

## Scenario-based recognition of possible childhood hearing loss among experienced preschool teachers working with children aged 3-6 years

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### ABSTRACT

**Aims:** This study aimed to evaluate experienced preschool teachers' recognition of possible childhood hearing loss using scenario-based classroom situations and to identify factors associated with accurate recognition.

**Methods:** This cross-sectional study included 124 experienced preschool teachers working with children aged 3-6 years. Data were collected using an online, expert-reviewed structured questionnaire that assessed theoretical knowledge, recognition of classroom signs of hearing loss, and the ability to differentiate hearing loss from other developmental or behavioral conditions through two classroom scenarios (behavioral cues vs. speech-language cues). Comparisons were performed using the Mann-Whitney U test, Kruskal-Wallis H test, McNemar's exact test, and Chi-square/Fisher's exact tests, as appropriate. Associations were examined using Spearman's rank correlation and binary logistic regression analyses.

**Results:** The mean knowledge score was  $22.98 \pm 3.09$  (possible range: 6-30). The most frequently recognized sign of hearing loss was increasing television/screen volume (80.6%). In the scenario characterized by behavioral cues, only 29.0% of teachers selected hearing loss as a possible cause, compared with 42.7% in the speech-language scenario (McNemar's exact test,  $p=0.002$ ). Previous hearing health training was the strongest independent predictor of recognizing hearing loss in both scenarios (OR=7.27 and OR=5.10, respectively; both  $p<0.001$ ), whereas teaching experience was not significantly associated with recognition.

**Conclusion:** Preschool teachers had a moderate level of theoretical knowledge regarding childhood hearing loss; however, this knowledge was not consistently reflected in scenario-based recognition, particularly when behavioral features predominated. Previous hearing health training, rather than teaching experience alone, was associated with better recognition of possible hearing loss, supporting the potential value of scenario-based educational programs and practical referral guidance.

**Keywords:** Hearing loss, children, school teachers, health knowledge, early diagnosis

### INTRODUCTION

Hearing loss is one of the most common sensory disorders worldwide, affecting approximately 34 million children according to the World Health Organization.<sup>1</sup> Childhood hearing loss may adversely affect speech and language development, communication, academic achievement, and psychosocial well-being, particularly when diagnosis and intervention are delayed.<sup>2</sup> Even unilateral or mild hearing loss may negatively influence educational performance and social participation, emphasizing the importance of early identification.<sup>3</sup>

Although universal newborn hearing screening has substantially improved the early detection of congenital hearing loss, delayed-onset or progressive hearing loss may develop after a child has passed newborn hearing screening and remain undetected without further surveillance.<sup>4-6</sup> Consequently, some children enter preschool or primary

school with previously unrecognized hearing difficulties that may interfere with classroom participation, language development, and learning.<sup>7</sup>

Childhood hearing loss does not always present with obvious auditory symptoms.<sup>8</sup> Instead, affected children may exhibit nonspecific classroom behaviors such as delayed responses to verbal instructions, inattention, poor concentration, speech and language difficulties, disruptive behavior, or academic underachievement.<sup>9</sup> These manifestations may be attributed to attention-deficit/hyperactivity disorder, autism spectrum disorder, learning disabilities, behavioral problems, or lack of motivation rather than an underlying hearing impairment.<sup>7,10</sup> As a result, hearing loss may remain unrecognized, delaying appropriate audiological assessment and intervention.

Teachers spend considerable time observing children in classroom settings and may therefore contribute to the early

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recognition of hearing-related difficulties.<sup>8</sup> Previous studies suggest that improving teachers' knowledge of hearing health may facilitate earlier identification and appropriate referral.<sup>11-13</sup> However, most studies have focused on teachers' knowledge or attitudes toward hearing loss rather than their ability to differentiate hearing loss from other developmental or behavioral conditions using realistic classroom scenarios.<sup>14,15</sup>

Therefore, this study aimed to evaluate experienced preschool teachers' recognition of possible childhood hearing loss using scenario-based classroom situations. Specifically, the study assessed teachers' knowledge of childhood hearing loss, their recognition of possible hearing-related signs, their ability to differentiate hearing loss from commonly suspected developmental or behavioral conditions, and their initial referral decisions for children with suspected hearing loss.

## METHODS

### Ethics

The study protocol was approved by the Malatya Turgut Özal University Health Sciences Researches Ethics Committee (Date: 14.03.2026, Decision No: 2026/133) and was conducted in accordance with the Declaration of Helsinki.

### Study Design and Participants

This cross-sectional study was conducted among preschool teachers working with children aged 3-6 years. Participants were recruited voluntarily through an online questionnaire administered via Google Forms (Google LLC, Mountain View, CA, USA). Electronic informed consent was obtained from all participants before participation.

Eligible participants were preschool teachers actively working with children aged 3-6 years, able to read and understand Turkish, and willing to participate. Teachers who were not actively teaching this age group, submitted incomplete or duplicate questionnaires, declined informed consent, or provided responses with substantial missing data were excluded from the analyses.

A convenience and snowball sampling strategy was used. Initial contact was made with preschool teachers within the authors' professional and personal networks, who were invited to participate voluntarily. Participants who agreed to take part were subsequently asked to further disseminate the online questionnaire link within their own professional WhatsApp groups of preschool teacher colleagues. As the survey was distributed through an open, self-propagating chain rather than a fixed sampling frame, the exact number of teachers who received the invitation and the resulting response rate could not be determined.

