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Incidence And Prevalence of Central Auditory Processing Disorder in School Going Children

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ABSTRACT

Introduction: Central Auditory Processing Disorder (CAPD) involves challenges in processing auditory information within the central nervous system, leading to difficulties in tasks like sound localization, discrimination, and auditory pattern recognition. While much of the research on CAPD has been conducted in Western populations, there is limited data on Tamil-speaking children. The prevalence of CAPD in children without comorbidities is approximately 1.94 per 1000, according to Nagao et al. (2016).
Aim of the Study: To determine the incidence and prevalence of CAPD among school-going children using the Screening Checklist of Auditory Processing (SCAP).
Objectives:
- To identify children at risk for CAPD using SCAP.
- To explore the relationship between scholastic performance and SCAP scores across different age groups.
- To assess the effect of gender on CAPD incidence.
Methods and Materials: The study involved 1007 participants aged 7 to 12 years from randomly selected government and private schools. Participants were divided into six age groups, each with around 167 children, all studying in 2nd to 7th standard with English as the medium of instruction. The SCAP checklist by Yathiraj and Macarenhas (2003) was employed to screen for CAPD in a school-based environment.
Results: A retrospective analysis conducted from June 2017 to July 2019 identified 65 children with CAPD, indicating a prevalence rate in the sample.
Discussion: CAPD is a neurological disorder that affects the ability to interpret sounds, especially speech phonemes. Due to varying diagnostic criteria, the estimated prevalence of CAPD ranges from 0.5% to 7% of the population.

Keywords: Central Auditory Processing disorders, school going population, screening checklist of auditory processing

INTRODUCTION

Central auditory processing disorder (CAPD) is defined as "difficulties in the perceptual processing of auditory information in the central nervous system and neurobiological activity that underlies

that processing and gives rise to the electrophysiological auditory potentials (DeBonis, D. A (2015). (ASHA,2005) American Speech – Language – Hearing Association, 2005 defined central auditory processing as the perceptual processing of auditory information in the central auditory nervous system (CANS) and the neurobiological activity that underlines that processing and gives rise to electrophysiological auditory potentials. National institute on deafness and other communication disorders in 2010 describes Auditory Processing Disorder (APD) as a condition in which people have trouble making sense of the sounds around them.

CAPD refers to difficulties in the processing of audible signals that are not attributable to impaired hearing sensitivity or mental impairment. Diagnosing CAPD varies based on the assessment, instruments and criteria used. Due to varied definition and differences in the diagnostic criteria for CAPD, the approximate prevalence measure varies from 0.5% to 1.0% to 7% of the population (Chermak & Musiek 1997; Hind et al., 2011) to 96% (diagnostic criteria by ASHA, 2005) in children.

Nagao et al. (2016), also reported that the prevalence of CAPD was two times higher for children studying in private schools compared to the children studying in public schools. In another study the prevalence estimates of CAPD were higher in males compared to females (Chermak & Musiek, 1997). Sharma et al. (2009) stated that 94% of the children diagnosed with CAPD had a comorbid language or reading impairment. To correctly identify school-going children who exhibit problems in auditory processing and to start the intervention untimely, there is a need to identify necessary tests that should be included in the CAPD test battery. Numerous studies have noted deficiency in one or more auditory processes in individuals with CAPD (Katz et al., 1992; Musiek et al., 1982; Muthuselvi & Yathiraj, 2009; Welsh et al., 1980). However, there is no gold standard for the selection of tests to be included in a test battery for CAPD (Yathiraj & Vanaja, 2018). The Bruton Conference, as it is more commonly known, recommended including the following CAPD tests in the minimum test battery: a dichotic task, a duration pattern sequence test, a temporal gap detection test, and electrophysiological tests like the auditory brainstem response (ABR) and middle latency response (MLR) (Jerger & Musick, 2000).

