

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

ICED conference 6th November 2019

Tess Bright

Audiologist | Research Fellow | PhD Candidate

International Centre for Evidence in Disability

CRD | ITD | LSHTM

LONDON
SCHOOL of
HYGIENE
& TROPICAL
MEDICINE



International
Centre for Evidence
in Disability

Improving health worldwide

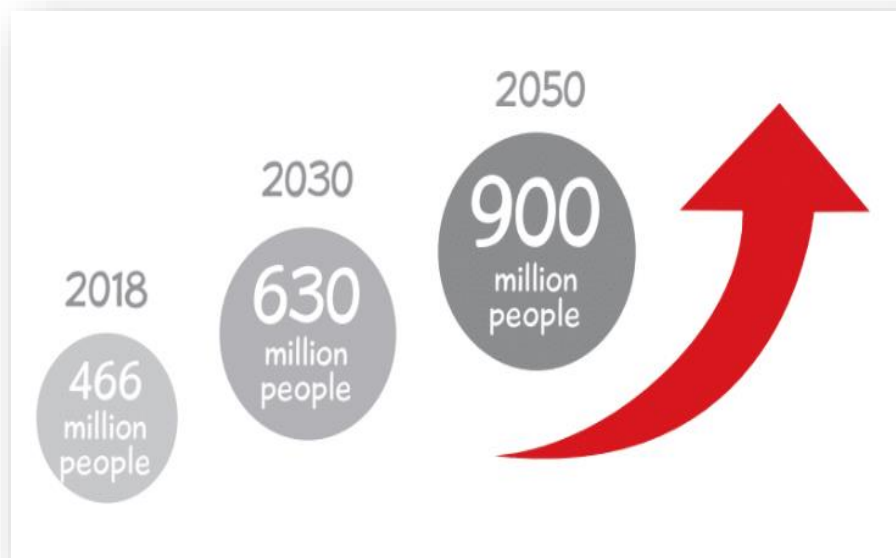
www.lshtm.ac.uk

Acknowledgements

- **Funder:** CBM International
- **PhD supervisors:** Dr Sarah Polack, Dr Islay Mactaggart, Dr Jen Yip
- **Advisory committee:** Prof. Hannah Kuper, Dr Robbert Ensink, Dr Wakisa Mulwafu, Dr Diego Santana, Prof. De Wet Swanepoel, Dr Tara Tancred
- **Partners:** hearX, Gao'an People's Hospital, Queen Elizabeth Central Hospital, WHO Prevention of Deafness and Blindness Programme
- **Open Research Kit @ LSHTM**
- **All my colleagues @ ICED & LSHTM**
- **Research participants**
- Many others that have helped me along the way

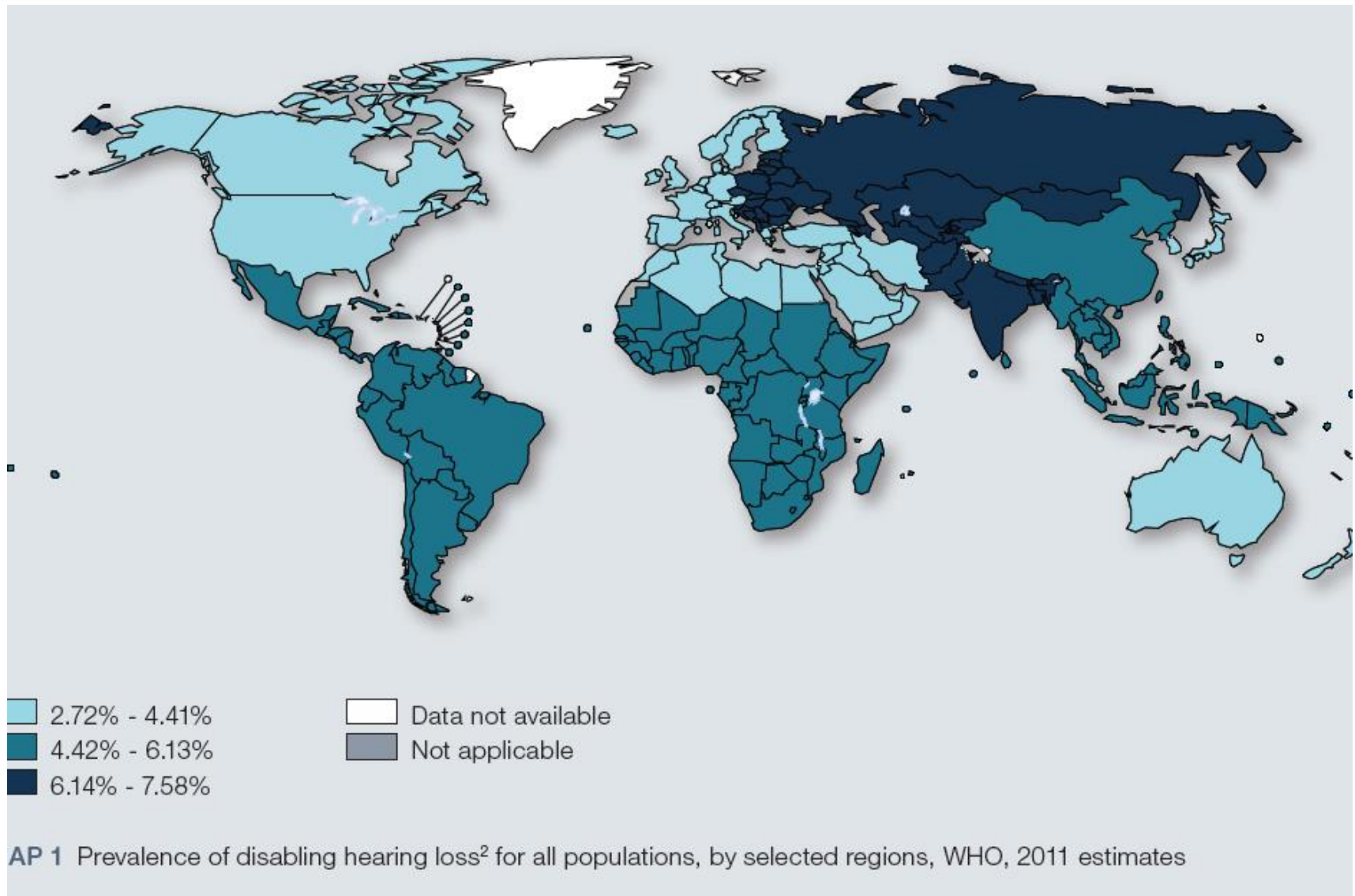
- Hearing impairment globally
- Why surveys are important
- Rationale for rapid assessment
- RAHL methodology
- Field testing in China and Malawi
- Next steps

