Developing a rapid survey protocol for measuring the prevalence of hearing loss in population-based surveys (RAHL)

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- **Open Research Kit @ LSHTM**
- **All my colleagues @ ICED & LSHTM**
- **Research participants**
- Many others that have helped me along the way
Overview

• Hearing impairment globally
• Why surveys are important
• Rationale for rapid assessment
• RAHL methodology
• Field testing in China and Malawi
• Next steps
Epidemiology of hearing loss

Over 466 million people live with disabling hearing loss. It is predicted that by 2050 nearly one in ten people will have hearing loss.

(World Health Organization 2018)
The majority of people with hearing loss live in low and middle income countries.
Who is affected?

Photograph taken by author

Prevalence of ≥35 dB HL (%)

Age (years)

(Stevens et al. 2011)
Who is affected?

- 1 or 2 babies per 1000 are born with permanent hearing loss in HICs
- 5 or 6 per 1000 in LMICs

Speech and language development
Communication
Literacy
Educational attainment
ENTs/million

(Mulwafu et al. 2017)
Systematic review

- Coverage of hearing aids ranged from 0–66% across studies
- But few studies identified (n=13) and measurement of coverage varied across studies

(Bright et al. 2018)
(World Health Organization 2018)
Where does the data come from?

Survey in India, ICED

Prevalence of hearing loss
Main likely causes
Coverage of services
Barriers

(World Health Organization 1999)
Previous surveys (Stevens et al., 2011)

Map created with mapchart.net
Previous surveys – sub Saharan Africa (Mulwafu et al. (2016))

Map created with mapchart.net
Comparison to vision

Can we do the same in a survey of hearing loss?

Image credit: RAAB presentation, ICEH
Why do we need surveys of hearing loss?

Surveys

- Monitor progress
- Evidence for advocacy
- Baseline service planning
- Compare
- Global stats
Why can’t we rely on global estimates that are already out there?

National governments use global estimates as a stop gap, and as an advocacy tool – “global estimates are completely useless for planning, but they are useful for political lobbying”

“Of all the types of knowledge produced, locally determined empirical measures are most likely to be used in ways that directly affect health service provision”

Pisani and colleagues (2017)
Challenges with conducting conventional (all-age) surveys
RAPID ASSESSMENT OF HEARING LOSS (RAHL)
What is a rapid assessment?
Rapid assessment of avoidable blindness

• Focus on people aged 50+: **majority of blindness in this group and causes are representative**
• Simplified examination protocol
• Enumeration and basic examination in one visit
• Automated data entry and analysis
• Personnel needed
  – Nurse: visual acuity assessment
  – Ophthalmologist: assessment of causes
• Usually done in <2 months

Image credit: ICEH
Research questions

• Can the age group of the study population be restricted from all-age to older adults?
• What tools should be included in a rapid survey protocol to measure hearing and assign causes?
• Which cadre of health worker should be involved in conducting the clinical tests within a survey setting?
• How does the survey protocol work in practice?
Can the age group of the study population be restricted from all-age to older adults?
Hearing loss by age

Majority of hearing loss in people aged 50+ (>70%)
Prediction model

- Poisson models created to predict prevalence based on people aged 50+
What about the causes?

Distribution of causes representative

- Wax
- CSOM
- Otitis media c effusion
- Dry perforation
- Non infectious
- Congenital
- Presbyacusis
- Undetermined
# Sample size

<table>
<thead>
<tr>
<th>Expected prevalence</th>
<th>Confidence interval</th>
<th>Margin of error (around the estimate)</th>
<th>Design effect</th>
<th>Minimum sample size</th>
<th>10% non-response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>95%</td>
<td>20% (0.01)</td>
<td>2</td>
<td>3650</td>
<td>4055</td>
</tr>
<tr>
<td>10%</td>
<td>95%</td>
<td>20% (0.02)</td>
<td>2</td>
<td>1729</td>
<td>1921</td>
</tr>
<tr>
<td>15%</td>
<td>95%</td>
<td>20% (0.03)</td>
<td>2</td>
<td>1089</td>
<td>1210</td>
</tr>
</tbody>
</table>
Focus on people 50+

Exposure to loud noise
Natural Aging
Heredity
Head Injury
Ototoxic Medications
Illness

Image credit Starkey
What tools should be included in a rapid survey protocol to measure hearing and assign causes?

- Systematic review of smartphone tools – availability and accuracy (MSc project)
- Literature review of other tools for accuracy in screening for hearing loss and assessing causes
Included tools
Other outstanding questions
Rapid Assessment of Hearing Loss

• Population-based survey of hearing loss and its causes in people aged 50+
• How is it rapid?
Field-testing in China and Malawi
Sites

China: Gao’an County

Malawi: Ntcheu District

Image credit: Chinafolio, Wikipedia
Brief overview of RAHL methods

1. Sampling
2. Teams
3. Data collection procedures
4. Actions
Sampling: 2 stage cluster sampling

Image credit: RAAB presentation, ICEH
Who collects the data?

