Retrospective analysis of common causes of hearing loss in a cohort of thousand children

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ABSTRACT

Daily activities, interpersonal relationship, employment, and general wellbeing; among such skills, communication skills are essential to a successful life for all individuals. Hearing impairment at any age has serious effects on the day to day life of an individual and he or she feels handicapped socially, emotionally, and scholastically. This study was conducted in order to find out various causes of hearing impairment in children and to study role of various audiological tests in finding the cause of impaired hearing in children. This study assess the possible etiological causes of hearing impairment in across age ranges and to compare the occurrence of conditions between the ages by carrying out a retrospective analysis of client records. A total number of 1000 of samples were selected from the audiologic caseload in the Hospital & Star Key Hearing Rehabilitation Center in between the year of 2015 to 2020. Out of which 955 samples were selected. Due to incomplete documentation 45 samples were rejected. These samples were taken with the focus being on the age group of birth to 6 years. Possible etiological causes occurred most frequently in the entire population were consanguinity (29.6%), caesarean (28.3%), and infantile jaundice (20.1%). Investigated only case files from audiology clinic. Due to incomplete documentation, detailed information on some of the risk factors (prematurity, low birth weight, trauma and maternal infection) may not have been available.

Keywords: hearing loss, common causes, pre-peri & post natal histories, ages from birth to 6 years, gender.

INTRODUCTION

The sense of hearing fundamentally facilitates communication and fosters social interaction. Hearing is the key to learning spoken language and is important for the cognitive development of children. Without suitable interventions, hearing loss is a barrier to both education and social integration (Yoshinaga-Itano et al., 1998). Some 360 million people (approximately 5% of the world's population) live with disabling hearing loss (Yoshinaga-Itano et al., 1998) and nearly 32 million of them are children (ASHA, 2019). It is estimated that over 60% of such hearing loss could be avoided through preventive measures. In addition, children who have hearing loss can benefit greatly from early identification and appropriate interventions. Action is required to ensure that the preventable causes of hearing loss are avoided and that everyone with unavoidable hearing loss can reach their full potential through rehabilitation, education and empowerment.

Normal hearing in the first six months of life is also considered critical for normal speech and language skills to develop. Therefore, early identification and appropriate intervention within the first six months of life have been considered important to prevent or reduce many of the adverse consequences and to facilitate language acquisition (Yoshinaga-Itano, 1998). Deafness in infants is a serious concern because it interferes with the development of language – that which sets humans apart from all other living things. The longer a child's deafness goes undiscovered, the worse the outcome is likely to be language remediation.

REVIEW OF LITERATURE

A list of factors that place a neonate or an infant at risk for hearing loss is known as a high-risk hearing register. Initially in 1970, the Joint Committee on Hearing Screening (JCIH) included a high-risk register, which contained risk factors for hearing loss. It has been estimated that the use of the high risk register for infant hearing screening identifies only 50% of infants with significant hearing loss (Hayes and Northern, 1996).

It is vital to obtain complete and accurate information about the child's prenatal and birth history, results of the newborn hearing screening, and the presence of specific early childhood conditions in order to determine if factors associated with hearing loss are present.

The JCIH Position Statement of the year 2007 identified eleven indicators associated with hearing loss (ASHA, 2007). It is vital to obtain complete and accurate information about the child's prenatal and birth history, results of the newborn hearing screening, and the presence of specific early childhood conditions in order to determine if factors associated with hearing loss are present.