### Questionnaire

As no standardized and validated Turkish questionnaire specifically evaluating preschool teachers' recognition of possible childhood hearing loss and referral-related decision-making was identified in the literature, a structured questionnaire was developed based on a comprehensive review of the literature on childhood hearing loss, early identification, educational manifestations of hearing

impairment, and teachers' roles in referral pathways.<sup>16</sup> Similar researcher-developed questionnaires have previously been used to evaluate teachers' awareness, knowledge, and practices regarding childhood hearing loss when no standardized instrument was available.<sup>17,18</sup>

The questionnaire's content validity was established through review by an interdisciplinary expert panel (three otorhinolaryngologists, two audiologists, one speech and language therapist, and one experienced preschool teacher), who evaluated each item for relevance, clarity, and clinical appropriateness; items were revised iteratively based on their feedback. Face validity was further supported through informal pre-testing with a small group of preschool teachers prior to full-scale distribution, after which minor wording clarifications were made. As this instrument was designed as a composite index sampling distinct, non-interchangeable knowledge and skill domains (theoretical knowledge, symptom recognition, and scenario-based clinical judgment) rather than a reflective psychometric scale measuring a single latent trait, formal reliability analysis (e.g., internal consistency) was not considered a primary validation requirement for this exploratory instrument; future research would nonetheless benefit from further psychometric validation, including test-retest reliability.

The final questionnaire consisted of five sections. The first section collected demographic and professional information, including gender, age group, years of teaching experience, classroom age group, previous experience with children diagnosed with hearing loss, and previous hearing health education.

The second section evaluated teachers' knowledge of childhood hearing loss using six five-point Likert-type statements. These items assessed knowledge of commonly overlooked clinical characteristics, including mild and unilateral hearing loss, listening difficulties in classroom environments, and the relationship between hearing loss and speech-language development.<sup>3,9</sup>

The third section consisted of a multiple-response question assessing recognition of common classroom signs of possible hearing loss, including communication, listening, speech-language, behavioral, and academic manifestations reported in the literature.<sup>9</sup>

The fourth section included two classroom-based scenarios designed to evaluate teachers' recognition of possible hearing loss and referral-related decision-making in situations where hearing loss may not be immediately apparent. Scenario 1 described a child presenting predominantly with behavioral and attention-related characteristics, whereas scenario 2 described a child presenting primarily with speech-language difficulties suggestive of possible hearing loss. In both scenarios, participants were asked to identify the most likely explanations from several developmental and behavioral alternatives, including hearing loss. In scenario 1, participants were additionally asked to indicate their preferred initial management strategy. The scenarios were designed to reflect the heterogeneous educational manifestations of childhood hearing loss, which may overlap with behavioral

or neurodevelopmental conditions.<sup>7,10</sup> A scenario-based approach was therefore adopted to evaluate how teachers apply their knowledge in realistic classroom situations rather than simply recalling factual information.

The final section assessed teachers' self-perceived ability to recognize children with possible hearing loss in classroom settings and their willingness to participate in future hearing health education programs

### Scoring Procedure

Questionnaire responses were converted into numerical scores to quantify teachers' awareness of childhood hearing loss. The six knowledge items were scored on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"), yielding a knowledge score ranging from 6 to 30. For the symptom recognition item, one point was assigned for each correctly identified sign of hearing loss based on current pediatric audiology literature and expert consensus, whereas incorrect or unselected responses received zero points (range: 0-8).

For the scenario-based items, one point was assigned for each predefined appropriate response. In scenario 1, points were awarded for identifying hearing loss as a possible cause and selecting appropriate initial management strategies (family consultation, audiological/medical referral, and appropriate classroom accommodation). In scenario 2, points were awarded for identifying hearing loss together with other appropriate responses reflecting recognition of hearing-related speech-language difficulties. The scenario 1 and scenario 2 clinical scores ranged from 0-4 and 0-3, respectively.

The total awareness score was calculated by summing the knowledge, symptom recognition, scenario 1 clinical, and scenario 2 clinical scores (possible range: 6-45), with higher scores indicating greater overall awareness. For descriptive purposes, total awareness scores were categorized as low, moderate, or high according to predefined score intervals.<sup>19</sup> The classification of total awareness score into low (<50%), moderate (50%-74.9%), and high ( $\geq 75\%$ ) categories followed the percentage-of-maximum-score convention commonly applied in comparable teacher knowledge/awareness surveys<sup>19</sup> allowing descriptive comparison with prior literature using the same cut-off structure.