The processes often affected in children with CAPD include auditory separation/closure (Katz,1992; Muthuselvi & Yathiraj, 2009; Welsh et al., 1980), binaural integration (Katz et al., 1992; Musiek et al., 1982; Muthuselvi & Yathiraj, 2009) and temporal processing (Musiek et al., 1982; Muthuselvi & Yathiraj, 2009). In addition, auditory memory has been observed to be often deviant in children "at risk" for CAPD (Muthuselvi & Yathiraj, 2009; Yathiraj & Maggu, 2013).

Thus, a multimodal perceptual testing is one reasonable approach to help illuminate the zone of examination. national level studies conducted in India indicate that the dropout rate in schools range from 2.54% to 13.7% (Census of India, 2011; Gouda & sekher, 2014; national sample survey organization, 2014; pratham educational foundation, 2013; sarva shikshana Abhiyan; Karnataka, 2010, 2013).

This dropout rate has been noted to be higher in rural areas compared to urban areas (Gouda & Sekher, 2014; national sample survey organisation, 2014; sarva shikshana abhiyan Karnataka, 2010, 2013). Additionally, it has also been seen that the dropout is more in higher grades compared to lower grades (chigari et al., 2015; Minz et al., 2015; sarva shiksha abhiyan, 2013). Considering the sensory processing an important factor in young children's performance.

Education is known to be of paramount importance in moulding the personality and confidence of individuals. It has been considered essential for an individual to succeed in life (McKay, 2015). Studies carried out in India indicate that the dropout of children from school varies depending on

the region. Across states of India as well as across districts within a stage, the dropout varies. It has also been shown that the number of children educated in rural and urban areas varies. The dropout rate has been also seen to vary depending on the grade in which children study (Chigari, Angolkar, Sharma, Faith, & Kumar, 2015; Gouda & Sekher, 2014; Minz, Jain, Soni, & Ekka, 2015; National Sample Survey Organisation, 2014; Sarva Shiksha Abhiyan, 2013; Sarva Shikshana Abhiyan Karnataka, 2010).

National level studies conducted in India indicate that the dropout rate in schools ranges from 2.54% to 13.7% (Census of India, 2011; Gouda & Sekher, 2014; National Sample Survey Organisation, 2014; Pratham Education Foundation, 2013; Sarva Shikshana Abhiyan Karnataka, 2010, 2013). This dropout rate has been noted to be higher in rural areas compared to urban areas (Gouda & Sekher, 2014; National Sample Survey Organisation, 2014; Sarva Shikshana Abhiyan Karnataka, 2010, 2013).

Additionally, it has also been seen that the dropout is more in higher grades compared tolower grades (Chigari et al., 2015; Minz et al., 2015; Sarva Shiksha Abhiyan, 2013). Christle, Jolivette, and Nelson (2007) observed a strong relation between academic achievement and school dropout rates.

Several reasons have been attributed in addition to it, factors like low socioeconomic status, literacy of the parents and domestic duties were also found to result in school dropouts (Chigari et al., 2015; Malik, Biswas, Mitra, & Chaudhury, 2002; Minz et al., 2015; Pratinidhi et al., 1992; Sarva Shiksha Abhiyan, 2013). Thus, it can be observed that the majority of reports in India state poor academic performance to be a factor for children dropping out of school.

Studies speculate that auditory processing disorder (APD) could be one of the factors that negatively influence the academic achievement of children (Bellis, 1996; Bellis & Ferre, 1999; Rosen, Cohen, & Vanniasegaram, 2010). Hus (1997) reported that APD is frequently diagnosed in children who have problems in pursuing their studies despite having normal hearing and cognitive abilities. Further, the presence of difficulties in language and reading abilities has been observed in children having APD (Cacace & McFarland, 1998; Katz, 1994; Sharma, Purdy, & Kelly, 2009; Wit et al., 2016). Additionally, western studies indicate that the prevalence of APD in school- going children is 2 to 5% (Chermak & Musiek, 1997; Silman, Silverman, & Emmer,2000).

