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AUDITORY DEVELOPMENT IN POLISH INFANTS AND TODDLERS AS ASSESSED WITH THE LITTLEARS® AUDITORY QUESTIONNAIRE

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Abstract

Introduction: The aim of the study was to assess the development of auditory behavior in Polish infants and young children with normal hearing who were attending childcare facilities. They were considered by their parents or guardians as being typically developing.

Material and methods: The study participants included parents and other caregivers of 293 children attending various nurseries in Lublin, Poland. The children's chronological age ranged from 2 to 35 months. The LittlEARS® Auditory Questionnaire was used as the assessment tool. Although the tool is designed to assess children up to 24 months of age, it was also used to evaluate somewhat older children to determine whether they had achieved an auditory development level equivalent to at least that of a 2-year-old.

Results: The study showed that all 25 children up to 12 months of age exhibited faster auditory development than the standard curve. Of the other 268 children 13 to 35 months old, delays were observed in 27% of them and faster development in 34%. Analysis of the responses to individual LittlEARS® Auditory Questionnaire items revealed that questions where children commonly encountered difficulties (i.e., "no" was the most frequent answer parents gave) involved questions 8, 14, 31, and 35.

Conclusions: The LittlEARS® Auditory Questionnaire is both user-friendly and reliable for screening assessments, suggesting that standard 12- and 24-month developmental screenings for children may be helpful in identifying auditory problems at an early stage. There is also a need to adapt tools suitable for children over 24 months of age, such as the PEACH questionnaire, into Polish.

Keywords: early childhood • risk of hearing impairment • auditory development • CAPD • speech therapy

OCENA ROZWOJU SŁUCHOWEGO POLSKICH NIEMOWLĄT I MAŁYCH DZIECI ZA POMOCĄ KWESTIONARIUSZA SŁUCHOWEGO LITTLEARS®

Streszczenie

Wstęp: Celem badania była ocena rozwoju zachowań słuchowych u polskich niemowląt i małych dzieci z prawidłowym słuchem, uznawanych za rozwijające się typowo.

Materiał i metody: Uczestnikami badania byli rodzice i opiekunowie 293 dzieci uczęszczających do różnych żłobków w Lublinie. Wiek chronologiczny dzieci mieścił się w przedziale od 2 do 35 miesięcy. Jako narzędzie oceny wykorzystano kwestionariusz słuchowy LittlEARS®. Choć został on opracowany w celu oceny dzieci do 24. miesiąca życia, zastosowano go również u dzieci starszych, aby sprawdzić, czy osiągnęły poziom rozwoju słuchowego co najmniej na poziomie dwulatka.

Wyniki: Badanie wykazało, że wszystkie 25 dzieci w wieku do 12 miesiąca życia charakteryzowały się szybszym rozwojem słuchu w porównaniu ze standardową krzywą rozwojową. W grupie 268 dzieci w wieku od 13 do 35 miesięcy opóźnienia w rozwoju słuchu stwierdzono u 27% badanych, natomiast przyspieszony rozwój u 34%. Analiza odpowiedzi na poszczególne pytania kwestionariusza LittlEARS® wykazała, że największe trudności (najczęściej udzielaną przez rodziców odpowiedzią było „nie") dotyczyły pytań 8, 14, 31 i 35.

Wnioski: Zaproponowano wprowadzenie obowiązkowych badań przesiewowych rozwoju słuchowego dzieci w 12. i 24. miesiącu życia. Ponadto wykazano, że kwestionariusz słuchowy LittlEARS® jest zarówno łatwy w użyciu, jak i wiarygodny w ocenie przesiewowej. Istnieje jednak potrzeba adaptacji do języka polskiego analogicznego narzędzia odpowiedniego dla dzieci powyżej 24. miesiąca życia, takiego jak na przykład kwestionariusz PEACH

Słowa kluczowe: wczesne dzieciństwo • ryzyko niedosłuchu • rozwój słuchowy • CAPD • terapia logopedyczna

Key to abbreviations	
CAPD	central auditory pro¬cessing disorder
CHAPS	Children's Auditory Performance Scale
ELF	Early Listening Function
FAPI	Functional Auditory Performance Indicators
FISHER	Fisher's Auditory Processing Problems Checklist
IT-MAIS	Infant-Toddler Meaningful Auditory Integration Scale
PEACH	Parent's Evaluation of Aural/Oral Performance of Children
SAB	Scale of Auditory Behaviors

Introduction

Normal hearing is essential for speech development. However, it is important to broaden the perspective and emphasize that sound reception is a condition for the development of auditory perception, which in turn forms the basis for the proper progression of language and speaking skills [1]. There is a group of children who, despite having normal sound reception in the peripheral structures, are unable to fully process the auditory information reaching them [2].