### Statistical Analysis

Data were summarized using descriptive statistics (frequency, percentage, mean $\pm$ standard deviation, median, and range). The normality of continuous variables was assessed using the Shapiro-Wilk test. Variables with normal distribution were analyzed using the independent-samples t test or one-way analysis of variance (ANOVA), whereas non-normally distributed variables were compared using the Mann-Whitney U test or Kruskal-Wallis H test, as appropriate. Differences among multiple related binary responses within each scenario were analyzed using Cochran's Q test, and paired comparisons of teachers' selection of hearing loss between the two scenarios were performed using McNemar's exact test. Associations between categorical variables were evaluated using the chi-square or Fisher's exact test, as appropriate. Relationships

among awareness subscales were examined using Spearman's rank correlation coefficient. Binary logistic regression analysis was performed to identify factors associated with selecting hearing loss as a possible cause in each scenario. Model fit was assessed using Nagelkerke  $R^2$ , and results were expressed as odds ratios (ORs) with 95% confidence intervals (CIs). Statistical significance was set at  $p < 0.05$ . A priori power analysis was performed before data collection. Based on Cohen's conventional benchmarks for a medium effect size ( $h = 0.50$ ), with 80% power and a two-tailed significance level of  $\alpha = 0.05$ , the required minimum sample size was calculated to be approximately 126 participants. The final sample of 124 teachers closely approximated this requirement.<sup>20</sup> In addition, the events-per-variable (EPV) ratios for the logistic regression models were 9.0 for the scenario 1 model and 13.25 for the scenario 2 model. These values were close to or exceeded the conventionally recommended minimum threshold of 10 EPV for stable coefficient estimation.<sup>21</sup> All statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, NY, USA).

## RESULTS

A total of 124 experienced preschool teachers working with children aged 3-6 years were included in the study. The sociodemographic and professional characteristics of the participants are presented in [Table 1](#). Of the participants, 75 (60.5%) were female, and 90 (72.6%) were between 30 and 49 years of age. Seventy-three teachers (58.9%) reported previous experience with a child diagnosed with hearing loss, while 75 (60.5%) had previously received education or information regarding childhood hearing health. Thirty-eight participants (30.6%) considered themselves sufficiently knowledgeable to recognize possible signs of hearing loss, whereas 64 (51.6%) reported partial knowledge and 22 (17.7%) were undecided. In addition, 106 teachers (85.5%) indicated that they would be willing to participate in further education on this topic.

Descriptive statistics for the knowledge score, symptom recognition score, scenario 1 clinical score, scenario 2 clinical score, and total awareness score are presented in [Table 2](#). The mean knowledge score was  $22.98 \pm 3.09$  (median=23). Scores could range from 6 to 30. The mean Total Awareness Score was  $30.34 \pm 4.34$  (median=30; range=6-45). According to the predefined awareness categories, 85 participants (68.5%) were classified as having moderate awareness, 35 (28.2%) as having high awareness, and 4 (3.2%) as having low awareness.

The frequency with which teachers recognized possible classroom signs of hearing loss is presented in [Figure 1](#). The most frequently recognized sign was increasing the television or screen volume ( $n=100$ ; 80.6%), followed by a tendency to lip-read ( $n=8$ ; 65.3%) and difficulty hearing or understanding speech in noisy environments ( $n=76$ ; 61.3%). Less frequently recognized signs included academic underachievement ( $n=37$ ; 29.8%) and appearing inattentive or distracted ( $n=44$ ; 35.5%). Two participants (1.6%) did not endorse any of the listed signs.

**Table 1. Sociodemographic and professional characteristics of participants (n=124)**

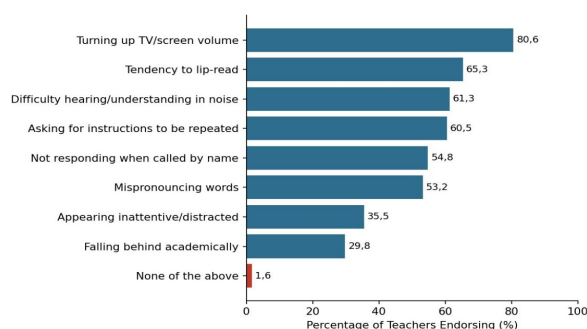
| Variable                                                | n   | %    |
|---------------------------------------------------------|-----|------|
| <b>Gender</b>                                           |     |      |
| Female                                                  | 75  | 60.5 |
| Male                                                    | 49  | 39.5 |
| <b>Age group (years)</b>                                |     |      |
| 20-29                                                   | 26  | 21.0 |
| 30-39                                                   | 48  | 38.7 |
| 40-49                                                   | 42  | 33.9 |
| 50 and above                                            | 8   | 6.5  |
| <b>Professional seniority (years)</b>                   |     |      |
| 0-5                                                     | 28  | 22.6 |
| 6-10                                                    | 33  | 26.6 |
| 11-20                                                   | 46  | 37.1 |
| 21 and above                                            | 17  | 13.7 |
| <b>Age group taught</b>                                 |     |      |
| 3 years                                                 | 28  | 22.6 |
| 4 years                                                 | 37  | 29.8 |
| 5 years                                                 | 35  | 28.2 |
| 6 years                                                 | 23  | 18.5 |
| Other <sup>a</sup> (8 years)                            | 1   | 0.8  |
| <b>Prior experience with a hearing-impaired student</b> |     |      |
| Yes                                                     | 73  | 58.9 |
| No                                                      | 40  | 32.3 |
| Not sure                                                | 11  | 8.9  |
| <b>Prior hearing health training</b>                    |     |      |
| Yes                                                     | 75  | 60.5 |
| No                                                      | 49  | 39.5 |
| <b>Self-perceived competence regarding hearing loss</b> |     |      |
| Yes, fully knowledgeable                                | 38  | 30.6 |
| Partially                                               | 64  | 51.6 |
| Undecided                                               | 22  | 17.7 |
| <b>Willingness to attend further training</b>           |     |      |
| Yes                                                     | 106 | 85.5 |
| Undecided                                               | 11  | 8.9  |
| No                                                      | 7   | 5.6  |