Risk indicators associated with permanent congenital, delayed-onset, or progressive hearing loss in childhood are as follows (ASHA, 2007): Caregiver concern regarding hearing, speech, language, or developmental delay, family history of permanent childhood hearing loss, neonatal intensive care of more than 5 days or any of the following regardless of length of stay, In utero infections, such as CMV (Cytomegalovirus), herpes, rubella, syphilis, and toxoplasmosis, craniofacial anomalies, including those that involve the pinna, ear canal, ear tags, ear pits,

and temporal bone anomalies. Physical findings, such as white forelock, that are associated with a syndrome known to include a sensorineural or permanent conductive hearing loss. Syndromes associated with hearing loss or progressive or late-onset hearing loss, such as neurofibromatosis, osteopetrosis, and Usher syndrome; other frequently identified syndromes include Waardenburg, Alport, Pendred, and Jervell and Lange-Nielson. Neurodegenerative disorders, such as Hunter syndrome, or sensory motor neuropathies, such as Friedreich ataxia and Charcot-Marie-Tooth syndrome. Culture-positive postnatal infections associated with sensorineural hearing loss, including confirmed bacterial and viral (especially herpes viruses and varicella) meningitis like Head trauma, especially basal skull/temporal bone fractures that requires hospitalization or chemotherapy, etc.

Yoshinaga-Itano (1998) and Moeller (2000), children who are born deaf or who lose their hearing very early in life and go on to receive appropriate interventions before 6 months of age are on a par with their hearing peers in terms of language development by the time they are five years old (in the absence of other impairments).

Cone-Wesson et al. (2000) documented the most prevalent risk factor was ototoxic medications occurring in more than 70% of infants studied.

Mukherjee et al. (2013), study tried to determine the hearing threshold by brainstem evoked response audiometry (BERA) in the high-risk infants from a middle socioeconomic background at around 1 year of age and correlate different risk factors with hearing loss. BERA was done on 127 infants of 6–18 months age of which 87 were high risk. All were given monaural acoustic stimulus using Cz-M1/ M2 Montage. Based on the appearance of wave V at minimum stimulus intensity, hearing threshold in decibels (dB) of each ear was determined. To study the association of the individual risk factor with hearing loss multiple logistic regression test was applied. Taking BERA threshold for 'Pass' as B40 dBnHL, out of 87 high risk infants 10.34 % (n = 9) had bilateral severe to profound hearing loss, 17.24 % (n = 15) had bilateral mild to moderate hearing loss and 12.64 % (n = 11) had impaired hearing in one ear. All of the control group infants had normal hearing threshold of 30 dBnHL. Twenty major risk factors were identified in the whole study group at an average of 2.3 factors per infant. Twelve factors were examined for correlation using Odd's ratio (OR) with 40 dBnHL threshold as the outcome variable. Factors with very high OR were family history of deafness, Ototoxic drugs and Craniofacial abnormality followed by others. High risk infants have a persistent and definitive risk of hearing loss prompting early intervention.

Biswal (2013), carried out a retrospective comparative study between the time period of 2006-2007 and 2011-2012 with respect to the incidence, prevalence and risk factors of hearing loss across age groups. Results revealed most common prenatal condition reported were excessive vomiting, anemia and malnutrition. There was no significant difference in gender distribution with respect to hearing impairment across the time periods studied and no difference in types and patterns of hearing impairments across the time periods studied.

Gouri et al. (2015), studied incidence of hearing damage and associated risk factors. A total of 415 babies were included in the

study. All the newborns were evaluated with Transient evoked Otoacoustic emission (TEOAE) which was done by age of 1–3 days. Auditory brain stem response audiometry (AABR) was performed at the age of three months for confirming the hearing loss in the neonates those who failed the TEOAE screening. For infants proven to have significant hearing loss in one or both ears, were denoted to an ear, nose, and throat specialist for further evaluation & rehabilitation. Results revealed that out of total 415 babies included in the study, 22 neonates showed abnormal TEOAE examination. Out of these 22 neonates, hearing loss was confirmed in 18 (82 %) subjects by AABR. The following antenatal and post-natal risk factors were associated with hearing loss: ante-partum bleeding, history of maternal blood transfusion, fetal distress, prematurity, severe birth asphyxia, NICU admission for more than 24 hour and Apgar score less than five at 5 min.

