

# **Prevalence of otitis media and risk-factors for sensorineural hearing loss among infants attending Child Welfare Clinics in the Solomon Islands**

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## **Abstract**

### *Objectives*

The present study aimed to assess the prevalence of otitis media and risk-factors for sensorineural hearing loss among infants in the Solomon Islands, in order to recommend an Infant Ear and Hearing Program that would be suitable to the Pacific Island context.

### *Methods*

Ear examinations and the JCIH Risk-Factor Questionnaire were administered to 288 infants attending Child Welfare Clinics in the Solomon Islands.

### *Results*

Overall, 150 infants (52.084%) presented with bilateral normal ear examinations and no risk-factors for SNHL. There were 73 infants (25.34%) with ear pathology in at least one ear, 13 (4.5%) of whom required referral to the ENT Clinic for medical management. The most common pathology was otitis media with effusion (OME) (21.87%). Infants aged 7-12 months were significantly more likely to present with OME ( $p<0.001$ ) and a history of otitis media ( $p=0.017$ ) than infants aged 0-6 months. There were 71 infants (24.65%) with at least one risk-factor for sensorineural hearing loss. The most common risk-factors were ototoxicity (8.3%), non-elective caesarean delivery (6.59%), and possible in-utero syphilis infection (5.55%).

### *Conclusions*

The prevalence of otitis media and risk-factors for sensorineural hearing loss indicate the importance of initiating Infant Ear and Hearing Programs in the Solomon Islands. Program should facilitate early education on prevention of ear disease, as well as early diagnosis and management of children with hearing loss.

**Keywords:** Otitis media; Sensorineural hearing loss; Newborn and Infant Hearing Screening; Pacific Islands

## 1. Introduction

The World Health Organization (WHO) recommends that Newborn and Infant Hearing Screening (NIHS) should be the goal of all member states [1]. Early identification and intervention for infants born with Permanent or Early-Onset Childhood Hearing Loss (PECHL) should reduce the well-known adverse effects of PECHL on childhood development and social well-being [1]. It is estimated that 90% of the infants born annually with PECHL are found in Low and Middle Income Countries (LMICs), where NIHS programs are limited or non-existent [1,2]. It is further estimated that up to 6 per 1000 infants in LMICs are born with PECHL (compared to 2-4/1000 in high-income nations), largely due to risk-factors associated with maternal and infant health care [3]. Given the competing health priorities and resource limitations of the LMIC context, an alternative model to the hospital-based Universal Newborn Hearing Screening (UNHS) found in high-income nations is required.

There is a growing body of literature on identification of infants with PECHL through NIHS programs in LMICs. Community-based immunization clinics have emerged as one of the most successful platforms for NIHS programs [4,5]. Physiological tests are used for hearing screening, and sophisticated audiological assessment and management is available for infants who require further intervention [6-8]. In contrast, there is limited literature on the implementation of NIHS programs in communities where audiological resources are few or non-existent.

There is little research evidence on NIHS programs in the Pacific Islands [9]. Although this region is estimated to have among the highest global burden of childhood hearing loss,

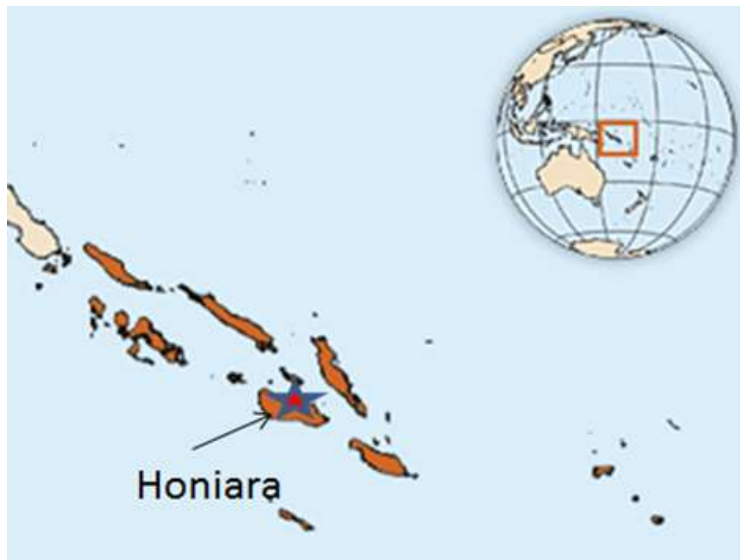
audiology services are virtually non-existent [10]. The United Nations Sustainable Development Goal Project has created opportunities to address childhood disability through WHO/UNICEF initiatives [11,12]. Child Welfare Clinics (CWCs) are a primary health care platform that may be suitable for NIHS programs in the Pacific Islands.

