Review Article

Linguistic and Metalinguistic Profiles of Persian-Speaking Children with Hearing Impairment: A Systematic Review of Observational Studies

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Citation: Abbasi H, Fayazi L, Ahadi H Linguistic and Metalinguistic Profiles of Persian-Speaking Children with Hearing Impairment: A Systematic Review of Observational Studies. Aud Vestib Res. ?.

Article info:
Received: 10 May 2026
Revised: 20 Jun 2026
Accepted: 20 Jul 2026

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Short running title: Linguistic and Metalinguistic Profiles of…

Highlights:

- Persian-speaking children with HI show significant delays in most linguistic domains
- Early CI (before age 2) and mainstream schools are associated with better outcomes
- A significant imbalance exists toward expressive vs. receptive skills in Persian

ABSTRACT

Background and Aim: Numerous studies have investigated the linguistic characteristics of Persian-speaking children with hearing impairment. Given the variability of findings across these studies, a systematic review is required to both identify research gaps and synthesize existing results. This systematic review aimed to answer the following question: in Persian-speaking children with hearing impairment compared to typically hearing Persian-speaking children, what is the profile of linguistic skills (phonology, morphosyntax, semantics, pragmatics) and metalinguistic skills (phonological awareness, syntactic awareness, semantic awareness)?

Recent Findings: Persian-speaking children with hearing impairment experience significant delays across most linguistic domains, particularly in phonetics/phonology (55% of studies), morphosyntax (16%), and semantics/pragmatics (13%). The most consistent deficits were observed in vowel production and perception, phonological awareness, grammatical omissions, tense marking errors, and comprehension of non-literal meanings. Children with cochlear implants outperformed hearing aid users, and early implantation (before age 2) was associated with more favorable outcomes.

Conclusion: Persian-speaking children with hearing impairment demonstrate significant and persistent delays in both linguistic and metalinguistic skills compared to typically hearing peers. Early cochlear implantation and linguistically rich educational environments (e.g. mainstream schools) are associated with better language

outcomes. Clinically, comprehensive language assessments should include both receptive and expressive skills, with targeted interventions focusing on phonological awareness, morphosyntax, and pragmatic abilities. Future research should prioritize neglected age groups (6–8 years and 10–15 years) and the understudied semantic-pragmatic domain.
Keywords: Hearing impairment; language; metalinguistic skills; Persian-speaking children; systematic review

Introduction

Numerous studies have examined language development in children with hearing impairment. Research by Pressnell [1] and Geers and Moog [2] in English, and by Tur-Kaspa and Dromi [3] in Hebrew, has demonstrated that these children follow developmental patterns different from their hearing peers. Compared with typically developing children, language acquisition and development in children with hearing impairment display three distinct patterns [4]. Certain stages, such as babbling, emerge similarly in both groups. In other domains, such as vocabulary, delays are observed in children with hearing impairment, although their developmental trajectory remains comparable to that of hearing children. However, in areas such as morphosyntax, their developmental pathway diverges. Such findings suggest that hearing impairment may lead to deficits and delays in the acquisition of language domains including phonology, vocabulary, semantics, morphology, syntax, and even pragmatics [4].

Babbling is known to be the first stage of language production, beginning around 6–10 months of age and preceding other stages of language development [5]. At this stage, children produce vowel and consonant sounds as well as their combinations. Children with hearing impairment, however, typically begin babbling between 12 and 25 months of age. Although children with cochlear implants show developmental delays when measured against chronological age, they demonstrate accelerated babbling growth when measured by "hearing age", i.e. the time since cochlear implantation. The relationship between babbling and later language abilities remains unclear. Nevertheless, evidence suggests that babbling is not necessarily a predictor of language development, nor is it an essential prerequisite for subsequent language acquisition [6].

Children with hearing impairment perform more poorly than their hearing peers in both the perception and production of vocabulary. They also face difficulties in interpreting polysemous words. A study by Lederberg and Spencer [7] on English-speaking children with hearing impairment revealed that, even when using cochlear implants, amplification devices, or high-quality educational programs, these children acquire vocabulary at a slower rate compared to their typically developing peers. Some children with hearing impairment who possess a vocabulary exceeding 100 words nonetheless learn new words at a slow pace, adding only a few words per month —a phenomenon not seen in hearing children [6]. Mayne et al. [8] reported that when children with hearing impairment are exposed to rich linguistic input early in infancy, their vocabulary development progresses more smoothly regardless of communication method. Overall, however, vocabulary acquisition in children with cochlear implants remains slower than in typically developing children [6].

Syntactic development in children with hearing impairment lags even further behind vocabulary development. These children often struggle with morphosyntax and complex sentence structures [9]. They tend to avoid producing complex constructions, preferring shorter utterances, and frequently experience difficulty using functional elements such as prepositions, demonstratives, conjunctions, and pronouns —features essential for proper sentence interpretation [6].

Pragmatic skills, particularly those involved in distinguishing literal from figurative meaning in idioms and proverbs, are also limited in children with hearing impairment [10]. Like hearing children, they acquire lexical categories such as verbs, nouns, adjectives, and prepositions before functional categories [11]. In English, one of the most common difficulties encountered by these children is omission of tense markers (present, past, progressive) in obligatory contexts. Unlike hearing children, they rarely overgeneralize irregular past tense forms, which means they may spend a long-time memorizing verb inflection. They also produce fewer errors with possessives and plural markers. Thus, the sequence of morpheme acquisition in children with hearing impairment differs from that of typically developing children [12]. German-speaking children with cochlear implants who use oral language show similar acquisition patterns for verbal inflections and plural morphemes as hearing children, but they display errors in grammatical agreement, particularly gender and case between articles and nouns [13]. In Hebrew, Tur-Kaspa and Dromi [14] found that children with hearing impairment make errors in number and gender agreement between nouns and verbs, and between adjectives and nouns.