<sup>a</sup>One participant reported teaching a mixed-age classroom that also included children older than 6 years. As this participant met all other eligibility criteria and represented a very small proportion of the study sample, the participant was retained in the analyses

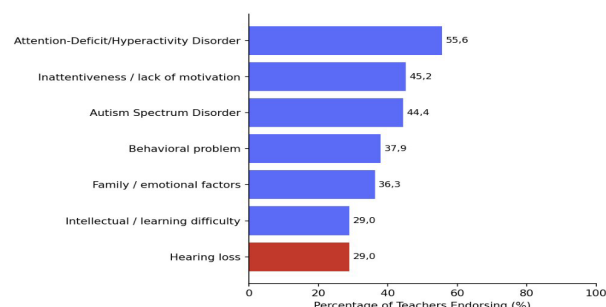
**Table 2. Descriptive statistics for awareness subscales (n=124)**

| Measure                   | Possible range | Mean±SD    | Median | Min-max | Shapiro-Wilk (p) |
|---------------------------|----------------|------------|--------|---------|------------------|
| Knowledge score           | 6-30           | 22.98±3.09 | 23     | 13-30   | p=0.005          |
| Symptom recognition score | 0-8            | 4.41±1.47  | 4      | 0-8     | p<0.001          |
| Scenario 1 clinical score | 0-4            | 1.48±1.17  | 1      | 0-4     | p<0.001          |
| Scenario 2 clinical score | 0-3            | 1.46±1.00  | 1      | 0-3     | p<0.001          |
| Total awareness score     | 6-45           | 30.34±4.34 | 30     | 18-42   | p=0.298          |

p<0.05 indicates a significant deviation from normality (Shapiro-Wilk test). SD: Standard deviation, Min: Minimum, Max: Maximum

**Figure 1. Recognition frequency of possible hearing loss signs among preschool teachers**

In scenario 1, which included behavioral and attention-related cues, the categories teachers endorsed as possible causes are presented in **Figure 2**. Cochran's Q test showed a statistically significant difference among the selection rates of the seven possible cause categories [ $Q(6)=25.92$ ;  $p<0.001$ ]. More than half of the teachers ( $n=69$ ; 55.6%) endorsed attention-deficit/hyperactivity disorder as a possible cause in this scenario, whereas hearing loss was endorsed by only 29.0% ( $n=36$ ), ranking among the least frequently selected categories along with intellectual/learning difficulty.

**Figure 2. Possible causes selected for scenario 1 (Ali)**

Teachers reported initial approach in scenario 1 is presented in **Table 3**. Half of the participants ( $n=63$ ; 50.8%) indicated that their first step would be to speak with the family, whereas only 12.9% ( $n=16$ ) reported that their initial approach would be to recommend a hearing test or referral to a health facility. No statistically significant association was found between prior hearing health training and the choice of initial approach [ $\chi^2(4)=3.55$ ;  $p=0.471$ ].

**Table 3. Reported initial approach for scenario 1 (Ali) (n=124)**

| Initial approach                                         | n  | %    |
|----------------------------------------------------------|----|------|
| Speak with the family                                    | 63 | 50.8 |
| Refer to the school guidance/counseling service          | 23 | 18.5 |
| Seat the student in front and provide extra attention    | 17 | 13.7 |
| Recommend a hearing test/referral to a health facility   | 16 | 12.9 |
| Observe for a while and wait for spontaneous improvement | 5  | 4.0  |

$\chi^2$ : Chi-square test; comparison by prior hearing health training status

The distribution of possible causes endorsed in scenario 2, in which speech and language developmental cues predominated, is presented in **Figure 3**. Cochran's Q test revealed a statistically significant difference among the selection rates of the six possible cause categories [ $Q(5)=21.30$ ,  $p<0.001$ ]. Speech/language developmental delay was the most frequently selected category ( $n=75$ ; 60.5%), followed by hearing loss ( $n=53$ ; 42.7%).

When the same participants' choices across the two scenarios were compared in a paired fashion (**Figure 4**), the proportion of teachers endorsing hearing loss as a possible cause was

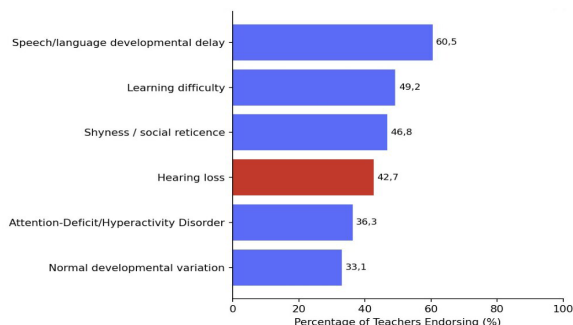


Figure 3. Possible causes selected for scenario 2 (Ayşe)

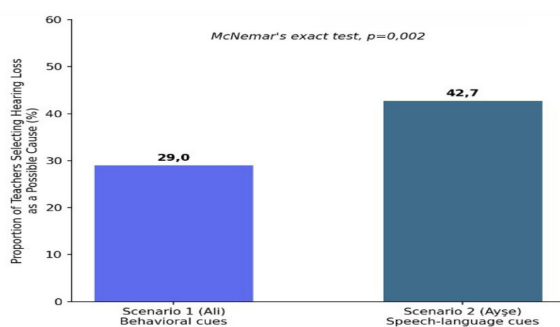


Figure 4. Proportion of teachers selecting hearing loss as a possible cause, by scenario type

significantly higher in scenario 2 (42.7%) than in scenario 1 (29.0%) (McNemar's exact test,  $p=0.002$ ). Examination of the discordant pairs showed that 23 teachers endorsed hearing loss only in scenario 2, whereas 6 teachers endorsed it only in scenario 1.

