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ORIGINAL ARTICLE

Psychometric evaluation of the Arabic version of the Quebec user evaluation of satisfaction with assistive technology (A-QUEST 2.0) in prosthesis users

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ABSTRACT

BACKGROUND: The evaluation of patient satisfaction and perceptions plays a vital role in determining the quality of prosthesis users' devices and the competency of healthcare services.
AIM: To evaluate the psychometric properties of the Arabic Quebec User Evaluation of Satisfaction with Assistive Technology (A-QUEST 2.0) with prosthetics users.
DESIGN: A methodological study.
SETTING: Saudi Arabia, Turkey.
POPULATION: A convenience sample of outpatient prosthesis users (N.=183).
METHODS: The A-QUEST 2.0 includes two subscales respectively evaluating the user's satisfaction with the device and the services provided. The data for each subscale were investigated using Rasch analysis to evaluate the item fit, reliability indices, item difficulty, local item dependency, and differential item functioning (DIF).
RESULTS: Both subscales met the Rasch criteria for the functioning of rating scale categories. All items showed an acceptable fit to the Rasch model. The person separation indices for the Device and Services subscales were 2.21 (Cronbach's α=0.90) and 1.72 (Cronbach's α=0.85), respectively. Therefore, the two subscales are sensitive enough to distinguish between at least three different levels of satisfaction. The unidimensionality of each subscale was confirmed, and none of the items displayed differential item functioning across age, gender, location of amputation, country, and duration of use.
CONCLUSIONS: Overall, the findings indicate the psychometric evaluation of A-QUEST 2.0 is effective with prosthesis users across different clinical contexts and cultures. Thus, the A-QUEST 2.0 allows for a comprehensive understanding of users' perceptions of prosthesis characteristics, particularly among subjects with lower limb amputations caused by traumatic injuries.
CLINICAL REHABILITATION IMPACT: Our paper provides clinicians dealing with Arabic patients a validated outcome measure for satisfaction with prosthesis. Besides providing information in the development of new products and service delivery. Further studies are necessary to improve the measure's metric quality in different contexts and for different prosthesis devices.

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KEY WORDS: Quality of life; Outcome assessment, health care; Prostheses and implants; Patient satisfaction; Psychometrics; Self-help devices.

As healthcare institutions work towards improving the parameters of their rehabilitation programs and in turn gaining accreditation for their facilities, interest in obtaining feedback from the individuals receiving care has increased.[1, 2] In rehabilitation, the American Board for Certification (ABC) in Orthotics, Prosthetics, and Pedorthics accredits clinics and determines the extent to which the implemented measures meet quality care standards.[3] Some quality standards are specific, such as collecting data on user satisfaction with products and services, whereas other

quality standards are discretionary.[4] Prosthetic services and rehabilitation must be designed to address users' functional status and goals, personal preferences, and health conditions. Accordingly, users' experience and feedback play a key role in determining the quality and efficiency of the care provided and in developing new designs and policies that can contribute to increased wellbeing and independence.[5]

Usage of assistive devices, including prostheses, has been on the rise in Arabic-speaking countries. Reasons for this increase include trauma (*i.e.* road traffic accidents),[6] which is a leading cause; war and terror events; and health conditions such as diabetes, which has a high prevalence in the Middle East region in countries such as Saudi Arabia (23.7%)[7] and Jordan (16.9%).[8, 9] Regarding rates of diabetes, Saudi Arabia is ranked 7th highest in the world and 2nd highest in the Middle East.[10-12] In addition, a large number of people suffering from limb losses includes active young individuals.[13]

Limb loss has tremendous consequences on functional capability and quality of life. The need for systematic assessments adapted to Arabic culture and language is therefore imperative. The Quebec User Evaluation of Satisfaction with Assistive Technology 2.0 (QUEST 2.0) developed by Demers *et al*. is a widely used tool for measuring specific outcomes regarding a user's degree of satisfaction with a device and with a healthcare provider's services; QUEST 2.0 is applied with all assistive device users, including prosthesis users, and stands out for its ease of use.[14-16] The tool consists of twelve items: eight items assess satisfaction level regarding the device, and four items assess the satisfaction level regarding the care and service provided.[17, 18] QUEST 2.0 is a psychometrically sound tool that has been translated into several languages,[14, 19-24] including Arabic.[15]

