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Academic Achievement of Children with Deafness or Hard of Hearing (DHH) Inclusive Educational Setting: A Scoping Review

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ABSTRACT

Education for children who are deaf or hard of hearing (DHH) has resulted in various outcomes. In the move to inclusivity, scarce studies have been conducted to evaluate the academic achievement of DHH children, especially in the inclusive education (IE) setting. Therefore, this review aims to map the literature about the academic achievement of children with DHH within IE settings worldwide, including the assessment tools and interventions received. Data were searched from five electronic databases: EBSCOhost [Academic Search Complete (ASC), MEDLINE and CINAHL], Science Direct, SCOPUS, PubMed (PMC) and ERIC (Education Resources Information Centre). Six studies were found to fulfil the inclusion criteria: investigated the achievement of students with DHH academically and in inclusive educational settings. These studies were organised based on the Problem-Intervention-Outcome Meta-Model (PIO MM) conceptual model. In this model, the problem (population of children with DHH) with the intervention [hearing device(s) used, communication mode, classroom type, and therapy received] and outcomes (academic achievement) were analysed. The resulting studies were conducted in Taiwan, the United States, the Netherlands, and Canada. This study described academic achievement using different tools. This review also showed that most of the studies focused on students with a cochlear implant(s) who usually had severe to profound hearing loss. Communication had been rated as a lower achievement by the classroom teachers and formal examinations. With the mapped findings from the scoping review, future research could focus on various degrees of loss, the hearing devices used, and their relationship to educational outcomes, especially in the IE setting.

Keywords: Academic achievement, deafness, hard-of-hearing, inclusive education

INTRODUCTION

Inclusive education (IE) allows children of different backgrounds to learn and grow side by side to benefit all. One of the barriers to education globally is disability (UNICEF, 2023). Deafness or hard of hearing (DHH) is an invisible disability that impedes speech and language development. Without early auditory intervention, for instance, hearing devices such as hearing aids (HAs) and/or cochlear implants

(CIs), the child with DHH will not have sound access, thus impeding speech and language development. This communication difficulty resulted in limited educational setting options. However, with the advancement in hearing technology and early intervention, more children with DHH are now enrolled on IE. Therefore, this scoping review aims to determine the tools used to quantify the academic achievement of DHH children and their outcomes worldwide.

LITERATURE REVIEW

The academic achievement or educational outcomes following auditory intervention vary in IE settings. The contributing factors include the nature of hearing loss (degree, type, and duration), the hearing device use, the age of intervention, and parental involvement in the intervention and educational programmes (Sarant et al., 2015; Yoshinaga-Itano, 1999). Other factors could be the language used, the academic assessment tools, and the area of assessments, either subject- or skills-based, were at variance. Thus, the tools used to assess the academic achievement of children with DHH and their hearing peers in IE setting from different countries can be gathered and summarised, including their academic outcomes under the same circumstances, that is, reported hearing status, previous intervention, and in an inclusive educational setting. Subsequently, to identify the niche area of existing knowledge about IE. The hearing intervention outcome review can be viewed from the conceptual model for Problem-Intervention-Outcome Meta-Model (PIO MM). The PIO MM may be used to describe how a problem of the population of interest (children who are DHH in IE) changes in outcome (academic achievement) to intervention and contextual factors (the use of HA, CI, therapy, and other confounding factors) (Monsen et al., 2017).

Research Questions

This scoping review is guided by the question, ‘What is the academic achievement of DHH children regardless of the degree of hearing loss in an IE setting?’. The research questions were further refined as: (1) what are the extent, range, and nature of peer-reviewed papers on their academic achievement, (2) what has been the focus in their academic achievement, and (3) what gaps exist in identifying the academic achievement?

METHODOLOGY

This study applied the scoping review framework by Arksey & O’Malley and the PRISMA extension for Scoping Review (PRISMA-ScR) Checklist. The scoping review frame describes five methodological stages: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarising, and reporting the results (Arksey & O’Malley, 2005). This scoping review does not require ethical approval. The results of the scoping review will consist of peer-reviewed publications.

