Correlation Between Language Skills and Degree of Hearing in a Group of Preschool Egyptian Children with Hearing Loss

Original Article

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ABSTRACT

Background: Language acquisition in hearing-impaired children is enhanced by adequate exposure to auditory stimuli achieved by early, regular hearing aid fitting and proper rehabilitation programs for optimum linguistic experience.

Objective: This research aims to examine the relationship between hearing impairment (HI) (at degrees of moderate to severe) and various language skills development to understand these issues better and plan appropriate intervention programs.

Patients and Methods: 25 cases (aged from 3 to less than 5) with moderate to severe degree of sensory neural hearing loss (SNHL) and average non-verbal intelligence participated in our study, recruited from Phoniatric unit outpatient clinic in Menofia University Hospital, from September 2020 to June 2021. The selected patients were subjected to language assessment protocol with the "A Proficient Preschooler Language Evaluation Tool" (APPLE). The results of the cases were compared to 25 control subjects matched for age and gender.

Results: By studying the correlation between cases and control subjects (regarding the development of different language skills using APPLE tool which presented in (receptive, expressive, total language, action picture subtests, narrative skills subtests, comprehension skills test, understanding simple question, and articulation test), there was a highly significant difference. Highly significant correlations were found between hearing aid use duration and language development and between the duration of rehabilitation and language development.

Conclusion: Language acquisition of hearing-impaired children depends on the HI degree, early and regular wearing of hearing aid with the suitable family enviroment, and proper intervention programs.

Key Words: APPLE tool, hearing impairment, language skills.

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INTRODUCTION

Human communication is described as a two-way exchange of meaning. One of the verbal forms of communication is language[1]. Language is the symbolic process that gives words meaning and allows people to communicate[2].

The prerequisites of proper language function depend mainly on the intact neural system, intact psyche, and intact sensory channels; auditory, visual, kinesthetic, and tactile sensation[1].

Verbal language perception, development, and usage are strongly related to the efficacy of the auditory system. So reception and perception of acoustic stimuli are essential prerequisites for verbal activities[3].

Even to a mild extent, hearing impairment (HI) has a negative effect on language development and results in sensory, cognitive, emotional, and academic defects in adulthood[4].

Early detection of language disorders is important because children need good skills in both communication and language to participate in daily life activities. Several studies have demonstrated that language development problems may be a precursor for later learning disabilities and social-emotional development deficits[5].

HI is an average hearing threshold level (HTL) of more than 15 dB for pure-tone audiometry[6]. It is an extremely common medical condition, and numerous risk factors contribute to its prevalence[7]. Around 466 million people worldwide have disabling hearing disorders, 34 million of these are children, according to World Health Organization[8]. In Egypt, SNHL incidence ranges from 1 to 3 per 1000 live births in healthy full-term neonates and 2– 4 live births per 100 in high-risk infants (due to prenatal causes: bacterial or viral infections, perinatal: neonatal jaundice and sepsis, postnatal: such as meningococcal infections and mumps)[9].

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HI is classified into 1- Conductive hearing loss: it is a disruption of the sound waves transmission to the cochlea; it may be genetically based like down syndrome or acquired like cerumen impaction. 2- SNHL is a permanent HI caused by a cochlea or auditory nerve defect. SNHL with genetic causes like Klippel-Feil syndrome or acquired (prenatal: bacterial or viral infections, perinatal: neonatal jaundice, postnatal: such as meningococcal infections and mumps). 3- Mixed hearing loss: this is a defect in transmission before and after the cochlea[10].

According to the American National Standards Institute, hearing loss ranking: in slight hearing loss average HTL is 16 to 25 dB, HTL in mild hearing loss is 26 to 40 dB, HTL in moderate hearing loss is 41 to 55 dB, HTL in moderately severe hearing loss is 56 to 70 dB, HTL in severe hearing loss is 71 to 90 dB, and in profound hearing loss average HTL is over 90 dB[11].

Ideally, assessment of language development in hearing-impaired children will help assess its deficiencies and plan adequate auditory and verbal rehabilitative programs before school age during the golden age of language acquisition [11].