There is also limited research to guide the development of NIHS programs where physiological testing, amplification options, or hearing health professionals are unavailable. While there are arguments against the implementation of NIHS programs in such circumstances [13], the WHO does in fact recommend interim measures until more sophisticated technologies become available [1]. Indeed, Community-Based Rehabilitation (CBR) workers are recognised by the WHO as essential health professionals in the care and management of children with hearing loss, and the vital role of CBR workers is gaining importance in Pacific Island nations [14].

The existing NIHS program literature from LMICs does not address middle ear disease. Yet, a recent global review estimated that the Pacific Islands have the highest incidence of infant Chronic Suppurative Otitis Media (CSOM), and the highest infant mortality rate due to complications of CSOM [15]. The high rates of ear disease among infants were also documented in two early landmark papers from the Solomon Islands and Micronesia [16,17]. More recent publications from Papua New Guinea highlight the on-going difficulties in accessing health care services that lead to potentially fatal complications of CSOM in children [18,19]. An NIHS program in the Pacific Islands cannot ignore the urgent public health need to prevent, diagnose, and manage OM among the infant population.

The ENT Clinic of the National Referral Hospital in the Solomon Islands is currently developing an outreach program to reduce the prevalence of advanced stages of ear disease in their community (Figure 1). Staffed by six registered nurses, this is the only ENT Clinic in the country. ENT Specialist consultation/surgical intervention is provided by an annual 10-day visit from the Royal Australasian College of Surgeons [20]. Audiology services currently consist of pure-tone audiometry assessment in conjunction with ENT Clinic consultation. The first author (AK) was invited by the ENT Clinic to collaborate in the development of community-based ear and hearing services for children, as a previous study showed there is high parental support for such services [21].

**Figure 1.** Map of the Solomon Islands



In order to recommend a suitable protocol for the ENT Clinic outreach service for infants, the present study was conducted to assess the prevalence of OM and risk-factors for sensorineural hearing loss among infants attending Child Welfare Clinics in the Solomon Islands. This study

differs from previous NIHS literature in developing countries by (1) placing an emphasis on the diagnosis and management of ear disease, and (2) using the JCIH Risk-Factor Questionnaire (Modified for Developing Countries) to provide information on the risk-factors for sensorineural hearing loss in this cohort of infants. Should the rate of otitis media and risk-factors for sensorineural hearing loss present a public health problem in this population, the recommendation of an interim NIHS program in the Solomon Islands will be justified.

## **2. Methods**

Ethical approval for the study was obtained from the National Health Research and Ethics Committee of the Solomon Islands Ministry of Health and Medical Services, and the University of Queensland Medical Research Ethics Committee. Gatekeeper approval for the study was also obtained from the Honiara City Council (Public Health Services), Solomon Islands.

### *2.1. Participants*

Eight Child Welfare Clinics (CWCs) in the capital city Honiara were approached for participation in the study. Data collection was performed over eight days during August 2017. All infants attending the CWCs for routine reviews on the days of data collection were eligible for the study. An invitation was issued to all caregivers on the days of data collection for participation in the study, and a total of 289 caregivers consented for their infant to take part in the project. One participant was the child of non-Solomon Islander parents living in Honiara, and his results were excluded from the study. A total of 288 infants, therefore, were included for data analysis.

Data collection was performed at five of the eight Honiara CWCs: Mataniko CWC (n=35), Whiteriver CWC (n=88), Rove CWC (n=63), Vura CWC (n=69), and Kukum CWC (n=33). There were 159 male and 129 female infants. The majority of participants belonged to the 0-6 months (n=151) or 7-12 months (n=100) age groups (Table 1). For each participating infant, data were collected regarding age of the mother, and the majority of mothers were between 20-29 (58.68%) and 30-39 (30.2%) years of age.

