Validation of LittlEARS® Early Speech Production Questionnaire in Arabic-speaking children with normal hearing

Tamer A. Mesallam, MD, PhD, *Medhat Yousef,* MD, PhD, *Ilona Anderson,* PhD, *Yassin Abdelsamad,* PhD, *Sara Alkhamiss,* BSc, *Abdulrahman Alsanosi,* MD.

ABSTRACT

الأهداف: التحقق من صحة النسخة العربية من استبيان ®LittlEARS المبكر لإنتاج الكلام (LEESPQ) في الأطفال الناطقين باللغة العربية الذين يتمتعون بسمع طبيعي في المملكة العربية السعودية.

المنهجية: هذه دراسة مقطعية أجريت في مدينة الرياض بين سبتمبر وديسمبر 2020. أكمل الآباء اختبار LEESPQ بناءً على تطوير إنتاج الكلام لدى أطفالهم. لتقييم قدرة الأطفال ذوي السمع الطبيعي الذين تتراوح أعمارهم بين 0 و 18 شهرًا في تطوير إنتاج الكلام واللغة، تم إنشاء منحنى معياري بناءً على القيم الموحدة التي تم حسابها من مجموعة بيانات السمع العربي.

النتائج: حللنا 198 استبانة. ترتبط النتيجة الإجمالية في LEESPQ بالعمر والجنس وثنائية اللغة. تم إنشاء منحنى معياري للإنتاج المبكر للكلام لدى الأطفال ذوي السمع الطبيعي.

الخلاصة: يبدو أن النسخة العربية من LEESPQ هي استبيان صالح يمكن استخدامه في تقييم تطور اللغة والكلام المبكر للأطفال الناطقين باللغة العربية ويتمتعون بسمع طبيعي وذلك في الفئة العمرية من 0 إلى 18 شهرًا. قد تكون النسخة العربية من LEESPQ أيضًا أداة مفيدة للكشف عن تأخر النمو واضطرابات السمع لدى الأطفال الصغار.

Objectives: To validate an Arabic version of the LittlEARS® Early Speech Production Questionnaire (LEESPQ), which assesses the early development of speech and language in infants between 0 and 18 months, in Arabic-speaking children with normal hearing in Saudi Arabia.

Methods: This is a cross-sectional study conducted in the city of Riyadh, Saudi Arabia between September and December 2020. Parents completed the LEESPQ regarding their child's speech production development. To assess the ability of normal hearing children aged 0-18 months in developing speech and language production, a norm curve has been generated based on the standardized

values that were calculated from the Arabic normal-hearing data set.

Results: A total of 198 questionnaires were analyzed. The total score on the LEESPQ correlated with age, gender, and bilingualism. A norm curve for early speech production in children with normal hearing was created.

Conclusion: The Arabic version of LEESPQ appears to be a valid questionnaire that can be used in the assessment of early language and speech development of Arabic-speaking children with normal hearing in the age range of 0-18 months. The Arabic version of the LEESPQ might also be a useful tool to detect developmental delays and hearing disorders in young children.

Keywords: language development, child, infant, hearing, hearing disorders

The LittlEARS® test battery was specifically developed by experts from different disciplines to document children's auditory and verbal development. Part of this test battery is the LittlEARS® Auditory Questionnaire (LEAQ).[1] The LEAQ assesses the auditory development in infants aged between 0 and 24 months. To date, the LEAQ has been validated in 23 languages, including Arabic.[2] Another part of the LittlEARS test battery is the LittlEARS® Early Speech Production Questionnaire (LEESPQ),[3] which assesses early speech and language development in infants aged 0-18 months. The LEESPQ focuses on reflexive behavior, precanonical vocalizations, canonical vocalizations, and postcanonical vocalizations in children up to 18 months old.[4] The questions cover the following speech production steps: production of reflexive sounds, expression of well-being, vowel production similar to adults, second babbling phase, word-like utterances, sound-object association, and production of first words. To date, the LEESPQ has been validated in German on 362 children with normal hearing (NH),[5] in Turkish on 222 children with NH,[6] and in one English version in Canada on 90 children with NH.[4]

No validated tools are available in the Arabic-speaking region for the assessment of language development in Arabic-speaking infants. Therefore, the primary aim of the current study was to test the validity of the Arabic version of the LEESPQ as an assessment tool for early speech production in Arabic-speaking children with NH in Saudi Arabia. The secondary aim was to assess the influence of age, gender, and monolingualism versus bilingualism on the speech production development of children with NH.