Additionally, the ratio of APD was observed to be 2:1 among boys and girls (Chermak & Musiek, 1997). Further, Muthuselvi and Yathiraj (2008-09) found 3.2% of school-going children to be at-risk for APD in India. Thus, from the literature it can be seen that a high percentage of children in the western world as well as in India have or are at-risk for APD. Nagao et al. (2016), also reported that the prevalence of CAPD was two times higher for children studying in private schools compared to the children studying in public schools. In another study the prevalence estimates of CAPD were higher in males compared to females (Chermak & Musiek, 1997). Studies have also shown that children with CAPD have various co morbid conditions.

Author	Year	Population	Results
Musiek, Gollegly & Lamb.	1990	School aged children	Prevalence rate: 7%
Chermak & Musiek	1997	School aged children	Prevalence rate: 2-5% CAPD higher in males compared to females
Dobrzanski-Palfrey& Duff	2007	Adults older than 60 years of age	Prevalence rate: 20-30%
Sharma	2009	School-aged children(7–12years)	Co morbid conditions along with CAPD like language impairment, and reading disorders in 47% children
Muthuselvi&	2009	School-aged children	Prevalence rate: 3.2%

Yathiraj			
Hind et al.	2011	Children and adults	Prevalence rate: 0.5–1.0%
Wilson& Arnott	2013	School aged children	Prevalence rate: 7.3%–96%
Nagao, Reigner & Padilla	2016	School aged children Mean age of 9.8 years for boys and 9.7 years for girls	CAPD prevalence was 1.94 per 1000 children

Table 1. The prevalence of CAPD reported across studies

Need for the study:

Most of the studies in CAPD are done in Western population especially with school going children however, very scarce studies exist in Indian context and even lesser in Tamil speaking population. The need for the study is that the prevalence of auditory processing disorder is becoming high in school going children. According to Nagao et al in 2016, the prevalence of APD was found to be 1.94 per 1000 children with no other comorbid conditions. So, the screening of CAPD is used to identify the severity and the incidence of the auditory processing disorder in school going children.

Aim of the Study

To determine the incidence and prevalence of CAPD in school-going children using the Screening Checklist of Auditory Processing (SCAP).

Objectives

- Identify children at risk of CAPD using SCAP.
- Establish the relationship between scholastic performance and SCAP scores across age groups.
- Determine the effect of gender on CAPD.

METHODS AND MATERIALS

The study was conducted at MERF Institute of Speech and Hearing (P) Ltd, and the aim of the study was to find the relation between the scholastic performance and at risk of central auditory processing disorder among school going children.

Participants:

The study included 1007 participants who attended government and private schools. The age ranged between 7 to 12 years. The participants were divided into 6 age groups. 7 to 8yrs; 8 to 9yrs; 9 to 10 yrs; 10 to 11yrs; 11 to 12yrs and 12 to 12.5years) each group consisted of 166.7 participants. All the participants were pursuing between 2nd standard to 7th standard and had English as the medium of instruction. The participants were made unaware of the SCAP checklist being administered by the teacher. A prior oral consent was taken from the school head and the parents of the children being administrated. Inclusion criteria was set to include children who attend regular school and age range of 7 to 12 years were include under the study. The study was conducted in Vellore district, Tamil Nadu.

Those children who developmental disability such as attention deficit hyperactive disorder (ADHD), Delayed speech and language (DSL), dyslexia and other co-morbid condition such as syndromes, intellectual disabilities and neurological condition (Trauma and stroke) peripheral hearing loss (from pinna to cochlea) were excluded from the study.

PROCEDURE:

The study was conducted using the screening checklist for auditory processing (SCAP) developed by Yathiraj and Macarenhas (2003). SCAP contains 12 questions concerning to the symptoms of auditory processing deficit. The question focuses on three main domains such as auditory perceptual processing, Auditory memory, and other miscellaneous symptoms. The checklist consists of two-point rating (YES/NO), whereas the scoring of each yes will be given 1 point, and each No would be given 0 point. Children who score 6 or more than 6 would be considered at risk of CAPD. SCAP was administered by the school, class

teacher who had taught the child and knows about the child performance for at least one year span. The teacher was asked to put a tick mark in Yes box if the child is suspected to have any of those symptoms.