Kumar et al. (2015), studied the incidence of hearing loss among children and tried to determine and confirm the distribution of common risk factors in children with hearing loss presenting at a tertiary care hospital in India. A total of 110 (22%) babies belonged to high risk category and 11 (2.2%) of total screened babies had significant hearing loss. Total number of babies who passed the initial screening with TEOAE was 284 (56.8%). On diagnostic AABR screening of TEOAE referred babies, the babies with no risk factor showed normal AABR tracings whereas from among those with one or multiple risk factors (110 babies), 11 (10%) showed different levels of hearing impairment.

Bielecki et al., (2023), studied hearing loss and risk factors in very low birth weight infants: The incidence of sensorineural hearing loss (SNHL) is still high in very low birth weight (VLBW) infants. The purpose of our study was to provide the prevalence rates of SNHL and to analyze the risk factors of hearing impairment and changes in hearing thresholds in a cohort of VLBW infants. A retrospective observational study was conducted in our neonatal intensive care unit (NICU) from 2012 to 2016. All VLBW infants included were screened by transient evoked otoacoustic emissions (TEOAEs) and diagnostic auditory brainstem response (ABR). In total, we enrolled 316 infants and SNHL was diagnosed in 68, leading to an early incidence of 21.5% as 36 infants out of 68 improved. Finally, SNHL was confirmed in 20 patients (6.3%) who needed hearing aids. They were significantly smaller, sicker, had longer hospitalizations, and received more ototoxic therapies. The results underlined how the total exposure to antibiotics is significantly associated with SNHL, even after GA correction. In conclusion, GA, birth weight and, above all, the length and complexity of NICU stay quantify the risk of SNHL and should be considered at the individual level for parent counseling.

Khan and Joseph (2024), study aimed to profile the frequency of risk factors and their manifestation in hearing outcomes of young children in the KwaZulu-Natal province of South Africa. Overall, 56% of the participants presented with either a conductive, sensorineural or a mixed hearing loss; 62% of the children had between 1 and 2 risk factors present (Mean [M] = 1.1; standard deviation [s.d.] = 0.98).

Admission to neonatal intensive care unit, maternal infections, bacterial and viral infections and chemotherapy, from the Joint Committee on Infant Hearing list of high-

risk factors were significantly associated with hearing loss ($p < 0.05$). Known non-JCIH risks, emerging risks and other statistically significant contextually relevant risk factors were also noted.

Having this concept in mind, one has to focus on detailing of hearing loss in terms of its types, severity, causative factors etc., and how it will impact on the person's whole lifestyle in terms of his/her communication (reception as well expression), academic, social skills so on, etc.

Need of the study

To have a clear idea about common high-risk conditions leading to hearing impairment, one has to consider the factors like age and gender. These conditions vary from congenital (pre and perinatal history) or acquired (post-natal history). Considering all these factors was taken up as a retrospective analysis of case histories of individuals for audiological evaluation/intervention visiting hospital & Star Key Hearing Rehabilitation Center in between the years of 2015 to 2020.

METHOD

Aim of the study

The present study attempted to following:

1. High risk conditions for hearing loss across the age groups
2. To compare the occurrence of conditions between the ages

By carrying out a retrospective analysis of client records

Inclusion criteria & Exclusion criteria

The present study was conducted in 3 phases.

Phase 1: Selection of case files

- Only case files from the department of hearing studies were selected for the study.

The total number of samples taken for the study was 1000, spread from 2015 to 2020. Out of which 986 samples were selected. Due to incomplete documentation 14 samples were rejected. These samples were taken with the focus being on the age group of birth to 6 years.

Phase 2: Data entry

Instrument used:

Sony-Vaio laptop loaded with Microsoft excel software 2007 version

Phase: 3

Appropriate percentage calculations were used for data analysis that is presented in following chapter.

Procedure

Samples were selected from the audiologic caseload in the Hospital & Star Key Hearing Rehabilitation Center by careful thorough observation on case history during their visit.