Given the importance of understanding the linguistic characteristics of children with hearing impairment across different domains of language, the variability of these features across languages, and their clinical implications for Persian-speaking children, a systematic review is warranted. Such a review can identify research gaps, synthesize findings on the linguistic and metalinguistic abilities of these children compared to their hearing peers, and provide clinicians with a comprehensive framework for intervention. Of note, this systematic review focuses exclusively on descriptive observational studies of linguistic and metalinguistic abilities. Intervention studies examining the effectiveness of therapeutic or educational programs, as well as studies primarily addressing reading and writing skills, were excluded from the synthesis.

This systematic review addressed the following questions: 1) in Persian-speaking children with hearing impairment compared to typically hearing peers, what is the profile of general language skills? 2) what are the differences in phonetic-phonological skills? 3) what are the patterns of morphosyntactic errors? 4) what are the differences in semantic-pragmatic skills? 5) what is the profile of metalinguistic skills? and 6) does age at implantation, type of device, and educational setting affect linguistic and metalinguistic outcomes?

Methods

The present systematic review was conducted following the PRISMA 2020 statement. A comprehensive search was performed in both Persian and English scientific databases, including the Comprehensive Portal of Humanities, Scientific Information Database (SID), Noormags, Magiran, and IranDoc for Persian sources, as well as Google Scholar for English sources. The search was performed up to 2025. No lower time limit was applied to maximize coverage.

To examine linguistic and metalinguistic studies on children who are hard of hearing or deaf, relevant keywords —including hard of hearing, deaf, hearing disorder, hearing loss, hearing impairment, and cochlear implant — were searched. The general search syntax used for all databases was as follows:

("hearing impairment" OR "hard of hearing" OR "deaf" OR "hearing loss" OR "cochlear implant" OR "hearing aid") AND ("language" OR "phonology" OR "phonetics" OR "morphology" OR "syntax" OR "semantics" OR "pragmatics" OR "metalinguistic" OR "phonological awareness")

The search was limited to original research articles published in peer-reviewed journals. Only studies that specifically targeted Persian-speaking children with hearing impairment were included, regardless of the language of publication (Persian or English). Review articles, case studies, and conference abstracts were excluded at the initial screening stage.

Studies related to linguistic abilities in children with hearing impairment were first identified through keyword search. Next, relevant titles were extracted, and abstracts (and, when necessary, full texts) were reviewed to collect studies directly related to the research topic.

Articles excluded from the review were those related to the following topics: studies focusing primarily on family members of children with hearing impairment (e.g. parental stress, family empowerment, mental health of parents, family-centered interventions without direct assessment of the child's linguistic or metalinguistic skills), motivation and self-concept, development of language teaching packages and similar interventions, reading and writing skills (literacy studies not directly reporting oral linguistic or metalinguistic skills), etiology, prevalence, and other theoretical foundations, standardization and test construction, effectiveness of therapy (intervention studies examining therapeutic or educational outcomes), translated or review articles, and intervention studies (e.g. effectiveness of therapy, language teaching packages).

Given that all included studies were original research articles published in peer-reviewed journals, we developed a five-criteria quality assessment framework adapted from the Joanna Briggs Institute (JBI) checklists for cross-sectional and case series studies, selected as the most relevant to the descriptive and observational nature of the included studies. The five criteria were: 1) clear inclusion/exclusion criteria, defined as participant characteristics (age, degree of hearing loss, device type, language background) being explicitly stated; 2) valid and reliable measurement tools, defined as the use of standardized validated tests or a clear report of validity and reliability for researcher-made tools; 3) appropriate statistical analysis, defined as statistical methods suitable for the research question and data type; 4) management of confounders, defined for controlled studies as confounders (age, sex, socioeconomic status) being addressed, and for uncontrolled studies as this limitation being explicitly acknowledged; and 5) clear reporting of findings, defined as results including measures of variability (standard deviation, confidence interval, or range) and/or effect sizes where applicable. Each criterion was rated as "Yes", "No", or "Unclear" by two independent reviewers, with "Not Applicable" used for criterion 4 when a study lacked a control group. A study was considered to have met a criterion only if the answer was "Yes". Studies that failed to meet any of the five criteria were excluded from the review at the full-text screening stage. Applying this framework, all studies that met the inclusion criteria also satisfied all five quality criteria (Figure 1).

Results

After reviewing 53 identified article titles, 47 studies focusing on the description of linguistic skills in children with hearing impairment were selected and 6 studies on their metalinguistic skills. These 47 studies were classified into four main categories: general language assessments, phonetic and phonological studies, morphosyntactic studies, and semantic and pragmatic studies. The majority of studies focused on phonetics and phonology (55%), while the fewest addressed semantics and pragmatics (13%).

General language studies

Eight studies conducted between 2005 and 2020 assessed language outcomes in preschool and early school years, with six including control groups for comparison with typical developmental milestones (Table 1) [15-19]. Participant groups predominantly comprised children with severe-to-profound hearing loss, particularly cochlear implant recipients, with sample sizes ranging from 6 to 60 across various Iranian cities. Assessment methods included the Language Development Scale [15, 18], Descriptive Speech Sample analysis [16, 17], vocabulary awareness tasks [17], a standardized auditory perception test for Persian [18], the Categories of Auditory Performance (CAP), Speech Intelligibility Rating (SIR), and Meaningful Use of Speech Scale (MUSS) [19], the Newsha Developmental Scale with parental interviews [20], and a verbal/non-verbal communication questionnaire [21]. Participant ages ranged from 12 months (hearing age) to 7 years, mostly preschoolers aged 6 years. Limitations included small sample sizes (e.g. only six children in one study [17]), reliance on data from single cities (predominantly Tehran [18-21]), and lack of control groups in some studies [18-20].