RESULTS

The study was conducted with the aim of determining the prevalence of central auditory processing disorder (CAPD).A retrospective case analysis was carried out by reviewing the case files of those who visited the institute presenting the complaint of difficulty in understanding and academic difficulties from June 2017 till July 2019.

Prevalence of CAPD

A total number of 1007 children have been taken as a subject and analyzed in the school based environmental setup on January 2024 to February 2024 across age group of 7 to 12 years. Out of which 65 children are screened to have CAPD. Thus, as per the results obtained the prevalence of the CAPD is 0.065%. According to the result indicates that the age group of 9 to 10 years (i.e.. 4th standard and 5th standard students) has more prevalence of 11.57 prevalence is the total children affected in a particular year in each period of time so as the result indicate that the overall incidence is very less when compared to the age group of 9 to 10 years.

Age Distribution	Total sample (n=1007)	CAPD (n=65)	Prevalence
7 to 8	150	9	6.00
8 to 9	143	4	2.80
9 to 10	121	14	11.57
10 to 11	150	13	8.67
11 to 12	217	23	10.60
12 to 13	226	2	0.88
Total	1007	65	6.45

Table 2. Age and Grade Distribution of participants and CAPD population in the present study

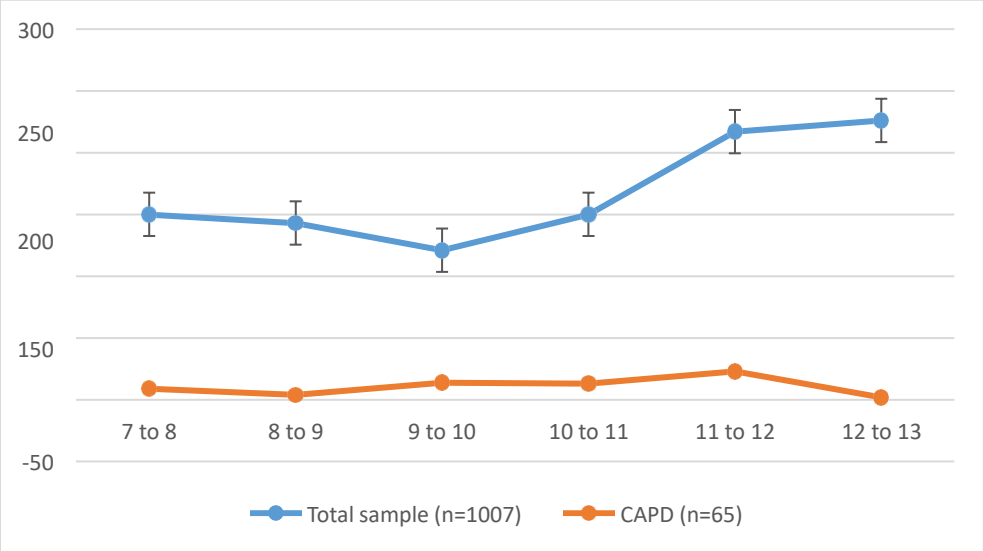

Figure 1. Graphical Representation of CAPD Prevalence.

The blue line indicates male school going children who are not having CAPD, and the orange line indicates that the total school children who are having CAPD.