There are psychoacoustic tests that allow one to assess speech understanding in distorted conditions, interaural integration and separation, temporal aspects of auditory information processing, and short-term auditory memory [3]. However, all these tests are designed for children over 7–8 years of age, as they require active cooperation between the examiner and the subject. Age-appropriate test batteries have been established, tailored to the developmental capabilities of the child. In exceptional cases, for younger children (aged 4–6 years) who are able to speak and cooperate with the examiner, these tests may be conducted to assess the potential risk of central auditory processing disorder (CAPD). In children even younger, objective methods, such as P300 wave registration, are typically applied if concerns are raised by the parents or guardians about the child's auditory processing ability [4,5].

There are certain questionnaires that attempt to systematize observations of the child's behavior and assess the risk of CAPD or even hearing impairment. Examples of popular screening tools adapted to the Polish language include the Children's Auditory Performance Scale (CHAPS), Fisher's Auditory Processing Problems Checklist (FISHER), and the Scale of Auditory Behaviors (SAB) [6]. All these screening tools are designed for children of school age, by which time speech development should be largely complete [7]. Therefore, any issues detected at this stage require therapeutic intervention, and this could possibly have been prevented if there were tools available for earlier stages of development.

Questionnaires designed for newborns and young children include the Infant–Toddler Meaningful Auditory Integration Scale (IT-MAIS), Early Listening Function (ELF), Functional Auditory Performance Indicators (FAPI), Parent's Evaluation of Aural/Oral Performance of Children (PEACH), and the LittlEARS® Auditory Questionnaire; however, only the latter has been validated in Polish [8,9]. An additional tool – the LittlEARS® Evaluation of Early Speech Production Questionnaire – has been developed to complement the LittlEARS® Auditory Questionnaire, and further supports the monitoring of speech development in children from birth to 18 months, as well as in children with hearing loss during the initial months of hearing aid or cochlear implant use. The questionnaire comprises 27 yes/no questions completed by parents or guardians, and follows a structure analogous to that of the auditory development assessment tool [10–12]. The additional tool was originally published in German and has since been translated into multiple languages; however, it remains unavailable in Polish.

There are four fundamental types of auditory abilities, each reflecting different levels of response to speech. These include detection (recognizing the presence or absence of sound), discrimination (noticing similarities and differences between sounds), recognition (also known as identification, which involves assigning meaning to sounds), and comprehension (the ability to understand speech, drawing on linguistic experience) [13]. The 6th, 12th, and 24th months of a child's life represent key milestones in speech development. Around 6 months of age, a child begins to produce reduplicated babbling, involving the repetition of consonant–vowel combinations, which may mark the transition from detection to sound discrimination. By the end of the first year, the child progresses from the preverbal (prosodic) stage to the vocabulary stage, indicating the development of auditory skills to the level of sound identification. After the second year, the child enters the early multi-word (sentence) stage, achieving the ability to comprehend speech sounds. These stages thus constitute a critical window for closer observation of the child's behavior and auditory and language stimulation [7]. The LittlEARS® Auditory Questionnaire was initially designed to determine the auditory age of children with hearing impairments who use hearing aids or cochlear implants during the first two years following device fitting. However, it is also suitable for children from birth to 24 months of age, regardless of their hearing level, to monitor the rate and degree of their auditory development based on established norms [9,14], and this is what the present study involves.