In this study, the "APPLE" tool was used for clinical evaluation to detect the subtle language affection of these children[12].

PATIENTS AND METHODS

This study is a cross-sectional study conducted on 25 children of moderate to severe degree of SNHL with average non-verbal intelligence. They attended Phoniatric unit outpatient clinics in Menofia University Hospital, and 25 normal control subjects matched for age and gender. Based on the past review of the literature[13], sample size had been calculated at power 90% and confidence interval CI 95% giving a total sample size of 50 children (25 participants for cases and 25 for controls). These children were selected with an age range of 3 years to 4 years, 11 months and 29 days, and they were collected randomly from September 2020 to June 2021. The local ethics committee of Menoufia University approved the study protocol. All subjects' parents gave written informed consent before inclusion into the study.

Children that presented with other disabilities (deaf-blind, autism spectrum disorder, attension deficit hyperactive disorder), or children subjected to cochlear implantation were excluded from the study.

All cases and controls were subjected to language assessment protocol which includes: 1- Elementary diagnostic procedures that represented in; analysis of the complaint, personal history (prenatal, natal, and postnatal history), developmental milestones, and general examination. 2- Clinical diagnostic aids which included cognitive abilities, audiological evaluation, and language evaluation.

Cognitive abilities were evaluated by applying Stanford Binet Intelligence Scale[14]; only children with an average non-verbal intelligence were allowed to participate in this study. Audiological ability was assessed through tympanometry, auditory brain stem response (ABR), and pure tone audiometry.

Language skills were evaluated through 'APPLE' tool[13], which is composed of the following items; main subtests: 1- Receptive skills which include: receptive vocabulary (RV), linguistic concepts (LC), sentence comprehension (SC), understanding oral instruction (UOI), receptive language score (RLS), understanding simple Yes/No Questions (USQ), and oral comprehension skills (OCS) & WH questions. 2- Expressive skills which include: expressive vocabulary (EV), expressive vocabulary_1 (EV_1), morphosyntax (MS), word, phrase, and sentence repetitions, expressive language score (ELS). 3- Total language score (TLS) (receptive language and expressive language). Additional subtests: 1- Action picture subtest (APS): Average number of words/sentence (ANW/S), total number of words (T), and diversity (D), quantity quality score (QQS). 2- Oral narrative skills retelling: Average number of words/sentence_2 (ANW/S_2), total number of words (T_2), and diversity (D_2): total number of different words. 3- Articulation test.

Statistical analysis

Data were collected, tabulated, and statistically analyzed using an IBM-compatible personal computer with Statistical Package for Social Science (SPSS) Version 26[15]. The qualitative data were presented as number (No) and percent (%), while quantitative data were presented as mean and standard error (SE).

Student's t-test is a test used to compare two groups having quantitative normally distributed variables. The Mann-Whitney test (non-parametric test) is a test of significance used to compare two groups not normally distributed having quantitative variables. The correlation coefficient test (r-test) was used for studying the correlation between two quantitative variables, and its results may be a positive or negative correlation.

Probability of error: *P-values* > 0.05 were considered non-significant, *P-values* <0.05 were considered significant and *P values*<0.001 were considered highly Significant.

RESULTS

This study included 25 cases, 14 males (56%) and 11 females (44%), and 25 control subjects 16 males (64%) and 9 females (36%). Cases were diagnosed as delayed language development due to HI (from moderate to severe degree) with average non-verbal intelligence and age ranging from 3 to 4years and 11 months.

Cases were divided into 2 groups: Group A: consisted of 10 cases, ranging from 3 years to 3 years, 11 months, and 29 days. Group B: consisted of 15 cases; their ages

ranged from 4 years to 4 years, 11 months, and 29 days. Controls were divided with the same age ranges in to 2 groups, group A-I consisted of 12 cases, and group B-I consisted of 13 cases. Each group was assessed by APPLE tool.