Methods. This cross-sectional study was conducted on children between age 0-18 months. The study was carried out in the city of Riyadh, Saudi Arabia between September and December 2020.

The inclusion criteria were children between 0 and 18 months old, had to have NH, had to have no cognitive impairment, and the parents had to use Arabic as their everyday language were included in the study. All children included in the study have been recruited from those who passed the neonatal hearing screening

test. The questionnaire was administered either directly to the parents of the children during their visit in the pediatric clinic or through personal contact with the parents. In either way, the investigator explained to the parents the purpose of the questionnaire and how they should respond to the questions.

The LEESPQ total score. The LEESPQ consists of 27 yes/no questions for the parents/guardian to answer, which takes between 10 and 15 minutes. Each "yes" response equals 1 point and each "no" response equals 0 points. The maximum achievable score is 27. The average of the total score per age group is calculated to show the child's age-dependent speech production responses. It is anticipated that, in general, older children with more improved speech production ability will answer more items with "yes" than younger children.

The LEESPQ was completed by the parents/guardians based on their observations of the child's behavior. They were instructed to answer "yes" if a reaction was observed at least once and "no" if a reaction was not observed or if they were not sure.

Calculation of critical values/minimum values. The confidence intervals in which the age-specific values are found with 95% probability were determined based on the results of the regression analysis. The lower confidence interval band was described as the crucial lower limit which is the minimum score that a child can achieve with the development of speech production according to his/her age. Values below this crucial level have only a probability of less than 5% of age-appropriate speech production and could indicate delayed language development. Scores above this limit are deemed to be matched with normal, age-appropriate, development of speech production (with a 95% probability).

Developing a norm curve. To assess the ability of normal-hearing children aged 0-18 months in developing speech and language production, a norm curve has been generated based on the standardized values that were calculated from the Arabic NH data set. A regression model or curve fitting with "age" as independent and "total score" as the dependent variable has been used to extract the standardized values. The best model to generate a norm curve was a second-order polynomial model according to the least square's method. From this structural equation, standardized expected values of age-dependent total scores were calculated for each age group. The normative scores for the age-specific speech production ability of a child were determined based on these values.

Statistical analysis. The correlation between the positive response (YES) probability and age has been tested using Pearson correlation (r). It is anticipated

that with increasing age the correlation will be higher because older children with more improved speech production ability will answer more items with "yes" than younger children. The Mann-Whitney U-test was applied to examine if there is a difference in scoring between bilingual children and monolingual children and if a child's gender influenced their total score. The internal consistency or scale homogeneity has been measured by Cronbach's alpha (α). The Guttman's split-half coefficient (r) was used as a measure of predictive accuracy.

The study has been approved by the Institutional Review Board, College of Medicine, King Saud University (IRB #E-20-5124). Parents/guardians gave informed consent on the first page of the questionnaire. The research was conducted following the principles of the Declaration of Helsinki.

Results. Caretaker responses from 13 children were not included in the validation analyses: 6 children who were younger than one month scored too high for that age group (based on clinical experience and on the German and English validation, the scores were identified as unrealistic for this age group); 7 children were older than 18 months (>18.2 months). Finally, 198 caretaker responses were analyzed, leading to a total study group of 86 male (43.4%) and 112 female children (56.6%). The age ranged from 0 months to 18 months old (Table 1). Eighty-one children (40.9%) were bilingual and 117 children (59.1%) were monolingual.

The average of the total score per age group shows the child's age-dependent speech production responses.

By a trend, with increasing age and more improved speech production ability, parents answered more items with "yes" (Table 2, Figure 1).