Data Sources, Search Strategy, and Citation Management

The initial search was implemented on 23rd March 2020 in five electronic databases: EBSCOhost [Academic Search Complete (ASC), MEDLINE and CINAHL] (2001-2020), Science Direct (2001-2020), SCOPUS (2003-2016), PubMed (PMC) (1/1/2001-31/1/2020) and ERIC (Education Resources Information Centre) (1/1/2001-31/1/2020). These databases were selected as their relevance to education and health science. To ensure a breadth of coverage and maintain a wide approach, with the connectors, the keywords selected were: “inclusive education”, “inclusion”, “mainstreaming”, “hearing loss”, “deafness”, “deaf”, “hard of hearing”, “educational outcomes”, “educational achievement”, and “academic achievement”. After applying the filters to comply with the eligibility criteria, 200 records were found that matched the keywords.

Eligibility Criteria

Studies eligible for inclusion are scholarly, peer-reviewed academic English journal articles of 2001-2020, subjects' age of 12 years old or less, hearing disorders or deafness, and elementary and inclusive educational settings, which were limited in the search range. Twelve-year-old was selected as most countries have upper cut-out age for primary school students younger than twelve years old (Corsi-Bunker, 2011; Pan, 2016; UK Department for Education, 2014). However, the "all child" age limit option was selected to broader the search (Arksey & O'Malley, 2005). With increasing familiarisation with the scoped topics, social inclusion was also included in the list for a broader search. Studies that discussed a review and without an education domain or no IE setting were excluded from the screened list.

Study Selection

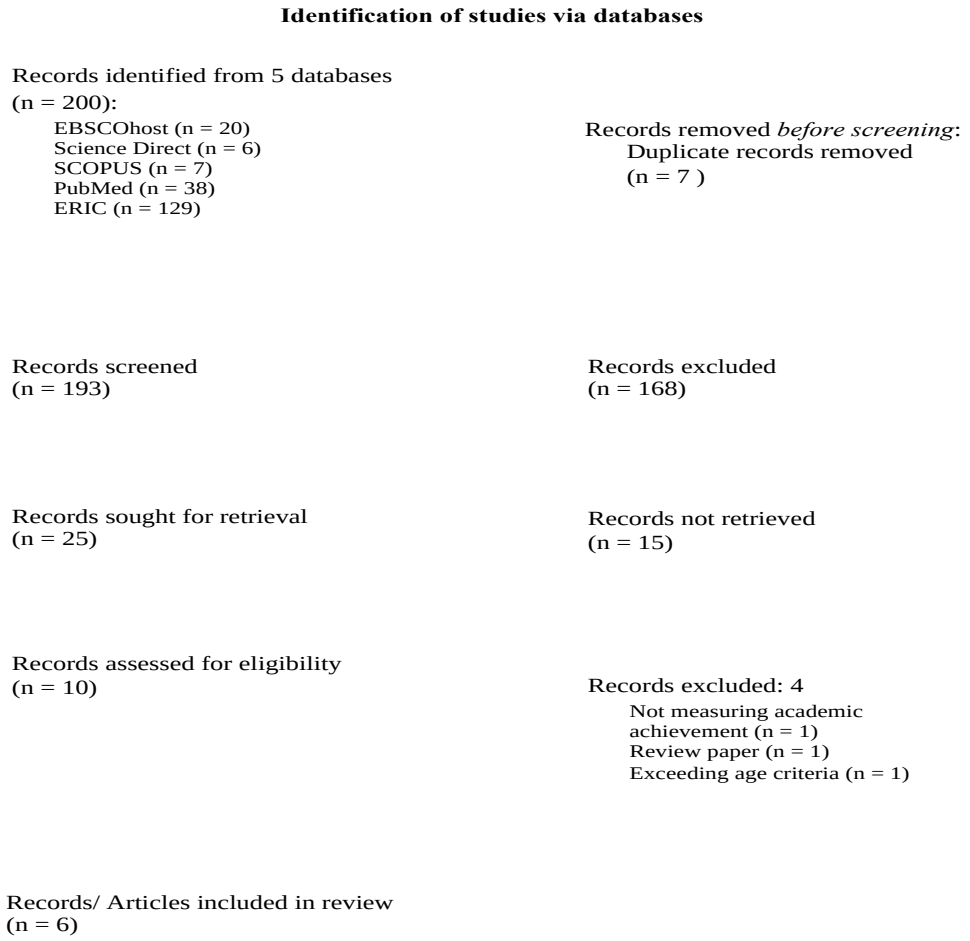
After applying the filters to match the eligibility criteria for the five databases, including children from birth to 12 years old with DHH in mainstream elementary education, 200 records were found. Table 1 shows the remaining 193 records after removing duplicates of the five databases. Figure 1 shows the process of article selection.