Comparison between cases and control subjects as regards APPLE tool parameters in case and control groups revealed:

In small age group (A and A-I) (aged from 3 to less than 4 years): Showed a highly significant difference between case and controls regarding receptive language skills, expressive language skills, total language test, and articulation test (Table 1). Also, there was a highly significant difference between both groups regarding ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS tests (Table 2).

Group A: Showed no significant difference between different studied hearing impaired cases regarding receptive language skills, expressive language skills, total language test, articulation test, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS test (Table 3).

In large age group (B and B-I) (aged from 4 to less than 5 years): Showed a highly significant difference between case and controls regarding receptive language subtests, expressive language subtests, total language test, and articulation test. A highly significant difference was found regarding ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, and OCS test scores. In contrast, no significant difference was found regarding the USQ test (Table 4).

Group B: Showed no significant difference between different studied hearing impaired cases regarding receptive language skills, expressive language skills, total language test, articulation test, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS test (Table 5).

By studying the correlation between duration of rehabilitation and APPLE tool parameters (main subtests and additional subtests), it was found that there were highly significant correlations (Table 6).

There were highly significant correlations in results between duration of hearing aid use and APPLE tool parameters (main subtests and additional subtests) (Table 6).

Table 1: Comparison of receptive language skills, expressive language skills, total language test, and articulation test scaled scores in (A and A-I) groups aged (3 – 4 years)

variable	Groups		Test of significance Test(U)	*P-value*
	Cases NO. =10 Mean±SD	Controls NO. =12 Mean±SD		
Receptive Vocabulary (RV)	4.2±2.04	9.08±1.31	3.998	<0.001**
Linguistic Concepts (LC)	2.9±1.5	10.58±1.78	3.988	<0.001**
Sentence Comprehension (SC)	2.4±1.07	11.75±1.54	4.030	<0.001**
Understanding Oral Instruction (UOI)	5.2±1.47	13.25±1.22	t=14.43	<0.001**
Receptive Language Score (RLS)	66.4±6.18	109.41±6.21	t=16.199	<0.001**
Expressive Vocabulary (EV)	5.4±1.84	13.33±1.07	t =12.626	<0.001**
Morphosyntax (MS)	3.6±1.84	13.25±1.76	U=4.017	<0.001**
Sentence Repetitions	6.2±1.62	11.75±0.45	t =11.4	<0.001**
Expressive Language Score (ELS)	72.8±6.71	118.58±3.73	t =19.235	<0.001**
Total Language Score (TLS)	69.9±6.44	115.32±4.077	t =20.387	<0.001**
Articulation Test	5.7±0.48	11.42±0.51	t =26.658	<0.001**

This table shows a highly significant difference between case and control groups as regards RV, LC, SC, UOI, RLS, EV, MS, ELS, TLS, and articulation test.

Table 2: Comparison of ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, UCS scaled scores in group (A and A-I) aged (3 – 4 years)

variable	Groups		Test of significance Test(U)	*P-value*
	Cases NO. =10 Mean±SD	Controls NO. =12 Mean±SD		
Average Number of Words/Sentence (ANW/S)	5.7±2.26	13.42±0.67	4.084	<0.001**
Total Number of words (T)	5.7±2.36	14.67±0.49	4.079	<0.001**
Sentence Comprehension (SC)	6.4±3.06	15.25±0.45	4.109	<0.001**
Diversity (D)	6.1±2.38	15.33±0.49	4.072	<0.001**
Quantity Quality Score (QQS)	2.8±2.89	12.75±1.48	U=4.062	<0.001**
Average Number of Words/Sentence (ANW/S_2)	3.3±3.3	13.33±1.44	U=4.045	<0.001**
Total Number of words (T_2)	3.4±3.86	15.33±0.49	U=4.140	<0.001**
Diversity (D_2) Total Number of different words	11.7±4.35	16±0	U=3.031	0.002**
Understanding Simple Yes / No Questions (USQ)	4.8±2.04	13.17±1.75	U=4.010	<0.001**
Oral Comprehension Skills(OCS)& WH questions	5.7±0.48	11.42±0.51	t =26.658	<0.001**

This table shows a highly significant difference between case and control groups as regards ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS.

