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Co-morbidities of Hearing Loss and Occupational Therapy in Preschool Children

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ABSTRACT

Introduction: *Many children with hearing impairment present with one or more health-related conditions defined as a co-morbidity in addition to hearing loss. Families and professionals are then faced with various challenges that often complicate the assessment, management and educational placement of these children. Appropriate holistic intervention is essential for the development and quality of life of the child. This study describes the co-morbidities within the field of occupational therapy, speech therapy and physiotherapy that pre-school children with hearing loss present with at the Centre for Language and Hearing Impaired Children (CLAHIC) and its implications for management.*

Method: *A descriptive, retrospective research design was employed. Using a non-probability, purposive sampling strategy the records of 62 children diagnosed with a hearing loss that attended the CLAHIC from 1999 to 2010, were reviewed.*

Results: *The prevalent co-morbidities identified in this study were found mostly within the field of Occupational Therapy and included fine and gross motor delay, visual motor integration disorders and bilateral integration disorders. Further findings indicated that co-morbidities of hearing loss are independent of the degree of the hearing loss.*

Conclusion: *The findings suggest that pre-school children with hearing loss, irrespective of the etiology and degree of hearing loss, should be screened for prevalent co-morbidities, such as fine and gross motor difficulties.*

Key words: Co-morbidities; hearing loss; interdisciplinary team; occupational therapy

INTRODUCTION

Parents of children with hearing loss and the health care professionals involved are faced with numerous challenges when a child with a hearing loss presents with additional health-related difficulties defined as co-morbid delays and/or disorders[1,2] such as delayed fine motor development. Access to appropriate healthcare and resources, financial costs and appropriate educational placement are just some of the possible challenges that are intertwined in the dynamic decision-making and management processes for these children.

As hearing loss may negatively affect health-related quality of life[3], the objective of professionals involved, should be to implement practices that lead to the best outcomes, and eliminate those that result in less than optimal results[4]. In the presence of co-morbidities in addition to a hearing loss, an interdisciplinary team approach to intervention that incorporates ongoing collaboration amongst the professionals in the team is proposed. However, in the absence of information regarding the types of co-morbid disorders and/or delays that present with hearing loss, appropriate intervention for these children may be compromised.

Disparities exist across medical and educational settings for children with therapeutic and support services needs such as for children diagnosed with hearing loss[5]. It is therefore imperative that referral systems are established between health care professionals working in these settings to facilitate collaboration and ultimately the best possible outcomes for children with hearing loss and their families.

LITERATURE REVIEW

Hearing Loss

It is estimated that in South Africa 6 in every 1000 babies in the public health sector and 3 in 1000 infants in the private health sector are born with a hearing loss[6]. Hearing loss refers to either a partial or complete loss of the ability to hear[7]. There are predominantly three different types of hearing loss namely, sensory-neural, conductive or mixed hearing loss. A sensory-neural hearing loss is the result of a problem with the inner ear or the auditory nerve[8] and is usually permanent in nature. Intervention could include hearing amplification such as hearing aids or cochlear implants and aural rehabilitation. A conductive hearing loss is a problem in the outer or middle ear and is often medically or surgically treatable[7]. Finally, a mixed hearing loss has both a conductive and sensory-neural component[8].

Hearing loss is further categorised according to the degree of hearing loss which is measured in decibels (dB). The point at which a person starts to hear sound is referred to as a dB of 0 and normal hearing for children is described as being between 0 and 15dB. The degrees of hearing loss for children range from slight to profound (See *Table 1*).

Table I: Degree of hearing loss in children[8]

Description	Range (in dB)
Slight	16 – 25 dB
Mild	26 – 40 dB
Moderate	41 – 55 dB
Moderately severe	56 – 70 dB
Severe	71 – 90 dB
Profound	>90 dB

Depending on the degree of hearing loss, everyday communication may be difficult or even impossible without a great deal of effort. As a result infants and children may experience a delay in speech, language, motor and social development as well as educational achievement[9].

Etiology of Hearing Loss

The causes of hearing loss may have a significant impact on the management and care of individuals with a hearing loss. Genetic and environmental factors contribute to the etiology of hearing loss[10]. It has been reported that in the case of genetic hearing loss, 30% is syndromic and therefore associated with specific abnormalities[10]. Syndromes that are commonly associated with hearing loss that were identified in this study included Goldenhar Syndrome, which is a congenital malformation syndrome predominantly affecting facial appearance[11], Waardenburg Syndrome described as a heterogeneous disorder affecting the auditory system and pigmentation of the hair, skin, and eyes[12], and Connexin 26 mutation known as mutations that occur in the Connexin 26 gene and are associated with sensory-neural hearing loss[13]. Environmental causes of hearing loss include excessive cerumen, noise exposure, infectious diseases (e.g. measles, mumps and meningitis), exposure to ototoxic medication and trauma[10]. Problems during pregnancy and childbirth could also give rise to hearing problems.