RESULTS

The present study attempted to investigate the following:

1. High risk conditions for hearing loss across the age groups
2. To compare the occurrence of conditions between the ages

By carrying out a retrospective analysis of client records

Aim 1): High risk conditions for hearing loss across the age groups

The total number of samples taken for the study was 986 spread over 2015 to 2020. Out of which 986 samples were selected. Due to incomplete documentation 14 samples were rejected. These samples were taken with the focus being on the age group of birth to 6 years.

Identifying reasons/factors for existing hearing loss was a major concern as this data will give an idea about preventability of causes. Keeping this in mind, the pre, peri, post-natal and family histories as listed out by the parents/informants during the case history were collected.

Percentage (%) = Total number of factors/total number of participants in each age groups and multiplied by 100.

Once the tabulation was done and the percentage calculated, ranks were assigned in the order of highest percentage of occurrence of a specific factor being ranked first and the next highest being ranked second and so on. Graph is plotted on basis of each age groups.

The samples are studied with respect to age and risk factors involved figures (1 to 5).

Following are the observations made with respect to the age range of birth to 1 year:

Highest ranked factor was infantile jaundice (34.5%), followed by caesarian (33.4%), consanguinity (26.3%), delay birth cry (17.75%) and seizures (17%) could be a risk factors for hearing loss in this age range.

Others 0 (Family history), cough 1%, low blood pressure 1.7% was least ranked risk factors where it may not be a risk factors for hearing loss in this age range.

(See Figure 1.)

Following are the observations made with respect to the age range of 1 year to 2 years:

The highest ranked factor was consanguinity (32.1%), followed by caesarian (26%), delay motor milestones (21.6%), infantile jaundice (16%) and family history of hearing problem (14.2%) could be a risk factors for hearing loss in this age range.

Others 0 (family history), high blood pressure (0), miscarriage (0.6%) was a least ranked risk factors where it may not be a risk factors for hearing loss in this age range.

(See Figure 2.)

Following are the observations made with respect to the age range of 2 years to 3 year:

The highest ranked factor was consanguinity (30%), followed by excessive vomiting (17.6%), delay speech milestones (17%), delay motor milestones (16%), infantile jaundice (14.4%) could be a risk factors for hearing loss in this age range.

Others 0 (family history), visual problem (0) and low blood pressure (0.5%) was a least ranked factors where it may not be a risk factors for hearing loss in this age range.

(See Figure 3.)

Following are the observations made with respect to the age range of 3 years to 4 years:

The highest ranked factor was consanguinity (35.4%), followed by delay speech milestones (19%), delay motor milestones (17.3%), infantile jaundice (14.4%) and abortion (13.4%) could be a risk factors for hearing loss in this age range.

Low and high blood pressure (0 and 0.8% respectively) and others 0 (family history) was a least ranked factors where it may not be a risk factors for hearing loss in this age range.

(See Figure 4.)

Following are the observations made with respect to age range of 4 years 5 years:

The highest ranked factor was consanguinity (27.4%), followed by caesarian (21.2%), delay speech milestones (13.3%), delay motor milestones (12.4%) and excessive vomiting (12.4%) could be a risk factors for hearing loss in this age range.

Others 0 (family history), visual problem 0, prematurity and low birth weight (1.7%) was a least ranked factors where it may not be a risk factors for hearing loss in this age range.

(See Figure 5.)

Following are the observations made with respect to age range of 5 years to 6 years:

The highest ranked factor was consanguinity (28.8%) followed by caesarian (21.2%), infantile jaundice (17.3%), delay motor milestones (11.5%) and fever (11.5%) could be a risk factors for hearing loss in this age range.

Prematurity (0), high, low blood pressure and miscarriage (1%) was a least ranked risk factors where it may not be a risk factors for hearing loss in this age range.

(See Figure 6.)

Overall following are the observations made with respect to aim 1:

Consanguinity, caesarian and infantile jaundice were the most highlighted risk/associated factors across the ages in this study.

Consanguinity was rated as highest ranked risk factor in the age range of 1 year to 6 years except birth to 1 year were infantile jaundice was a major risk factor

Differences in terms of percentage of various risk factors was found across the ages.