Results of the comparisons of awareness subscales and the Total Awareness Score according to sociodemographic and professional characteristics are presented in Table 4. No statistically significant differences in the total awareness score were observed according to gender, age group, professional seniority, or self-perceived competence (all  $p>0.05$ ). Previous experience with a hearing-impaired child was associated with the knowledge score [Kruskal-Wallis H (2)=7.28,  $p=0.026$ ], whereas no significant differences were observed for the remaining awareness domains (all  $p>0.05$ ).

Participants who had previously received hearing health training achieved significantly higher scores on the knowledge score ( $23.83\pm2.81$  vs.  $21.69\pm3.07$ ; Mann-Whitney U=2527.5,  $p<0.001$ ), scenario 1 clinical score ( $1.80\pm1.28$  vs.  $1.00\pm0.74$ ; U=2471.5,  $p=0.001$ ), scenario 2 clinical score ( $1.73\pm0.96$  vs.  $1.04\pm0.91$ ; U=2573.0,  $p<0.001$ ), and total awareness score [ $31.80\pm4.08$  vs.  $28.10\pm3.78$ ;  $t(122)=5.08$ ,  $p<0.001$ ]. No

statistically significant difference was observed between training groups for the symptom recognition score ( $p=0.659$ ) (Table 4).

The categorical classification of total awareness level in relation to prior hearing health training also supports this finding (Table 5). Among teachers who had received prior training, 41.3% ( $n=31/75$ ) fell into the 'high' awareness category, compared with only 8.2% ( $n=4/49$ ) among those without training; this association was statistically significant (Fisher's exact test, OR=7.93;  $p<0.001$ ).

Table 5. Distribution of total awareness level by prior hearing health training status

| Awareness level | Prior training, n (%) | No training, n (%) | Total, n (%) |
|-----------------|-----------------------|--------------------|--------------|
| Low             | 1 (1.3)               | 3 (6.1)            | 4 (3.2)      |
| Moderate        | 43 (57.3)             | 42 (85.7)          | 85 (68.5)    |
| High            | 31 (41.3)             | 4 (8.2)            | 35 (28.2)    |
| Total           | 75 (100.0)            | 49 (100.0)         | 124 (100.0)  |

Fisher's exact test (low/moderate vs. high): OR=7.93 (95% CI: 2.64-23.84),  $p<0.001$ . OR: Odds ratio, CI: Confidence interval

Relationships among the awareness subscales were examined using Spearman's rank correlation analysis, and the results are presented in Table 6. No statistically significant correlation was observed between the knowledge score and the symptom recognition score ( $\rho=0.012$ ,  $p=0.899$ ). The knowledge score was weakly correlated with the scenario 2 clinical score ( $\rho=0.273$ ,  $p=0.002$ ), whereas no significant correlation was observed with the scenario 1 clinical score ( $p>0.05$ ). The symptom recognition score showed weak positive correlations with both the scenario 1 clinical score ( $\rho=0.210$ ,  $p=0.019$ ) and the scenario 2 clinical score ( $\rho=0.205$ ,  $p=0.022$ ). A moderate positive correlation was observed between the scenario 1 and scenario 2 clinical scores ( $\rho=0.351$ ,  $p<0.001$ ).

Table 6. Spearman correlation coefficients ( $\rho$ ) among awareness subscales

| Variable                     | 1       | 2      | 3       | 4 |
|------------------------------|---------|--------|---------|---|
| 1. Knowledge Score           | -       |        |         |   |
| 2. Symptom recognition score | 0.012   | -      |         |   |
| 3. Scenario 1 clinical score | 0.119   | 0.210* | -       |   |
| 4. Scenario 2 clinical score | 0.273** | 0.205* | 0.351** | - |

\* $p<0.05$ , \*\* $p<0.01$  (Spearman's rank correlation coefficient)

Table 4. Comparison of awareness scores by sociodemographic and professional variables

| Variable                         | Knowledge score | Symptom recognition | Scenario 1 clinical | Scenario 2 clinical | Total awareness |
|----------------------------------|-----------------|---------------------|---------------------|---------------------|-----------------|
| Gender (F/M)                     | $p=0.276^b$     | $p=0.331^b$         | $p=0.725^b$         | $p=0.484^b$         | $p=0.439^a$     |
| Age group                        | $p=0.977^c$     | $p=0.998^c$         | $p=0.259^c$         | $p=0.999^c$         | $p=0.818^d$     |
| Professional seniority           | $p=0.105^c$     | $p=0.781^c$         | $p=0.351^c$         | $p=0.413^c$         | $p=0.082^d$     |
| Prior experience with HI student | $p=0.026^{*c}$  | $p=0.997^c$         | $p=0.598^c$         | $p=0.110^c$         | $p=0.227^d$     |
| Prior hearing health training    | $p<0.001^{*b}$  | $p=0.659^b$         | $p=0.001^{*b}$      | $p<0.001^{*b}$      | $p<0.001^{*a}$  |
| Self-perceived competence        | $p=0.228^c$     | $p=0.973^c$         | $p=0.511^c$         | $p=0.058^c$         | $p=0.451^d$     |