Material and methods

The study included parents and caregivers of 303 children aged 2 to 35 months from 39 childcare facilities ("żłobek" in Polish) in Lublin, Poland. Parents or primary caregivers were asked to provide observations of their child's auditory behaviors by completing the LittlEARS® Auditory Questionnaire. It was designed to focus on children considered to be typically developing, aged from birth to nearly 3 years. "Typically developing" means that none of the children had ever been referred for additional diagnostic assessment, nor had they received any formal diagnosis or opinion from a specialist clinic. This was largely due to their young age, since many developmental disorders are not typically identified until after the age of 3 or 4, when standardized diagnostic tools become applicable. The selection of children was therefore based on the absence of

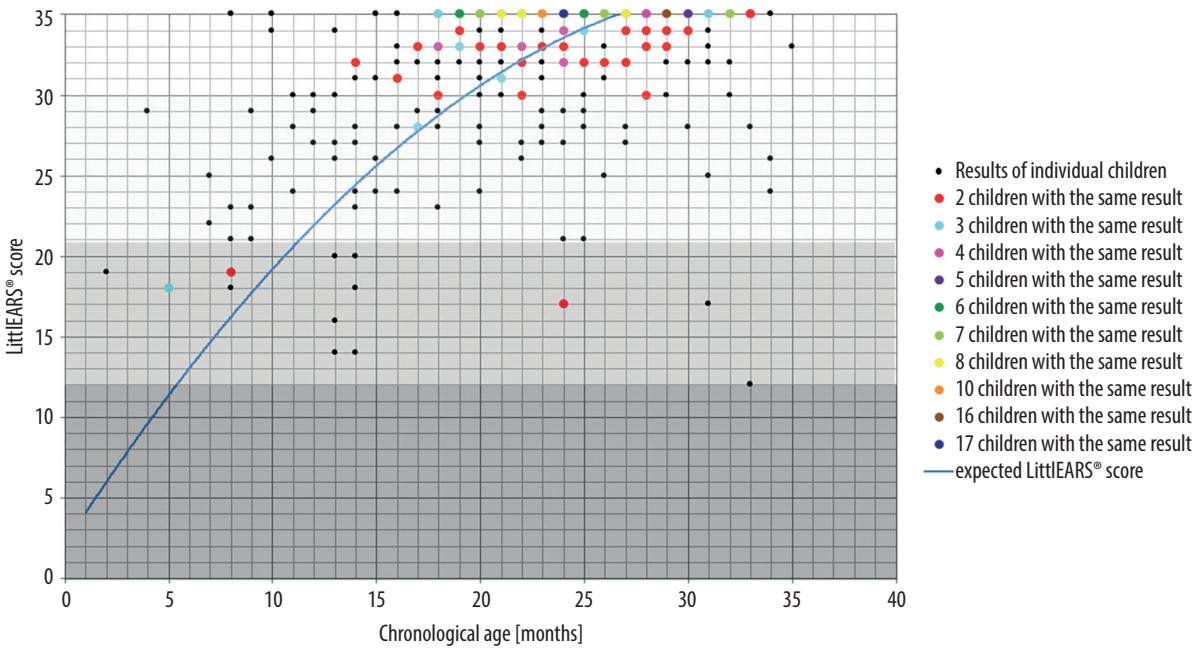

Figure 1. LittlEARS® Auditory Questionnaire scores plotted against chronological age of the children. The three shaded horizontal bands indicate the boundaries of developmental phases (0–12 Sound detection; 12–21 Sound discrimination; 21–30 Sound identification; 30–35 Comprehension). The solid blue line is the standard provided with the LittlEARS questionnaire [14]. The shaded areas illustrate the types of behaviors exhibited by children at each level of auditory development: children whose scores fall within a band are considered to be developing normally; those above it have accelerated development, and those below it have delayed development

any reported concerns from parents or carers, with no behavioral or developmental red flags being raised prior to participation. Although the questionnaire is intended for assessing hearing development in children up to 24 months of age, the decision was made to experimentally apply the questionnaire to a group of older children as well. Thus, the test results were interpreted in terms of whether the child had at least reached a level of development typical for a 2-year-old.

Note that in Poland attendance at nurseries and even kindergartens is not mandatory. Until the age of 5, attending an appropriate care or educational institution is voluntary and remains the parents' choice. Children typically spend a few hours each day in a nursery, with a legal maximum of 10 hours. (At age 6, children are expected to complete a one-year school preparation program, and from ages 7 to 18 schooling is compulsory.)