Routine data gathering to monitor users' outcomes is challenging for clinicians irrespective of the context, but Arabic-speaking countries in particular often lack access to validated, psychometrically sound outcome measures.[25] Prosthesis users in Arabic-speaking countries would therefore benefit from a validated outcome measure.[4] Accordingly, the aim of this study was to examine the psychometric properties of the A-QUEST 2.0 with prosthesis users.

Materials and methods

Cohort

This was a methodological multicenter study. From June 2017 to August 2019, 205 subjects were approached across two countries. Of these subjects, 8 declined to participate.

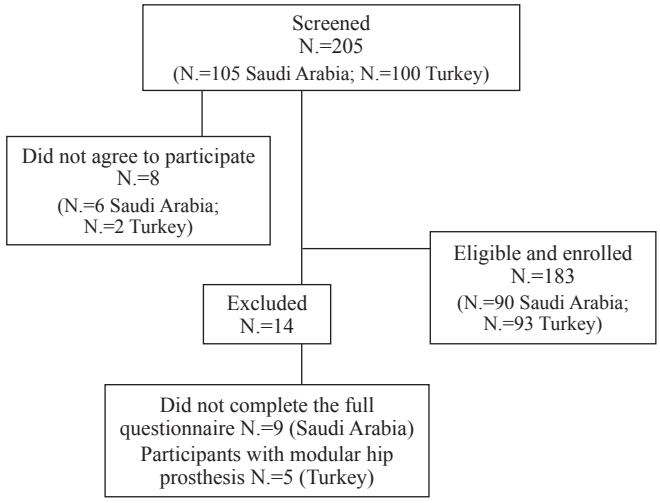

Figure 1.—Flow chart of participants recruitment procedure.

After exclusion of some participants (Figure 1), a total of 183 participants were enrolled. In Saudi Arabia, 90 participants were enrolled; these participants were accessed *via* the outpatient rehabilitation departments of the three medical cities located in Riyadh. In Turkey, 93 participants were recruited; these participants came from three prosthesis and orthosis centers located in Istanbul, Reyhanli and Sanliurfa. All three centers were funded by the Zakat House of Kuwait and established and managed by the Alliance of International Doctors (AID), an international non-governmental organization (NGO) that provides prosthetics and orthotics services to Syrian refugees living in Turkey who have been injured in the Syrian civil war or as a result of accidents or medical complications (*e.g.* diabetes-related amputation).

The inclusion criteria were as follows: 1) current use of a prosthesis; 2) aged 18 years or older; 3) native Arabic speaker; and 4) used the prosthesis for a minimum of 6 months. The exclusion criteria were as follows: 1) difficulty reading the Arabic language; 2) non-Arabic native speaker; 3) presence of cognitive deficits (a Mini-Mental State Examination was conducted by the treating physician, and mild cognitive impairment was indicated by scores 28 or lower); and 4) have used the prosthesis for less than 6 months. The demographics and clinical characteristics of the sample are reported in Supplementary Digital Material 1: Supplementary Table I; Table I.

Outcome measures and procedure

QUEST 2.0 includes two subscales. The first evaluates a user's satisfaction with the device (items 1-8), and the

TABLE I.—*Prosthesis joint type (N.=183).*

Prosthesis type	Saudi Arabia N.=90		Syrian refugees in Turkey N.=93		Total N.=183	
	N.	%	N.	%	N.	%
Upper limb prosthesis						
Passive/cosmetic prosthesis	2	2	0	0	2	1
Body-powered	0	0	14	15	14	8
Myoelectric	3	3	0	0	3	2
Hybrid (myoelectric + body powered)	1	1	0	0	1	1
Lower limb prosthesis						
Prosthetic knee						
Passive MCP prosthetic knee*	25	28	1	1	26	14
Polycentric	17	19	22	24	39	21
Single axis (constant friction)	0	0	13	14	14	8
Prosthetic feet						
Dynamic elastic response	2	2	0	0	2	1
Ankle-foot-orthosis	1	1	0	0	1	1
Pirogoff foot	0	0	4	4	2	2
Dynamic foot	16	18	11	12	27	15
Single-axis foot	11	12	16	17	27	15
Carbon fiber foot	8	9	6	6	14	8
SACH foot**	4	4	6	6	10	5