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.**

The majority of people with hearing loss live in low and middle income countries

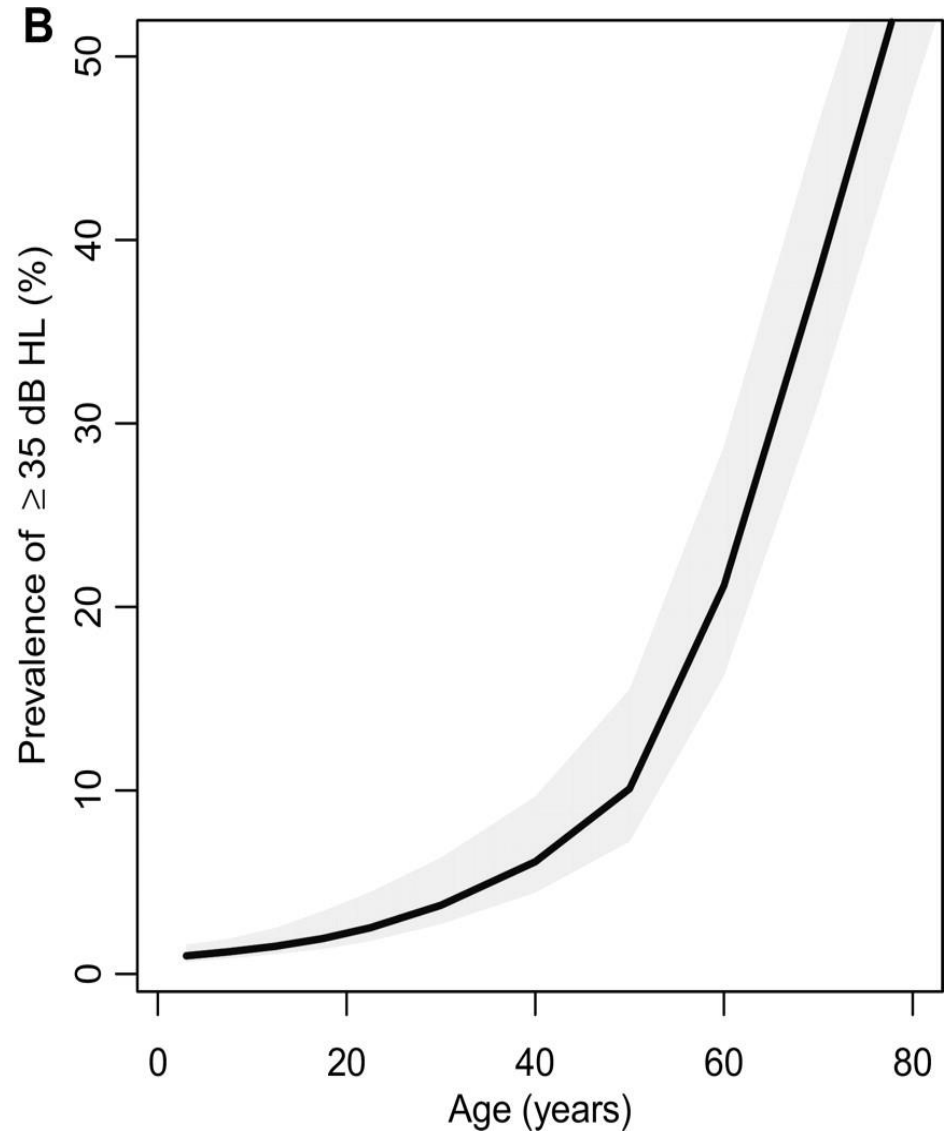


(World Health Organization 2013)

Who is affected?



Photograph taken by author



(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**

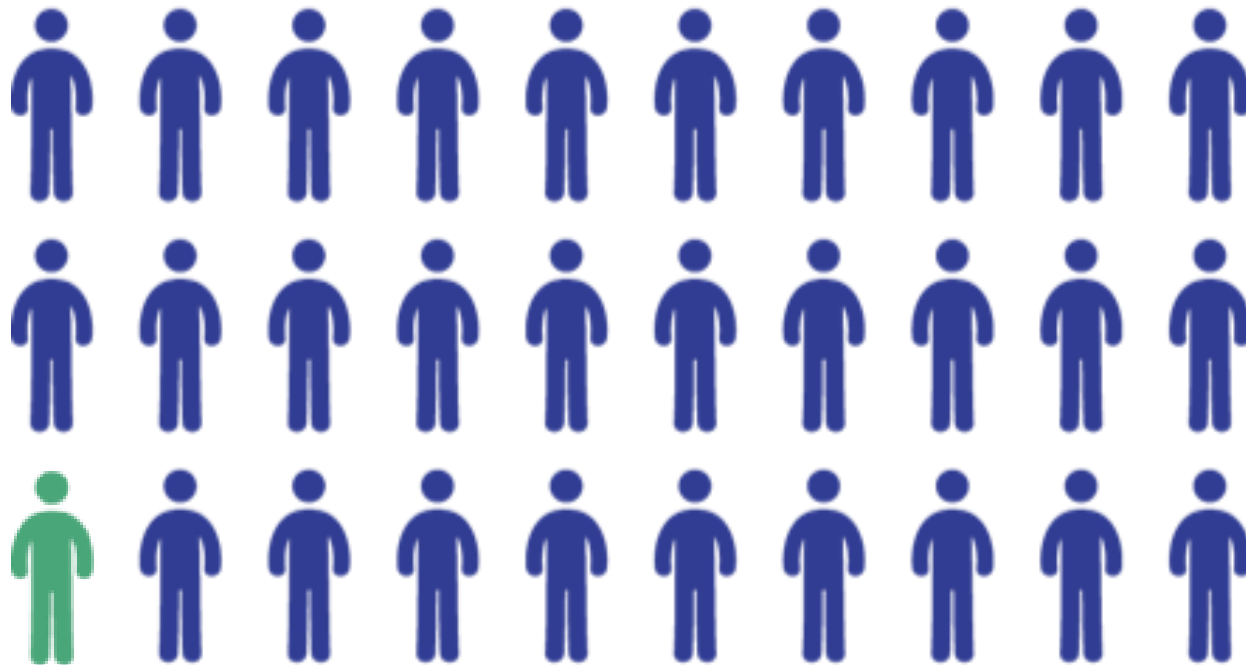
Communication

Literacy

Educational attainment



ENTs/million



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)