Co-Morbidities of Hearing Loss

Co-morbidity is defined as the presence of additional conditions in relation to a specific index condition[1,2]. In the present study a co-morbidity will refer to a disorder that is in addition to hearing loss. Co-morbidities of hearing loss include motor impairment, cognitive or learning difficulties (LD), global developmental delay described as a significant delay in two or more developmental domains[14], sensory integration (SI) impairment that occurs when there is a disruption in the neurological process that organises sensation from the body and the environment[15], communication disorders such as verbal apraxia, attention deficit-hyperactivity disorder (ADHD) and other medical, physical, or emotional problems[16].

It has been found that attention disorders, learning disorders and intellectual difficulties are the most prevalent co-morbidities that children with hearing loss present with. The other prevalent co-morbidities of hearing loss that have been identified are sensory integration disorders and motoric problems[16]. Suarez et al.[16] noted that sensory-motor problems were found in children with a hearing loss who attended mainstream schools and used spoken language in their communication. In addition, they found that children with sensory-neural hearing loss appeared to experience more difficulties with vestibular processing when compared to their typically developing peers with normal hearing[16]. It is postulated that these difficulties result in delays in the development of gross motor skills.

Implications for the Assessment and Management Approach

Holistic intervention and management is essential to meet the needs of children that present with co-morbidities of hearing loss and their families. One approach to the holistic management is the interdisciplinary team approach when team members collaborate to produce a comprehensive intervention plan[17]. It further promotes the responsibility of each team member, including the parents who are considered to be the most important members of the team, to achieve the child's outcomes[18].

Assessment of children with hearing loss should in addition to the audiological aspects, include the assessment of all developmental domains including cognition, communication and language, behaviour, social-emotional skills, and motor skills[19]. Concern about the child's developmental skills may warrant referrals to the relevant specialists, such as a speech-language therapist, an occupational therapist, physiotherapist, psychologist and otolaryngologist.

Research has confirmed that early diagnosis, appropriate amplification and prompt entry into early intervention programmes are factors that potentially affect the auditory and spoken language outcomes of children with severe and profound hearing loss[20,21]. Early intervention for infants and children with hearing loss should build communication skills that will facilitate social and cognitive development[16]. For children with hearing loss that also present with co-morbidities, early intervention that is interdisciplinary in nature is even more critical.

In addition, the educational placement of these children requires careful selection of a setting that will meet their needs as well as those of their families. Educational programmes should ideally offer an integrated curriculum that nurtures speech, language, literacy development, innovations in the areas of auditory perception, social emotional learning, motor development, and vestibular function to enhance outcomes[22]. Inclusive programmes in the clinical pre-school setting, that maintain small class sizes and use a co-teaching model, can provide differentiated teaching.

Rationale for the Study

The move towards inclusive education in South Africa for children with disabilities is positive. However, the dearth of information on the prevalence of co-morbid disorders and/or delays that pre-school children with hearing loss present with may impact on the availability of appropriate educational placements and intervention for these children[23]. This study is an attempt to determine the co-morbidities of hearing loss in pre-school children. It is proposed that this information could guide the development of intervention protocols for this population within an inclusive and interdisciplinary educational setting.

METHOD

Aim

The primary aim of the study was to describe the co-morbidities that pre-school children with hearing loss at an early intervention center for children with language and hearing impairment present with, and their implications for management. In order to achieve the primary aim, the prevalence of the different types of co-morbidities was identified and the services provided to these children described. A secondary aim of the study was to determine if there was any relationship between the severity of the hearing loss and the co-morbidities identified.

Research Design

A descriptive, retrospective record review[24] was implemented to determine the prevalence of co-morbid delays and/or disorders present in pre-school children with hearing loss, as well as the services provided to them.

Population and Sample Procedure

The Centre for Language and Hearing Impaired Children (CLAHIC), situated in Johannesburg, is an early intervention centre that provides a language-enriched learning environment for children with delayed language development and/or hearing loss. The CLAHIC has six classes with only eight children per class, and offers a range of additional professional services to the children and their families if required. These services include audiology, speech therapy, occupational therapy, physiotherapy and educational psychology.