Phonological and phonetic studies

Twenty-seven studies (Table 2) conducted between 2001 and 2025 revealed a sustained research focus on phonological abilities, intensified by increased cochlear implant availability. Recent studies focused predominantly on children with Cochlear Implants (CIs), while earlier research included hearing aid users [22-28]. Age-matched control groups were frequently used, though several studies lacked such controls [29-34]. Research spanned multiple Iranian cities (Tehran, Isfahan, Shiraz, Zahedan, Karaj, Kerman, Ahvaz, Hamedan, Khorasan) with sample sizes ranging from 4 to 238 children.

Assessment methods covered segmental skills (vowel production and perception, often distorted due to reliance on spectral information [24-26]) and suprasegmental features (intonation production and comprehension [22, 23]), as well as higher-order metalinguistic skills like phonological awareness [27, 28]. Tools included vowel production tasks analyzed with PRAAT or SFS win software [24-27], the Phonetic-Phonological Test [29], sentence repetition and reading for intonation [22, 23], CAP and SIR scales [32-34], speech intelligibility tests at the word level [35, 36], picture naming [37], researcher-made tests [38], vowel discrimination tasks [33], syllable repetition in CV, CVC, and VC contexts [39-47], auditory perception assessment [44], and vowel analysis using meaningful Persian sentences [45].

Gaps included small sample sizes (e.g. a study with only 4 children [29]), reliance on researcher-made tools, absence of control groups in several studies, and the need for longitudinal and cross-sectional studies across wider geographical areas.

Notably, two studies with previously unspecified age ranges have been identified: Norouzpour et al. assessed auditory perception in children aged 2–7 years with cochlear implants [35], and Amirfattahi and Sheikhzadeh Najjar examined vowel production using meaningful Persian sentences in children aged 7–13 years [36].

Morphosyntactic studies

Studies on complex grammatical structures (verb tense usage, passive voice comprehension) examined higher-order competencies essential for academic and social communication (Table 3) [48-50] across Tehran, Mashhad, and Qazvin with clinical sample sizes of 9–75. Methodologically, naturalistic approaches (spontaneous speech samples, descriptive speech, story retelling [51-53]) were combined with structured assessments using standardized and researcher-constructed tests for passive constructions [48, 49], the Picture Sentence Comprehension Test [54], and the Sentence Development Scoring Scale in Persian [55]. Limitations included consistently small sample sizes (several studies with fewer than 20 participants [51-53]), with one exception using a large control group (n=691) for test standardization [48]. Participant ages spanned from preschoolers (4–6 years) to adults [55], indicating persistent morphosyntactic deficits. Some studies lacked control groups [53, 54]. Participant groups primarily included children with severe-to-profound hearing loss and CI recipients, with one comparison of adults with profound versus severe hearing loss [55].

Semantic and pragmatic studies

Six studies (2006–2024) examined social language use and comprehension of non-literal meanings, including metaphors, proverbs, indirect speech acts, inference, title selection, and humor (Table 4). Pragmatic skills such as topic maintenance, turn-taking, and conversation repair were investigated in 4–6-year-old children with severe hearing loss [56]. At the elementary level (5–8 years), children with cochlear implants showed significant differences from normal-hearing peers in using contextual cues and performed more poorly in some pragmatic levels [57]. High school students with severe hearing loss demonstrated significantly lower total pragmatic competence scores than normal-hearing peers and could not use pragmatic competencies appropriately across contexts [58]. The effect of cochlear implantation age on pragmatic abilities was evaluated in children implanted before and after age three [59]. A semantic study using antonym and synonym writing tests revealed that normal-hearing children outperformed hearing-impaired groups, and mainstreamed students outperformed those in special schools [60]. Additionally, story retelling skills in 6–7-year-old Persian-speaking children with cochlear implants were shown to be weaker than those of normal-hearing peers, particularly in microstructure components such as syntactic complexity and cohesion [61]. Reliable pragmatic assessment tools included the Bishop's Children's Communication Checklist [57, 58], the Communication Checklist for Children [61], and story retelling tasks [62]. Participants spanned preschool/early school years (ages 4–8) where social communication skills rapidly develop [56, 58, 61]. Sample sizes ranged from 4 to 70, with most studies conducted in Tehran. Notably, one study lacked a control group [61]. Findings consistently indicated that even with auditory access, children with hearing loss remain at significant risk for pragmatic and semantic deficits, underscoring the need for targeted social language interventions.

Metalinguistic studies

Metalinguistic skill refers to the conscious ability to reflect on, analyze, and manipulate language as an objective system independent of meaning [62], emerging when attention is directed to language structure rather than content alone [63]. This ability is fundamental to cognitive and linguistic development and predicts literacy success [64]. Metalinguistic skills are divided into four areas [65]: phonological awareness (manipulating syllables, rhyme, and phonemes); word awareness (understanding words as independent units); syntactic awareness (reflecting on sentence structure and grammaticality); and pragmatic awareness (using language appropriately in social contexts). Among these, phonological and syntactic awareness have received the most attention in research on children with hearing impairment [63], who face significant challenges due to reduced auditory feedback [28]. In Persian, most metalinguistic research has focused on phonological awareness and, to a lesser extent, word awareness (Table 5).