Table 3: Comparison of receptive language skills, expressive language skills, articulation test, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS scaled scores in group A aged (3 – 4 years)

	Groups			Test of significance#	*P-value*
	Moderate HL NO. =1 Mean±SD	Moderate –severe HL NO. =6 Mean±SD	Severe HL NO. =3 Mean±SD		
RV	2±0	3.5±1.64	6.33±1.15	5.255	0.072
LC	1±0	2.67±1.5	4±1	3.340	0.188
SC	1±0	2.17±0.98	3.33±0.57	4.298	0.117
UOI	5±0	4.67±1.5	6.33±1.15	2.614	0.217
RLS	61	63.67±2.94	73.67±5.85	5.941	0.051
EV	5±0	4.83±1.94	6.67±1.53	2.161	0.339
EV_1	1±0	4±2.76	3±0	2.605	0.272
MS	2±0	3.17±2.04	5±0	2.625	0.269
Sentence Repetitions	6±0	6±2.09	6.67±0.578	0.662	0.718
ELS	64±0	71.5±6.44	78.33±3.05	F=2.777	0.129
Articulation test	6±0	5.5±0.55	6±0	2.571	0.276
ANW/S	8±0	5.5±2.81	5.33±0.58	1.226	0531
T	6±0	5.5±3.15	6±0	0.779	0.677
D	7±0	6.1±4.07	6.67±0.578	0.788	0.675
QQS	7±0	6.17±3.13	5.67±0.58	0.881	0.644
ANW/S_2	7±0	3±3.09	1±0	3.286	0.193
T_2	8±0	3.67±3.44	1±0	3.613	0.164
D_2	9±0	3.67±4.13	1±0	3.286	0.193
USQ	8±0	10.33±4.4	15.67±0.58	2.460	0.292
OCS	1±0	4.83±1.9	6±0	4.031	0.133

This table shows no significant difference between different studied hearing impaired cases as regards RV, LC, SC, UOI, RLS, EV, MS, ELS, TLS, articulation test ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS.

Table 4: Comparison of receptive language subtests, expressive language subtests, total language test,articulation test, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, OCS scaled scores in group (B and B-I) aged (4 – 5 years)

variable	Groups		Test of significance Test(U)	*P-value*
	Cases NO. =15 Mean±SD	Controls NO. =13 Mean±SD		
RV	5.87±3.39	10.31±1.03	3.275	<0.001**
LC	5.07±4.15	11.92±1.03	3.875	<0.001**
SC	6.33±4.58	13.38±0.77	4.080	<0.001**
UOI	6.87±4.17	15±0.91	4.230	<0.001**
RLS	84.2±22.16	125.15±4.45	t=6.995	<0.001**
EV	9±3.64	14.92±0.95	4.516	<0.001**
MS	3.73±2.89	15.54±0.52	4.561	<0.001**
Sentence Repetitions	7.93±2.89	12.23±0.44	4.406	<0.001**
ELS	82.73±14.21	119.6±1.89	t=9.264	<0.001**
TLS	81.88±17.03	122.31±2.89	t=8.046	<0.001**
Articulation Test	6.53±2.39	11.62±0.51	4.465	<0.001**
ANW/S	9.53±3.76	15.31±0.48	4.397	<0.001**
T	10.07±3.88	15.31±0.48	4.214	<0.001**
D	11.27±4.06	15.53±0.78	3.766	<0.001**
QQS	11.07±3.83	15.53±0.51	3.271	<0.001**
ANW/S_2	8.33±3.77	13.92±1.03	4.126	<0.001**
T_2	9.07±3.47	15.08±0.49	4.579	<0.001**
D_2)	10.67±4.59	15.61±0.51	3.363	<0.001**
USQ	15.47±2.66	16±0	0.931	0.352
OCS	6.47±4.79	15.31±0.85	4.481	<0.001**

This table shows a highly significant difference between case and control groups as regards RV, LC, SC, UOI, RLS, EV, MS, ELS, TLS, articulation test, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, and OCS. While there is no significant difference as regards USQ.