Conclusions

• A non-specialist can be trained to accurately assess hearing using mobile-based audiometry.

• Accurate diagnosis of ear conditions (causes of hearing loss) requires at least an ENT clinical officer (or equivalent).

(Bright et al. 2019)
Who collects the data?

China: 2 teams made up of...
- Enumerator: Medical student
- Hearing tests: Nurse, medical student
- Ear examination and diagnosis: ENT doctor

Malawi: 2 teams made up of...
- Enumerator: Nurse
- Hearing tests: Nurse, and audiology officer
- Ear examination and diagnosis: ENT Clinical officer
List all eligible people
Informed consent
Demographic questionnaire
Hearing assessment
Ear examination
Management of any condition in the field or referral
**Questionnaires completed on Open Data Kit (mobile data collection)**

<table>
<thead>
<tr>
<th>Number</th>
<th>Question</th>
<th>Response</th>
<th>Skip pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>Date (DD/MM/YY)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Taku (DD/MM/YY)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>Interviewer name</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Dzina la yemwe okufuna mafuruse mukufukufukuyu</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>Cluster name</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Dzina la gulu</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A4</td>
<td>Participant name</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Dzina la yemwe okutenga n'owo mball mukufukufukuyu</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>Participant initials</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Dzina la yemwe okutenga n'owo mball mukufukufukuyu</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>Sex</td>
<td>Male, Female</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Ndwa mkazi kapena watwamwamuna</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RISK FACTOR SCREEN**

A28 | Have you ever been involved in any work or activities where you were exposed to loud noise? For example, loud noises a day, several days per week? Loud noise means so loud that you could hear it even when raising your voice.

*Munyamba mwaywara ntchito kapena munobamba mwasekaka pamalo pati panai phokosa kwenda vokwana mela anayi kapena kumwe apo patsiku kapena kwa masiku angapo musabota imodzi?

1=Eya
2=Ayi

A29 | For how long have you been exposed to work with loud sounds for more than 4 hours a day, several days a week?

*Kodi munyawa mntchito zovwoyi! Yavitisani bwanji pamalo a phokosa lamachini lamwe limali lotupfira mela anayi pa tsiku?

1=Less than 1 year
2=1 year or more
3=Ntchito yosempera chaka
Simplified examination protocol

Assessment of hearing loss

Thresholds obtained at 500, 1000, 2000, 4000

(van Tonder et al. 2017)

Image credit: hearX; PATH medical; CoolClips; Simply Psychology
Prevalence of hearing loss

**Moderate or greater hearing loss**

- Malawi: 9.9, 11.8, 8.1%
- China: 16.3, 16.2, 16.4%

**Any level of hearing loss**

- Malawi: 35.6, 33.6, 37.4%
- China: 53.2, 55.6, 50.7%
Moderate or greater hearing loss

China
16.3%

Malawi
9.9%
Probable causes of hearing loss: China

<table>
<thead>
<tr>
<th>Cause</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Otitis media with effusion</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chronic suppurative otitis meida</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wax</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Otitis externa</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other middle ear</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Infectious disease</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Noise</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Ototoxicity</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Trauma</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Age related</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mixed</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Potentially need an assistive device
Probable causes of hearing loss: Malawi

Potential causes:
- Wax
- Otitis externa
- Infectious disease

Notable causes:
- Age related
- Unknown

Some individuals may potentially need an assistive device.
Service needs

- Medication
- Wax removal
- Surgery
- Diagnostic hearing assessment, hearing aid trial

Malawi
- 1 Medication
- 23 Wax removal
- 3 Surgery
- 98 Diagnostic hearing assessment, hearing aid trial

China
- 1 Medication
- 5 Wax removal
- 2 Surgery
- 82 Diagnostic hearing assessment, hearing aid trial
Hearing aid coverage

Ntcheu (Malawi)
Not covered

Gao’an (China)
Not covered
Previous care seeking

Ntcheu (Malawi)

- Why?
  - Did not feel the need (76.5%)
  - Did not feel treatment was possible (13.4%)

Gao’an (China)

- Why?
  - Did not feel the need (97.8%)
## Feasibility findings

<table>
<thead>
<tr>
<th></th>
<th>Malawi</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response rate</td>
<td>93.7%</td>
<td>94.6%</td>
</tr>
<tr>
<td>Sample size</td>
<td>1080</td>
<td>1344</td>
</tr>
<tr>
<td>Time taken</td>
<td>24 days</td>
<td>25 days</td>
</tr>
<tr>
<td></td>
<td>23.7 minutes/participant</td>
<td>-</td>
</tr>
<tr>
<td>Cluster completion</td>
<td>13% needed return visits</td>
<td>100% completed in one day</td>
</tr>
<tr>
<td>Background noise</td>
<td>No major problems</td>
<td>No major problems</td>
</tr>
</tbody>
</table>
Rapid vs conventional survey
What happens to those with identified hearing loss or ear disease?