Gender Distribution

When comparing male and female distribution, there were significant differences ($p>0.05$) between both the groups with the male having a larger percentage (41.1% for males and 21.5% for

females). Figure 2 shows that both boys and girls of 2nd standard to 7th standard has less. than one significant value. Even though the standard error value is less and equal for both of them where 0.1 difference is seen

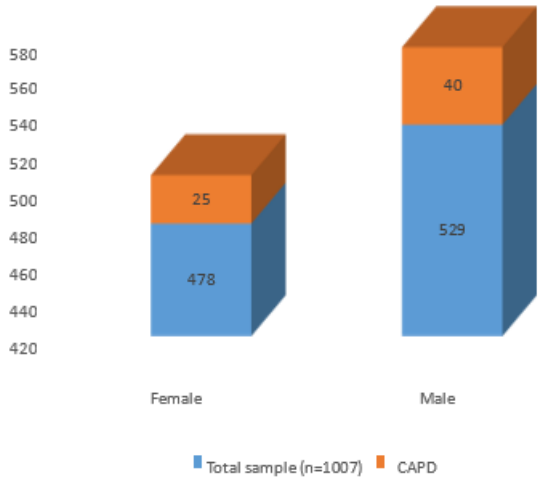

Figure 2. Gender wise Distribution of participants

DISCUSSION

CAPD is a neurological disorder in which a person has difficulty interpreting sounds received by the ears, particularly the phonemes of speech. CAPD involves the deficit in processing of auditory information. Due to varied definition and difference in the diagnostic criteria for CAPD, the approximate prevalence measure varies from 0.5% to 1.0% to 7% of the population. Thus, a prevalence in school going children was screened to have the central auditory processing disorder at Merf Institute of Speech and Hearing in Chennai in Tamil Nadu from January to February 2024, the prevalence is reported to be 7.56 in male population and 5.23 in female population. From the SCAP scores obtained from the 1007 children, it was found that 65 of them had one or more symptoms of the (C)APD. However, using the cut-off score of 6, only 0.6% children were suspected to have (C)APD. Thus, based on the SCAP results, it can be construed that the possible prevalence of (C)APD in the population studied was just 0.025% without accounting for the false negatives and false positives.

Academic Performance with Children

Cacace and McFarland (1998) reported that the basis for the evaluation for CAPD in school going children is on the assumption that an auditory perceptual deficit would be an underlining issue in various learning problems including specific reading and language issues , there must be a modality specific examination of reading, language and attention disorders in school going children as they have perceptual dysfunction limited to a single perceptual modality thus this becomes a great difficulty for the assessment of the condition. The reliability of the CAPD test battery was done on two children showed that the overall diagnosis of the presence/ absence of CAPD. The analysis of the data revealed that a single symptom on the SCAP was not a good indicator of the presence of (C)APD. Hence, the need to use a group of symptoms was felt necessary. It was found that attention span related symptoms were more prevalent in school-going children with suspected (C)APD. This was followed by memory problems and difficulty in hearing in noisy situations. Further, a comparison of various cut-off scores of SCAP with the (C)APD diagnostic test findings indicated that a SCAP cut-off score of 6 yielded a good correlation with the results of SPIN and AMT as well as with the overall diagnosis of (C)APD. Using a cut-off criterion of six on the SCAP, the prevalence of suspected (C)APD in school-going children was 3.2%. The overall results revealed that the SCAP could be used as a simple and practical measure to screen for the presence of (C)APD.

Auditory processing disorder (APD) has been speculated to cause reading and learning difficulties that results in poor scholastic performance (Bellis, 1996; Bellis & Ferre, 1999; Cacace & McFarland, 1998; Dawes & Bishop, 2007; Katz, 1994; Rosen et al., 2010; Sharma et al., 2009; Wit et al., 2016).In India, it has been noted that the dropout rate from schools is more in rural schools compared to urban schools (Gouda & Sekher, 2014; National Sample Survey Organisation, 2014; Sarva Shiksha Abhiyan,

2013; Sarva Shikshana Abhiyan Karnataka, 2010).

The primary aim of the study was to compare the number of children at-risk for APD between rural and urban government schools. Further, the effect of family literacy/ educational support received at home on SCAP scores of children in rural and urban government schools was studied.

A comparison of knowledge teachers regarding APD /years of experience in teachers across rural and urban government schools was also studied. The study was carried out in three stages. The first stage involved the development of questionnaires to assess the knowledge of school-teachers regarding APD and to collect information about the family literacy and educational support provided to children at home. The second stage included the assessment of knowledge of APD in teachers from rural government schools and teachers from urban government schools. In the third stage, 1007 children from different government primary schools in rural and urban schools were screened using SCAP. In addition, information regarding family literacy and educational support provided to the children were obtained from the teachers in the third phase.