Word definition, a metalinguistic skill reflecting lexical knowledge about language function [66], considers two dimensions: "content" (semantic features) and "form" (syntactic structure) [66-68]. In bilingual (Azeri-Persian) children with CIs, no significant differences were found compared to Normal Hearing (NH) children in either content or form [17], a finding replicated in another study comparing children with CIs to NH peers [69].

Regarding phonological awareness, children with severe-to-profound hearing loss score lower than NH children in rhyme detection and syllable segmentation, performing better on rhyme than syllable tasks —the opposite of NH patterns [70]. Children with CIs outperform hearing aid users in rhyme detection [71] but score significantly lower than NH children across all phonological awareness subtests [72, 73]. These findings align with international research showing delays in all metalinguistic skills among hearing-impaired children [74]. Existing research has primarily focused on rhyme detection and syllable counting in grades 1–4 [70, 71], with comprehensive assessment only conducted in 4–6-year-old children with Cis [72]. Thus, examination of phonological awareness across syllabic, intra-syllabic, phonemic, and morphological levels in elementary school children with varying degrees of hearing loss —particularly comparing mainstreamed versus non-mainstreamed settings —is essential. Overall, hearing-impaired and cochlear-implanted children differ from NH peers in metalinguistic skills. While word definition appears relatively preserved (possibly due to positive effects of implantation and rehabilitation), phonological awareness shows significant weakness across almost all studies, though with a different performance pattern (better rhyme than syllable detection) [73]. Given the critical role of phonological awareness in literacy, precise assessment and targeted interventions are essential. A significant research gap remains in comprehensive investigation of all four metalinguistic domains, particularly across different levels of phonological awareness, in elementary school children with varying degrees of hearing loss and educational settings (mainstreamed vs. non-mainstreamed).

Distribution of studies across receptive and expressive domains

Among 53 unique studies reviewed (one study appeared in both general language and metalinguistic sections [17]), studies were classified into linguistic (47 studies) and metalinguistic (6 studies) categories. Linguistic studies were further divided into expressive (productive), receptive (perceptual), and combined skills. In general language (8 studies), 50% examined expressive, 25% receptive, and 25% combined skills. In the phonetic-phonological domain (27 studies, the largest volume), 78% focused on expressive skills while only 22% addressed receptive skills. In morphosyntax (8 studies), 62.5% examined expressive and 37.5% receptive skills. The pragmatic-semantic domain (6 studies) showed perfectly balanced distribution (50% expressive, 50% receptive). In the metalinguistic domain (6 studies), 16.6% were receptive-analytical (phonological awareness), 33.3% expressive (word definition), and 50% investigated both aspects (Table 6).

Overall, of the 47 linguistic studies, 67.5% addressed expressive skills, 28.5% receptive skills, and only 4% both skills combined. This pattern indicates that research on hearing impairment and cochlear implantation in Iran has predominantly focused on productive and expressive aspects of language, while receptive and perceptual skills —particularly in phonetic-phonological and morphosyntactic domains —have received less attention.

The imbalance between expressive and receptive studies should be interpreted with caution, as it partly arises from the nature of the linguistic phenomenon under investigation. In phonology, where the units (phonemes, phones) are inherently meaningless, direct observation of production is more straightforward than inferring perception or comprehension. Conversely, in semantics and pragmatics, where meaning is central, receptive tasks (e.g. picture pointing, story retelling) are more common, yet expressive tasks are still numerous due to the richness of spontaneous speech analysis. Our findings confirm that the imbalance is most extreme in phonology (78% expressive) and least pronounced in pragmatics (50% expressive), which is consistent with the intrinsic characteristics of these domains.

Discussion

In the following discussion, the findings are organized into two main sections —linguistic studies and metalinguistic studies —with the linguistic studies further subdivided into general language, phonetic-phonological, morphosyntactic, and pragmatic-semantic domains. Subsequently, all studies are classified into receptive versus expressive skills.

General language skills

Analysis of language studies reveals that most research pertains to the phonetic-phonological domain (55%), followed by morphosyntax (17%), with the smallest proportion in semantic-pragmatic domain (13%). Additionally, 15% of linguistic studies have examined language skills in a general manner without focusing on a specific domain. Research on general language skills indicates that even two years post-implantation, children with CIs do not perform similarly to NH peers [15]. However, non-verbal communication skills are similar across deaf children without CIs, children with CIs, and NH children, with no significant differences. Notably, deaf children who receive CIs (12–24 months post-implantation) show no significant difference from NH children in verbal communication abilities, whereas deaf children without CIs remain significantly impaired [21]. Bilingual children with CIs show delays in Mean Length of Utterance (MLU) and lexical richness in Azeri, while in Persian only MLU is delayed [17]. Preschoolers with severe-to-profound hearing loss exhibit significant weaknesses in MLU, mean length of correct utterances, and well-formed sentences compared to NH children [16], highlighting severe language weaknesses in this population [16].

Longitudinal evaluations demonstrate significant upward trends in auditory and speech skills post-implantation, with auditory skills developing faster than speech skills [19]. Advanced outcomes such as speech intelligibility and telephone conversation require sustained rehabilitation [20]. Long-term auditory rehabilitation is essential post-implantation to accelerate development until deaf children achieve age-appropriate skills. Studies on general language skills have only been conducted in preschoolers and first graders [15-21]; investigations in elementary school ages and comparisons between mainstream versus special schools are necessary.