$p<0.05$ . <sup>a</sup>Independent-samples t test. <sup>b</sup>Mann-Whitney U test. <sup>c</sup>Kruskal-Wallis H test. <sup>d</sup>One-way ANOVA. F/M: Female/male, HI: Hearing-impaired student, ANOVA: Analysis of variance

Results of the binary logistic regression analyses examining factors associated with selecting hearing loss as a possible cause in each scenario are presented in Table 7. The model for scenario 1 was statistically significant [LLR  $\chi^2$  (4)=25.74,  $p<0.001$ ; Nagelkerke  $R^2=0.268$ ]. Prior hearing health training was the only significant predictor (OR=7.27; 95% CI: 2.21-23.93;  $p=0.001$ ). Teachers who had previously received hearing health training had 7.27-fold higher odds of selecting hearing loss as a possible cause than those without prior training. The model for scenario 2 was also statistically significant [LLR  $\chi^2$  (4)=30.03,  $p<0.001$ ; Nagelkerke  $R^2=0.289$ ]. In this model, both prior hearing health training (OR=5.10; 95% CI: 2.03-12.84;  $p<0.001$ ) and the standardized symptom recognition score (OR=1.57; 95% CI: 1.04-2.37;  $p=0.033$ ) were significant predictors. Neither the knowledge score nor previous experience with a hearing-impaired child was significantly associated with the outcome in either model (all  $p>0.05$ ).

demonstrated marked improvements in teachers' hearing health knowledge following a brief educational intervention. Likewise, Abraham and Masunga<sup>19</sup> suggested that structured professional education may contribute more to teachers' ability to recognize hearing-related problems than routine classroom experience. Together, these findings suggest that differential recognition of childhood hearing loss may be more closely associated with targeted education than with years of teaching experience or incidental exposure to affected children, although the cross-sectional design of this study does not allow causal or temporal conclusions to be drawn regarding this relationship; teachers who had received training may also differ from untrained teachers in other unmeasured respects, such as personal interest in hearing health or general professional engagement. This pattern was also observed in the regression analyses, in which prior hearing health training remained a significant predictor of

Table 7. Logistic regression results for variables predicting selection of hearing loss as a possible cause in each scenario

| Predictor                              | Scenario 1 OR (95% CI) | p      | Scenario 2 OR (95% CI) | p       |
|----------------------------------------|------------------------|--------|------------------------|---------|
| Knowledge score (z)                    | 1.22 (0.76-1.96)       | 0.419  | 1.44 (0.92-2.26)       | 0.108   |
| Symptom recognition score (z)          | 1.49 (0.95-2.33)       | 0.081  | 1.57 (1.04-2.37)       | 0.033*  |
| Prior hearing health training (yes)    | 7.27 (2.21-23.93)      | 0.001* | 5.10 (2.03-12.84)      | <0.001* |
| Prior experience with HI student (yes) | 2.12 (0.85-5.30)       | 0.110  | 1.84 (0.80-4.23)       | 0.150   |

p<0.05. Continuous predictors were standardized (z-scores). Scenario 1: LLR  $\chi^2$  (4)=25.74,  $p<0.001$ ; Nagelkerke  $R^2=0.268$ . Scenario 2: LLR  $\chi^2$  (4)=30.03,  $p<0.001$ ; Nagelkerke  $R^2=0.289$ . OR: Odds ratio, CI: Confidence interval, HI: Hearing-impaired

## DISCUSSION

The present study showed that although experienced preschool teachers demonstrated a relatively good level of theoretical knowledge regarding childhood hearing loss, this knowledge was not consistently reflected in their ability to recognize hearing loss in classroom scenarios. This discrepancy was particularly evident when hearing loss presented with behavioral or attention-related characteristics rather than speech-language difficulties. Although the average knowledge score corresponded to approximately three-quarters of the maximum obtainable score, overall awareness remained somewhat lower, indicating that theoretical knowledge alone may not adequately capture teachers' ability to recognize possible hearing loss in real classroom situations. Abraham and Masunga<sup>19</sup> reported a comparable pattern, showing that although teachers were generally aware of childhood hearing loss, many failed to recognize important hearing-related symptoms and instead attributed these behaviors to other conditions. Similarly, the lack of association between the knowledge score and symptom recognition score in our study suggests that factual knowledge alone may not be sufficient for recognizing hearing loss in everyday classroom situations.

The most consistent finding of the present study was the strong and consistent statistical association between previous hearing health training and scenario-based recognition performance. Teachers who reported previous hearing health training achieved higher scenario-based recognition scores and greater overall awareness, whereas professional seniority and previous experience with a hearing-impaired child were not independently associated with better performance. These findings are in line with those of Kapalamula et al.,<sup>22</sup> who

recognizing hearing loss in both scenarios after adjustment for theoretical knowledge and previous experience with a hearing-impaired child, though this finding should likewise be interpreted as associative rather than causal.