**Table 1.** Participant Age and Gender distribution (n=288)

Age	Male	Female	Total
0-6 months	79	72	151 (52.4%)
7-12 months	60	40	100 (34.7%)
13-18 months	14	11	25 (8.7%)
19-24 months	4	5	9 (3.1%)
24+ months	2	1	3 (1.1%)
Total	159	129	288 (100%)

## 2.2. *Assessment Procedure*

A senior ENT Registered Nurse (ON) performed ear examinations on all participating infants using the Vorotek-O-Scope equipment, and administered the JCIH Risk-Factor Questionnaire (Modified for Developing Countries) to all participating caregivers in Solomon Island Pijin. The first author (AK) reviewed the participating infant's Child Health Record book for birth/growth/medical history, as well as any recorded episodes of OM. Participation in the project was offered to all ENT Clinic staff members, however time and resource restrictions prevented their participation. The second author (ON) was the most suitable candidate for the project as the only senior ENT Registered Nurse with an Audiometrist qualification. He was also

the person who approached the first author (AK) about the possibility of the project, and facilitated approval for the study among the relevant stakeholders in the Solomon Islands.

Ear examination results were recorded for each ear, and classified as No Abnormalities Detected (NAD), Acute Otitis Media (AOM), CSOM, OME, Dry Perforation of the Tympanic Membrane, Cerumen Impaction, or Other Abnormality. Medical intervention was administered as required by the senior ENT Registered Nurse. As per the ENT Clinic protocol, infants were prescribed topical ciprofloxacin ear drops for CSOM, oral amoxicillin for AOM, tetracycline ointment for eczema, and pure coconut oil to soften impacted wax prior to its removal. Infants were referred to the ENT Clinic for review to monitor resolution of these ear pathologies. For infants presenting with OME, the ENT Registered Nurse advised keeping the child's nose clean and dry, and recommended review at their next CWC appointment.

The JCIH Risk Factor Questionnaire (Modified for Developing Countries) [1] consisted of 14 items: family history, cranio-facial anomalies, syndromes associated with hearing loss, in-utero infections, prematurity/low birthweight, birth asphyxia and/or Apgar score 0-6 at 5 minutes, mechanical ventilation lasting 5 days or more, ototoxic medication, bacterial meningitis, hyperbilirubinemia requiring exchange blood transfusion, maternal hypertensive disorders in pregnancy, non-elective caesarean delivery, unskilled attendant at delivery, and undernutrition. The first 10 items are established risk-factors for Permanent or Early-Onset Childhood Hearing Loss (PECHL), while the last 4 items are emerging risk-factors for PECHL in developing countries. The present study excluded "consanguinity" and "sickle-cell anemia" from the questionnaire as there is minimal probability of these risk-factors in the Solomon Islands. It was noted that



testing for the five in-utero infections is not routinely performed in the Solomon Islands, and mothers were able to report an antenatal positive screen for syphilis only. Blood transfusion for hyperbilirubinemia is rare and we, therefore, only noted infants with neonatal jaundice who required phototherapy. For each item on the JCIH Risk-Factor Questionnaire, a “yes”, “no”, or “unsure” response was required.

The infant’s Child Health Record book provided evidence for the following items: cranio-facial anomalies, syndromes associated with hearing loss, prematurity/low birthweight, birth asphyxia and/or Apgar score 0-6 at 5 minutes, mechanical ventilation lasting 5 days or more, ototoxic medication, bacterial meningitis, hyperbilirubinemia, and undernutrition. All other items required parental report.

Following the ear examination and administration of the JCIH Risk-Factor Questionnaire, all caregivers received basic information on ear health care for infants. A summary of the assessment was recorded in the participating infant’s Child Health Record book, including any recommendations. Infants who required further medical intervention for ear pathology (i.e., CSOM) were referred to the ENT Clinic, while infants with OME were advised to be reviewed by CWC nurses. Infants with risk-factor(s) for sensorineural hearing loss were referred to the visiting Community-Based Rehabilitation worker for monitoring of speech and language development milestones.