Table 1: The included records from the initial search after removing the duplicates.

Database	Included Records
EBSCO host [Academic Search Complete (ASC), MEDLINE and CINAHL]	14
Science Direct	6
SCOPUS	6
PubMed	38
ERIC	129
Total	**193**

The resulting records were screened two times for relevancy in fulfilling the inclusion criteria. From the 193 records, 25 records were included for the next level, full-text review assessment. Many records were excluded during the screening level because the specific studied population, DHH in IE settings, was predetermined. Most record removals were from non-DHH studies, 73.2% (n=123), followed by non-educational or academic achievement-related studies, 10.7% (n=18). Excluded review studies were 8.9% (n=15) and the same number of non-children and other disability studies, 3.6% (n= 6) each. Therefore, only 25 records were independently included for subsequent full-text by two reviewers (Author 1 and Author 2).

Figure 1: The process of study selection



Author or journal names were not masked to reviewers. Copies of the full-text article were obtained for those that appeared to represent a 'best fit' with the research question. Two reviewers then applied the inclusion and exclusion criteria to all the citations in rating the eligibility of the citation on a form. Along the process, the researchers refined the inclusion criteria accordingly with the increased familiarity with the area of study from the literature review (Arksey & O'Malley, 2005).

After successive readings, the study with a co-existent disability that could not be distinctly separated from the studied group was excluded. Studies without academic assessment tools to evaluate the student's academic achievement with DHH were excluded. As shown in Figure 1, only 10 records were included for further data characterisation. Most of the excluded records (n=15), 33.3% (n=5) were not IE related, followed by non-academic achievement-related, 26.7% (n=4), non-children (20%, n= 3), review article (13.3%, n=2) and other disability included, 6.7% (n=1). Based on the criteria, which include the type of articles, age, and confounding topics about the inclusion criteria, for instance, the type of educational setting, academic and social performance or inclusion, the interrater rating (Cohen's Kappa, K) between two reviewers' judgment on the inclusion and exclusion of records was 0.834. There was a strong agreement between the two reviewers' judgements, $\kappa = 0.834$ (95% CI, 0.80 to 0.90), $p < 0.001$ (McHugh, 2012). No significant disagreements between both reviewers on the 25 records, and only one record required further discussion on the inclusion criteria. Fifteen studies were excluded as they did not meet the eligibility criteria.

For subsequent assessment of eligibility of the full-text article (n= 10), two reviewers went through the study characteristics again, such as publication year, publication type, the scope of the study (educational setting, age of subjects), reported and educational outcomes. Four studies that had been excluded with mutual agreement by the reviewers as not fulfilling the inclusion criteria: not measuring

academic achievement (n= 1), review paper (n= 1), and exceeding the age criteria (n=2). The data were extracted from the extent, range, nature, and focus of studies conducted regarding the academic achievement of DHH in the IE setting. Thereafter, the data were summarised, and new insight was synthesised.