Phonetic-phonological studies

Two studies on intonation revealed that children with CIs differ significantly from NH peers in both production (reading, imitation, speech duration) [22] and perception of declarative and interrogative sentences [23], with performance correlating with age at implantation and device use duration. Research in this area is limited to elementary school children with CIs, necessitating examination across other age groups and hearing aid users.

Regarding vowel production, individuals with hearing loss centralize vowel spaces: open vowels become semi-closed, closed vowels semi-open, back vowels fronted, and front vowels backed [24]. Children with CIs show increased first formant values (significant only for /i/) [25] and produce more centralized vowels [27]. They also differ from NH children in fundamental frequency, jitter, shimmer, harmonic-to-noise ratio, and exhibit longer vowel duration [28]. As hearing loss severity increases, vowel space constricts, reducing tongue mobility and causing convergence of vowels with similar formants [26]. Early cochlear implantation (before age two) is associated with more natural vowel production [29], and children with CIs produce vowels with less acoustic distinction than hearing aid users, though both groups lag behind NH peers [27]. Vowel production has been studied in elementary school children [24-26], but no studies exist for ages 10–15 or adolescents 15–18 with CIs. Formant analysis shows F2 of /a/ and /i/ differs significantly between NH and all hearing-impaired groups, while F1 differs only between NH and profound loss groups [28]. F2 is more affected than F1 due to lower audibility and difficulty learning through vision.

In auditory perception, children with CIs outperform hearing aid users [30], though speech intelligibility does not differ significantly between these groups [32]. Vowel /â/ shows the highest perception scores in severe hearing loss, while /i/ demonstrates better audiovisual discrimination than /e/ and /æ/ [31]. Research on vowel perception is limited to ages 5–7 years, and longitudinal studies show gradual improvement in phoneme and word perception with increased device use, though NH children remain superior [33].

Phonological processes persist longer and occur more frequently in children with CIs [34], with final consonant deletion most frequent and cluster reduction least frequent among natural processes, and backing most frequent among atypical processes [35]. In Balochi-speaking children, deletion of voiceless plosives and final cluster reduction are most frequent [38]. Research on phonological processes is limited to ages 2–10 years [34-36], which aligns with the typical developmental window for these simplifications. For older age groups, future research should focus on persistent phonetic errors, intelligibility, or phonological awareness rather than on developmental phonological processes themselves.

Children with CIs perform better than hearing aid users in lexical complexity and speech intelligibility [38]. A 5-year follow-up showed progressive improvement: 91% responded to speech sounds at 6 months, 96% discriminated speech sounds at 1 year, and 84% understood common phrases without lip-reading at 3 years, with speech intelligibility stabilizing by 5 years post-implantation [37]. No significant correlation was found between fundamental frequency (a suprasegmental feature) and perceived speech intelligibility, suggesting that unlike segmental features, this parameter does not significantly impact intelligibility [39].

Notable research gaps remain for ages 10–15 and 15–18 with CIs. Additionally, Norouzpour et al. [35], assessed auditory perception in children aged 2–7 years with cochlear implants, and Amirfattahi and Sheikhzadeh Najjar [36] examined vowel production in children aged 7–13 years using meaningful Persian sentences.

Morphosyntactic studies

Grammatical analysis of language samples from hearing impaired children reveals distinct error patterns. In descriptive speech, the most common error in preschool hearing-impaired children is inappropriate omission, whereas NH children show inappropriate selection; in spontaneous speech, inappropriate grammatical omission is most common in both groups. Hearing impaired children also have lower MLU, particularly in spontaneous speech [51]. The language development of 4–5-year-old children with severe to profound hearing loss roughly equates to that of typical 3-year-old [52]. Five-year-old children with CIs perform more poorly than NH peers in complex syntactic structures and verb morphology, though differences are smaller in simpler structures [53]. Thus, a syntactic gap persists despite post implantation progress.

In deaf students aged 8–16 years, the most common errors occur at sentence and verb levels, including inappropriate omission of grammatical elements, verb tense errors, and lack of subject verb agreement.

Significant relationships exist between nonlinguistic variables (grade level, mainstream schooling history, hearing aid use) and correct utterance production [53]. Study on passive voice show significant delays in comprehension and use of passive verbs [49]; eight-year-old hearing-impaired children comprehend passive sentences similarly to three-year-old NH children [48]. Mehrparvar et al. [54] found that comprehension of relative clauses, particularly subject-object type, is significantly weaker in children with CIs than NH peers. In subject relative clauses, errors occur mainly in the main clause (failure to understand subject-verb relationship), while subject-object relative clauses produce higher error rates overall.

Grammatical errors in hearing impaired adults correlate with hearing loss severity; adults with profound loss exhibit more verb related errors than those with severe loss [55]. Most morphosyntactic studies have relied on spontaneous language samples [51, 52, 54], with standardized tests used only for passive voice comprehension [48, 49]. Examination of other Persian morphosyntactic features using standardized tests is needed, along with comparisons across degrees of hearing loss, device type, and educational settings (special vs. mainstream schools). No studies have examined children aged 6–8 years or under 4 years, representing critical research gaps.

Semantic and pragmatic studies

Pragmatic skills have been studied across preschool, elementary, and high school levels, while semantic skills have been examined only in fifth grade. Preschoolers (4–6 years) with severe hearing loss show significant differences from NH peers in topic maintenance duration, turn-taking scores, and conversation repair, indicating poorer pragmatic skills [56]. At the elementary level (5–8 years), children with CIs show no difference in initiation but differ significantly from NH children in using contextual cues and perform more poorly in some pragmatic levels [57]. High school students with severe hearing loss have significantly lower total pragmatic competence scores than NH peers, with significant grade-level differences within the hearing-impaired group (absent in the NH group), and cannot use pragmatic competencies appropriately across contexts [58].