*Passive microprocessor-controlled knee; **solid ankle cushion heel.

second evaluates satisfaction with services (items 9-12). Both subscales use a five-point Likert Scale (with 1= "not satisfied at all;" and 5= "very satisfied"). Each subscore is achieved by adding the valid scores and dividing the total by the number of valid answers in the relevant subscale. The result is a score in the range from 1.00 to 5.00.[16]

Either prior to or immediately after a rehabilitation follow-up session, subjects were approached by an occupational therapist and/or physical therapist who was neither responsible for the subject's care nor affiliated with the rehabilitation institution. This representative therapist explained the study's purpose and the questionnaire. Subjects willing to participate signed a consent form to enroll in the study and then self-completed the questionnaires. Ethical approval was granted by all three medical cities in Saudi Arabia and from Marmara University's Faculty of Medicine. This study followed the rules and regulations stipulated in the Helsinki Declaration.

Statistical analysis

To outline the cohort's clinical characteristics and measurement scores, descriptive statistics were used. For psychometrics, a Rasch analysis (RA) was used to determine whether the properties of each measure fulfilled a wide range of psychometric requirements (*e.g.* content validity and unidimensionality) that could not be examined with classical testing methods.[26, 27] The RA was performed using WINSTEPS Version 4.6.1[28] to investigate the subsequent aspects of each subscale separately. We considered a sample with a minimum of 150 participants to allow for stable calibration of items within ±0.5 logit and with 99% confidence.[29]

Rating scale diagnostics

Linacre's guidelines were followed to assess the A-QUEST 2.0 subscales' rating options. The criteria were as follows: 1) a minimum of 10 observations per category; 2)

TABLE II.—*Descriptive statistics of A-QUEST 2.0 measurement scores.*

Variables	Device subscale mean (SD); median (IRQ)						
	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7
Saudi Arabia N.=90	3.8 (1.14); 4 (5)	3.5 (1.19); 4 (4)	3.7 (1.04); 4 (4)	3.9 (0.98); 4 (5)	4.1 (1.04); 4 (5)	3.9 (0.94); 4 (5)	3.4 (1.19); 4 (4)
Turkey .=93	3.5 (1.3); 3 (5)	3.5 (1.2); 3 (5)	3.5 (1.3); 3 (5)	3.3 (1.4); 3 (5)	3.5 (1.3); 4 (5)	3.3 (1.3); 3 (4)	3.2 (1.4); 3 (4)
Total N.=183	3.6 (1.2); 4 (5)	3.5 (1.2); 4 (4)	3.6 (1.2); 4 (5)	3.6 (1.2); 4 (5)	3.8 (1.2); 4 (5)	3.6, (1.2); 4 (5)	3.3 (1.3); 3 (4)

SD: standard deviation; IQR: interquartile range (75th).

even distribution of category use; 3) category outfit mean square values more than 2; 4) monotonic increase in both average measures of individuals with a given category and thresholds; and 5) threshold differences larger than 0.81 log-odd units and smaller than 5.[30]

Item fit statistics

Each of the A-QUEST 2.0 subscales were investigated. The fit of each item to the latent trait and the consistency of the item difficulties with the model's expectations were determined.[31] Information-weighted (infit) and outlier-sensitive (outfit) mean-square statistics (MnSq) were calculated for each item. Acceptable fit values were defined as MnSq values from 0.75 to 1.3.[28, 31] Values outside of this range were considered under and overfit, respectively (*i.e.*, suggesting either an overly predictable pattern or an expectedly high variability). Standardized *t*-scores (ZSTD) were also calculated to examine the probability that the data would fit the Rasch model within the acceptable range for ZSTD scores (defined as ±2.0). Consequently, for an item to be misfit, both the MnSq and ZSTD had to be outside the respective defined ranges.[32] Additionally, item difficulty was evaluated informally using the Wright map by comparing the distribution of the person parameter estimates and the distribution of the item thresholds.