First, approval was obtained from the directors of the respective institutions to distribute the questionnaires. Parents or carers of the children attending the nurseries were provided with both oral and written information about the purpose of the study, as well as contact details should they wish to inquire about their child's auditory development. No nursery staff members took part in the study. Parental figures were also informed that the study was anonymous and that by submitting the completed questionnaire they were consenting to its use for scientific purposes.

The LittlEARS® Auditory Questionnaire forms were distributed to the parents or carers of the children, along with instructions to complete all 35 'yes or no' questions and to provide the child's gender, date of birth, and any information about diagnosed disorders. The respondents filled out the Polish version of the questionnaire, adapted by Obrycka et al. [9,15] from the English version, following the back-translation procedure recommended by the International Test Commission, which helps minimize translation-related errors. Some 10 responses were excluded from the analysis: in one case, the child's date of birth was not provided; 6 children exceeded the maximum age limit of 35 months; and 3 had diagnosed conditions such as hearing impairment or issues related to muscle tone or sensory integration.

Ultimately, the results for 293 children were analyzed (148 boys, 137 girls, and 8 children of unspecified gender). The children's chronological ages ranged from 2 to 35 months. The age group of 2–12 months included 25 children; the 13–24 months group consisted of 161 children; and the 25–35 months group comprised 107 children. The chronological age of children was calculated in the standard way, based on the child's date of birth and the date of the assessment. The auditory age, on the other hand, was determined based on the number of points obtained in the LittlEars® Auditory Questionnaire. The number of points scored by the children is plotted against their ages in **Figure 1**.

Results

Figure 1 shows the scores from the LittlEARS® Auditory Questionnaire for all the children. The blue curve represents the expected score for each age. The grey-shaded

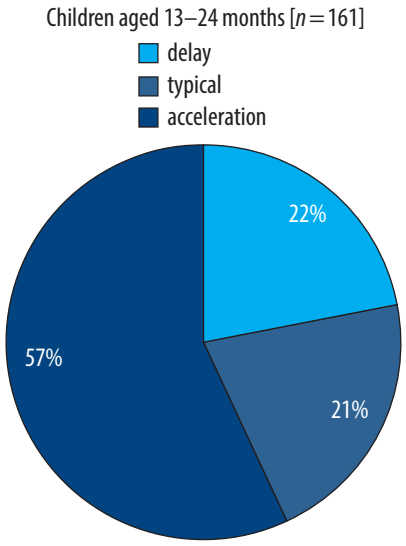

Figure 2. The auditory development of children aged 13–24 months ($n = 161$) based on their LittlEARS® Auditory Questionnaire scores and where the scores fell relative to the bands marked in **Figure 1**

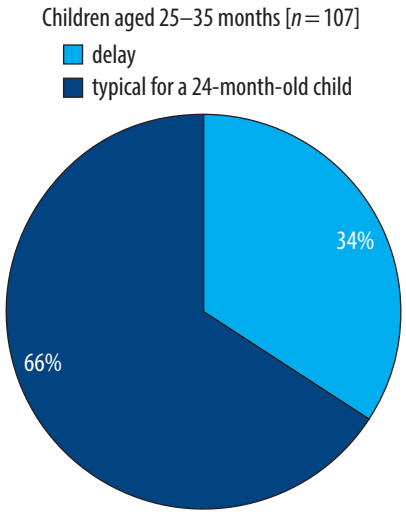

Figure 3. The auditory development of children aged 25–35 months ($n = 107$) based on their LittlEARS® Auditory Questionnaire scores and where the scores fell relative to the bands in **Figure 1**

regions indicate the range of questionnaire scores corresponding to various levels of auditory development (detection, discrimination, identification, and comprehension).

All children in the youngest group ($n = 25$) showed a higher level of development than expected. Their mean chronological age was 8.4 months ($SD = 2.6$), while the average number of points (responses marked "yes") was 24.8 ($SD = 5.6$), indicating that the auditory age of this subgroup was about 14.7 months ($SD = 5.0$) – that is, above the expected auditory age corresponding to the number of points scored. Children of this age are typically expected to function at the level of sound detection. However, according to their parents or carers, all the children surpassed this stage – some were still below the level of sound discrimination, but the majority had already reached the level of sound identification (see **Figure 1**).