Research on metaphor and proverb comprehension, examined only in high school students [58], is needed in younger children and across varying degrees of hearing loss. Pragmatic skills such as topic maintenance, turn-taking, and conversation repair have only been studied in 4–6-year-olds with severe hearing loss [56], requiring investigation in older age groups, CI users, and mainstreamed versus non-mainstreamed students. Children implanted before age three show significantly higher composite pragmatic scores than those implanted after three (except in coherence and engagement subscales), indicating better pragmatic abilities with earlier implantation [59]. Additionally, story retelling skills in 6–7-year-old Persian-speaking children with CIs have been shown to be weaker than those of NH peers, particularly in microstructure components such as syntactic complexity and cohesion, highlighting the need for targeted narrative interventions in this population [61].

A semantic study using antonym and synonym writing tests showed that NH children outperform hearing-impaired groups, and mainstreamed students outperform those in special (Baghcheban) schools [60]. All groups demonstrated better comprehension of antonyms than synonyms, and processing speed was significantly higher in NH children. The advantage of mainstream over special school settings highlights the effect of linguistically rich environments with NH peer interaction on semantic development [60]. Further research is needed on other semantic aspects (relations, association) across different ages, degrees of hearing loss, and in children with CIs.

Integration of findings: research gaps and the receptive-expressive imbalance

The synthesis reveals two overarching patterns. First, a significant imbalance exists toward expressive skills (68.0% of linguistic studies) compared to receptive skills (29.7%), most pronounced in the phonetic-phonological domain (76.9% expressive vs. 23.0% receptive). It is important to note that a relative paucity of comprehension studies is not unique to Persian; as noted in psycholinguistics, production studies are inherently easier to design and interpret because their products are directly observable, whereas comprehension must be inferred indirectly [75]. Nevertheless, the degree of imbalance observed in Persian research —particularly in the phonetic-phonological domain-suggests that deliberate efforts are still needed to expand receptive language assessments. This suggests that current understanding of language abilities in Persian-speaking children with hearing impairment may be incomplete, as perceptual and comprehension skills —foundational for accurate production —remain understudied. Second, several critical research gaps were identified: age related gaps (children under 4 years, ages 6–8 years, 10–15 years, and adolescents 15–18 years with cochlear implants); domain related gaps (semantics and pragmatics comprise only 13% of studies vs. 55% for phonetics/phonology); methodological gaps (lack of standardized assessment tools for receptive skills in Persian, absence of longitudinal designs, limited comparisons between mainstream and special school settings); and outcome related gaps (almost no studies examining the relationship between receptive and expressive skills within the same population). Addressing these gaps should guide future research agendas and inform development of targeted, evidence-based interventions.

Conclusion

The analysis of 53 unique studies reveals a predominant focus on expressive aspects of language (68.0% of linguistic studies) compared to receptive skills (29.7%), with only 2.1% examining both skills within the same study. This imbalance is most pronounced in the phonetic-phonological domain (76.9% expressive vs. 23.0% receptive). In the metalinguistic domain, a different pattern emerged: 16.6% focused on receptive-analytical skills (phonological awareness), 33.3% on expressive skills (word definition), and 50% on both.

Regarding the research questions, Persian-speaking children with hearing impairment show significant delays in general language skills (mean length of utterance and lexical richness), though evidence is limited to preschoolers and first graders [15-21]. In the phonetic-phonological domain, consistent deficits are observed in vowel production (centralized vowel space, prolonged duration, reduced acoustic distinction), intonation, and phonological processes [22-39]. Early cochlear implantation (before age two) is associated with better outcomes [29, 30], and children with cochlear implants generally outperform hearing aid users [27, 32, 38]. In the morphosyntactic domain, common errors include inappropriate grammatical omissions, tense marking errors, and lack of subject-verb agreement [48-54]; eight-year-old children comprehend passive sentences at the level of three-year-old normal-hearing peers (approximately a five-year delay) [48, 49]. The semantic-pragmatic domain (only 13% of studies) shows consistent deficits in synonym/antonym tasks, topic maintenance, turn-taking, conversation repair, and metaphor/proverb comprehension [56-61]. Metalinguistically, phonological awareness is significantly delayed [70-73], while word definition appears relatively preserved [17, 69]. Moderating variables favoring better outcomes include early implantation (before age two), cochlear implants over hearing aids, and mainstream over special school settings [21, 58, 62].

The findings indicate that, similar to the general trend in psycholinguistics research worldwide [75], Iranian researchers have prioritized speech production over perception and comprehension. This pattern is not unique to Persian-speaking children. Nevertheless, a comprehensive understanding of language abilities in hearing-impaired children requires greater attention to receptive skills across all languages, including Persian. Age-related gaps (children under 4 years, ages 6–8 years, 10–15 years, and adolescents 15–18 with cochlear implants) hinder accurate mapping of developmental trajectories. This review is limited to descriptive observational studies; therefore, conclusions regarding the effectiveness of specific interventions cannot be drawn from this synthesis.

To obtain a complete picture of linguistic capabilities and to design evidence-based rehabilitation programs, future research should: 1) allocate greater attention to receptive and perceptual skills across all language domains, particularly in the phonetic-phonological and morphosyntactic areas; 2) target neglected age groups, especially elementary school children and adolescents; 3) develop and standardize assessment tools for both receptive and expressive aspects of Persian; and 4) employ longitudinal designs to track developmental trajectories in hearing-impaired and cochlear-implanted populations. Targeted interventions and further research in these areas are warranted.