International Journal of
*Environmental Research
and Public Health*



Review

A Systematic Review of Access to Rehabilitation for People with Disabilities in Low- and Middle-Income Countries

Tess Bright , Sarah Wallace and Hannah Kuper

International Centre for Evidence in Disability, London School of Hygiene & Tropical Medicine, London WC1 E7HT, UK; Sarah.Wallace1@lshtm.ac.uk (S.W.); hannah.kuper@lshtm.ac.uk (H.K.)

* Correspondence: tess.bright@lshtm.ac.uk

Received: 10 August 2018; Accepted: 27 September 2018; Published: 2 October 2018

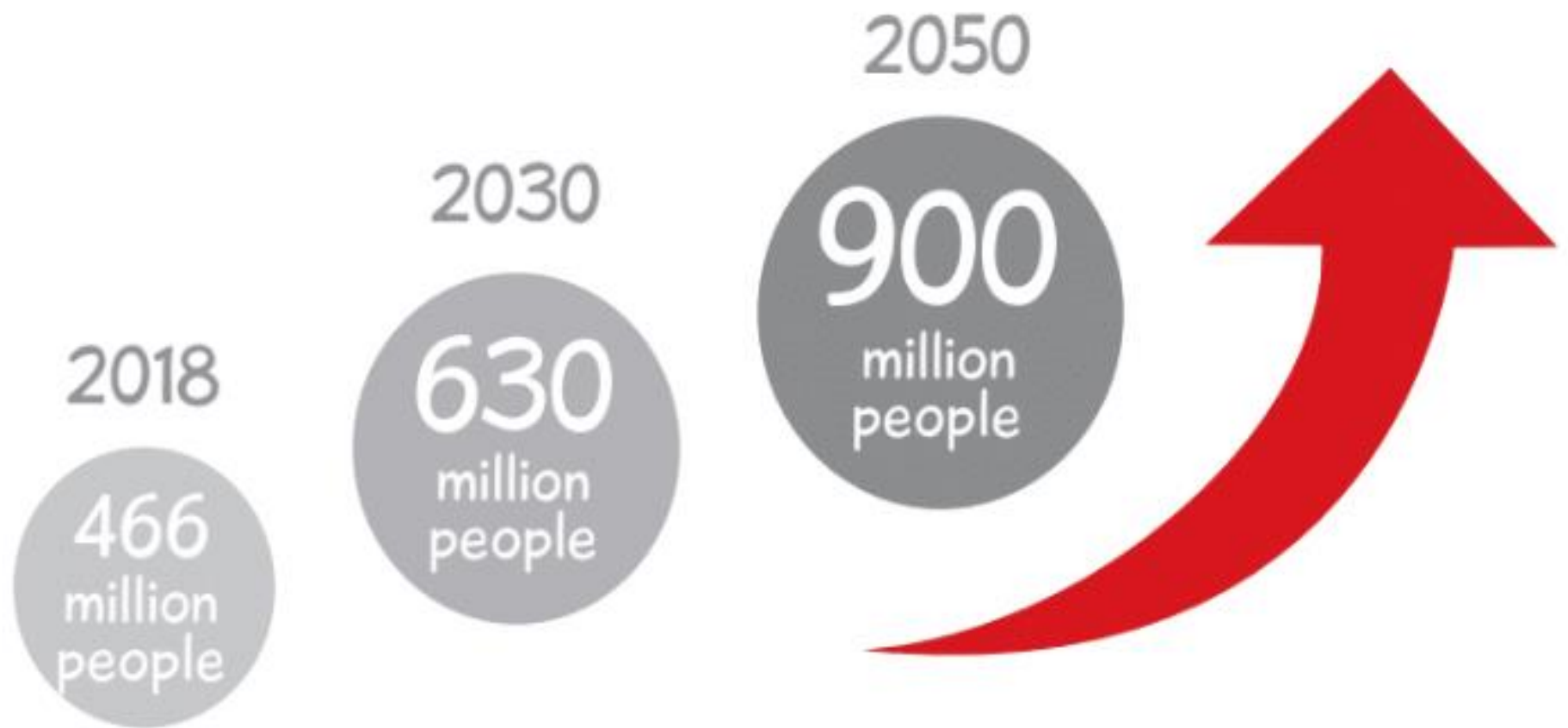


Abstract: Rehabilitation seeks to optimize functioning of people with impairments and includes a range of specific health services—diagnosis, treatment, surgery, assistive devices, and therapy. Evidence on access to rehabilitation services for people with disabilities in low- and middle-income countries (LMICs) is limited. A systematic review was conducted to examine this in depth. In February 2017, six databases were searched for studies measuring access to rehabilitation among people with disabilities in LMICs. Eligible measures of access to rehabilitation included: use of assistive devices, use of specialist health services, and adherence to treatment. Two reviewers independently screened titles, abstracts, and full texts. Data was extracted by one reviewer and checked by a second. Of 13,048 screened studies, 77 were eligible for inclusion. These covered a broad geographic area. 17% of studies measured access to hearing-specific services; 22% vision-specific; 31% physical impairment-specific; and 44% measured access to mental impairment-specific services. A further 35% measured access to services for any disability. A diverse range of measures of disability and access were used across studies making comparability difficult. However, there was some evidence that access to rehabilitation is low among people with disabilities. No clear patterns were seen in access by equity measures such as age, locality, socioeconomic status, or country income group due to the limited number of studies measuring these indicators, and the range of measures used. Access to rehabilitation services was highly variable and poorly measured within the studies in the review, but generally shown to be low. Far better metrics are needed, including through clinical assessment, before we have a true appreciation of the population level need for and coverage of these services.