### 2.3. *Data analysis*

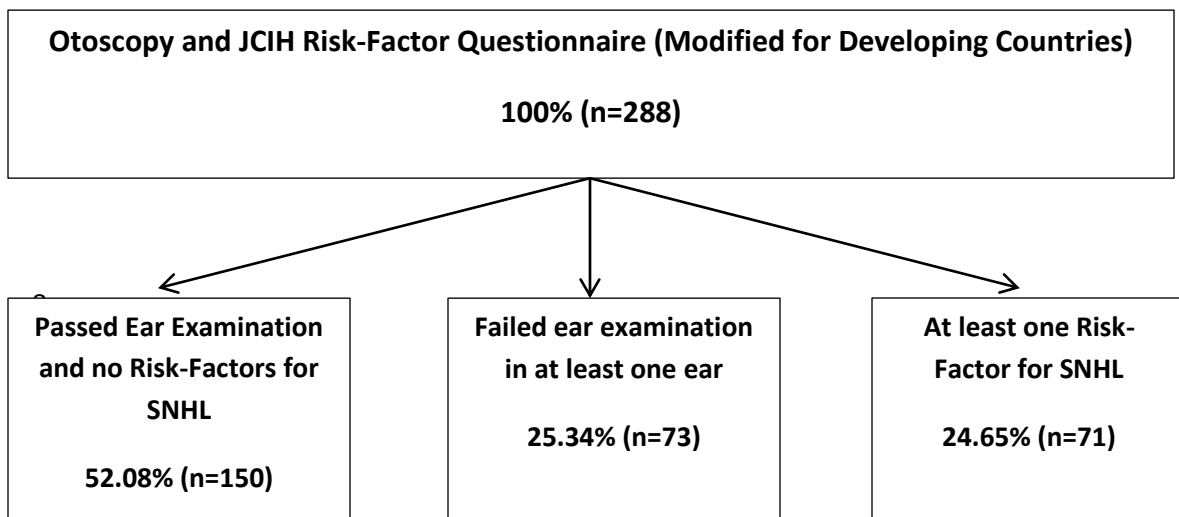
The study results were entered into an Excel spreadsheet by the first author. Ear examination results and responses to the JCIH Risk-Factor Questionnaire were assigned a numerical code.

These results were then transferred into the STATA and SPSS statistical software packages, and data analysis was performed in collaboration with the Audiology Division of the University of Queensland, which included consultation with a statistician. Ear examination results were tallied according to age group, and the Pearson chi-squared test was performed to investigate for any significant difference between ear examination results, and the infant age and gender variables. For the JCIH Risk-Factor Questionnaire, response frequencies were tallied for each item.

### 3. Results

There were 215 infants (74.65%) who passed their ear examination for both ears, while 73 infants (25.35%) presented with ear pathology in at least one ear (Figure 2). The most common diagnosis was OME (n=63, 21.87%), followed by CSOM (n=5, 1.73%), eczema on auricle (n=4, 1.38%), acute OM (n=2, 0.69%), and impacted cerumen (n=2, 0.69%). There were 13 infants (4.5%) who required referral to the ENT Clinic for further medical intervention.

**Figure 2.** Summary of Infant Ear and Hearing Program Results



Among infants with OME (n=63), 77.78% of cases (n=49) were bilateral OME. Among infants aged 0-12 months (n=251), OME ( $p<0.001$ ) and a history of OM ( $p=0.03$ ) were significantly more common among the 7-12 month age group than the 0-6 month age group. Gender was not a significant factor for OME diagnosis or history of OM (Table 2).

**Table 2.** Summary of OM Results for 0-12 month old infants (n=251)

	GENDER				AGE			
	Male	Female	Pearson $\chi^2$ Test		0-6 months	7-12 months	Pearson $\chi^2$ Test	
OME in at least one ear	27/139	16/112	$\chi^2=1.1537$	$p=0.283$	12/151	31/100	$\chi^2=22.5202$	<b><math>p&lt;0.001^*</math></b>
Bilateral OME	23/139	13/112	$\chi^2=1.231$	$p=0.267$	9/151	27/100	$\chi^2=21.6766$	<b><math>p&lt;0.001^*</math></b>
History of at least one episode of OM	16/139	9/112	$\chi^2=0.8352$	$p=0.361$	10/151	15/100	$\chi^2=4.7079$	<b><math>p=0.030^*</math></b>