By a trend, with increasing age, the correlation is higher, as older children with more improved speech production ability answered more items with "yes" than younger children. Table 3 shows the results of Pearson correlation between the probability of positive response (YES) and age.

Homogeneity or internal consistency was reached with a value of α=0.861 (Cronbach's alpha), indicating that the Arabic-LEESPQ questionnaire almost exclusively assesses speech production ability. The result of Guttman's split-half coefficient (r=0.533) reflects the predictive accuracy of the scale.

On average, female children (n=112; mean=14.58; ±SD[standard diviation]=5.274) answered more items with "yes" than male children (n=86; mean=13.45;

Table 1 - Number of children by age category (N=198).

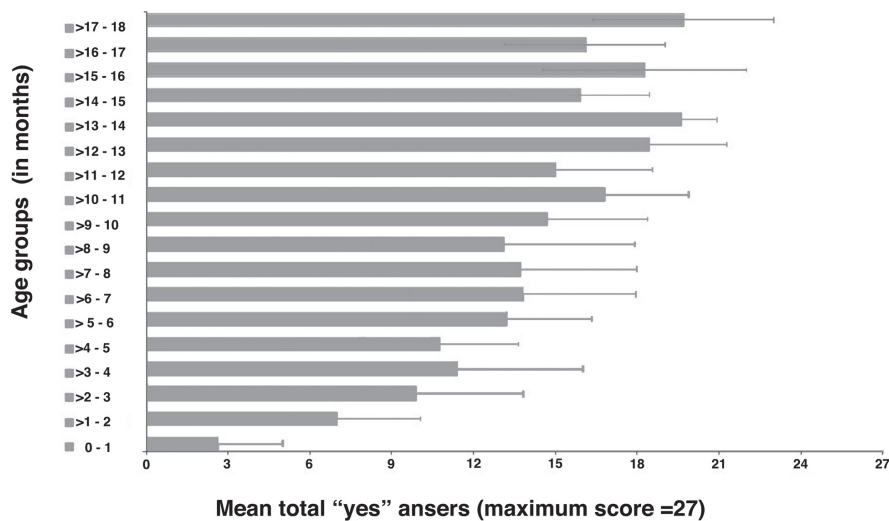| Age (months)	n	Age (months)	n
0 - 1	5	>9 - 10	10
>1 - 2	16	>10 - 11	10
>2 - 3	8	>11 - 12	11
>3 - 4	13	>12 - 13	14
>4 - 5	12	>13 - 14	8
>5 - 6	11	>14 - 15	11
>6 - 7	10	>15 - 16	11
>7 - 8	13	>16 - 17	11
>8 - 9	11	>17 - 18	13

Figure 1 - Mean total "yes" answers (± standard deviation) for Arabic-LEESPQ per age group (maximum score = 27).

±SD=5.077); this difference was not significant (*p*=0.122). On average, bilingual children answered more items with "yes" (n=81; mean=14.53; ±SD=5.097) than monolingual children (n=117; mean=13.79; ±SD=5.281); this difference was not significant (*p*=0.287).

Developing a norm curve. The norm curve generated from the raw data and the lower band of the 95% confidence interval are shown in **Figure 2** of the scatter plot of the raw data. The best model, which explains 72% of the entire variance (adjusted R2=0.518), was a second-order polynomial model according to the least square's method with the regression equation:

$$y = 5.040 + 1.533*age - 0.045*age^2$$

Calculation of critical values/minimum values. Table 4 shows the minimum values, also defined as the critical lower limit (such as, the lower band of the confidence interval), that a child with NH should reach to age-appropriate speech production development (**Figure 2**). Children who score below this minimum level have a minor probability (<5%) of demonstrating an age-appropriate speech development ability.

Discussion. The primary aim of the current study is to test the validity of the Arabic version of LEESPQ as an assessment tool for early speech production in Arabic-speaking children with NH in Saudi Arabia. The secondary aim was to assess the influence of age, gender, and monolingualism versus bilingualism on Arabic-

Table 3 - Pearson correlation (r) results for each item.