The group of children aged 13 to 24 months ($n = 161$) was more diverse. The overall mean chronological age in this group was 20.0 months ($SD = 3.4$), and the average questionnaire score was 31.5 ($SD = 4.62$), indicating that the group functioned at the auditory level of children aged 21.1 months ($SD = 4.3$). This suggests that, overall, these children functioned at a slightly higher level of auditory processing development than expected based on the normative data. In more detail: 21% of them reached the developmental level expected for their age; 57% surpassed it, functioning at the level of sound identification and comprehension; and 22% scored below the expected level (**Figure 2**). Children with the lowest auditory development levels in this age group functioned at the sound detection and discrimination stage, which is typical for children aged 6 to 17 months.

Turning to the children aged 25 to 35 months ($n = 107$), it was expected that out of the 35 LittlEARS® questionnaire items, the respondent would give 34 or 35 "yes" answers, which would indicate that the children had completed all stages of auditory development typical for a 2-year-old. However, it was found that 71 of the children (66%) met this criterion (**Figure 3**). The average chronological age of the remaining 34% of the oldest children (those with suspected auditory development delay and recommended for monitoring) was 28.7 months ($SD = 3.0$), and their average questionnaire score was 29.2 points ($SD = 4.7$). This score corresponds to the expected score for a 19-month-old child ($SD = 4.5$) entering the level of sound identification in auditory development.

It is worth noting that the lowest LittlEARS® Auditory Questionnaire score among all participants (12 points, see **Figure 1**) was recorded in the oldest age group (25–35 months). This result was from a girl whose chronological age was 33 months, although her auditory age was approximately 5 months, corresponding to the transition from the sound detection phase to the sound identification phase (see blue line in **Figure 1**). Despite such a significant delay in auditory and speech development, no concerns had been raised about the child's behaviour and no early speech therapy or audiological intervention had been initiated.

Discussion

All the children in the study aged up to 12 months obtained scores higher than expected. Several hypotheses can be proposed to explain this outcome, including the positive influence of the environment (family lifestyle, parenting choices, childcare centre) or potential bias due to wishful interpretation by parents or carers. A better understanding would require an expanded study.

Deviations from the norm were predominantly observed in children aged 13 months and older, and these cases will be discussed in the following sections.