\*p-value significant at  $<0.05$

There were 71 infants (24.65%) with at least one risk-factor for SNHL. The most commonly reported risk-factor (Table 3) was a history of ototoxic medication (8.3%). In the majority of cases (75%), this was the administration of a combination drug therapy which included gentamycin for the treatment of neonatal sepsis. The remaining cases were administration of gentamycin in the treatment of meningitis (n=2), severe pneumonia requiring hospitalization (n=2), and admittance to Special Care Nursery (n=2). The second most common risk-factor was the emerging JCIH risk-factor of non-elective caesarean delivery (6.59%), followed by a reported positive result on antenatal syphilis screening blood test (5.55%).

Among the 71 infants with at least one risk-factor for SNHL, 46 infants (64.8%) presented with one risk-factor only. Among the 25 infants (35.2%) with more than one risk-factor for SNHL, 17 infants presented with ototoxic medication as one of the risk-factors: 12 infants reported one other risk-factor, which might explain the reason for administration of gentamycin (i.e.,

meningitis, mechanical ventilation during hospitalization for neonatal sepsis or severe pneumonia).

**Table 3.** Distribution of responses to the JCIH Risk-Factor Questionnaire (n=288)

JCIH Risk-factor for SNHL	Yes n(%)	No	Unsure
1. Family history	5 (1.73%)	282	1
2. Cranio-facial anomalies	1 (0.34%)	287	0
3. Syndromes associated with hearing loss	1 (0.34%)	287	0
4. In-utero infection (rubella, CMV, syphilis, toxoplasmosis, herpes)	16 (5.55%)	254	18
5. Prematurity (<34 weeks) /low birthweight (<1500g).	5 (1.73%)	272	11
6. Birth asphyxia and/or Apgar score 0-6 at 5 minutes	6 (2.08%)	266	16
7. Mechanical ventilation lasting 5 days or more	5 (1.73%)	282	1
8. Ototoxic medication	24 (8.3%)	262	2
9. Bacterial meningitis	2 (0.69%)	285	1
10. Hyperbilirubinemia requiring exchange blood transfusion	2 (0.69%)	285	1
11. Maternal hypertension disorders in pregnancy	11 (3.81%)	268	9
12. Non-elective cesarean delivery	19 (6.59%)	269	0
13. Unskilled attendant at delivery	4 (1.38%)	283	1
14. Undernutrition	8 (2.77%)	280	0

#### 4. Discussion

The aim of the present study was to assess the prevalence of OM and risk-factors for SNHL among infants in the Solomon Islands. Approximately half the infants in our study sample both passed their ear examinations and reported no risk-factors for sensorineural hearing loss.

Almost a quarter of all infants were diagnosed with ear pathology in at least one ear, with OME the most common diagnosis. Almost a quarter of infants also presented with at least one risk-factor for SNHL, with administration of ototoxic medication reported as the most common risk-factor. These findings suggest that the implementation of routine ear and hearing health

services at Child Welfare Clinics should contribute to reducing ear disease and hearing loss among infants in the Solomon Islands.

OME was present in almost a fifth of all participants. Older infants (7-12 months) were more likely to present with OME than younger infants (0-6 months), and they were also more likely to present with a history of at least one episode of OM. There were few cases of AOM or CSOM in the present study, and this is probably because mothers are generally advised to wait until resolution of any illness before attending the Child Welfare Clinic for infant immunization. In an early study conducted in Micronesia in 1985, OM was found in 46-47% of apparently-well infants attending clinics for their immunizations [17]. While the authors did not specify the type of OM diagnosed, it may have been OME if the infants were otherwise apparently well. Although not as medically urgent as CSOM, asymptomatic OME may persist in children for several weeks (63%) or months (26% after 3 months) following an episode of AOM, and is clearly an important and common condition that requires clinical management and surveillance [22].

The high prevalence of OME in the present study may be attributed to the well-known risk-factors associated with the greater prevalence of OM in developing countries such as poverty, malnutrition, and lack of access to medical care [23]. Acute respiratory infections are a significant cause of mortality and morbidity in the Solomon Islands, and may also contribute to the high prevalence of OME [24]. An improvement in public health and greater accessibility to primary health care services should, therefore, reduce the disease burden of paediatric hearing loss associated with OM, as well as make a positive impact on child health and survival rates.