Item no.	(r)	Item no.	(r)
q1	0.097	q13	0.295
q2	0.044	q14	0.413
q3	-0.189	q15	0.417
q4	-0.085	q16	0.634
q5	0.246	q17	0.424
q6	0.341	q18	0.531
q7	0.403	q19	0.483
q8	0.216	q20	0.359
q9	0.235	q21	0.539
q10	0.281	q22	0.397
q11	0.354	q23	0.588
q12	0.564	q25	0.340

Table 4 - The minimum values of age-dependent speech production ability a child should reach.

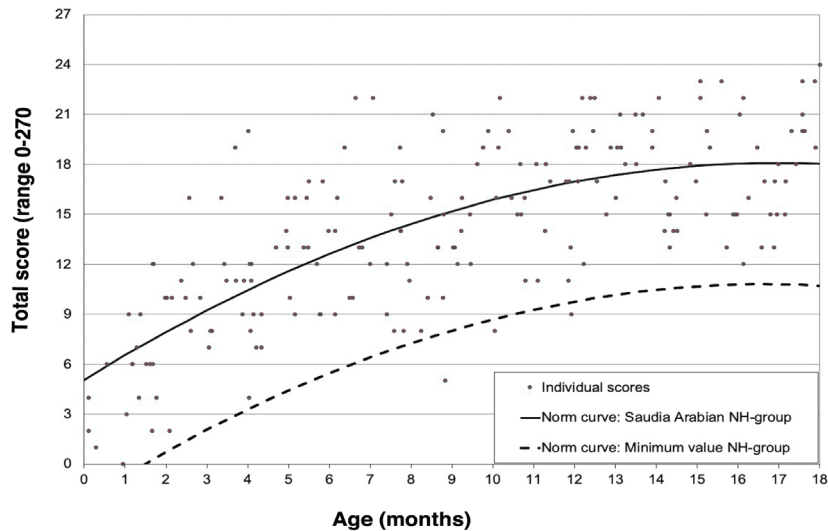| Age (months)	Minimum values	Age (months)	Minimum values
0 - 1	0 - 0.5	>9 - 10	8 - 9
>1 - 2	0.5 - 1	>10 - 11	8 - 9
>2 - 3	1 - 2	>11 - 12	9 - 10
>3 - 4	2 - 3	>12 - 13	9 - 10
>4 - 5	3 - 4	>13 - 14	9 - 10
>5 - 6	4 - 5	>14 - 15	10 - 11
>6 - 7	5 - 6	>15 - 16	10 - 11
>7 - 8	6 - 7	>16 - 17	10 - 11
>8 - 9	7 - 8	>17 - 18	10 - 11

Figure 2 - Regression curve (quadratic) with age as independent and total score as the dependent variable. Individual scores, standardized expected values (norm curve), and standardized minimum values (lower 95% confidence interval) of age-specific speech production abilities of the Saudi Arabian normal hearing (NH) sample (n=198).

speaking children's speech production development. The results clearly demonstrate that the Arabic LEESPQ is a validated, gender-independent, and age-dependent parent questionnaire. It facilitates the assessment of the speech development of Arabic-speaking children in the age range of 0-18 months with NH in Saudi Arabia. The Arabic version of the LEESPQ has shown good homogeneity and internal consistency (α=0.861), indicating that the Arabic-LEESPQ questionnaire almost exclusively assesses speech production ability. These results were in accordance with the results of similar studies of validating LEESPQ for other languages.[4-6] Moreover, the results of the current study confirmed that Arabic-LEESPQ scores are significantly correlated with age. This has been demonstrated by the significant Pearson correlation between the age of children and the parents' responses to the questionnaire. Similar results have been reported in other related studies[4-6] indicating that older children have improved speech production abilities as measured by LEESPQ. On the other hand, there was no influence of gender (*p*=0.12) or bilingualism (*p*=0.28) on the early speech production in the Arabic-speaking children as reported in the studies of validating the Turkish and German versions of LEESPQ.[5,6] In the study of validating the Turkish LEESPQ, the authors reported no significant difference between boys and girls scores (*p*=0.34), while in the German LEESPQ validation study there was no significant effect of both gender and language exposure on the total scores of LEESPQ (*p*=0.48 and 0.68 respectively). These results confirm the validity of LEESPQ in measuring early speech production of children with NH regardless of their gender or bilingual exposure.