Reliability

This assessment was based on separation, which is defined as the ratio of the true spread of the measures to the measurement error.[31] A good Person Separation Index of 2.0 was used as a criterion as this index allows for distinction among three stages or "strata" of measures that are statistically evident and equal to a reliability of 0.80, which is interpreted similarly to Cronbach's alpha.[33]

Principal component analysis (PCA)

This analysis of standardized residuals was conducted to provide additional confirmation on each subscale's unidimensionality. Two criteria were used to determine whether additional factors were likely to be present in the residuals:

- a cut-off of 50% of the variance explained by the initial latent trait (Rasch factor);
- eigenvalue of the first contrast <2.

Furthermore, an analysis of the local independency of items was conducted, and the presence of high correlation (>0.30) of residuals for two items signified that those items may have been locally dependent.[28]

Differential item functioning (DIF)

This assessment was used to determine whether the items had comparable difficulty hierarchies across demographic groups and to investigate potential differences due to context effects between the measures obtained across the subgroups. Five dichotomous mutually exclusive categories were defined based on the following criteria: 1) gender (male *vs*. female); 2) amputation location (lower *vs*. upper limb); 3) duration of use (less than one year *vs*. over one year); 4) country (Saudi Arabia *vs*. Turkey); and 5) age (younger *vs*. older, with mean age of 36 years old). Pairwise item-by-item difficulty tests between the two sets were calculated (two-sided *t*-test for the difference between means, α=0.05 with Bonferroni's correction). A prior hypothesis was that we would not find DIF in the analyzed groups (aside from possible minor differences due to typical gender-, age-, or culture-related characteristics). A criterion of at least 0.5 logit difference with a P<0.05 was used to detect DIF.[34]

Results

The study consisted of 183 participants; a flow chart of participant enrolment is presented in Figure 1, and the demographic, clinical characteristics, and measurement scores of the cohort are outlined in Supplementary Table I; Table I, Table II.

The RA revealed the following:

- rating scale diagnostics demonstrated that, in both

Device subscale mean (SD); median (IRQ)		Service subscale mean (SD); median (IRQ)				
Item 8	Total	Item 9	Item 10	Item 11	Item 12	Total
3.8 (1.13); 4 (5)	3.8 (80); 4 (4.21)	3.4 (1.38); 4 (5)	3.7 (1.19); 4 (5)	3.8 (1.16); 4 (5)	3.6 (1.19); 4 (4)	3.6 (1.02); 4 (4.25)
3.4 (1.2); 3 (4)	3.4 (1.0); 3 (4.25)	3.8 (1.2); 4 (5)	3.9 (1.0); 4 (5)	3.8 (1.2); 4 (5)	3.9 (1.2); 4 (5)	3.9 (1.0); 4 (4.75)
3.6 (1.2); 4 (5)	3.6 (0.9); 4 (4.25)	3.6 (1.3); 4 (5)	3.8 (1.1); 4 (5)	3.8 (1.2); 4 (5)	3.8 (1.2); 4 (5)	3.7 (1.0); 4 (4.5)

TABLE III.—*Category functioning for A-QUEST 2.0 subscales.*

Subscales	Category label	Category measure	Andrich threshold	Outfit MnSq	Infit MnSq	Observed count
Device subscale	1. Not satisfied at all	-2.73	NONE	1.54	1.31	113 (8%)
	2. Not very satisfied	-1.31	-1.24	1.01	0.92	162 (11%)
	3. More or less satisfied	-0.16	-1.06	0.87	0.85	371 (25%)
	4. Quite satisfied	1.25	0.47	0.77	0.72	409 (28%)
	5. Very satisfied	3.09	1.83	1.05	1.10	409 (28%)
Services subscale	1. Not satisfied at all	-3.01	NONE	1.51	1.31	49 (7%)
	2. Not very satisfied	-1.53	-1.56	0.68	0.71	62 (8%)
	3. More or less satisfied	-0.27	-1.22	0.76	0.78	160 (22%)
	4. Quite satisfied	1.46	0.36	0.83	0.78	214 (29%)
	5. Very satisfied	(3.61)	2.42	1.17	1.34	247 (34%)