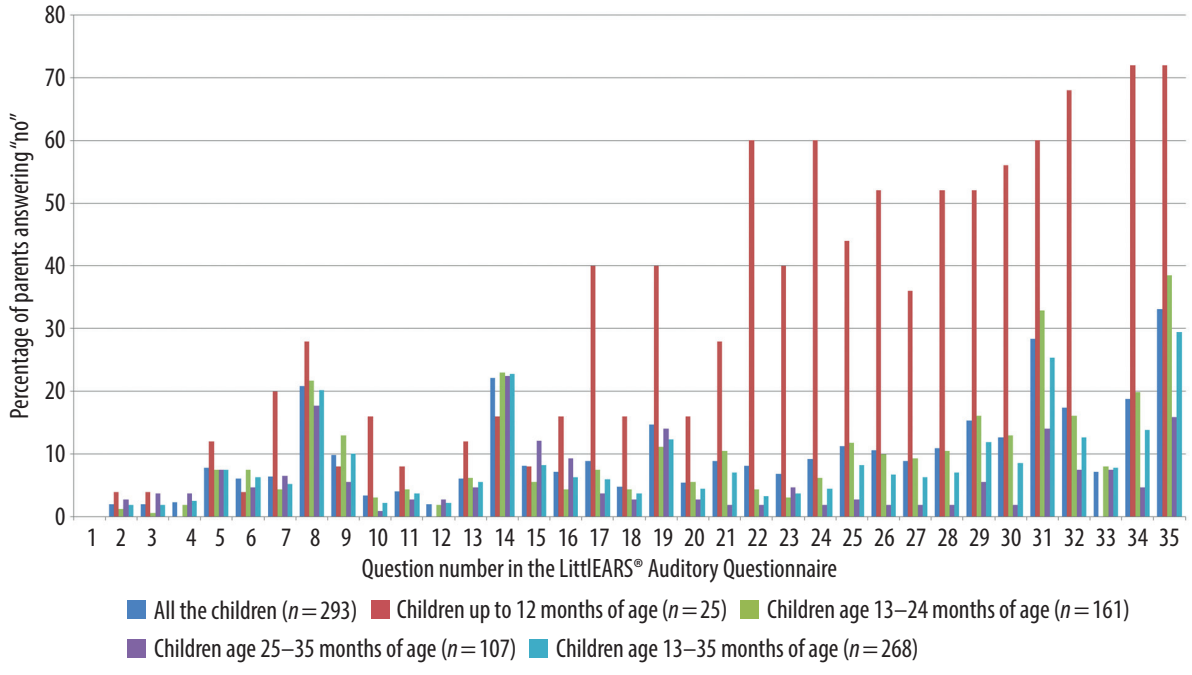

Figure 4. The percentage of parents who answered "no" to each question within the set of 35 LittlEARS questions

The findings can be categorized according to whether the three groups of children had accelerated auditory development, auditory development appropriate for their chronological age, or delayed auditory development. The pie charts show the percentages of children in each category: **Figure 2** is for 13–24 months ($n = 161$) and **Figure 3** is for 25–35 months ($n = 107$).

As shown in **Figure 2**, among children aged 13–24 months ($n = 161$), 78% did not require further monitoring, while 22% showed signs of delayed auditory development. It is surprising that in the first year of life, all children demonstrated faster-than-expected development, yet in the second year, around one-fifth required preventive action. Several factors may explain this. First, undetected perilingual hearing loss may be present: children with mild hearing impairment often develop similarly to their peers early on, with characteristic symptoms appearing only later. Second, parents typically have less experience observing their child during the first year of life; in the second year, their assessments may become more accurate, allowing delays to be identified. Third, these apparent delays may be early symptoms of a risk for auditory processing disorders or signs of immature auditory system development, potentially linked to environmental influences, the quality of the acoustic environment, and the child's auditory learning experience.

Figure 3 shows that among the 107 children aged 25–35 months, 66% achieved a score corresponding to the expected level for a 2-year-old. Since the test used in the study is standardized only for children up to 24 months and there are no higher bands for them to fall into, it is impossible to determine, based on this assessment alone, whether the children in the older age group were developing entirely typically. One can only conclude that they have mastered the fundamental stages of auditory development. Further evaluation would require the use of other diagnostic tools suitable for older ages. It is concerning, however, that 34% of the children had not mastered fundamental auditory skills, and based on the LittlEARS® Auditory Questionnaire results, they can be identified as having delayed auditory development. This percentage is higher than in the younger age group (compare with **Figure 2**). The reasons may again include undiagnosed hearing loss, as well as a lack of supportive environmental factors in the child's upbringing, such as insufficient auditory stimulation, exposure to noise, or limited verbal interaction. It is also possible that, just as wishful thinking may have led parents or guardians of the youngest children to overestimate their child's abilities and report higher scores than warranted, with this age group (25–35 months) parental anxiety may have led to underreporting. At the age of 3 years, children in Poland usually leave daycare and may begin preschool, representing a major change in their lives. Parents may feel uncertain about how their child will cope in a new environment, so when unsure whether they observed a behavior or not, they may err on the side of caution and report it less positively. This is a responsible approach and is strongly encouraged in assessments such as this one.

All children in the study achieved at least the basic level of sound detection. Among those identified by the LittlEARS® Auditory Questionnaire as requiring further monitoring, only a small number remained at the level of sound discrimination. The majority of children appear to be working hard in making progress from sound identification to sound comprehension.

Unfortunately, there also seem to be some children who have reached a stage of sound comprehension, but at a level lower than expected based on their chronological age.

These children may be at risk of not receiving adequate support for speech and auditory development; their difficulties may be subtle and go unnoticed or they may be underestimated on the assumption that, over time, they will catch up naturally.

To make a preliminary assessment of which factors tend to give rise to a delay in auditory development, we looked at those questions in the questionnaire to which parents or carers most frequently answered "no". The bar chart (**Figure 4**) shows the percentage of "no" responses to each question, divided by children's ages. Recall that some of the children over 13 months of age were identified in this study as having delayed auditory development, based on their LittlEARS® Auditory Questionnaire score.