Keywords: access; health care; rehabilitation; people with disabilities; low- and middle-income country; universal health coverage





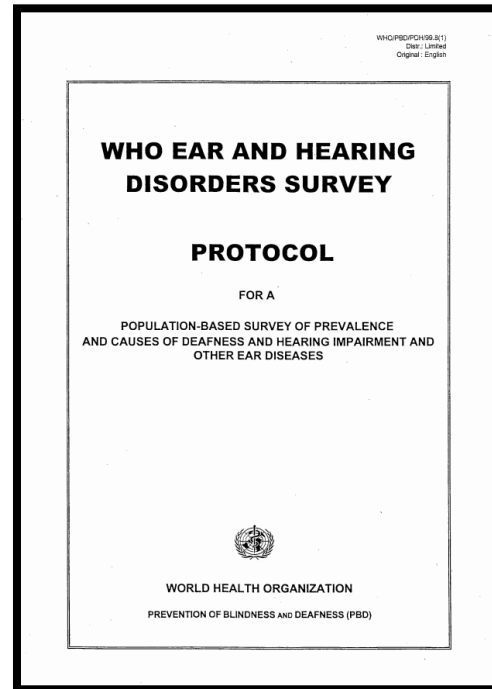


(World Health Organization 2018)

Where does the data come from?



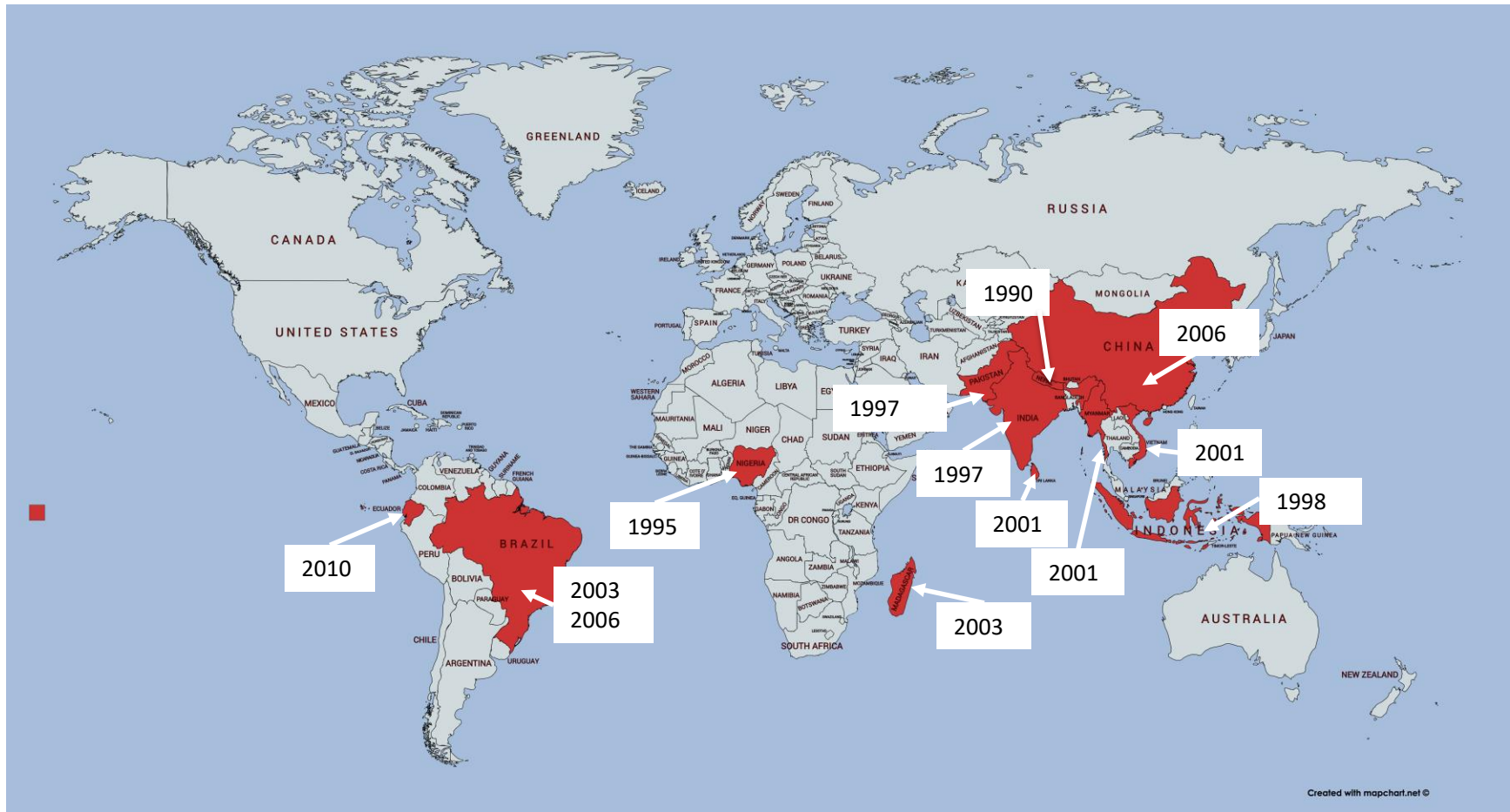
Survey in India, ICED



(World Health Organization 1999)