An important finding of the present study was that hearing loss was recognized considerably less frequently when children presented primarily with behavioral characteristics than when speech-language difficulties were more prominent. In the first scenario, hearing loss was frequently overshadowed by attention-deficit/hyperactivity disorder, autism spectrum disorder, and other behavioral explanations despite several findings compatible with hearing impairment. Previous studies have shown that childhood hearing loss may present with nonspecific classroom behaviors, including inattentiveness, delayed responses to verbal instructions, poor concentration, and academic difficulties, making differentiation from behavioral or neurodevelopmental disorders challenging.<sup>7,9</sup> Our findings support these observations and further suggest that behavioral manifestations may reduce teachers' clinical suspicion of hearing loss, even when their theoretical knowledge is relatively adequate. The paired comparison between scenarios further supports this observation, demonstrating that teachers considered hearing loss significantly more often when speech-language cues were present than when behavioral features predominated.

In contrast, teachers were more likely to consider hearing loss when speech-language characteristics accompanied the clinical presentation. Difficulty understanding speech in noisy environments together with articulation problems and delayed speech development appeared to increase teachers' suspicion of hearing loss. This finding is consistent with

previous evidence indicating that speech-language difficulties are among the most recognizable consequences of childhood hearing loss.<sup>3</sup> Nevertheless, fewer than half of the teachers selected hearing loss even in this scenario, suggesting that speech-language symptoms alone may not consistently trigger appropriate suspicion.

Our findings should also be considered in light of those reported by Shinn et al.,<sup>18</sup> who demonstrated that teachers were able to identify children at risk for hearing loss through routine classroom observation and suggested that teachers may represent an important first step in school-based hearing identification. Although this may initially appear inconsistent with our results, the objectives of the two studies differ. In the Kenyan study, teachers identified children they already suspected of having hearing-related problems, whereas our participants were required to distinguish hearing loss from several plausible developmental and behavioral explanations presented within standardized classroom scenarios. This difference suggests that recognizing a child who is struggling and correctly identifying hearing loss as a possible underlying cause are related but distinct processes.

The present findings also have practical implications for school-based hearing surveillance. Elbeltagy et al.<sup>4</sup> reported that a proportion of children who had passed newborn hearing screening were later diagnosed with delayed-onset sensorineural hearing loss after entering primary school. The authors emphasized that these children may easily be perceived as inattentive or academically weak unless hearing loss is specifically considered. Our findings appear to support this concern, as hearing loss was least likely to be recognized when behavioral characteristics predominated. Since newborn hearing screening cannot identify all cases of childhood hearing loss, teachers may represent an important opportunity for recognizing children who require further audiological evaluation.

Although previous hearing health training was associated with higher recognition performance, only a small proportion of participants indicated that recommending an audiological or medical evaluation would be their first management decision. A similar observation was reported by Kapalamula et al.,<sup>22</sup> who found that improvements in knowledge were not always accompanied by confidence in referral pathways. This finding suggests that educational programs should not only improve theoretical knowledge but also provide practical guidance regarding appropriate referral procedures when childhood hearing loss is suspected.

Overall, the present findings suggest that improving teachers' recognition of childhood hearing loss requires more than increasing factual knowledge alone. Educational activities incorporating realistic classroom scenarios, identification of hearing loss from commonly encountered behavioral and developmental conditions, and clear referral pathways may better prepare teachers to identify children who require timely audiological assessment.

### Limitations

A limitation of the present study is that no standardized and validated Turkish instrument specifically designed to assess

teachers' recognition of possible childhood hearing loss was available. Consequently, a structured questionnaire developed from the literature and reviewed by an interdisciplinary expert panel was used. The scenario-based responses may not fully reflect teachers' actual behavior in real classroom settings. Future studies should focus on the psychometric validation of standardized instruments assessing teachers' knowledge, recognition, and referral practices related to childhood hearing loss.

This study should be considered a preliminary, exploratory investigation that may serve as a foundation for future, larger-scale research on this topic; the sample size, while modest, closely approximated the benchmark required to detect a medium effect size with adequate statistical power (see Sample Size section). A convenience and snowball sampling strategy was used, which limits the generalizability of the findings, as participants with a pre-existing interest in hearing health may have been more likely to complete the questionnaire or to be included in colleagues' networks. Formal psychometric validation of the questionnaire, including reliability testing, was beyond the scope of this exploratory study and represents an important direction for future research. Finally, as this was a cross-sectional study, the observed association between prior training and recognition performance cannot be interpreted as causal.

### CONCLUSION

Preschool teachers demonstrated moderate theoretical knowledge of childhood hearing loss; however, this was not consistently reflected in scenario-based recognition, particularly when behavioral features predominated. Previous hearing health training, but not teaching experience, was associated with better recognition of possible hearing loss. These findings support the inclusion of scenario-based education and practical referral guidance in teacher training programs.

### ETHICAL DECLARATIONS

#### Ethics Committee Approval

This study was approved by the Malatya Turgut Özal University Health Sciences Researches Ethics Committee (Date: 14.03.2026, Decision No: 2026/133).

#### Informed Consent

Written informed consent was obtained from all individual participants prior to their inclusion in the study. Participants were fully informed about the study's aims, procedures, potential risks and benefits, and their rights-including the right to withdraw at any time without consequence. All participants voluntarily signed a written informed consent form.

#### Peer Review Process

This manuscript was subject to external peer review.

#### Conflict of Interest

The authors declare no conflicts of interest related to this study.