Ethical Considerations

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

HA: Acquisition of data, Statistical analysis and drafting the manuscript; LF: Study design, acquisition of data; HA: Study design, interpretation of the results, and drafting the manuscript

Conflict of interest

The authors have no conflicts of interest to declare.

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Table 1. General language studies

Author	Test	City/sample size	Participants age	Control group
Mohseni-Ezhiyeh et al. [15]	Language development scale (faramerzi, 2007)	Isfahan/35 children with ci	Preschool (6 years)	35 THC
Rahgozar et al. [16]	Language development test and descriptive speech sample	Tehran/38 severe-profound hl	Preschool (6 years)	28 THC
Rezaee et al. [17]	Vocabulary awareness and descriptive speech sample	Zanjan/6 children with ci	7 years old (1st grade)	6 THC
Ahadi et al. [18]	Auditory speech perception test "modarres" (test construction)	Tehran/60 children with sensory-neural hl	6–7 years	—
Ghazvini et al. [19]	1. Categories of auditory performance (cap) 2. Speech intelligibility rating (sir) 3. Meaningful use of speech scale (muss)	Tehran/50 children with ci	40 months	—
Jeddi and Kassani [20]	Niyusha developmental scale parent interview	Tehran/15 children with ci	45 months	—
Kamali [21]	Verbal and non-verbal communication questionnaire hearing age 12–24 months	Tehran/39 children (14 deaf children without ci, 25 children with ci with hearing age of 12–24 months)	Hearing age 12–24 months	49 THC aged 12–24 months

CI; cochlear implants, THC; typically hearing children; HL; hearing loss

Table 2. Specifications of phonological-phonetic studies

Author	Test	City/number of participants	Age of participants	Control group
Hasanvand et al. [22]	Sentence repetition and reading (intonation production)	Tehran/30 children with ci	Elementary school	32 THC
Kord et al.[23]	10 interrogative and 10 declarative sentences (intonation comprehension)	Tehran/25 children with ci	Elementary school	50 THC
Bahrami et al. [24]	Vowel production	Isfahan/32 with moderate to severe hl	15–18 years	32 THC
Jafari et al. [25]	Repetition of Persian vowels in single consonant clusters (cv)	Hamedan/10 children with ci (5 children before age three, 5 children after age three)	7–9 years	—
Salehi et al. [26]	Vowel production	Isfahan/32 with moderate to severe hl	7–9 years	30 THC
Jafari et al. [27]	Repetition of Persian vowels	Tehran/20 children with ci (12 girls, 8 boys)	5–9 years	20 THC (12 girls, 8 boys)
Naderi Far et al. [28]	Vowel production and analysis with praat	Tehran/40 hl (moderate, moderate-to-severe, severe, profound)	7–9 years	40 THC
Zamani et al. [29]	Vowel production and analysis with sfs win acoustic analysis software	70 children implanted before age two and 70 children implanted after age two	—	238 THC
Asghari et al. [30]	Repetition of Persian vowels in single consonant clusters (cv)	hamedan/10 children with ci (5 Children before age three, 5 children after age three)	7–9 years	—
Jafary et al. [31]	Vowel production	Tehran/20 children with ci	5–10 years	20 THC
Jalil Abkenar et al. [32]	Auditory perception level scale	Tehran/20 children with ci and 20 with ha	5–7 years	20 THC
Ebrahimiān et al. [33]	Vowel phoneme discrimination test	Shiraz/22 children with severe hl	5–8 years	—
Mahmoudi et al. [34]	Auditory perception level scale and speech intelligibility level scale	Tehran/20 children with ci and 20 with ha	5–7 years	20 THC
Norouzpour et al. [35]	auditory perception	Fars/96 children with ci	2–7 years	—
Sheikhzadeh Najjar & Amirfatahi [36]	Five meaningful Persian sentences (vowel analysis)	Tehran/4 deaf children with ci	7–13 years	—
Ahadi and Arabali [37]	Phonetic-phonological test	Karaj/4 children with ci	7–10 years	—
Khalifehloo et al. [38]	Researcher-made test	Zahedan/16 hearing-impaired children	7–10 years	16 THC
Bakhshaee et al. [39]	Auditory performance classification scale (apcs)	Khorasan/47 children with ci	Under 8 years	—
Manouchehri et al. [40]	Perception of speech sounds and words	Tehran/14 children with ci	Mean 5.5 years	—
Fathi Herat et al. [41]	Naming 108 pictures	Shiraz/28 children with ci	2–8 years	28 THC
Rezaei et al. [42]	Speech clarity (at word level)	Hamedan/25 children with ci and 25 children using ha	4–6 years	—
Mirahmadi et al. [43]	Persian speech intelligibility test and fundamental frequency calculation with praat software	Ahvaz/18 children with ci	4–6 years	—
Roohparvar et al. [44]	Repetition of monosyllabic words containing plosive consonants and analysis with praat software	Tehran/48 children with ci	Mean hearing age 5 years	50 THC aged 5 years
Roohparvar et al. [45]	Repetition of monosyllabic words containing plosive consonants and analysis with praat software	Tehran/48 children with ci	Mean hearing age 5 years	50 THC aged 5 years
Roohparvar et al. [46]	Repetition of syllables with voiceless affricates and fricatives and vowel /æ/ in cv, cvc, and vc contexts	Kerman/15 children with ci	4–6 years	15
Roohparvar et al. [47]	Repetition of eight syllables with voiceless plosives and vowel /æ/ in cv context	Kerman/21 children with ci	9–12 years	22