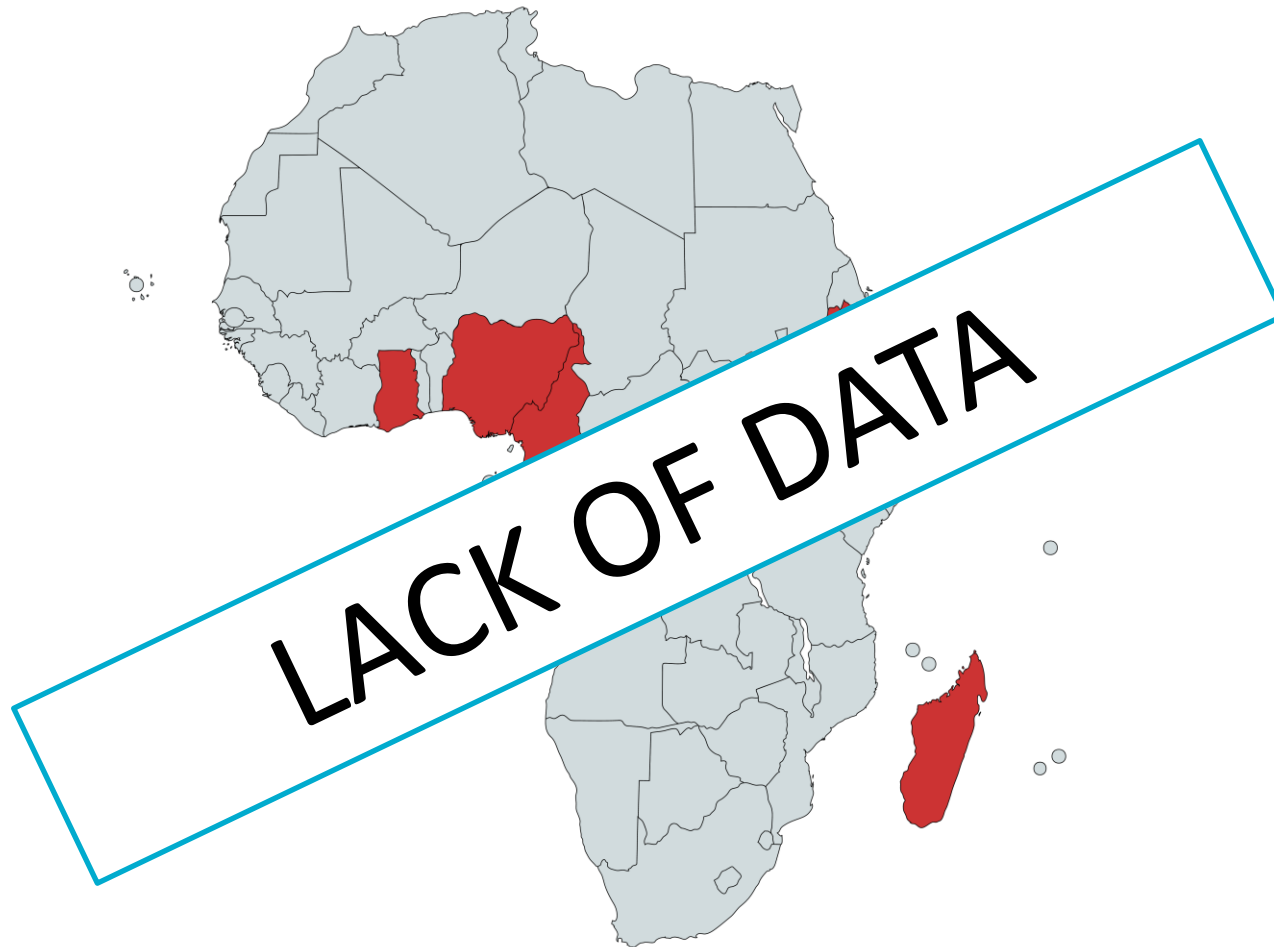
Prevalence of hearing loss
Main likely causes
Coverage of services
Barriers

Previous surveys (Stevens et al., 2011)