Using a non-probability, purposive sampling strategy, the archived records of children attending the CLAHIC between 1999 and 2010 were reviewed. A total of 62 records of children diagnosed with hearing loss were included in the study. The gender of the

sample was evenly distributed and the average age of the participants was 5.0 years (range 3.0 to 7.7; standard deviation [*SD*] = 1).

Measures

A checklist was developed, using the literature findings, to assist in the record review. The checklist comprised of six sections:

- Section one and two contained biographical information and hearing status. This assisted in the description of the participants.
- The third section contained the medical history of each participant and provided information on the etiology of hearing loss that could have implications for the type of specialised services and referrals that might be required. Confirmed diagnosis of ADHD by a paediatric psychiatrist, learning disorders diagnosed by an educational psychologist and visual impairment identified by an optometrist, were also recorded in this section.
- The fourth section contained information on the specialist intervention provided by occupational therapists, physiotherapists and speech therapists. The co-morbidities identified were based on the test results and findings of individual assessments (and subsequent diagnoses) detailed in each of the professionals' report. These co-morbidities included gross and fine motor development, vestibular disorders that can be characterised by atypical movements; poor spatial relations; visual acuity problems etc.[25], visual motor integration disorders that occur when the eyes and hands do not work together in smooth, efficient patterns[26], sensory integration and bilateral integration disorders that can be part of a dyspraxia in which the child may have impaired ability to plan, sequence or execute actions in the presence of tactile, vestibular disorder or a visual motor integration disorder[27].
- The fifth section identified the external medical professionals these children were referred to, whilst the last section looked at the educational placement of children.

Procedures

Ethical considerations*:* Various ethical considerations were implemented throughout the study. The researcher obtained ethical clearance from the University of the Witwatersrand's Research Ethics Committee before the research was conducted. Written informed consent was obtained from the CLAHIC. On admission to the CLAHIC, parents sign and provide consent that information from their child's file may be used for research purposes. Confidentiality was assured as files were allocated a participant number and no identifying information was reported.

Data collection and analysis. A systematic review of all records and reports in the files was conducted. Data were captured on a MS Excel spreadsheet and thereafter tabulated into ordinal categories for statistical analysis. A coding method of using 0 as false indicator and 1 as a true indicator for the co-morbidity present was implemented. Pivot tables were created to interrogate the data as well as perform calculations within the various sets of data. Descriptive statistics were utilised to analyse those data, and included averages, range, SD, frequency and percentages.

Reliability. The use of the term reliability in communication disorders research is related to the general trustworthiness of the data and is synonymous with dependability, consistency, predictability and stability[24]. Observer bias was eliminated as there was no contact with participants and therefore increased the reliability of the study. To ensure reliability of the recording of information, the researcher, who is familiar with the settings of the CLAHIC, had complete administrative control over the data collection.

Validity. A comprehensive literature review was conducted and served as an underpinning for the measurement instrument of this study, the checklist. The validity of the study was increased by conducting a pilot study. The data collected from the pilot study was used in the final analysis of the main study to add to the sample size, and it can therefore be referred to as an internal pilot[28]. Fourteen participants' files of 2009, who met the inclusion criteria as for the main study, were included in the pilot study. The inclusion criteria were (1) diagnosis of a hearing loss (2) attendance at the CLAHIC between 1999 and 2010; and (3) aged between 3.0 to 7 years eleven months. The researcher converted the information from the pilot study into numerical data that were collated onto a MS Excel spreadsheet for analysis. The average age of the participants was 4 years 6 months (range: 3 years 4 months to 6 years 7 months, SD: 0.98). Thirteen participants were diagnosed with a bilateral hearing loss. The recommendations stemming from the pilot study were implemented in the main study i.e. the areas of language delay and auditory perceptual skills delay were not considered as categories for the checklist as these are delays that occur as a result of the hearing loss and not in addition to the hearing loss.

RESULTS

Hearing status

The majority of the participants (98%; *n* = 61) had a bilateral hearing loss. The types of hearing loss included sensory-neural hearing loss (89%; *n* = 55), conductive hearing loss (6%; *n* = 4) and mixed hearing loss (5%; *n* = 3). The degrees of hearing loss ranged from moderate to profound, with the majority of participants (47%; *n* = 29) diagnosed with a profound hearing loss.