Average category measures, thresholds, category fit statistics (outfit and infit mean square, MnSq), and observed frequency (count) for the 5-category rating scales of the two A-QUEST 2.0 subscales. A monotonic increase in both average measures across rating scale categories was observed, thresholds increased (but the distance between categories 2 and 3 was narrow), category outfit mean square values were less than 2, and the number of observations per category was appropriate, with a negatively skewed distribution. Overall, these findings suggest that the category structure functions in an acceptable way.
Outfit: outlier-sensitive; Infit: information-weighted; MnSq: mean square.

TABLE IV.—*Item calibration (measure; increasing bottom-up) with standard errors, infit and outfit mean-square statistics (MnSq) and t standardized statistics (ZSTD) for the A-QUEST2.0 Device subscale, and A-QUEST2.0 Services subscale.*

Items	Measure (SE)	Infit		Outfit	
		MsSq	ZSTD	MnSq	ZSTD
Device subscale					
7. How comfortable your assistive device is?	0.40 (0.09)	0.97	-0.29	1.01	0.10
2. The weight of your assistive device?	0.12 (.09)	1.13	1.25	1.17	1.47
6. How easy is it to use your assistive device?	-0.02 (0.10)	0.73	-2.70	0.77	-2.13
8. How effective is your assistive device	-0.03 (0.10)	0.90	-0.90	1.03	0.33
4. How safe and secure your assistive device is?	-0.03 (0.10)	1.08	0.79	1.12	1.07
3. The ease in adjusting the parts of your assistive device	-0.05 (0.10)	0.83	-1.61	0.81	-1.78
1. The dimensions of your assistive device?	-0.06 (0.10)	1.02	.23	1.03	0.33
5. The durability (resistance to wear) of your assistive device?	-0.33 (0.10)	1.30	2.51	1.27	2.08
Services subscale					
9. The service delivery program (procedures, length of time) in which you obtained your assistive device?	0.35 (11)	1.21	1.73	1.19	1.56
12. The follow-up services received for your assistive device?	-0.03 (0.11)	0.85	-1.30	0.84	-1.38
11. The quality of the professional services (information, attention) you received for using your assistive device?	-0.11 (0.11)	1.01	0.12	0.98	-0.13
10. The repairs and servicing (maintenance) provided for your assistive device?	-0.21 (0.11)	0.89	-0.95	0.90	-0.85

Acceptable fit range defined as MnSq 0.75-1.3 and ZSTD -2–2. The difficulty estimate for the item as a whole is the mean value of the difficulty measures of the thresholds along that item. Higher item measures (items #7 and #9) reflect lower satisfaction with that prosthesis feature or service.
SE: standard errors.

subscales, all 5 response options functioned acceptably and fulfilled category function criteria as described by Linacre[35] (Table III);

• item fit statistics showed that, in both subscales, all items fit the measured constructs, Satisfaction with Device and with Services (Infit and Outfit MnSq 0.75 to 1.3) (Table IV). Figure 2 illustrates the Wright map for participants' ability (in terms of satisfaction) and item difficulty for each of the two subscales. For the Device subscale, participants' ability levels ranged 7.46 logits (from -2.35 to 5.11, where the average measure of non-extreme persons was 0.69), and item difficulty estimates spanned 0.73 logits (from -0.33 to 0.40). Furthermore, on the Device subscale, eleven (6%) participants obtained a maximum score. On the Services subscale, participants' ability levels ranged 9.17 logits (from -4.20 to 4.97, where the average measure of non-extreme persons was 0.81). Item difficulty estimates spanned 0.56 logits (from -0.21 to 0.35), with thirty-two (17.5%) participants obtaining the maximum score and three (1.6%) participants obtaining a minimum score;