Data Characterization

(Charting the Data, Collating, Analysing, and Reporting the Results)
Extraction of data was based on the concept and context of the study's aim, i.e., the extent, range, and nature of peer-reviewed papers on the academic achievement of DHH children in IE setting, the focus, and gaps in the academic achievement of children who are DHH in IE. It was also in line with the charting framework based on the PIO MM model. The data was charted into a few categories: authors, year of publication, country of origin, aims, study population and sample size (participants, device used, mode of communication, type of educational setting), methodology (study design), intervention type &/ duration, outcomes, and details (educational instrument, outcomes) and key findings that relate to the scoping review questions(Peters et al., 2015). Based on these categorisations, the two reviewers charted the data of six articles independently on the same agreed form. Refinements were made on the form after charting the six studies by the two reviewers. This aligns with the Joanna Briggs Institute recommendation (Peters et al., 2020).

RESULTS AND FINDING

The six articles were organised and analysed according to their general background of studies (countries, aims, study design) and the PIO MM. Table 2 shows the general characteristics of the studies. Half of the studies (n=3) are before 2010, and the other half (n=3) are after 2010. Half of the studies are from the Netherlands (50%), each from Taiwan, the United States, and Canada. Fifty per cent (n= 3) of the studies are retrospective cohort studies, 33.3% (n=2) are longitudinal studies, and one (16.7%) is a case-controlled study. All three studies from the Netherlands were related but conducted at a gap of at least three years apart and of different study designs.

The PIO MM

(1) Problem of a Population: Children with DHH in IE setting
Table 3 reveals that five out of six studies (83.3%) involved students with CI, and all the children have congenital or prelingual deafness. A total of 169 children with DHH, aged from 4.5 to 13 years old, with a mean age of 12 years old or less, were reviewed from the six studies. Two studies did not state the gender of the subjects. Generally, the study focused on documenting the academic achievement or progress after intervention (with hearing devices: HAs and/or CI) in the IE setting. Some compared the performance of children with DHH in different classroom settings. For instance, in mainstream versus DHH and bilingual deaf education. Others compared their performance with hearing devices among typical hearing (TH) peers and/ or peers with co-existence disability (DHH with a disability, DHH-D).

(2) Intervention: Hearing Device(s) Used, Communication Mode, Classroom Type, and Therapy Received
The device used in most studies (83.3%) is CI, with the mean duration ranging from 5 to 8.61 years. The longest duration of CI use is from a study by Wu and colleagues (2013), and one study did not mention the device and duration of use. Nevertheless, this study also did not indicate the degree of hearing loss the students had (McCain & Antia, 2005). All the studies were in the mainstream classroom, as required in the inclusion criteria, and students were using spoken language to communicate (i.e., verbal communication) in the class. Auditory verbal therapy (AVT) was part of the intervention in one of the studies (Boothroyd & Boothroyd-Turner, 2002). Besides, one study examined students' communication participation, academic achievement, and social behaviour of students in a co-enrolled (CE) classroom with a mixture of Grade 3 to 5 students. A CE classroom typically has a

2:1 ratio of hearing and DHH students. A team of two teachers, a general education teacher and a teacher of DHH students, collaborate to provide instructions. They typically use spoken English and sign language (McCain & Antia, 2005).

(3) Outcome: The instruments used to measure academic achievement and the outcomes)