Table 5: Comparison of receptive language skills, expressive language skills, articulation test, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS scaled scores in group B aged (4 – 5 years)

	Groups			Test of significance#	*P-value*
	Moderate HL NO. =1 Mean±SD	Moderate –severe HL NO. =6 Mean±SD	Severe HL NO. =3 Mean±SD		
RV	6.86±3.76	4.75±2.22	5.25±4.03	0.893	0.640
LC	4.57±5.03	5.5±3.32	5.5±4.2	0.435	0.804
SC	5.57±5.06	6.5±4.2	7.5±5.07	0616	0.735
UOI	6.43±4.47	5.25±2.63	9.25±4.79	1.091	0.579
RLS	83.43±26.11	79.75±15.84	90±24.6	0.637	0637
EV	9.71±2.98	8.25±3.86	8.5±5.19	0.414	0.813
MS	3.71±3.3	3.5±2.08	4±3.56	0.033	0.984
Sentence Repetitions	8.57±2.44	7.5±2.65	7.25±4.27	0.493	0.781
ELS)	84.28±15.53	78.5±11.85	84.25±16.94	0.278	0.279
Articulation test	81.85±20.15	78.75±12.92	85±18.67	0.118	0.890
ANW/S	9.71±3.64	10.25±2.5	8.5±5.57	0.071	0.965
T	10.29±3.64	10.5±2.51	9.25±6.02	0.001	1
D	11.43±3.56	12±2.94	10.25±6.39	0.059	0.971
QQS	11.43±3.82	11±2.71	10.5±5.57	0.080	0.961
ANW/S_2	8.71±3.64	8.5±3.42	7.5±2.59	0.148	0.928
T_2)	9.14±3.44	9.25±3.09	9.75±4.79	0.005	0.998
D_2	11±4.39	11±3.56	9.75±6.75	0.080	0.961
USQ	16±0	16±0	14±4	2.750	0.253
OCS	6.71±5.62	4.5±2.89	8±5.23	0.998	0.607

This table shows no significant difference between different studied hearing impaired cases as regards RV, LC, SC, UOI, RLS, EV, MS, ELS, TLS, articulation test ANW/S, T, D,QQS, ANW/S_2, T_2, D_2, USQ, and OCS.

Table 6: Pearson correlation between duration of rehabilitation with APPLE tool parameters & duration of hearing aid use with APPLE tool parameters in the two age groups

Variable	Duration of rehabilitation		Duration of hearing aid use	
	r	*p-value*	r	*p-value*
RLS	0.764	<0.001**	0.593	0.002**
ELS	0.682	<0.001**	0.592	0.002**
TLS	0.723	<0.001**	0.598	0.002**
ANW/s	0.686	<0.001**	0.661	<0.001**
T	0.644	<0.001**	0.684	<0.001**
D	0.592	<0.002**	0.657	<0.001**
QQS	0.66	<0.001**	0.732	<0.001**
ANW/S_2	0.674	<0.001**	0.776	<0.001**
T_2	0.672	<0.001**	0.788	<0.001**
D_2	0.665	<0.001**	0,781	<0.001**
USQ	0.321	0.117	0.396	0.05
OCS	0.591	0.002**	0.517	0.008**

This table shows a highly significant correlation between duration of rehabilitation and RLS, ELS, TLS, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS. Also it shows a highly significant correlation between duration of hearing aid use and RLS, ELS, TLS, ANW/S, T, D, QQS, ANW/S_2, T_2, D_2, USQ, and OCS.

DISCUSSION

Language development requires early and consistent access to auditory cues, and its affection, even with a mild degree, threatened this access[16]. Intact auditory channels contribute substantially to successful language development and its function across life[17]. So, hearing provides a means to communicate with others and monitor any change either in the acoustic or linguistic environment[18]. The language environment experienced by children with hearing disabilities totally differs from that of normal-hearing children[19].

HI appears to affect children regardless of the severity of the degree, and its effects are more vigorous with delays in its identification and proper intervention[20]. Work by Delage and Tuller,[21] indicated that subtle language problems associated with mild to moderate HI could be undetected in early childhood but persist and become more manifest in adolescence when high-level language functions are used.