Medical Diagnosis

Sixty percent of the children (*n* = 37) presented with medically related conditions. Of these, congenital anomalies, such as cleft-lip and palate, respiratory conditions and dysmorphic features, were evident in 15% (*n* = 9) of the participants, whilst 11% (*n*= 7) were diagnosed with a syndrome prior to admission into the CLAHIC. These syndromes included Goldenhar syndrome (n= 2), Waardenburg Syndrome (n= 1), Connexin 26 mutation (n= 1) and Respiratory Distress Syndrome (n= 2). Sixteen percent (*n* = 10) were born prematurely and 6% *(n* = 4) of the participants had very low birth weights. Recurrent middle ear infections were experienced by 16% (*n*= 10) of the participants. The remaining 11% (*n* = 7) included ototoxicity, infections, jaundice and birth asphyxia.

Co-morbidities

Information obtained from the medical diagnosis and specialist intervention sections were used to determine the types of co-morbidities that the participants presented with in addition to hearing loss. Each co-morbidity was diagnosed by the relevant specialist based upon assessment findings for each child. The results are presented in *Table II*.

Table II: Prevalence of Co-morbidities (N= 62)

Co-morbidity Diagnosed	Intervention/Specialist	% (n)
Fine motor delay	Occupational Therapy	42 (26)
Gross motor delay	Occupational Therapy	26 (16)
Visual Motor Integration disorder	Occupational Therapy	21 (13)
Gross motor delay	Physiotherapy	18 (11)
Bilateral integration disorder	Occupational Therapy	16 (10)
Verbal apraxia	Speech Therapy	16 (10)
ADHD	Psychiatrist (External)	13 (8)
Sensory integration disorder	Occupational Therapy	10 (6)
Vestibular disorder	Occupational Therapy	8 (5)
Visual impairment	Optometrist (External)	5 (3)

It is evident from the findings that the more frequently occurring conditions that participants presented with, were in the field of occupational therapy. The most prevalent co-morbidity diagnosed was a delay in fine motor skills (42%; *n* = 26), followed by delays in gross motor development (26%; *n* = 16) that included crossing of the body midline, sequencing in gross motor co-ordination and postural control, followed by visual motor integration disorders

(21%; $n = 13$). Further co-morbidities diagnosed within the field of occupational therapy were bilateral integration disorders (16%; $n = 10$); sensory integration disorders (10%; n = 6) and vestibular disorders (8%; n = 5). The co-morbidity of a gross-motor delay diagnosed by a physiotherapist was 18% of the participants ($n = 11$) that included disorders in postural control and positioning, flexion and extension control and balance integration. Sixteen percent of the participants ($n = 10$) presented with verbal apraxia and received intervention by speech therapists.

The prevalence of the co-morbidities were then identified in children with the same degree of hearing loss bilaterally, to determine if there was a relationship between degrees of hearing loss and co-morbidities.

Table III: Degrees of Hearing Loss and Co-morbidities

Co-morbidity	Moderate HL (n = 5)	Moderately Severe HL (n = 4)	Severe HL (n = 9)	Profound HL (n = 29)
GM delay (PT)	1	0	3	5
FM Delay (OT)	2	3	5	10
GM Delay (OT)	1	1	3	7
Vestibular disorder	0	0	1	3
VMI Disorder	3	2	0	5
SI Disorder	0	2	0	3
BI Disorder	0	1	3	5
Verbal apraxia	2	1	2	4
ADHD	1	1	2	2
LD	0	0	0	1
Visual impairment	0	0	1	2

Statistical analysis did not reveal a significant occurrence or pattern of co-morbidity in relation to the degree of hearing loss.

Referrals

In addition to the occupational therapy, physiotherapy and speech therapy interventions, referrals were made to a number of other medical professionals after admission to the CLAHIC. Twenty four percent of children ($n= 15$) were referred to a developmental specialist, whilst 15% ($n= 9$) were referred to a psychologist as they presented with behavioural and/or emotional problems. Referrals to a geneticist for genetic testing after admission to CLAHIC were limited to 3% ($n= 2$) of participants.

Educational Placement

A large number of the participants (37%; $n= 23$) were referred for placement in a remedial school. Of these participants, 52% ($n= 12$) presented with a delay in fine motor skills, whilst the remaining participants presented with visual motor integration difficulties. Nineteen percent of participants ($n= 12$) were recommended to continue at the CLAHIC, whilst a further 19% ($n= 12$) were referred to schools that offered education using sign language. Mainstream schooling was only recommended for 15% ($n= 9$) of the participants. Two of these participants presented with fine motor difficulties and vestibular disorders. The remaining 10% of participants were referred to schools for learners with special educational needs.