After identifying the population and intervention received, the outcome category (instruments used to measure academic achievement and the outcomes) is analysed (Table 3). Most of the studies used teacher-rated questionnaires, formal standardised examinations of the states of countries, and tests or interviews conducted by a psychologist. Only one study considered the children's cognitive ability using an intelligence quotient (IQ) test rated by a clinical psychologist (Wu et al., 2013). While in the other study, a psychologist conducted a semi-structured interview regarding school well-being (Langereis & Vermeulen, 2015). The commonly used teacher-rated instruments to quantify the academic achievement of students with DHH are Screening Instruments for Targeting Educational Risk (SIFTER), Academic Competence rating of the Social Skills Rating Scale (SSRS), Regular School Adjustment Scale (RSAS), Classroom Participation Questionnaire (CPQ), and Assessment of Mainstream Progress (AMP). While the formal examinations that were used in the studies include The Chinese Literacy Ability Test for School-Aged Students in Taiwan – Median Level, The Mathematics Ability Test for School-Aged Students in Taiwan – Median Level, the Canadian Test of Basic Skills (CTBS), the Standford-9 test, Canadian Test of Basic Skills (CTBS) and National Educational Curriculum aptitude test (CITO). SIFTER was the most used teacher-rated questionnaire (50%) to rate students' academic achievement with DHH, followed by the Academic Competence rating of the SSRS, AMP, RSAS, and CPQ. Regardless of the methodology and students' received intervention, their hearing backgrounds, and academically, teachers rated their performance as 'sufficient' (Damen et al., 2006; Vermeulen et al., 2012; Wu et al., 2013) in elementary mainstream classrooms in Taiwan and Netherlands. Besides SIFTER and formal standardised examination, Netherlands studies utilised AMP to determine skills required to be successful in mainstream school settings, in which teachers evaluated participation in typical classroom activities and age and content-appropriate behaviour (social domains) (Damen et al., 2006; Vermeulen et al., 2012). In Taiwan's study, the researcher used the teacher-rated Regular School Adjustment Scale (RSAS) for DHH students to evaluate their communication, learning and adaptation performances and overall performances in reading, writing, academics, arts, music, interpersonal interaction, and emotional performance in comparison with those of their hearing classmates (Wu et al., 2013). In the United States, different tests were used to evaluate DHH students' classroom participation and social domains: CPQ and Social Skills and Problem Behaviour rating from the SSRS (McCain & Antia, 2005).

Table 2: The general characteristics of the included studies

Author	Year	Country of Origin	Aim	Study Design	Participants	Age (years)	Classroom
Wu et al.	2013	Taiwan	Document Chinese literacy and Mathematics achievement, general classroom performances, and the possible predictive factors contributing to the academic and class performance among pre-lingually deafened children with CI and attended in mainstream elementary school in Grade 4-6.	Retrospective cohort studies	35 (15 boys & 20 girls) Mandarin-speaking, congenital/pre-lingual, children with DHH	10 to 12.9 Mean =11.66	Mainstream elementary school
McCain & Antia	2005	United States	Examine the communication participation, academic achievement, and social behavior of Deaf or Hard-of-Hearing (DHH), DHH with additional disabilities (DHH-D) (specifically learning disabilities, language impairment, and mental retardation), and normal hearing peers.	Retrospective cohort studies	10 (5 DHH students, 5 with DHH-D) & 18 TH peers (gender not mentioned)	9 to 12	Multi-age Grade 3-4-5 combination Co-Enrolled (CE) Classroom
Vermeulen et al.	2012	Netherlands	Explore the progress of children with implants in mainstream environments and considers some of the reasons for the delay.	Retrospective cohort studies	26 children with unilateral CI & 6 TH classmates (Gender not mentioned)	6.4 to 12.7 Mean= 9.8	Mainstream
Damen et al.	2006	Netherlands	Compare classroom performance of children with a CI with that of their normal hearing peers in mainstream education.	Case-control studies	32 CI children (18 boys and 14 girls) who were congenitally or prelingually deaf, and 37 hearing classmates (14 boys & 21 girls)	4.5 to 13 Mean = 9.0	Mainstream

continued

Boothroyd & Boothroyd-Turner	2002	Canada	Evaluate pos- implantation audition and educational attainment in children with prelingually acquired profound deafness.	Longitudinal cohort study	8 profoundly deaf, orally trained children (5 girls & 3 boys); 7 for CTBS	Mean 9.5	=	Morning special class Afternoons in a mainstream setting, some auditory verbal therapy (AVT)
Langereis & Vermeulen	2015	Netherlands	Evaluate the long-term effects of CI on auditory, language, educational and social-emotional development of deaf children in different educational-communicative settings.	Longitudinal cohort study	58 children (gender not mentioned) with profound hearing loss and normal non-verbal cognition in	Mean 8.1	=	45% Mainstream, 19% DHH education 36% Deaf education