There are other factors like neonatal asphyxia, prematurity, low birth weight and maternal infections that were not so evident in this current study. The reason would be incomplete documentation.

Aim 2): To compare the occurrence of conditions between the ages

Each age groups gives an idea of various risk factors which are involved in children with hearing impairment. These factors keep varying in terms of percentage and ranks across the age groups. It is very much clear that many of these risk factors may not have any direct relation to hearing loss and it is to be kept in mind that such factors may require further investigations.

DISCUSSION

Risk factors that occurred most frequently in the entire population are as follows:

consanguinity (29.6%), caesarean (28.3%), infantile jaundice (20.1%), delay birth cry (13%), delay motor milestones (12.6%), excessive vomiting (12.5%), seizures (12.5%), fever (11%), delay speech milestones (10.4%), and abortion (10.1%).

Risk factors that occurred less frequently (<10%) are as follows: family history of hearing problem (8.7%), family history of speech problem (8.1%), cold (7.5%), ear infection (7.4%), others (Postnatal) like Down's syndrome, blueness, cleft lip and palate, pneumonia, tuberculosis, head injury, thyroid, cardiac problem and wheezing etc., (5.3%), diabetes (4.7%), low birth weight (4%), high and low blood pressure (3.8%), fever (prenatal) 3.1%, others (Prenatal) like bleeding, anemia, thyroid, tuberculosis, wheezing problem etc. (3.1%), miscarriage (3), premature (3%), ear discharge (2.8%), cough (2.3%), visual impairment (2%), others (Perinatal) (1.6%).

Among all these factors, consanguinity (29.6% of total population - 986) was ranked in higher (1st) position across the age groups. Reddy et al. (2006) have also reported that consanguinity in the general population was 22.36%. The consanguineous marriages promote a rise in homozygosis of the pathological recessive genes increasing the risk of birth of handicapped babies (Panakhian, 2005).

Zakzouk (2002) reported 50% consanguinity in hearing loss among 6421 subjects studied from Riyadh city and 9540 subjects from other parts of Saudi Arabia. This necessitates the need for public awareness campaigns focussing on the issues of consanguinity. This can be carried out through press and electronic media. This could lead to reduction in birth of children with disability due to consanguinity. Besides the high risk families could be advised to go for genetic counselling.

Caesarean (28.3% of total population - 986) was found to be 2nd highest ranked associated factor with hearing loss in the current study. It may not necessarily have a direct link to hearing loss, but one should keep this in mind for future investigation.

As a prenatal factor, excessive vomiting (12.5%) was highest ranked factor. Miscarriage, prematurity, ear discharge, cough and visual impairment etc., are those least ranked factors.

Most common prenatal factors reported were excessive vomiting, anemia and malnutrition (Biswal, 2012), excessive vomiting was only the highest rated factor in this study.

The prenatal risk factors that appear to be common in western population (JCIH, 2007) like prematurity, low birth weight, anoxia, trauma and maternal infections were not evident in the current study, may be due to this being a non-randomized study investigating only individuals who reported to the clinic. This population is not representative of the overall population with hearing impairment. It also could be due to incomplete documentation which were noted/observed during retrieval of the case history of infants with hearing impairment.

Thus, this study was an attempt to highlight the risk factors for hearing impairment that were prevalent in the Indian scenario. Though there are some studies that quote 35% to 45% prenatal factors having a link to hearing loss, it is also important to remember that hearing losses do exist even in absence of risk factors (Weichbold et al., 2006).

The present study attempted to investigate:

- High risk conditions for hearing loss across the age groups
- To compare the occurrence of conditions between ages

The total number of samples taken for the study was 986 spread from 2015 to 2020.

There were no significant differences across gender with respect to hearing impairment in the periods of 2015 to 2020, though more males seem to seek services.

The highest ranked risk factors are as follows: consanguinity 29.6% (family history), caesarean 28.3% (perinatal factor), infantile jaundice 20.1% (postnatal factor) and excessive vomiting 12.5% (prenatal factor).