Discussion

It is evident from the findings that the most prevalent co-morbidities that children with hearing loss enrolled at CAHIC presented with, was in the field of occupational therapy. These specific co-morbidities included delays in fine and gross motor delay as well as VMI disorders. Research has found that auditory deprivation as a result of pre-lingual deafness may lead to the atypical development of specific motor skills[29]. It is postulated that the fine and gross motor skills that share the same cortical processes as language, may specifically be delayed[29]. It is suggested that compounding factors such as (i) the age of identification of the motor delays, (ii) parental involvement, and (iii) early intervention, could influence the outcomes of these children. This is confirmed by Rajendran and Roy[30] who found that children with hearing loss and co-morbid motor impairments presented with significantly lower health-related quality of life as well as a result of sub-optimal levels of functioning. This necessitates the provision of appropriate, multi-disciplinary intervention for children with hearing loss and co-morbid motor difficulties.

Visual motor integration (VMI) disorders were the next more frequently occurring co-morbidity (21%; $n= 13$). The children who had VMI disorders also presented with fine motor difficulties and had hearing losses that ranged from moderate to profound degrees. A VMI disorder is the ability of the eyes and hands to work together in smooth, efficient patterns and it involves visual perception and eye-hand co-ordination[26]. Therefore, a VMI disorder could have an influence on a child's fine motor development.

Interestingly, eight percent of the participants that had fine- and gross motor delays also presented with vestibular disorders. As the vestibular system is linked to the visual system, it plays an important role in eye movements which could influence spatial awareness and fine motor co-ordination[31]. It has been reported that difficulties within the vestibular system may further contribute to sensory seeking behaviour, hyperactivity and distractibility due to the influence of vestibular problems on muscle tone[31]. This was confirmed in a study that found that children that have difficulties with auditory processing, as well as vestibular processing, have difficulties with body movement and motor planning[31].

Cochlear implants are becoming a more accessible and feasible option of amplification for children with hearing loss. Cochlear implants are surgically implanted electronic devices coupled to external components that provide useful hearing to children and adults with severe-to-profound hearing loss and ultimately leads to improved spoken communication[32]. It is postulated that in addition to more age-appropriate language development and improved levels of self-confidence, cochlear implants may have a positive effect on motor performance and vestibular function in these children[32,33]. Contradictory findings however highlight the potential risk of vestibular deficits after cochlear implantation and thus motor function[34].

A small percentage of participants in this study also presented with SI disorders. SI disorders are often associated with specific language impairments[35]. Findings from the present study concurred as all of the children who had SI disorders also had articulation errors.

The overall finding of this study indicates that the most common occurring co-morbidity of hearing loss in children enrolled at the CLAHIC is fine motor difficulty. This supports findings of other studies that indicated that auditory deprivation, as in the case of a hearing loss, may lead to atypical development of specific motor and language skills that share common cortical processes[29]. Importantly, the findings of this study demonstrate that occurrence of the co-morbidities of hearing loss is independent of the degree of the hearing loss, and confirms the fact that all children with hearing loss may be at risk for delays in a range of skills. The increased risk for delay in fine- and gross motor skills development as well as VMI, BI, SI and vestibular disorders noted in this study, highlights the role of the occupational therapist as an important team member in the management of pre-school children with hearing loss. As the educational placement of a child with co-morbidities of hearing loss can be a complex process it is imperative that there is effective collaboration between healthcare professionals and those professionals working in the educational setting. The case manager should be a professional who has qualifications and knowledge of all developmental areas of the child and should be someone who does not see the child for rehabilitation and can thus be the objective manager as well as liaison between families and professionals. It is only with the development and implementation of a holistic

management plan for children with hearing loss that present with co-morbid delays and/or disorders that the best outcomes can be achieved for these children and their families.

CONCLUSION AND RECOMMENDATIONS

The findings suggest that pre-school children with hearing loss, irrespective of the degree of hearing loss, should be screened, assessed and monitored for prevalent co-morbidities, such as fine and gross motor difficulties. It is suggested that an interdisciplinary team approach should be followed when working with children with hearing loss that present with co-morbid delays and/or disorders. The results of this study should be cautiously interpreted in light of its small sample size and context limitations. Further research should address the replication of this study with a larger sample size in various pre-schools that include children with hearing loss to allow for the generalisation of findings to the broader South African context. In addition, the relationship between the degree of hearing loss and the presence of co-morbidity should be determined

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