athletes (*b*) and in athletes (c)

The suitability of data on the completion of questionnaires was explored for the use in the focal patient population. All questionnaires were completed by the patients with no items missed (0 % missing data). A small number of patients showed minimum (0) and maximum scores (100) on the scales, i.e. the "floor and ceiling effect" was not evident. Preoperative data demonstrated the proportion of answers with maximum values in 3 % on the sports scale, 1 % and 0 % on the FAAM and FADI ADL, respectively. None of the patients showed minimum score in ADL and sports. The findings indicated the high quality of the data and confirmed that respondents could understand the questions that cause no discomfort to them when answering and posed no difficulties when choosing an answer. On average, it took 8 minutes to complete the FADI questionnaire, and 12 minutes to fill out the FAAM.

DISCUSSION

Patient-administered questionnaires are widely used for a comprehensive assessment of foot and ankle dysfunction and associated limitations in orthopaedic patients [7]. They have been shown to be informative and useful in determining the effectiveness of surgical treatment and rehabilitation [2, 3]. The FADI and FAAM questionnaires are most common tools recommended by the international orthopaedic community for assessing the foot and/or ankle, including intraoperative evaluation [12]. The questionnaires are widely used for scientific and practical purposes abroad [8, 20]. Previously, we developed the Russian versions [6]. However, a new language version of the questionnaire can be used if its psychometric properties have been tested and the instrument has been tested in a focal patient population [21–23]. This study was aimed to analyze the psychometric properties of the Russian versions of the FADI and FAAM questionnaires and test them in a domestic sample of patients who needed surgical treatment for forefoot condition. Validation was produced in accordance with modern international recommendations [13, 14]. Different aspects of the reliability and validity of the FADI and FAAM questionnaires were explored. Both questionnaires were shown to have good internal consistency and reproducibility.

High Cronbach's α coefficient was obtained for the FADI and FAAM questionnaires with identical score for ADL that amounted to 0.91 and 0.92 for sports. The findings were similar to those determined with validations of the questionnaires performed in other countries [24–26, 27]. High intraclass correlation coefficients ICC were obtained with 0.999 for the FADI ADL, 0.992 for the FAAM ADL and 0.999 for the sports with questionnaires being completed twice by patients in a stable condition characterizing the reproducibility. Our data on the reproducibility of FADI and FAAM were not inferior to the results reported in other studies [26, 28, 29].

An extensive analysis of the validity: criterion, convergent and discriminant was performed for the validity of the Russian versions of the FADI and FAAM questionnaires. Based on the Spearman's *r* correlation coefficient between the ADL and sports scores, satisfactory construct validity of both questionnaires was shown. A correlation analysis was used for the FADI and FAAM questionnaires with the TC angle in the MCP1 to assess the criterion validity. As part of the assessment of convergent validity, a correlation analysis was performed for the FADI and FAAM scores, the SF-36 and the total LEFS scores. The significant correlations indicated acceptable criterion and convergent validity of the Russian versions of the FADI and FAAM questionnaires. There were statistically significant differences in the ADL and sports scores measured with FADI and FAAM in patients with no or mild impairments in the range of motion in the MTP1 compared to the patients with moderate or severe impairments in the range of motion in the MTP1. These findings indicated good discriminant validity of the questionnaires. In general, the findings reflected the reported results on the validity of the FADI and FAAM questionnaires [25, 26, 28, 30, 31]. The types of validity assessed in our series were not reported in other series. This suggested that our results on the reliability of the Russian versions of the FADI and FAAM questionnaires had a good evidence. The sensitivity of the Russian versions of the FADI and FAAM questionnaires was determined by estimating the effect size ES of changes in scores after foot surgery. There were significant positive postoperative changes in ADL and sports scores measured with FADI and FAAM suggesting a moderate ES effect size (0.403 and 0.443), and a larger effect size (0.781) for the sports. The ES values were similar to those reported in other studies [32]. In our series, the period for filling out the questionnaire after surgery was shorter and amounted to two months, instead of six months as mentioned in other studies. The Russian versions of the FADI and FAAM questionnaires were sensitive to changes in the foot after surgical treatment and can be recommended for self-administered surveys. However, some validation studies failed to assess the sensitivity of the FADI and FAAM questionnaires.

Modern recommendations for assessing the psychometric properties of a newly developed language version of the questionnaire [14] suggest testing of the sensitivity to changes as a necessary component of the validation procedure. Testing of the instrument in a focal patient population is of particular interest. We tested the Russian versions of the FADI and FAAM questionnaires in patients with foot pathology who were indicated for surgical treatment. Parameters of the questionnaires were analyzed preoperatively and at two months. The analysis was performed for the whole sample, in athletes and in non-athletes. Non-athletes showed significant postoperative improvements in FADI and FAAM scores, in the functionality of the foot with ADL and sports. Athletes demonstrated significant improvements in sports, in the functionality of the foot during normal ADL and during sports. In addition to that, good completion rates with no extreme values in the scores ("floor and ceiling effect") were demonstrated indicating their suitability and informativeness for monitoring the foot condition in orthopedic patients during treatment. The advantages of our study include, first, the comprehensively analysis of the psychometric properties of the Russian versions of the FADI and FAAM questionnaires using different methods. Secondly, the questionnaires were tested in the domestic population of patients undergoing surgical treatment of foot pathology. And finally, the questionnaires were tested in a group of non-athletes and a group of athletes. The presence of a sports activity scale in the FADI and FAAM questionnaires distinguishes them favorably from other instruments focused on assessing the condition of the foot and ankle and associated limitations [15, 32–34]. The specific testing among athletes seems extremely valuable. The study has a number of limitations. The main limitation is that the sample consisted mainly of patients with one type of orthopaedic pathology, hallux valgus. Another limitation of the study is that the majority of patients were females. Another limitation is that all patients were treated in the same health care facility. We can conclude that in the future it would be advisable to test the Russian versions of the FADI and FAAM questionnaires in patients with other foot pathologies and to conduct multicenter studies using these questionnaires.

CONCLUSION

The Russian versions of the FADI and FAAM questionnaires are reliable and valid tools for assessing the condition of the foot/ankle joint in orthopAedic patients. the FADI and FAAM questionnaires were found to be sensitive to changes in the foot/ankle joint in the Russian patients who had indications for surgical treatment of the foot. Significant improvements were recorded in the postoperative scores of both questionnaires in patients with forefoot condition. The information content of the FADI and FAAM questionnaires in athletes and their sensitivity to postoperative changes in the foot/ankle joint in patients of this cohort were demonstrated. The results of testing the FADI and FAAM questionnaires indicate that the instruments are convenient and understandable for patients, are informative for monitoring the condition of the foot/ankle joint, and can be recommended for use in domestic clinical studies and clinical practice.

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Ethical Approval *The study was reviewed and approved by the local ethics committee. Minutes No. 07/22 of 07/07/2022 of the meeting of the Committee on Biomedical Ethics of the Clinic of High Medical Technologies named after. N.I. Pirogov (polyclinic, hospital) St. Petersburg State University.*

Informed consent *was given prior to inclusion in this study by all patients.*

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