Household smoke exposure was a significant predictor of OME in a recent medical mission to Fiji [25], and this may also be the case in the Solomon Islands where woodfire smoke from traditional cooking and burning of household waste is common. There is some evidence to suggest that Islander populations may have a greater genetic predisposition to OM, given that OME was present in 25.4% of 2-year-old Pacific Island children living in New Zealand (n=1001) who had good access to healthcare services [26,27].

The three most common risk-factors for SNHL in the present study were ototoxicity, non-elective caesarean delivery, and possible in-utero syphilis infection. These risk-factors are already being addressed in the Solomon Islands through WHO/UNICEF initiatives in order to achieve Sustainable Development Goal “Good Health and Well-Being”. The role of hearing health advocates should be to promote community participation in these WHO/UNICEF programs, which will improve maternal and childhood health generally, and reduce permanent childhood hearing loss and other disabilities specifically. Their role would also be to raise awareness of these major risk-factors to enable timely referral of children with suspected hearing loss to either the ENT Clinic, Community-Based Rehabilitation workers, or the Red Cross School for Children with Disabilities.

In our study sample, ototoxicity was usually due to the administration of gentamycin in the treatment of neonatal sepsis. Quinine/chloroquine therapy for malaria as a major cause of hearing loss in the Pacific Islands should be in decline since the recent introduction of artemisinin-based combination therapy, a successful non-ototoxic malaria treatment [28,29].

The literature from other developing countries shows that aminoglycoside-induced ototoxicity

is a common risk-factor for SNHL among children [30-32]. Unrestricted access to aminoglycosides was also determined to be a major cause of ototoxicity among children in Nicaragua [33].

The second most common risk-factor for SNHL in the present study was the emerging JCIH risk-factor of non-elective caesarean delivery [34,35]. Our study sample is based in the capital city Honiara, where there is good access to hospital delivery and emergency maternal healthcare if required. With 21% of the Solomon Island population residing in urban settings, our result is unlikely to reflect the situation in the majority rural/remote parts of the country. It should be noted that although fewer non-elective caesarean deliveries are performed in rural/remote areas, this is a reflection of service availability rather than need. Similarly, unskilled attendant at birth was not a common risk-factor for SNHL in the Honiara population, but the rate of unskilled attendants at birth could be expected to be higher in other parts of the Solomon Islands.

The third most common risk-factor for SNHL in the present study was In-Utero infections. Ideally, this question ascertains whether the mother was tested positive for rubella, cytomegalovirus, syphilis, toxoplasmosis, or herpes during her pregnancy. Interpretation of our result is difficult, and highlights some of the challenges in developing country settings. The true response to the question for all mothers should be “unsure”, as routine antenatal screening for all these infections is unavailable. We elected to record if the mother received a positive result on her antenatal blood test which alerted us to the possibility of syphilis in-utero infection. Sexually Transmitted Infections are another major focus of public health care in the Pacific

Islands, and the fact that 5.55% of mothers admitted to a positive result rendered the documentation and inclusion of this question in our study worthwhile.

#### *4.1. Limitations of the present study*

Although OAE-screening equipment was available for the study, the high ambient noise levels, limited space availability, and volume of infants attending Child Welfare Clinics, led to the research team limiting data collection to ear examinations and responses to the JCIH Questionnaire. A short questionnaire on infant hearing ability, such as that used by Newton and colleagues in China, would have been beneficial in our resource-limited context [36]. The present study was conducted in the capital city Honiara, and the prevalence and pattern of ear disease and risk-factors for SNHL is likely to be higher in rural/remote regions of the country.

## **5. Conclusions**

The prevalence of otitis media and risk-factors for sensorineural hearing loss indicate the importance of initiating Infant Ear and Hearing Programs in the Solomon Islands. These programs should facilitate early education on prevention of ear disease, as well as early diagnosis and intervention. Ototoxicity, non-elective caesarean delivery, and possible in-utero syphilis infection were the main risk-factors for SNHL in this population.

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