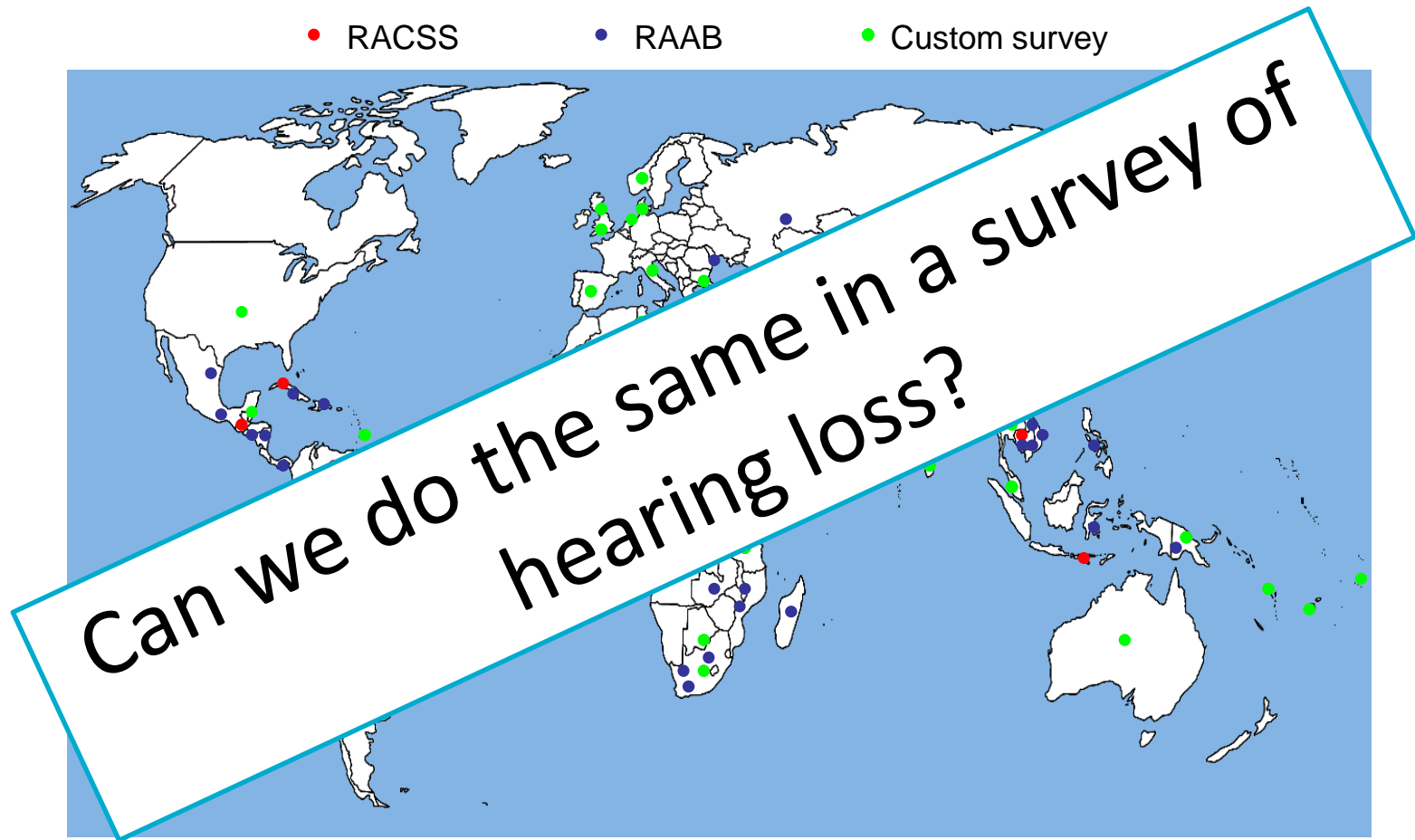
Map created with mapchart.net

Previous surveys – sub Saharan Africa (Mulwafu et al. (2016))



Created with mapchart.net ©

Comparison to vision



Why do we need surveys of hearing loss?



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)

LONDON
SCHOOL of
HYGIENE
& TROPICAL
MEDICINE



International
Centre for Evidence
in Disability

the
overseas
disability
charity

cbm
together we can do more

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



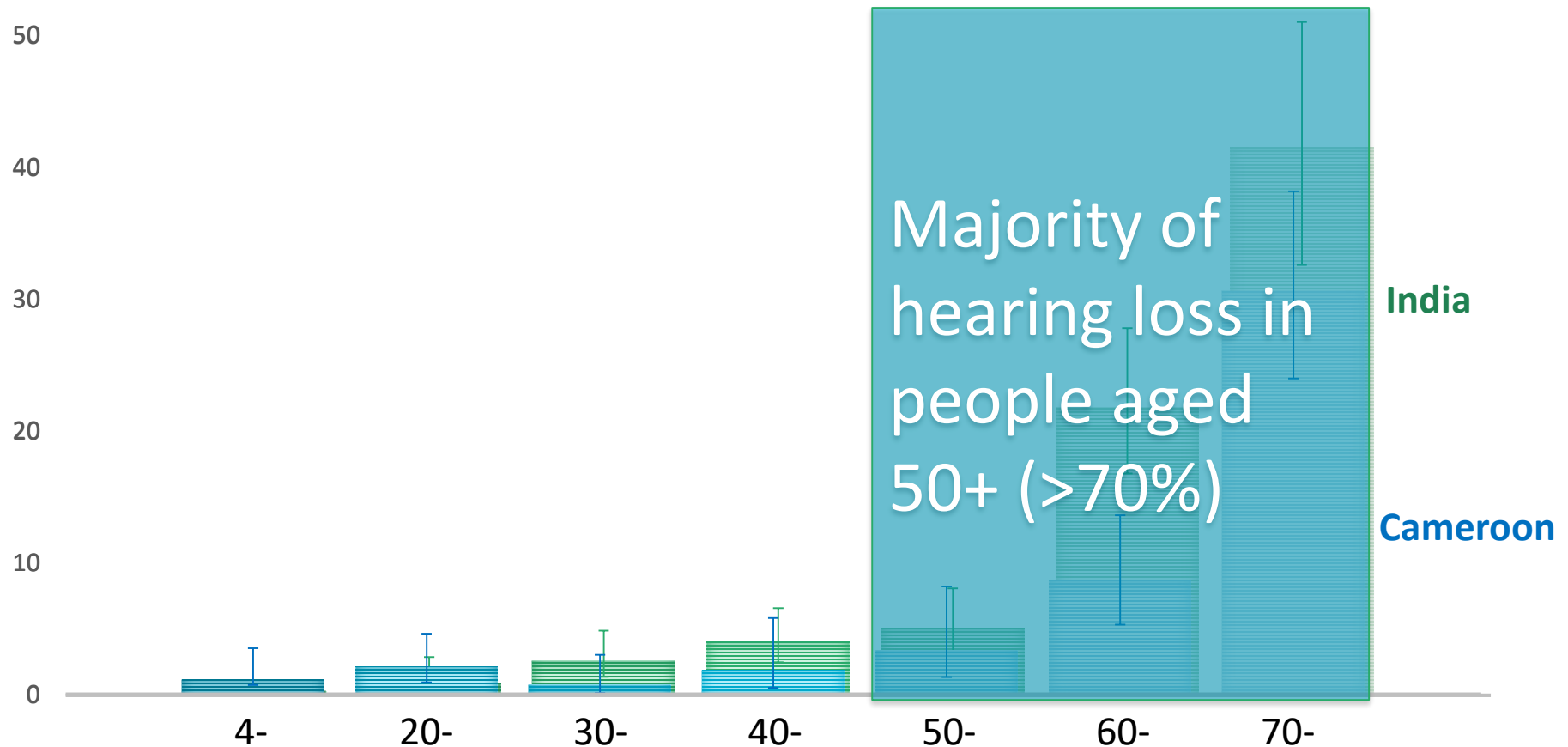
Image credit: ICEH

- 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?