• the reliability indices outcomes of the Device subscale have a Person Separation Index: 2.21 with person separation reliability: 0.83 (Cronbach's α=0.90). Furthermore, the Services subscale Person Separation Index: 1.72 with person separation reliability: 0.75 (Cronbach's α=0.85);

• the PCA results of the standardized residuals revealed

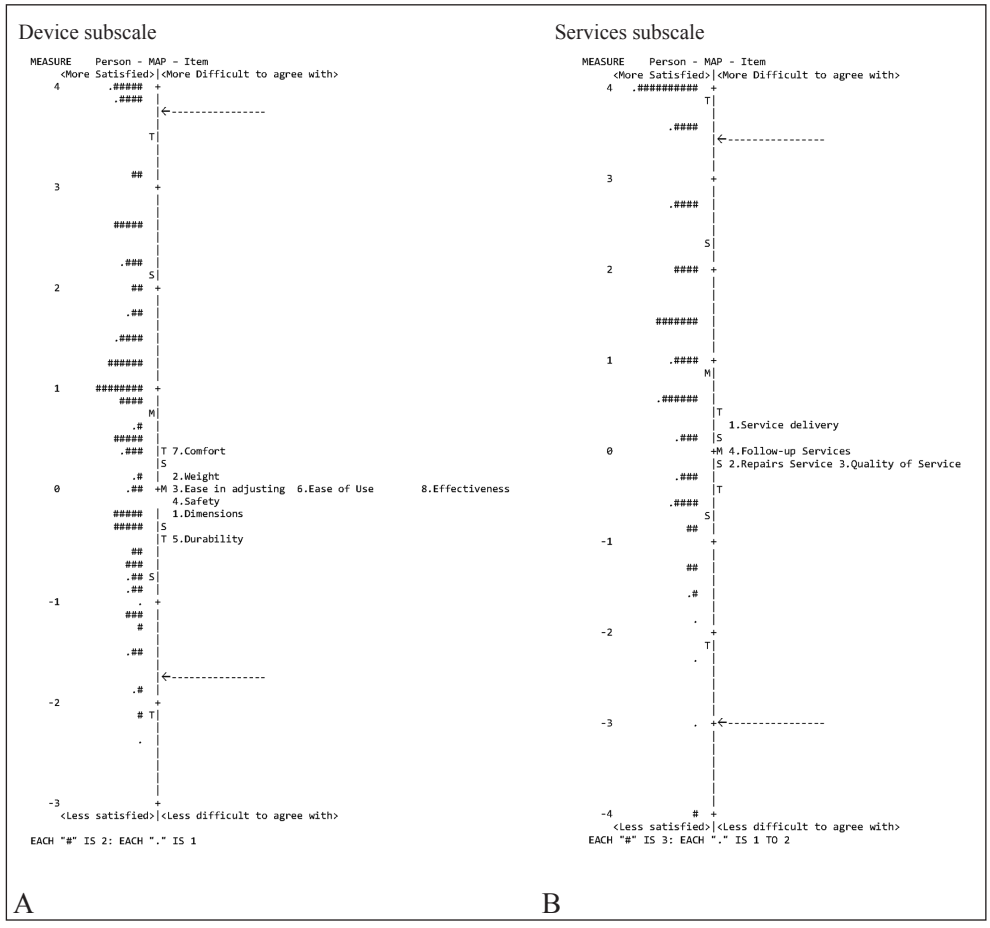

Figure 2.—Wright's Map: participant ability and item difficulty map of the A-QUEST 2.0. A) Device; and B) services subscales.
The vertical line represents the measure of the variable in linear logit units. The left-hand column locates the individual's ability along the variable. Each "#" indicates 3 persons whereas "." indicates 1-2 persons. The right-hand column locates the items' difficulty measures along the variable (for each item, the difficulty estimate represents the mean calibration of the threshold parameters according to the rating scale model). From the bottom, measures indicate "lower satisfaction" for patients and "lower difficulty to be satisfied with" for items, whereas "higher satisfaction" and "higher difficulty to be satisfied with" are located at the top. The average difficulty of items in the test is set at 0 logits (and indicated with M). Accordingly, a candidate with average ability is indicated with M′. The two arrows represent the threshold boundaries for item difficulty.