In general, there is a considerable lack of validated tools in Arabic that assess language development progress in Arabic-speaking children. To date, 3 validated auditory questionnaires are available in Arabic: the LEAQ,[2] which assesses the development of auditory skills in children aged 0 to 24 months; the Auditory Behavior in Everyday Life (ABEL) questionnaire[7] for children aged 3.9 to 14.3 years; and the Categories of Auditory Performance-II (CAP-II).[8] As there is no validated instrument to assess speech production progress in the Arabic language, the Arabic version of the LEESPQ could fill the gap and, as such, be a welcome tool for parents and audiological specialists. The well-structured and easy-to-use LEESPQ can be used for different clinical purposes: to report the speech and language development of Arabic-speaking children with NH and in Arabic-speaking children with a cochlear implant or hearing aid, as a screening tool for GPs and ENTs, and as a measuring instrument in auditory research.[5]

Study limitation. The absence of group of infants with hearing loss. Further validation studies are needed to determine if the LEESPQ can be considered a universal, language-independent questionnaire such as the LEAQ that has been validated for many other languages.

In conclusion, the Arabic version of LEESPQ appears to be a valid questionnaire that can be used in the assessment of early language and speech development of Arabic-speaking children with NH in the age range of 0-18 months. The Arabic version of the LEESPQ might also be a useful tool to detect developmental delays and hearing disorders in young children.

References

1. Coninx F, Weichbold V, Tsiakpini L, Autrique E, Bescond G, Tamas L, et al. Validation of the LittlEARS((R)) Auditory Questionnaire in children with normal hearing. *Int J Pediatr Otorhinolaryngol* 2009; 73: 1761-1768.
2. Geal-Dor M, Jbarah R, Meilijson S, Adelman C, Levi H. The Hebrew and the Arabic version of the LittlEARS® auditory questionnaire for the assessment of auditory development: results in normal hearing children and children with cochlear implants. *Int J Pediatr Otorhinolaryngol* 2011; 75: 1327-1332.
3. Wachtlin B, Brachmaier J, Amann E, Hoffmann V, Keilmann A. Development and evaluation of the LittlEARS((R)) Early Speech Production Questionnaire - LEESPQ. *Int J Pediatr Otorhinolaryngol* 2017; 94: 23-29.
4. Daub O, Cardy JO, Johnson AM, Bagatto MP. Validity evidence for the LittlEARS Early Speech Production Questionnaire: An English-speaking, Canadian sample. *J Speech Lang Hear Res*. 2019; 62: 3667-3678.
5. Keilmann A, Friese B, Lassig A, Hoffmann V. Validation of the second version of the LittlEARS((R)) Early Speech Production Questionnaire (LEESPQ) in German-speaking children with normal hearing. *Eur Arch Otorhinolaryngol* 2018; 275: 883-888.
6. Kosaner J, Sonuguler S, Ogut F, Kirazli T, Uruk D, Ornekci R, et al. LittlEARS((R)) early speech production questionnaire validation in hearing Turkish infants. *Cochlear Implants Int* 2014; 15: S39-S42.
7. Geal-Dor M, Jbarah R, Adler M, Yehezkely MK, Adelman C. Auditory Behavior in Everyday Life (ABEL) questionnaire in Hebrew and in Arabic and its association with clinical tests in cochlear-implanted children. *J Basic Clin Physiol Pharmacol* 2014; 25: 301-306.
8. Al-Shawi Y, Mesallam TA, Alfallaj R, Aldrees T, Albakheet N, Alshawi M, et al. Inter-rater reliability and validity of the Arabic Version of Categories of Auditory Performance-II (CAP-II) among children with cochlear implant. *Otol Neurotol* 2020; 41: e597-e602.