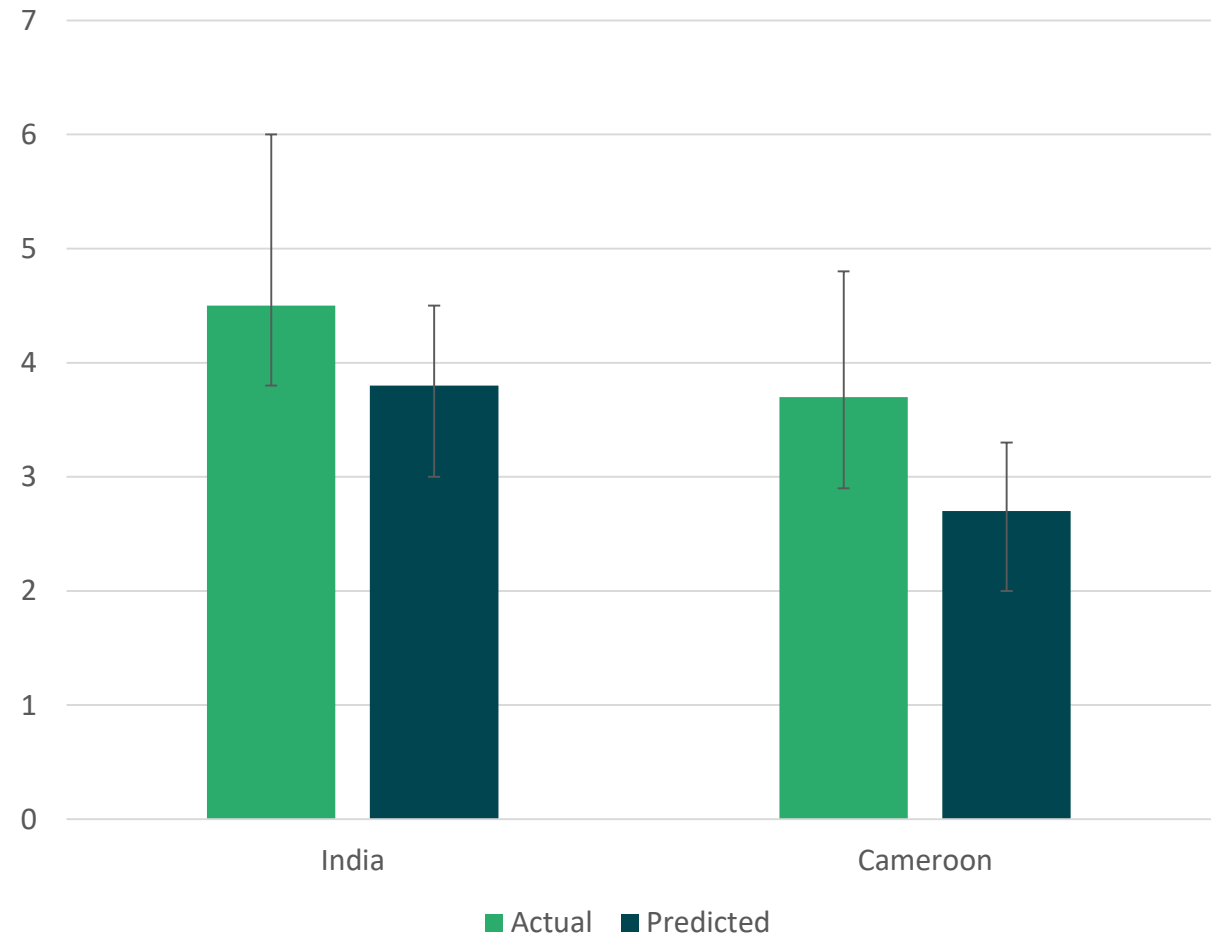


Hearing loss by age

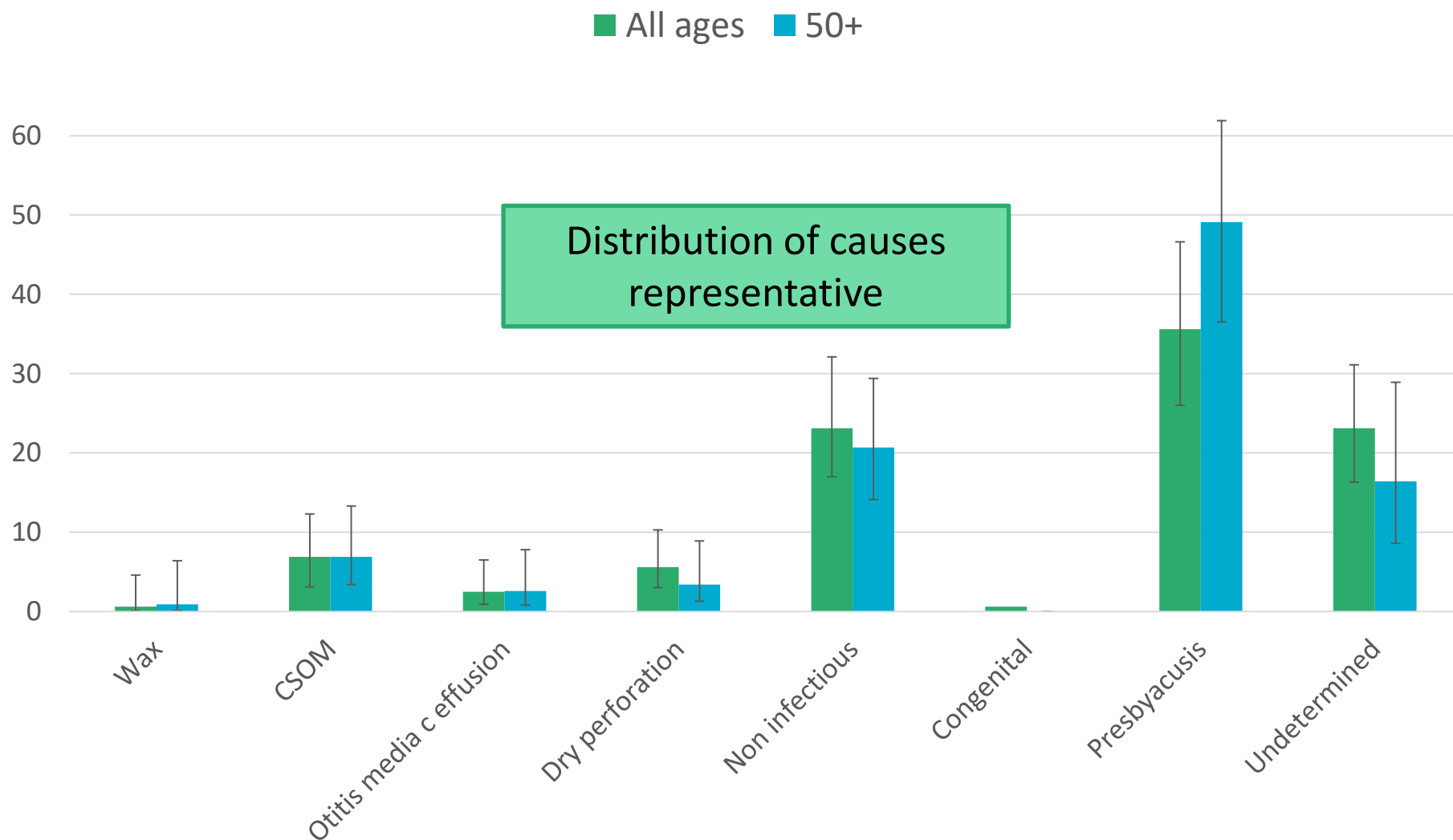


Prediction model

- Poisson models created to predict prevalence based on people aged 50+



What about the causes?



Sample size

| | Expected prevalence | Confidence interval | Margin of error (around the estimate) | Design effect | Minimum sample size | 10% non-response |
|---|---------------------|---------------------|---------------------------------------|---------------|---------------------|------------------|
| 1 | 5% | 95% | 20% (0.01) | 2 | 3650 | 4055 |
| 2 | 10% | 95% | 20% (0.02) | 2 | 1729 | 1921 |
| 3 | 15% | 95% | 20% (0.03) | 2 | 1089 | 1210 |



70%

Focus on people 50+



Exposure
to loud noise



Natural Aging



Heredity



Head Injury



Ototoxic
Medications



Illness





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

JMIR REHABILITATION AND ASSISTIVE TECHNOLOGIES

Bright & Pallawela

Review

Validated Smartphone-Based Apps for Ear and Hearing Assessments: A Review

Tess Bright, BBiomedSc, MCLinAud, MSc; Danuk Pallawela, BSc, MSc
London School of Hygiene & Tropical Medicine, London, United Kingdom

Corresponding Author:

Tess Bright, BBiomedSc, MCLinAud, MSc
London School of Hygiene & Tropical Medicine
Keppel St
London, WC1E 7HT
United Kingdom
Phone: 44 (0)20 7636 8636
Fax: 44 (0)20 7436 5389
Email: tess.bright1@lshtm.ac.uk