Table 3: Descriptive summary of the studies in the intervention category

Author (s), Year & Country	Intervention	Mode of Communi-cation	Methodology	Instrument and Educational Attainment	Key Finding
Wu et al. (2013) Taiwan	Unilateral CI Duration of implant use ranged from 5.17 to 11.07 years (mean= 8.61 years).	Verbal	(1) Formal examination on Chinese literacy ability and Mathematics (2) Teacher-rated questionnaires (3) IQ test performed by clinical psychologist	(1) **SIFTER academic** subscale: 42.9% of CI children were rated as not sufficient (i.e., marginal or failed) and 14.3% failed. (2) **RSAS**: About 80% of CI children were rated as having good to excellent school adjustment and interpersonal interaction while 40% had communication problems. (3) The **academic achievement outcome measures** (Chinese literacy and Mathematics) in CI users are not significantly different from normal hearing children. (4) **Class ranking**: Appx. 23% of the children with CI ranked in the top 20%, while 34% ranked in the lowest 40% of the class.	Standard tests showed that children who received CIs from a young age and integrated into mainstream elementary school system appear to fall within the normal range of their hearing counterparts after 5-11 years of implant use.

continued

McCain & Antia (2005) United States	NA	Sign language and spoken English	(1) National examination (Stanford-9) composed of academic subtests from Grade 1 to 9 over a 3-year period. (2) Teacher-rated questionnaires	(1) **CPQ**: All normal hearing, DHH and DHH-D students scored high in the ability to understand and be understood by their teachers; For peers, hearing students expressed the highest satisfaction, followed by DHH students and DHH-D students; (2) **Academic Competence rating of the SSRS**: Hearing students had higher academic scores than DHH and followed by DHH-D students; (3) Three consecutive years of **Standford-9 test scores**: DHH students are performing below their hearing classmates and grade-mates in all three subject areas for all 3 years; (4) **Social Skills and Problem Behavior rating from the SSRS**: All groups' students were rated average by teachers while DHH-D students received significantly lower social skills scores and significantly higher scores on problem behaviours.	CE programs may indeed be a viable option for meeting the academic and social needs of DHH students, particularly for those without additional disabilities.
Vermeulen et al. (2012) Netherlands	Unilateral CI (1-99 months, mean 63 months)	Verbal	Secondary data analysis: (1) Reynell Developmental Language Scales (RDLS) (2) Teacher-rated questionnaires	(1) **SIFTER**: On average, academics, class participation, and school behaviour were rated as 'sufficient' while attention was rated as 'marginal', and communication was rated as a 'failure'. (2) **AMP**: Children demonstrating fewer language delays in receptive language showed more often appropriate behaviour on the AMP and obtained higher class ranking and communication scores. The two areas 'academics' and 'communication' were highly correlated.	Deaf children, particularly those with unilateral CI, may not reach their full potential, unless their subtle learning needs are addressed.

continued

Table 3. (Continued)