CI; cochlear implants, THC; typically hearing children, HL; hearing loss, HA; hearing aids

Table 3. Specifications of morphosyntactic language studies

Author	Test	City/number of participants	Age of participants	Control group
Afaghi et al. [48]	Passive voice (comprehension test)	Tehran –18 children with Severe HL	8 years	691 children aged 3–8 years
Ghaemi et al. [49]	Comprehension test for passive verbs (Mehri, 2009)	Mashhad/10 children with CI	5–6 years	10 THC
Golestani et al. [50]	Sentence development scoring scale in Persian (while describing pictures)	22 children with CI	5 years	11 THC
Zarifian et al. [51]	Descriptive speech (story retelling and spontaneous speech)	Tehran –9 HL	4–6 years	16 THC
Golpour et al. [52]	Spontaneous speech and descriptive speech	Qazvin –10 children with severe-profound HL	4–5 years	10 THC
Shariat Rezavi et al. [53]	Questionnaire completion and spontaneous speech sample	Tehran –75 HL	8–16 years	—
Mehrparvar et al. [54]	Picture sentence comprehension test	15 children with CI	8–12 years	15 THC aged 6–10 years
Amiri Shavaki et al. [55]	Open-ended questions in three sections: present, future, and past tenses	35 adults with profound HL	Adult	35 adults with severe hearing impairment

HL; hearing loss, THC; typically hearing children, CI; cochlear implants

Table 4. Specifications of studies on pragmatics and semantics

Author	Test	City/number of participants	Age of participants	Control group
Mousavi et al. [56]	Researcher-made tasks regarding topic maintenance, turn-taking, and conversation repair	Tehran/21 children with severe HL	4–6 years	21 THC
Ghiasian et al. [57]	Bishop's children's communication checklist	Tabriz/15 bilingual children with CI	5–8 years	5 THC
Mehri et al. [58]	Questionnaire and test of pragmatic functions	Tehran/70 male and female students with severe HL	9th to 12th grade (high school)	70 THC
Nikrah et al. [59]	Children's communication checklist	4 Children with CI	5–8 years	—
Rabiee and Ghorbani [60]	Researcher-made test for writing synonyms and antonyms	Tehran/25 students of deaf school and 25 students from integrated education	Baghcheban: avg. 14.4; integrated: avg. 11.76; normal: avg. 11.16	25 THC
Safaeyan et al. [61]	Story retelling	Mashhad/18 children with CI	6–7 years	18 THC

THC; typically hearing children, HL; hearing loss, CI; cochlear implants

Table 5. Specifications of metalinguistic studies

Author	Test	City/number of participants	Age of participants	Control group
Shahriari et al. (69)	Researcher-made test	Tehran/160 children with HL >70 dB	1st to 4th grade (boys and girls)	—
Safaeian Titkanlou et al. [70]	Phonological awareness test	Mashhad/25 children with CI	4–6 years	25 THC
Weisi et al. [71]	Rhyme detection, phoneme deletion, and non-word reading subtests of Nama test	Tehran/12 children with CI (18 months post-implant)	2nd grade	12 Children with HA
Dashtelei et al. [72]	Phonological awareness	Tehran/30 children with CI	7–11 years	30 THC
Rezaee et al. [17]	vocabulary awareness: word definition test	Zanjan/6 children with cochlear implant	7 years old (first grade)	6 THC
Hosseinabadi et al. [73]	Vocabulary awareness: word definition test	Tehran/16 children with CI	8–9 years old	30 THC

HL; hearing loss, CI; cochlear implants, THC; typically hearing children, HA; hearing aids

Table 6. Distribution of studies across receptive and expressive skills by domain

Domain	Total studies	Expressive	Receptive	Combined
General language skills	7	4 (57.1%)	2 (28.5%)	1 (14.2%)
Phonetic-phonological	26	20 (76.9%)	6 (23.0%)	0
Morphosyntactic	8	5 (62.5%)	3 (37.5%)	0
Pragmatic-semantic	6	3 (50.0%)	3 (50.0%)	0
Total linguistic studies	47	32 (68.0%)	14 (29.7%)	1 (2.1%)
Metalinguistic	6	2 (33.3%)	1 (16.6%)	3 (50.0%)

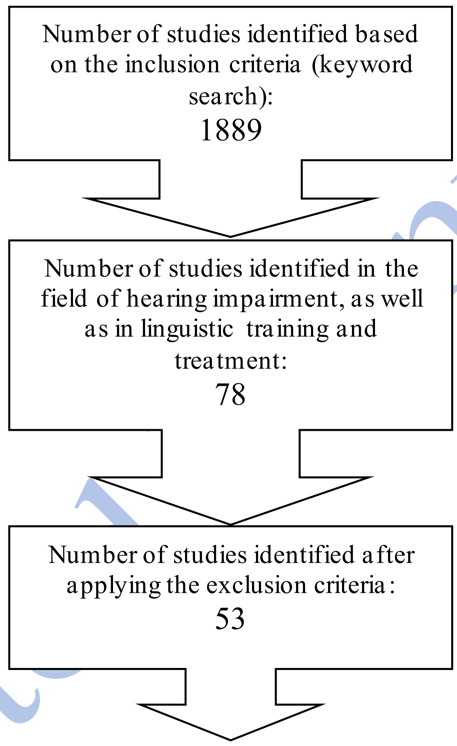

Figure 1. Related studies identified in each stage