The least ranked risk factors are as follows: Others 1.6% (prenatal), visual impairment 2%, cough 2.3%, ear discharge 2.8%, miscarriage 3% and prematurity 3%.

Regarding limitations of the study, all cases investigated were case files from audiology clinic. Also, due to incomplete documentation, detailed information on some of the risk factors (prematurity, low birth weight, trauma and maternal infection) may not have been available.

Regarding recommendations and future directions of the study, there should be more awareness on the part of the educating professionals in the field of audiologists and speech language therapist. Being aware of which risk factors are more likely to cause children to fail the hearing screening can be helpful for the audiologists and physicians determining follow-up care for the neonates involved. New born hearing screening centers should be available throughout the country and mandatory in all maternity centers of the country, so that a single case of hearing impairment will not be missed within 0 to 3 months. Government can make school screening mandatory in order not to miss late onset/progressive/unilateral hearing losses. Advanced epidemiological statistics will help the government for planning and designing early identification and rehabilitation programs.

CONCLUSION

The prevalence for known etiologies for hearing loss has changed over 50 years. Technology has improved at a rapid rate in recent decades, bringing not only new methods of testing, but also new methods of treating very sick infants and advances in identifying previously unknown causes of hearing loss, particularly in the area of genetics. Thus, there are currently causes of hearing loss which were previously common, but which now rarely occur such as RH incompatibility and rubella. Associate issues such as maternal drug use, hypoxia, and intraventricular haemorrhage are factors that have not been examined as they relate to hearing impairment.

There is an ever present need to update effectiveness of the highrisk register. Additionally, the highrisk register is useful to determine follow-up plans, particularly in cases of those risk factors associated with late onset or progressive hearing loss, such as cytomegalovirus (CMV), ECMO, meningitis and ototoxic medications. Therefore, there are several issues necessitating the review of the effectiveness of the risk factors currently used as well as those not currently included.

The purpose of the present study was to review medical records for a large population of children to examine risk factors status. The high risk register remains

helpful to determine follow-up plans so that children who may develop late-onset or progressive hearing loss will not be missed. Being aware of which risk factors are more likely to cause children who have that risk factor to fail the hearing screening can also be helpful for the audiologists and physicians determining follow-up care for the neonates involved.

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APPENDIX

Figure 1.

Birth to 1 year: Risk factors

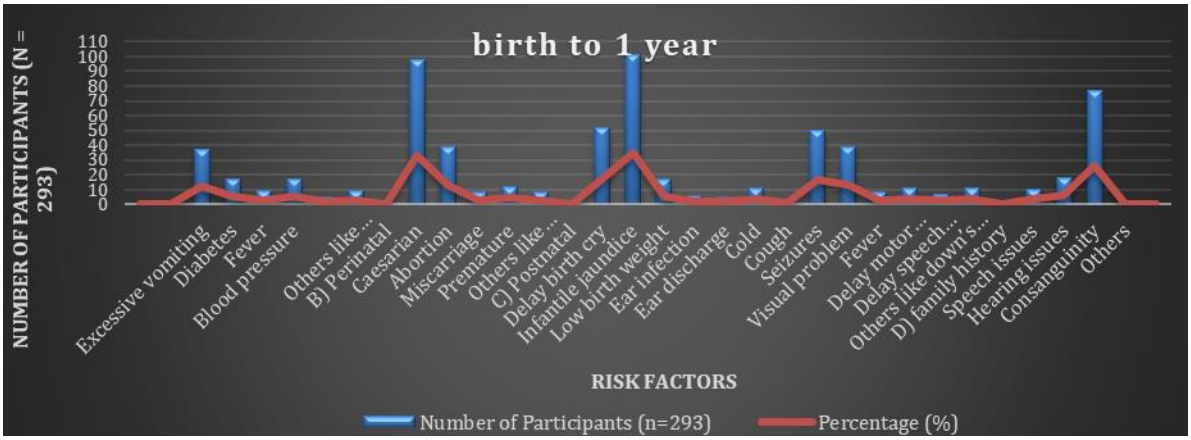

Figure 2.