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## Author Contributions

Concept: HK; Design: HK; Control: PT; Resources: SHT, PT; Materials: SHT, PT; Data Collection and/or Processing: SHT, PT; Analysis and/or Interpretation: YT; Literature Review: HK, YT; Writing the Article: HK, YT; Critical Review: SHT; Final Approval: HK, SHT, PT, YT.

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## REFERENCES

- World Health Organization. World Report on Hearing. World Health Organization; 2021.
- Shave S, Botti C, Kwong K. Congenital sensorineural hearing loss. *Pediatr Clin North Am*. 2022;69(2):221-234. doi:10.1016/j.pcl.2021.12.006
- Tamanini D, Ramos N, Dutra LV, Bassanesi HJC. Triagem auditiva escolar: identificação de alterações auditivas em crianças do primeiro ano do ensino fundamental. *Rev CEFAC*. 2015;17(5):1403-1414. doi:10.1590/1982-0216201517512314
- Elbeltagy R, AlObayed W, Mashbri S, et al. Delayed-onset hearing loss in first-grade students who previously passed the newborn hearing screening. *Front Pediatr*. 2025;13:1623225. doi:10.3389/fped.2025.1623225
- Núñez Batalla FJ, Fernández-Cedón Bermejo C, Guntín García M, et al. Universal neonatal hearing screening and delayed hearing loss or late-developmental hearing loss. *Acta Otorrinolaringol Esp (Engl Ed)*. 2023;74(5):283-289. doi:10.1016/j.otoeng.2022.10.007
- Corazzi V, Fordington S, Holland Brown T, et al. Late-onset, progressive sensorineural hearing loss in the paediatric population: a systematic review. *Eur Arch Otorhinolaryngol*. 2024;281(7):3397-3421. doi:10.1007/s00405-024-08527-x
- Mattingly J, Werfel KL, Lund E. Parent-reported attention-deficit/hyperactivity disorder-linked behaviors, fatigue, and language in children who are deaf and hard of hearing. *Perspect ASHA Spec Interest Groups*. 2023;8(6):1409-1421. doi:10.1044/2023\_PERSP-23-00086
- Lieu JEC, Kenna M, Anne S, Davidson L. Hearing loss in children: a review. *JAMA*. 2020;324(21):2195-2205. doi:10.1001/jama.2020.17647
- Purcell PL, Shinn JR, Davis GE, Sie KCY. Children with unilateral hearing loss may have lower intelligence quotient scores: a meta-analysis. *Laryngoscope*. 2016;126(3):746-754. doi:10.1002/lary.25524
- Ansari MS. Hearing screening program for school going children in India: necessity, justification, and suggested approaches. *Egypt J Otolaryngol*. 2021;37:118. doi:10.1186/s43163-021-00182-x
- Bell M, Galyon M, LeMaster B. Hearing screening guidelines for the pre-school/school population. Alaska Department of Health and Social Services, Division of Public Health; 2016.
- Swanepoel D, Clark JL. Hearing healthcare in remote or resource-constrained environments. *J Laryngol Otol*. 2019;133(1):11-17. doi:10.1017/S0022215118001159
- Olusanya BO, Neumann KJ, Saunders JE. The global burden of disabling hearing impairment: a call to action. *Bull World Health Organ*. 2014;92(5):367-373. doi:10.2471/BLT.13.128728
- AlOtaibi AF, Bashawri HA, AlOtaibi HF, Alqahtani AH, Alzahrani AS, AlOtaibi MS. Knowledge and attitudes of school teachers toward hearing problems with students in general elementary schools in Makkah, 2019. *Medical Science*. 2020;24(105):2900-2917.
- Ookeditse G, Mukhopadhyay S. Teachers' transition attitudes for students with disabilities in two regions of Botswana. *SAGE Open*. 2021;11(4):1-13. doi:10.1177/21582440211059166
- World Health Organization. Vision and Hearing Screening for School-Age Children: Implementation Handbook. World Health Organization; 2025.
- Nilisha DA, Ranjan R. Development, validation and reliability of a questionnaire to assess awareness, knowledge, and practice about hearing impairment among school teachers. *Int Tinnitus J*. 2021;25(2):162-168. doi:10.5935/0946-5448.20210029
- Shinn JR, Jayawardena ADL, Patro A, Zuniga MG, Netterville JL. Teacher prescreening for hearing loss in the developing world. *Ear Nose Throat J*. 2021;100(3 suppl):259S-262S. doi:10.1177/0145561319880388
- Abraham ZS, Masunga H. Primary school teachers knowledge attitudes and teaching challenges regarding hearing loss among pupils in central Tanzania. *Discov Public Health*. 2026;23:451. doi:10.1186/s12982-026-01861-x
- Cohen J. Statistical Power Analysis for the Behavioral Sciences. 2<sup>nd</sup> ed. Lawrence Erlbaum Associates; 1988.
- Peduzzi P, Concato J, Kemper E, Holford TR, Feinstein AR. A simulation study of the number of events per variable in logistic regression analysis. *J Clin Epidemiol*. 1996;49(12):1373-1379. doi:10.1016/S0895-4356(96)00236-3
- Kapalamula G, Gordie K, Khomera M, Porterfield JZ, Toman J, Vallario J. Hearing health awareness and the need for educational outreach amongst teachers in Malawi. *Audiol Res*. 2023;13(2):271-284. doi:10.3390/audiolres13020024