Author (s), Year & Country	Intervention	Mode of Communication	Methodology	Instrument and Educational Attainment	Key Finding
Damen et al. (2006) Netherlands	CI user (duration 1.0- 9 years, average 5.0 years)	Verbal	(1) Retrospective data (audiological data) (2) Teacher-rated questionnaire	(1) **SIFTER**: Both kindergarten and elementary school CI children showed sufficient overall outcomes in all 5 sub-areas of SIFTER except significantly lower scores in communication than their hearing peers. (2) **AMP**: Kindergarten CI children often participated in classroom activities and showed age-appropriate behavior. In elementary school, CI children showed regular participation and appropriate communicative behaviors. Moreover, this is significantly different from the hearing children. Teacher rated scores for class ranking was insignificantly different between CI children and non-CI children.	The shorter the duration of deafness, the longer the CI use, thus, the better the performance in various SIFTER areas. CI students seems to perform well in mainstream education but failed or scored marginally in communication
Boothroyd & Boothroyd-Turner (2002) Canada	HA use (mean 4.3 years) before CI, Duration of implant use 4.9 years (mean)	Spoken language	(1) Longitudinal standardized tests: Literacy and educational attainment (Mathematics, reading & vocabulary) CTBS (2) Audition: IMSPAC; (3) Language: Verbal sub score of the WISC-III & GAEL-C	**CBTS**: CI children achieved performance at grade level on mathematical computation but showed below grade level performance on mathematical concepts and problem solving. Grade lag was marked and increased over time on reading and vocabulary tests.	It is predicted that early implantation would result in more age-appropriate language and literacy.

continued

Langereis & Vermeulen (2015) Netherlands	60 months of CI use	45% Spoken language, 19% sign supported spoken language, 36% Sign Language of the Netherlands and Sign Supported Dutch	(1) Auditory speech perception abilities: Dutch open set identification test; (2) Spoken language comprehension: Dutch version of the Reynell Developmental Language Scales; (3) Educational attainment: CITO (4) Well-being: Semi structured interviews by psychologist	**CITO**: Children in mainstream performed significantly better than children in deaf education and hard-of-hearing education. Children in deaf education showed significantly poorer educational achievement than that of children in hard-of-hearing education.	Children with CI who are placed in early intervention environments that facilitate auditory development can achieve good auditory speech perception levels on the long term.

DISCUSSIONS

More than 83% (n=5) of the studies in this review involved students with CI. This is in line with the increased popularity of this technology among individuals with bilateral severe-profound sensorineural hearing loss over the years. Only one study from the United States examined children with mild to severe hearing loss. However, the hearing devices (CI or HA) provided to the students were not mentioned (McCain & Antia, 2005). The IQ test has proven to be one of the predictive factors of oral language outcomes in children with CI (Sarant et al., 2015). On the other hand, receptive language ability predicts reading achievement (Camarata et al., 2018). Co-existence disability with DHH also significantly affects speech, language, and functional auditory outcomes (Cupples et al., 2014). In short, to investigate the academic achievement of DHH children in IE settings, various degrees of hearing loss and different types of hearing devices should be considered. This also includes the number of devices used, unilateral or bilateral, and/ or other assistive listening devices such as frequency modulation (FM) systems. Two of five studies mentioned the devices used (Vermeulen et al., 2012; Wu et al., 2013). However, it is unclear about the bilateral CIs or bimodal hearing (one side CI and one side HA) (Damen et al., 2006; Langereis & Vermeulen, 2015; Vermeulen et al., 2012). In addition, it is crucial to include factors related to classroom learning, such as teachers' ability to modify instruction and effective teaching practice to meet the student's needs so that a comprehensive understanding can be gained of their impacts on academic achievement (Reed et al., 2008). It is undoubtedly true that classroom teachers spend most of their time with the students in the classrooms. However, teachers' rating performance is influenced by the teacher's implicit expectations of students' future performance. Therefore, utilising both teacher-rated and students' formal examinations may better estimate different students' academic performance levels (Machts et al., 2016).

CONCLUSIONS

This scoping review has systematically mapped the existing literature on academic achievement, including the assessment tools used and interventions received with DHH in IE in the 20 years. The review showed that the focus was mostly on CI. Their performance in IE was at par with hearing peers (Damen et al., 2006; Wu et al., 2013). Nevertheless, this review showed that the specific area of research exploring the academic performance of students with milder degrees of hearing loss or HA use had received relatively less attention. In addition, to optimise the educational experience and support the full potential of students with DHH, implementation strategies and interventions related to classroom acoustics, assistive listening devices, and communication and learning strategies within the classroom should also be investigated in future studies.

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