The findings reveales that the children at-risk for APD were found to be significantly high in rural government schools than in urban government schools. No such significant difference in number of children at-risk for APD was noted across the age groups (≥ 7 to < 8 years, ≥ 8 to < 9 years, ≥ 9 to < 10 years, & ≥ 10 to < 11 years) in rural government schools. However, in urban government schools, children in the age range of ≥ 10 to < 11 years were observed to have significantly less number of children at-risk for APD as compared with the children in the age range of ≥ 7 to < 8 years and ≥ 8 to < 9 years. Further, a significant negative moderate correlation was found between family literacy / educational support and SCAP scores in rural government schools whereas in urban government schools this correlation was found to be weak. Additionally, in children who were not at-risk for APD, family literacy and educational support were noticed to be high in rural areas when compared to urban areas. However, in children at-risk for APD, only educational support was high in rural areas, but the family literacy was found to be similar across rural and urban areas. Further, the knowledge of APD in teachers was observed to be more in teachers from rural government schools than in teacher from urban government schools.

Importance of screening of CAPD

The primary and secondary screening is regularly done before any formal tests are conducted. The importance of the primary screening is to detect the children at risk of APD, whereas the secondary screening focuses to govern who should be referred for further formal evaluation of APD (Johnson et al,1997). He also postulated that once the peripheral hearing is been investigated and hearing loss is ruled out, a secondary screening is carried out to investigate in depth about the APD using more formal screening procedures. There are two forms of secondary screening: auditory processing screening tests and teacher checklist. Few auditory screening tests include screening test for auditory processing disorder (SCAN), test for auditory processing disorders in adolescents and adults (SCAN-A), and the selective auditory attention test (SAAT).

CONCLUSION

CAPD refers to difficulties in the processing of audible signals that are not attributable to impaired hearing sensitivity or mental impairment. This processing includes tasks involving perception, cognition and linguistics which results in efficient comprehensive communication of passive (e.g. conscious and unconscious, mediated, and unmediated) capacity for attending, discriminating, and recognizing acoustic signals, followed by transforming and communicating the data on an ongoing basis through both the peripheral and central

nervous systems. Diagnosing CAPD varies based on the assessment, instruments and criteria used. The demographic characteristics of pediatric CAPD and its prevalence are still debatable. Due to varied definition and differences in the diagnostic criteria for CAPD, the approximate prevalence measure varies from 0.5% to 1.0% to 7% of the population (Chermak & Musiek 1997; Hind et al., 2011) to 96% (diagnostic criteria by ASHA, 2005) in children.

Some of the clinical applications indicate:

- The study provides the prevalence of CAPD in school children.
- The study the difference between the correlations in male and female participants.
- Highlight the presence of academic performance in these individual

Analysis based on diagnostic tests of CAPD

In the present study it was noted that the most common deficit seen in children with CAPD is speech perception in noise followed by binaural integration. Gap detection was the least affected deficit. Studies have shown that auditory closure is the most affected ability in children with CAPD (Maggu & Yathiraj, 2014). Lagace (2010) reported that in CAPD population, SPIN- like tests should be utilized to assess difficulties with perceiving speech in noise and nature of deficit underlying it.

Keith (1999) reported that basic difficulty in individuals with CAPD is that any speech signal presented in the conditions that are less than optimal is difficult to understand. Similarly, Chermak (2002) characterized individuals with CAPD as having trouble perceiving spoken language in the presence of competing signal or in noisy backgrounds and in reverberating conditions. However, in a study by Maggu and Yathiraj (2014) they revealed that the screening test for auditory processing (STAP) findings showed auditory memory subsection of the STAP is more impacted followed by the dichotic CV later by speech-in-noise subsection.

Declaration by Authors

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