Treat in field

- Wax or foreign body removal
- Medication (OE, AOM)
- Dry mop (CSOM)

Refer to nearest services

- Hearing loss
- Surgical assessment (CSOM, DP)
- Other
Next steps

• 2019
  • Launch manual – this Friday!
  • Test the manual in Chile

• 2020 ++
  • Retesting the age group rationale in The Philippines
  • Training of trainers programme
  • Develop automated analysis + reporting
  • Further surveys planned in Malaysia, China, Cambodia
Publications of interest


- **Bright, T; Muwafu, W; Phiri, M; Ensink, R; Smith, A; Mactaggart, I; Polack, S; Yip, J;** (2019) *Diagnostic accuracy of non-specialist versus specialist health workers in diagnosing hearing loss and ear disease in Malawi.* Tropical Medicine and International Health. ISSN 1360-2276 DOI: https://doi.org/10.1111/tmi.13238

- **Bright, T; Mactaggart, I; Kuper, H; Murthy, GV; Polack, S;** (2018) *Prevalence of Hearing Impairment in Mahabubnagar District, Telangana State, India.* *Ear and hearing.* ISSN 0196-0202 DOI: https://doi.org/10.1097/AUD.0000000000000599


- **Bright, T; Pallawela, D;** (2016) *Validated Smartphone-Based Apps for Ear and Hearing Assessments: A Review.* *JMIR Rehabil Assist Technol, 3* (2). e13. ISSN 2369-2529 DOI: https://doi.org/10.2196/rehab.6074
Thank you for listening – any questions?

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Research Fellow | PhD Candidate | Audiologist
International Centre for Evidence in Disability
London School of Hygiene & Tropical Medicine
Parking lot
## Assessment of causes

<table>
<thead>
<tr>
<th>Type</th>
<th>Cause</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conductive</td>
<td>Acute otitis media&lt;br&gt;Otitis media with effusion&lt;br&gt;Chronic suppurative otitis media&lt;br&gt;Wax impaction&lt;br&gt;Foreign body&lt;br&gt;Otitis externa&lt;br&gt;<strong>Rarer causes:</strong> cholesteatoma, mastoiditis, otosclerosis, tumours</td>
<td>Clinical history&lt;br&gt;Otoscopy (+/-) tympanometry (tbd)</td>
</tr>
<tr>
<td>Sensorineural</td>
<td>Presbyacusis&lt;br&gt;Noise exposure&lt;br&gt;Ototoxicity&lt;br&gt;Non-communicable diseases (diabetes, cardiovascular disease)&lt;br&gt;Infectious disease (acquired)&lt;br&gt;Congenital (in utero infection, birth complications, genetic)&lt;br&gt;Trauma&lt;br&gt;Unknown aetiology&lt;br&gt;<strong>Rarer causes:</strong> acoustic neuroma, Meniere’s disease</td>
<td>Clinical history</td>
</tr>
<tr>
<td></td>
<td>Malawi</td>
<td>China</td>
</tr>
<tr>
<td>---------------</td>
<td>-----------------</td>
<td>------------------</td>
</tr>
<tr>
<td></td>
<td>Disabling</td>
<td>Any level</td>
</tr>
<tr>
<td>All</td>
<td>9.9 (7.8, 12.4)</td>
<td>35.6 (31.4, 40.1)</td>
</tr>
<tr>
<td>Male</td>
<td>11.8 (8.3, 16.5)</td>
<td>33.6 (27.4, 40.5)</td>
</tr>
<tr>
<td>Female</td>
<td>8.1 (6.5, 10.1)</td>
<td>37.4 (33.2, 41.9)</td>
</tr>
</tbody>
</table>
0.9% <18 years

Sample size for children=11,765
Causes: Cameroon
## Rapid vs conventional survey

<table>
<thead>
<tr>
<th></th>
<th>All age survey</th>
<th>Rapid Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
<td>3000-5000</td>
<td>1000-1500</td>
</tr>
<tr>
<td>Examination</td>
<td>Detailed</td>
<td>Basic</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Disease intervention</td>
<td>Planning and follow-up</td>
</tr>
<tr>
<td>Human Resources</td>
<td>Expert staff</td>
<td>Non-expert staff can be involved in audiometry; expert staff still required for ear examination</td>
</tr>
<tr>
<td>Survey Population</td>
<td>Large (10-100 mln.)</td>
<td>Smaller (0.5-5 mln.)</td>
</tr>
<tr>
<td>Duration</td>
<td>Years</td>
<td>Rapid (weeks-months)</td>
</tr>
<tr>
<td>Cost</td>
<td>Expensive</td>
<td>Cheap (20-40,000 US$)</td>
</tr>
</tbody>
</table>
## Feasibility findings

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<tr>
<td>Background noise</td>
<td>No major problems</td>
<td>No major problems</td>
</tr>
<tr>
<td>Costs</td>
<td>Tbd</td>
<td>Tbd</td>
</tr>
<tr>
<td>RAAB+RAHL</td>
<td>Feasible, but additional questions remaining</td>
<td>N/A</td>
</tr>
</tbody>
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