Recent studies indicated that children born with HI form a heterogeneous population with a variable range of language skills development affection. At three years of age, relevant variables such as gender, maternal level of education, socioeconomic status, and duration of hearing aid use makes the child have a significant disability in addition to HI degree[22].

Early language intervention can be successful, although progress in language abilities may not be rapid depending on the severity of HI and onset of the age of diagnosis[23]. To say that this intervention program is appropriate, it must include good family consultation, hearing aid fitting and programming, especial auditory training for language development, and finally, educational strategies based on the abilities of the hearing impaired children[24].

In this study, there was significant difference between cases and controls regarding receptive language subtests presented in RV, LC, SC, UOI, and RLS. These findings agreed with results of Stevenson *et al*.[25] - who investigated the relationship between language development and HI - found that hearing-impaired children had lower scores on language measures. Hearing status was a significant predictor of receptive language, and its effects were tested using a regression test.

Also, there are different studies[21,26;27] which have reported that there was evidence of delayed receptive language development in hearing-impaired children, and these results have been linked to smaller vocabulary sizes and delay in the semantic ability development. Adlof and Catts,[28] have reported that HI has affected receptive language skills twice as large compared to expressive language skills.

On the level of expressive language test which presented in EV, (EV_1) (for the smaller age group), MS, REP, and ELS, there was a highly significant difference between cases and control subjects, and these findings were consistent with the results of Halliday *et al*., Park *et al*., and Park *et al*.,[29,30,31], who studied the development of expressive language in hearing-impaired children and found that there were oral language deficits which in turn lead to reading comprehension difficulties. Both expressive language impairments and poor reading comprehension skills encompass semantic and syntactic skills development[28].

Highly significant difference in results was found between cases and controls regarding MS and this were in line with results of several researches Hammer *et al*., Koehlinger *et al*., Moeller *et al*., Tomblin *et al*.,[32,33,34,16] - which examined the development of these skills in hearing-impaired children- showed persistent deficits in

both perception and production of grammatical morphemes and syntax development. Differences in affection of the grammatical structure of sentence versus vocabulary development might help explain why hearing-impaired children complain of reading comprehension difficulties. The child's syntactic level is a good predictor of future reading comprehension difficulties than vocabulary[35].

Also, a highly significant difference was noted between different studied groups regarding the REP test. These findings go with the results of several studies that have demonstrated poorer word repetition abilities in hearing-impaired children relative to age-matched peers[30,31]. Also Halliday,[13] – who investigated the performance of the word repetition test in hearing-impaired children -found poor abilities in performing word repetitions test with HI.

There were highly significant differences between cases and controls on the level of action picture subtests presented in ANW/S, T, D, and QQS. These results were constituent with Koehlinger *et al*.[33] - who examined a group of children with HI from three to six years of age - noted that there was a reduction in the mean length of utterance - because hearing-impaired children mostly tend to use short sentences in their utterance with simple grammatical structures.

This study also demonstrated that there was a highly significant difference between the two studied groups regarding oral narrative skills-story retelling subtest which presented in ANW/S_2, T_2, and D_2, and this goes with the results of several studies of Kiese-Himmel *et al*.,; Pittman *et al*.,; Wake *et al*., and Delage *et al*.,[26,27,36,21] - that have examined the vocabulary size and the ability of story retelling skills of SNHL children - reported that there was evidence for delayed both language domains which in turn affected their ability in story retelling relative to their normal peers.

There was a significant difference in understanding simple yes/no questions in the small age group (from 3 to 4 years) because they have a small vocabulary. This test examines the ability to identify different semantic groups. On the other hand, it showed no significant difference in the group aged (from 4 to 5 years) due to the simplicity of the questions.

