Background
Hearing loss is widespread in children in resource-limited countries (1), and hearing loss affects language and/or cognitive development. Despite this fact, hearing loss is often not screened in studies examining child development that are conducted in these countries, likely related to expense and lack of trained personnel. In studies of children affected by HIV, assessment is particularly relevant, as hearing loss is more prevalent in HIV-infected children than HIV-uninfected children (2, 3, 4). Torre et al (2015) found that HIV-infected children were more at risk of unilateral and sensorineural hearing loss than their uninfected counterparts. Children who are exposed to HIV (HEU) through having a mother with HIV, though uninfected themselves, are a vulnerable population with increased morbidity and mortality over children who have no HIV exposure (HUI) (5).

In a study in Botswana called Tshipidi, we investigated the health and neurodevelopmental (ND) outcomes of HEU and HU children, enrolling mothers during pregnancy and following their children through two years of age. The mothers with HIV had different regimens of antiretroviral medications. For the two year assessment, at the time of the neurodevelopmental testing, hearing was screened to understand prevalence of problems and potential impact on neurodevelopmental domains.

Methods
Hearing: Nurses were trained to complete an otoscopic screen and hearing test by an audiologist in Botswana, with instructions and monitoring by an audiologist in Boston (CM). Children were tested at two years of age, at a visit that included health and neurodevelopmental assessment and parent questionnaires.

Otoacoustic Emission Testing (OAE): AudiDX® Pro is a portable system that administers OAE testing, using a combination of hardware and specialized software. AudiDX produces a controlled acoustic signal in the ear canal and measures the byproduct of outer hair cell motility (a sign of cochlear function). The result is to "clear" the child if no problems are noted or "refer" for further assessment. Children who received a "refer" were sent to an otolaryngologist.

Otolologic Screening: The children’s ears were viewed via an otoscope. If the ears showed signs of infection or increased wax, the child was referred to an otolaryngologist or pediatrician.

Caregiver Questionnaire: Ten Questions Questionnaire (TQQ) (6) is an internationally used set of brief questions asked to parents to screen for hearing problems in childhood. This study was “Does the child appear to have any difficulty hearing”.

Results
Of the 778 total infants who attended a two-year assessment, 75% (583) were able to obtain OAE results from 47% (272), mainly due to problems with the functioning of the equipment, as well as problems with cooperation of children, who were not used to ear examination or sitting still for the OAE testing.

Of the children that completed both audiological and otoacoustic assessment, it was found that 18% (108) were referred to an otolaryngology clinic. Referrals were based on either a failing of the hearing screening, presence of excessive wax, or evidence of ear infection. This finding is significant because upon analysis of the Ten Questions Questionnaire, we found that only .05% of caregivers (29 caregivers) noted concerns regarding their child’s hearing. We found no differences in ear health, audiological results, or referrals between HEU and HU children.

Discussion and Conclusion
Early detection of hearing loss is key to preventing delays in speech, language, and cognition (7). However, in developing countries, it is difficult to screen newborns and diagnose hearing loss in patients due to lack of resources and new methods.

The current study suggests the following:
• Otoacoustic and audiological screening showed evidence of a significant number of problems in this group of children and facilitated referrals for needed treatment.
• Given this incidence, hearing screenings would be a valuable part of research studies looking at child development, in part to rule out hearing loss as a contributor to poor performance. It is also essential to find children in need of care for hearing loss or ear health issues.
• Ways to support improved functioning of equipment and strategies for gaining cooperation of children unfamiliar with this type of procedure to increase the number of successful screenings will be important in future studies.
• Caregivers (less than .05%) had concerns about their child’s hearing. This finding would suggest that we need to educate caregivers about their child’s ear health to help recognize the signs of hearing loss or ear infections.
• Studies should continue to follow up with children who have been referred to otoacoustic clinics and aim to diagnose the cause of hearing loss in this population.

Table 1: Demographics of Children

<table>
<thead>
<tr>
<th>Variable</th>
<th>HIV-exposed (N=453)</th>
<th>HIV-unexposed (N=457)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestational Age (median, weeks)</td>
<td>40 (IQR 39-42)</td>
<td>40 (IQR 39-42)</td>
</tr>
<tr>
<td>Birthweight (median, kg)</td>
<td>3 (2.7 - 3.4)</td>
<td>3.2 (3.0 - 3.5)</td>
</tr>
<tr>
<td>Low birthweight (z-score=0)</td>
<td>85 (15%)</td>
<td>44 (10%)</td>
</tr>
</tbody>
</table>

Table 2: Demographics of Mothers

<table>
<thead>
<tr>
<th>Variable</th>
<th>HIV-infected (N=453)</th>
<th>HIV-uninfected (N=457)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age (median years)</td>
<td>29 (IQR 26-31)</td>
<td>29 (IQR 26-31)</td>
</tr>
<tr>
<td>Primigravida</td>
<td>29% (163)</td>
<td>33% (151)</td>
</tr>
<tr>
<td>Educated (highest education level)</td>
<td>17% (79)</td>
<td>22% (106)</td>
</tr>
<tr>
<td>Secondary</td>
<td>55% (253)</td>
<td>54% (245)</td>
</tr>
<tr>
<td>Completed</td>
<td>18% (83)</td>
<td>16% (74)</td>
</tr>
<tr>
<td>Household employment</td>
<td>54% (245)</td>
<td>56% (262)</td>
</tr>
<tr>
<td>Caregiver concerns</td>
<td>54% (245)</td>
<td>56% (262)</td>
</tr>
<tr>
<td>Feeding issues</td>
<td>46% (214)</td>
<td>46% (214)</td>
</tr>
<tr>
<td>No CERD denial</td>
<td>89% (412)</td>
<td>90% (409)</td>
</tr>
</tbody>
</table>

Figure 1: OAE/Otoscopic Testing

- No Results Available
- Cleared
- Referred for Otolaryngological Treatment

Figure 2: OAE/Otoscopic Testing

- No Results Available
- Cleared
- Referred for Otolaryngological Treatment
- CERD Concern for Hearing

References

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