The questions that presented the greatest apparent difficulties for children aged 13–35 months ($n = 268$) were numbers 8, 14, 31, and 35, to which more than 20% of respondents answered "no". Based on these questions, the following conclusions can be drawn: the parental figure's voice and music are not used for emotional regulation (questions 8 and 14); speaking in a gentle voice, singing, or playing music does not influence the child's behavior (question 31); and the child does not attempt to sing – whether along with a recording, with another person, or independently from memory (question 35).

Next, difficulties emerge in areas addressed by questions 9, 19, 29, 32, and 34, to which more than 10% of respondents caring for children aged 13–35 months ($n = 268$) answered "no". Based on these findings, it can be concluded that the children do not demonstrate an understanding of emotional prosody, as evidenced by their lack of an appropriate reaction to an angry voice. They also do not exhibit a tendency to repeat either individual words or sequences of syllables. Additionally, they are not yet able to reproduce sequences of syllables of varying lengths. Furthermore, they are unable to follow verbal commands – both simple ones, such as responding to the word "no", and more complex instructions, such as "Take off your shoes and come here".

It was found that parents or guardians answered "no" to almost all questionnaire items relating to music, with one exception: whether children listen when the radio/CD/tape player is turned on (question no. 6). This is rather concerning: children were exposed to music but did not hum along, nor did they repeat memorized fragments after the song was turned off. This lack of engagement with music does not support prosodic development. The children had difficulty repeating sequences of long and short syllables, suggesting difficulties in temporal processing of sounds.

One possible explanation is that parents or carers may be playing recorded songs to children, but over time these recordings become background noise. Instead of supporting auditory and language development, they may actually be hindering it. The parents may believe their children are actively listening to these songs, but the responses to the other questionnaire items suggest otherwise.

Conclusions

The present study leads to the conclusion that it might be beneficial to consider introducing a "12- and 24-month developmental screening" or a "well-child check-up" into clinical practice, with the aim of assessing a child's auditory and speech development at an early age. A speech therapist would be the most appropriate professional to conduct such an evaluation. The LittlEARS® Auditory Questionnaire has been proven to be a useful screening tool for this type of preventive assessment.

It should, of course, be noted that the presented results are based on normative data established over a decade ago. The observed acceleration in auditory development in some children, and delay in others, may be related to global shifts in lifestyle and child-rearing practices, including being cared for in a nursery. Thus, it may be worth considering a revalidation of the questionnaire, along with a new study involving children who are confirmed to be typically developing – verified through additional assessments using a cross-check method.

Adapting the second part of the LittlEARS® Auditory Questionnaire – the LittlEARS® Evaluation of Early Speech Production Questionnaire – to Polish would also be beneficial. Additionally, there is a need to adapt a questionnaire suitable for children over the age of 2 years into Polish, such as the PEACH Questionnaire.

Another recommendation is to enhance educational efforts aimed at parents of newborns and infants. Key topics to address include a child's exposure to noise, the role of music in auditory development, and communication strategies that support auditory and speech development. The latter would be tailored to the child's actual developmental level, which does not always correspond to their chronological age. Encouraging parents and others to actively sing to children is particularly valuable, and workshops could be arranged to promote this practice. Live singing directed at a child has a greater impact on development than even the best recordings. It forms the foundation for dialogue, speech, communication, and, most importantly, emotional bonding. Additionally, adding well-designed music and speech-rhythm activity into childcare settings could provide significant benefits to children.

Finally, there is a need to expand research and examine early childhood environments more closely. First, it is important to verify whether the hypothesis that children are constantly exposed to recorded background music is true. Second, a broader investigation is needed into the role of modern technological devices such as tablets, computers, and smartphones in contemporary family life. Finally, it is an interesting question as to whether the time that children are spending in childcare has an effect on their auditory development. What effects do factors such as the duration of nursery attendance, the type of activities provided, group size, and other organizational aspects of childcare have? Indeed, how does nursery attendance in general affect children's auditory development compared to staying at home under the care of a family member or a nanny? Addressing this issue could provide valuable insights for future research in early speech and hearing prevention.

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