On the phoneme level, which presented in sound examination in different word positions, showed highly significant differences in results between two studied groups, and these findings were consistent with the results of Moeller *et al*.[34], who examined the development of phonology and morphology in children with SNHL, noted that phonological processes were varied according to various degrees of hearing impairment. Also, Ertmer,[37] found that hearing-impaired children had multiple phonological processes that affected their speech intelligibility. Moreover, Nittrouer *et al*.[38] found that children with HI had a significant delays in phonological awareness skills but developed in the same order as normal-hearing children,but it takes a long time for acquisition.

Regarding the correlation between duration of rehabilitation and different APPLE tool parameters (as mentioned before), there was a highly significant difference in results between cases and controls. Ching *et al*.[22] reported that earlier intervention with suitable rehabilitation programs improved language outcomes of hearing-impaired children. The best time for better intervention is to reach better language results over the first 3 years of life (typical brain development age).

Unlike previous studies of Pimperton *et al*.[39], researchers used cutoff points for early identification. They suggested that the child has a maximum time of benefit of intervention and called it a "sensitive period" that ended before 1 year to 18 months.

It was found that highly significant correlation between duration of hearing aids use and different APPLE tool parameters, and this goes with the results of Tomblin *et al*.[16], who reported that early hearing aid fitting increased the duration of receiving benefit for language development and decreased the duration of hearing impairment hazards.

In this study, there was noted no significant difference in results obtained between different studied hearing impaired cases (about the degree of hearing impairment) regarding scaled scores of different parameters of APPLE tool which presented in (receptive language subtests, expressive language subtests, total language test, action picture subtests, oral narrative story retelling subtests, oral comprehension skills test, understanding simple yes/no Q, and articulation test).

Understanding the reason beyond these mixed findings can be quite complex. The degree of severity of HI has a role in determining language outcomes, but it is not the whole story. Multiple factors decrease its affection on language skills development. These findings contradicted with the results of some studies of Friedmann *et al*., and Tuller *et al*.,[40,41] who found that the degree of HI is the main determining factor for language outcomes.

Other researchers noted that several factors can reduce the effects of HI on language development such as the age of diagnosis of this disability and the age of hearing aid fitting[21,33,36,42].

Early identification and planning proper intervention programs are the variables with the greatest impact on language acquisition. Other important variables are the degree of hearing impairment, intelligence quotient (IQ), presence or absence of other disabilities such as inattention, socio background of the family, parents' culture, family communicative pattern, gender, and the mother's level of education or literacy[24].

Consistency wearing of hearing aids is also an important factor that should be considered since many children don't use their hearing aids in a regular manner[43].

Cupples *et al*.[44] has studied the influence of early hearing aid fitting on language outcomes for a group of HI children. He found that early auditory stimulation had strong effects on language development and may emerge even at an age older than three years. More importantly, this finding demonstrated the importance of early hearing aid fitting in children with comorbid disabilities.

Several studies of[37,45] ensured that children with HI, who were early identified, early fitted with hearing aids, and received appropriate intervention programs were nearly normal language development that is similar to typically developing peers.

So these results demonstrated that language acquisition can be enhanced by adequately exposure to auditory stimuli carried by early and regular hearing aid fitting and proper rehabilitation programs for reaching optimum linguistic experience in hearing-impaired children.

CONCLUSION

Language is important for communication, and hearing is a critical precursor for language acquisition. HI is a common medical problem in which children complain of delayed language development, emotional, cognitive, and behavior problems. Normal language acquisition sequelae of hearing-impaired children depend not only on the degree of HI, but also early and regular wearing of hearing aid with a suitable family conditions that is mandatory for achieving this. Moreover, building intervention programs and early language therapies help to improve both language domains.

RECOMMENDATIONS

HI screening should be seriously taken into consideration to reduce the hazards and the negative impact on language and communication skills that might occur in the future. Using universal newborn hearing screening is a method for early detection as it can lead to early fitting and rehabilitation thereby increasing the progress achieved with therapy.

Future research efforts must focus on pre and post-assessment to determine the effect of rehabilitation programs on different language skills development. On the clinical level, it is also important to regularly monitor the progress achieved with therapy to determine the effect of the applied rehabilitation programs on the linguistic performance of the child. This, in turn, can aim to provide a better life for hearing impaired generations in the future.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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