1 year to 2 years: Risk factors

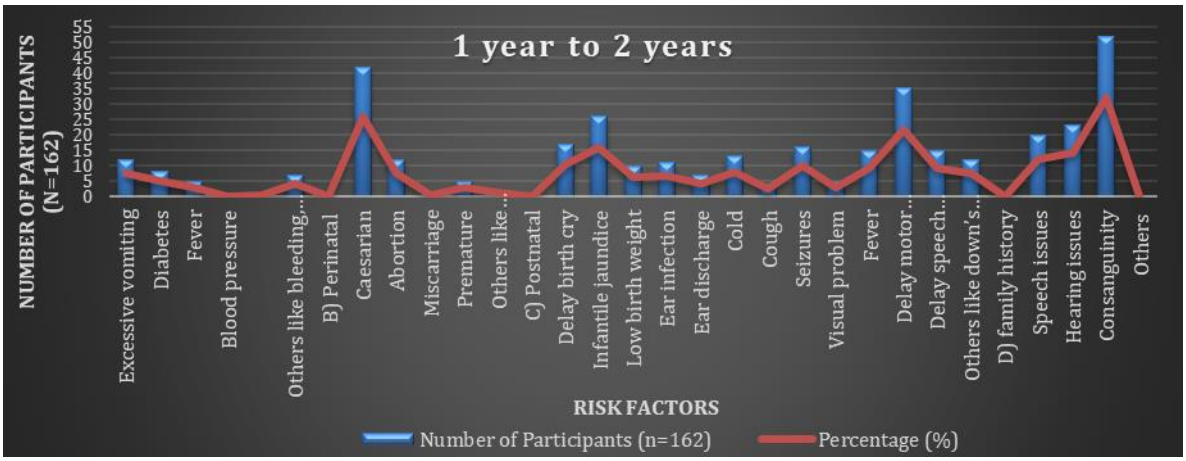

Figure 3.

2 years to 3 years: Risk factors

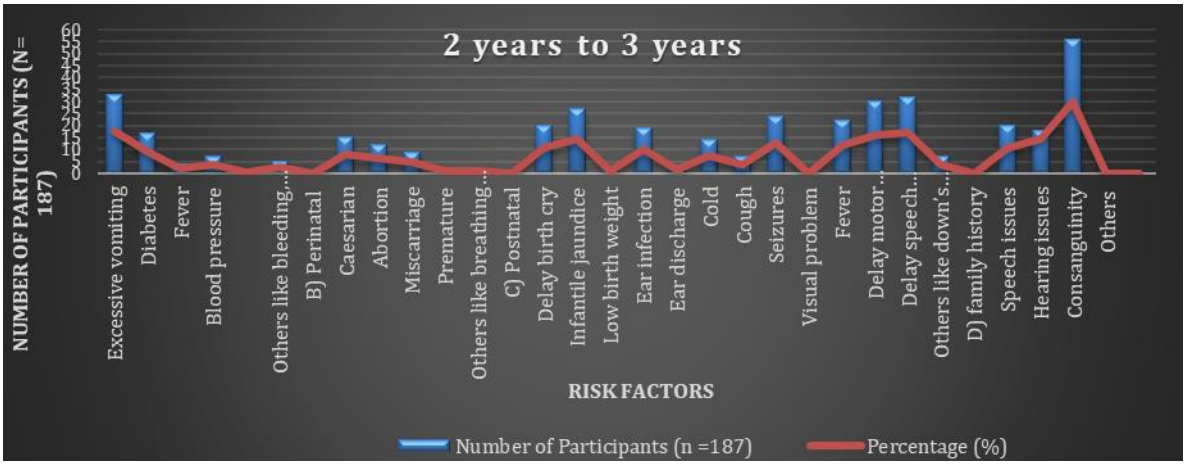

Figure 4.