that the Device subscale showed variance. That variance was explained by the estimated Rasch measure (56.3%; eigenvalue 10.31), and the eigenvalue of the first contrast was 1.51. Furthermore, the Services subscale showed positive variance, which was also explained by the estimated measure (56.2%; eigenvalue 5.14). The eigenvalue of the first contrast was 1.54. PCA residuals correlations for both subscales were lower than 0.30;

- the DIF investigation revealed no distinct dependence of the measure on the cohort's attributes (*i.e.*, age, gender, level of amputation, country, and duration of use).

Discussion

The implementation of outcome measures for clinical outcomes and users' perception and satisfaction has increased steadily as these measures are considered key to improving the quality of healthcare service delivery, particularly in the field of prosthetics.[36] However, many factors influence and limit the adoption of evidence-based quality indicators in prosthetics, including limited availability of valid and psychometrically sound outcome measures adapted to different cultural contexts.[4]

This study aimed to evaluate the psychometric properties of the Arabic version of the Quebec User Evaluation of Satisfaction with Assistive Technology 2.0 (A-QUEST 2.0) on prosthesis users and to establish further evidence of its psychometric robustness. This study is the first to test A-QUEST as a measure for evaluating satisfaction with Arabic-speaking users of both lower and upper limb prostheses. Most previous studies involving QUEST 2.0 have been conducted using assistive technologies and orthoses.[19, 21, 23, 37-39] Only one study has used A-QUEST 2.0 in an Arabic-speaking country, but this study examined only orthoses users from a single country.[15] It should be noted that the present study is also the second attempt to investigate the metric properties of A-QUEST 2.0 using RA, the first one being the aforementioned study.[15]

Firstly, the rating scale diagnostics showed that the rating categories for both subscales were used appropriately (Table III), meaning that the participants were able to differentiate the satisfaction levels among the five rating choices. These results confirmed the findings reported in the first validation study related to A-QUEST 2.0.[15] Furthermore, fit statistics for both subscales demonstrated that all items fit the underlying construct, as shown in Table IV. Moreover, the order of item difficulty demonstrated that Item 5 on 'durability' (Figure 2A) and Item 10 on "repairs and servicing" (Figure 2B) were the easiest to endorse. However, a detailed and extensive comparison with other studies is not possible, as ours is only the second study to measure item difficulty. Additionally, differences in item performance are to be expected as item performance is influenced by different contexts and what type of device each patient has.[40, 41]

Furthermore, with regards to the item difficulty hierarchy, both subscales demonstrated diversion from perfect targeting of the user's ability in our cohort. The average satisfaction level was higher than the difficulty range of these items. These findings were also observed by Bakhsh *et al*., who noted that some orthosis users scored high in both subscales.[15] In general, with the context of the present study in mind, these findings are reasonable from a clinical perspective as users' satisfaction with their prosthesis is often high.[14, 38, 42-44] Nonetheless, the poor targeting indicates an absence of items in both subscales for analysing and addressing factors more relevant to higher levels of satisfaction (*e.g.* aesthetic appearance, functionality, technical quality, accessibility, and availability).[41, 45]

In terms of reliability indices, the findings indicate that both subscales are good and sensitive in differentiating among at least three satisfaction ranks (low, medium, high). These findings are in line with those reported by Berardi *et al.* (for total score Cronbach's α=0.858),[39] Koumpouros *et al*. (for Device subscale, Cronbach's α=0.754),[19] de Carvalho (Cronbach's α=0.862 and 0.717),[24] Mao *et al*. (Cronbach's α=0.87 and 0.84),[21] and others.[2, 20, 37, 46]