3 years to 4 years: Risk factors

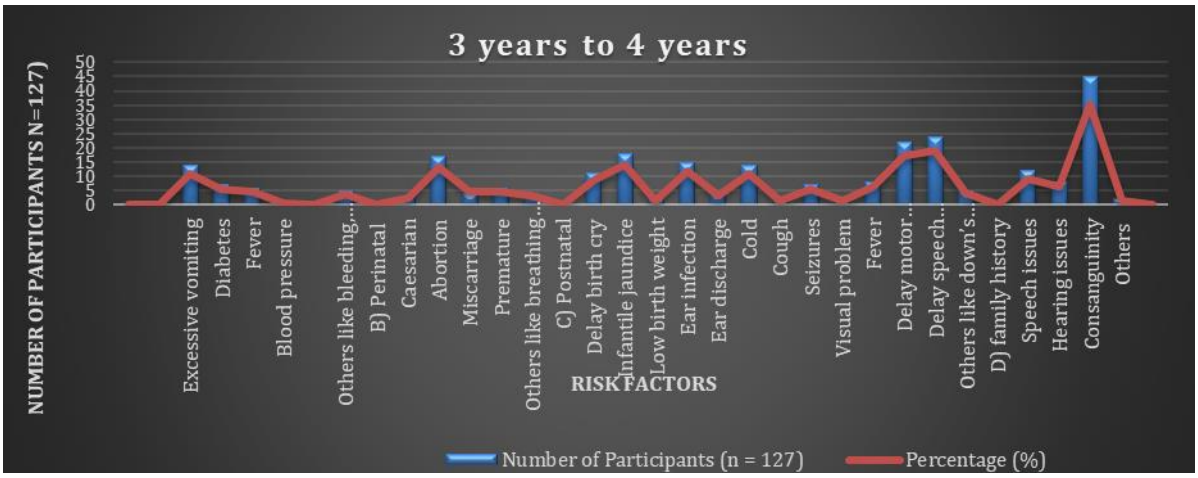

Figure 5.

4 years to 5 years: Risk factors

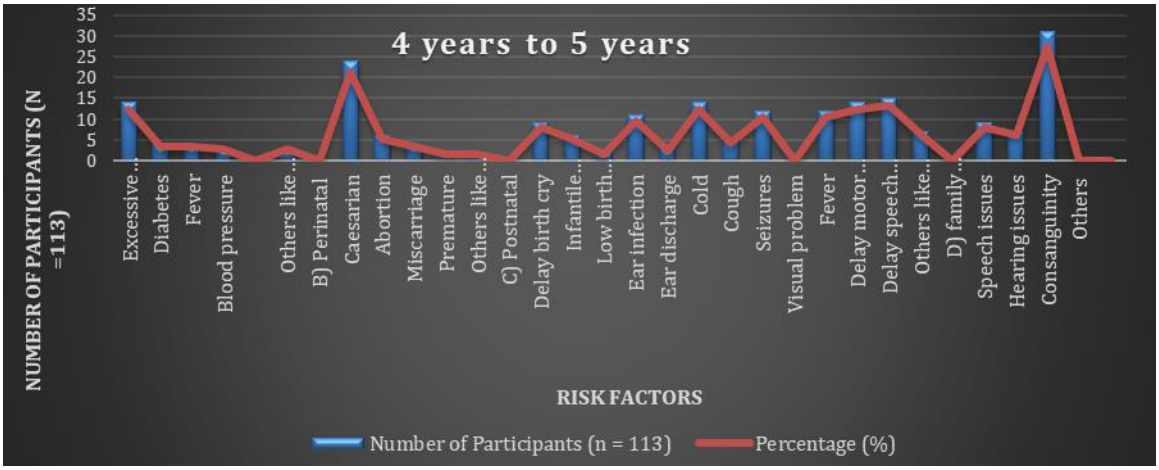

Figure 6.

5 years to 6 years: Risk factors