Unidimensionality was positively confirmed based on the PCA of standardized residual evaluation, as there was no presence of any second dimension for either subscale. The same PCA also confirmed the local independence of the items. Thus, the subscales were tapping into different aspects of the satisfaction construct in addition to having different metric properties, as established in previous studies.[15, 37] Only Koumpouros *et al*. has challenged this notion; their exploratory factor analysis for the Device subscale showed the presence of a three-factor structure. However, they attribute this finding at least in part to their population and the fact that they performed the analysis solely on the eight-item Device subscale rather than on the whole measure consisting of 12 items.[19]

Overall, the findings of this study support the A-QUEST 2.0 as a valid tool in determining user satisfaction with prosthesis devices in the included subjects. However, it should be noted that some aspects and domains of satisfaction are not wholly covered by this measure. Although the tool is useful in assessing specific domains of the prosthesis (*e.g.* dimension, comfort, and service delivery), other domains believed to contribute more holistically to use satisfaction with the device and services are absent (*e.g.* outcomes, continuity, and accessibility.[47] Therefore, clinicians seeking a comprehensive, complex evaluation of users' perspectives should consider the addition of other tools and measures alongside A-QUEST 2.0.

Limitations of the study

Care should be taken when generalizing the results of this study. While this study was based on a multicenter approach across two countries and included several types of prostheses, it had a number of limitations. First, our results may have been affected by the selection of the convenience sample, as the sample had uneven distribution in gender, etiology, and location of amputation (*i.e.* the sample predominantly consisted of male subjects who had suffered a traumatic injury resulting in lower limb amputation). This distribution of the sample demographics has been observed to be common in this part of the world in several studies.[13, 45, 48-51] For example, Albabtain *et al*. reported that the majority of subjects affected by blunt injuries caused by road traffic accidents were men (accounting for 79.9% of a sample of 3,263 subjects).[6, 52] This finding gains significance in that trauma is recognized as the top cause of mortality in Saudi Arabia, with motor vehicle accidents the major reason for that trauma and blunt injuries the most reported type of trauma (87%).[52] In addition, Ali *et al*. found that out of 100 patients 80 were male, the majority of the cases [76] were due to unplanned accidental causes, and only 8 cases were upper limb amputations.[48] Nevertheless, that further research is needed to address this limitation.

Second, most of the Syrian refugees – who comprised a large number of our study participants – had only recently received their first prosthesis; in other words, they had been using their prosthesis for only a short period of time. This cohort of participants demonstrated a similar degree of satisfaction compared with the Saudi cohort, which was characterized by a longer duration of prosthesis use. This

finding is in line with a previous study which confirmed that the duration of limb loss did not significantly correspond to satisfaction with the device, even in young amputees.[53] Furthermore, Luthi *et al*. argued that participants who have been using a prosthesis for a longer period of time have been able to adjust to their prosthesis, and therefore, they tend to report maximum scores of satisfaction; thus Luthi *et al*. recommended that future studies include participants with recent amputations.[54] Consequently, despite the fact that our study participants are using a prosthesis for the first time, a sense of satisfaction occurred in relation to the prosthesis and service.

Lastly, this study did not account for potential DIF in devices among different types of prostheses. This limitation is especially concerning given that the participants in Saudi Arabia had access to myoelectric prostheses while the Syrian participants in Turkey did not. Thus, further research is needed to verify the symmetric properties of this outcome measure in patients of different age groups using various prosthesis devices.

Conclusions

This study surveyed a multicenter cohort of prosthesis users from two countries with the aim of examining the psychometric properties of A-QUEST 2.0. The study confirmed the measure's satisfactory psychometric properties for the included subjects in terms of item performance, as indicated by the positive internal construct validity across prosthesis users with an acceptable range of items, though these measures were improvable. Furthermore, each subscale was confirmed to be unidimensional. Though A-QUEST 2.0 does appear to enable improved understanding of users' perceptions of prosthesis features in included subjects, Further studies are necessary to improve the measure's metric quality in different contexts and for different prosthesis devices.

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