Abstract

Background: An estimated 360 million people have a disabling hearing impairment globally, the vast majority of whom live in low- and middle-income countries (LMICs). Early identification through screening is important to negate the negative effects of untreated hearing impairment. Substantial barriers exist in screening for hearing impairment in LMICs, such as the requirement for skilled hearing health care professionals and prohibitively expensive specialist equipment to measure hearing. These challenges may be overcome through utilization of increasingly available smartphone app technologies for ear and hearing assessments that are easy to use by unskilled professionals.

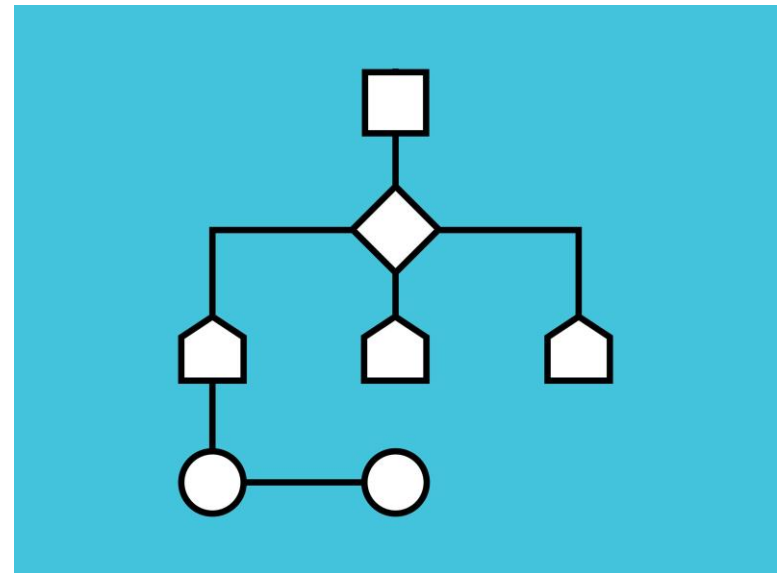
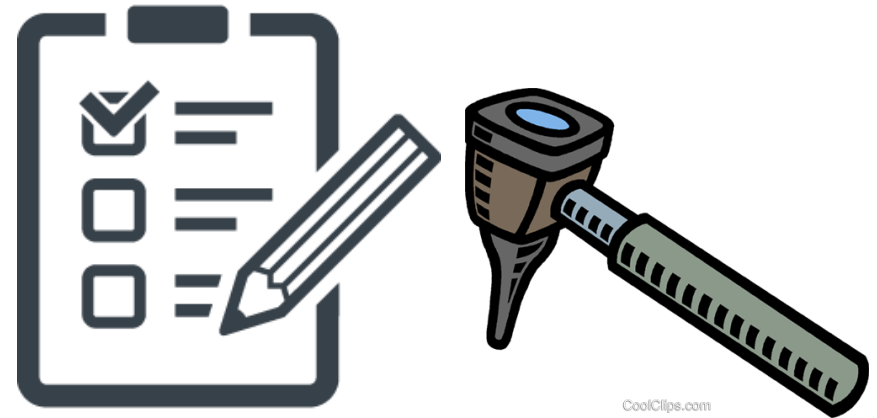
Objective: Our objective was to identify and compare available apps for ear and hearing assessments and consider the incorporation of such apps into hearing screening programs

Methods: In July 2015, the commercial app stores Google Play and Apple App Store were searched to identify apps for ear and hearing assessments. Thereafter, six databases (EMBASE, MEDLINE, Global Health, Web of Science, CINAHL, and mHealth Evidence) were searched to assess which of the apps identified in the commercial review had been validated against gold standard measures. A comparison was made between validated apps.

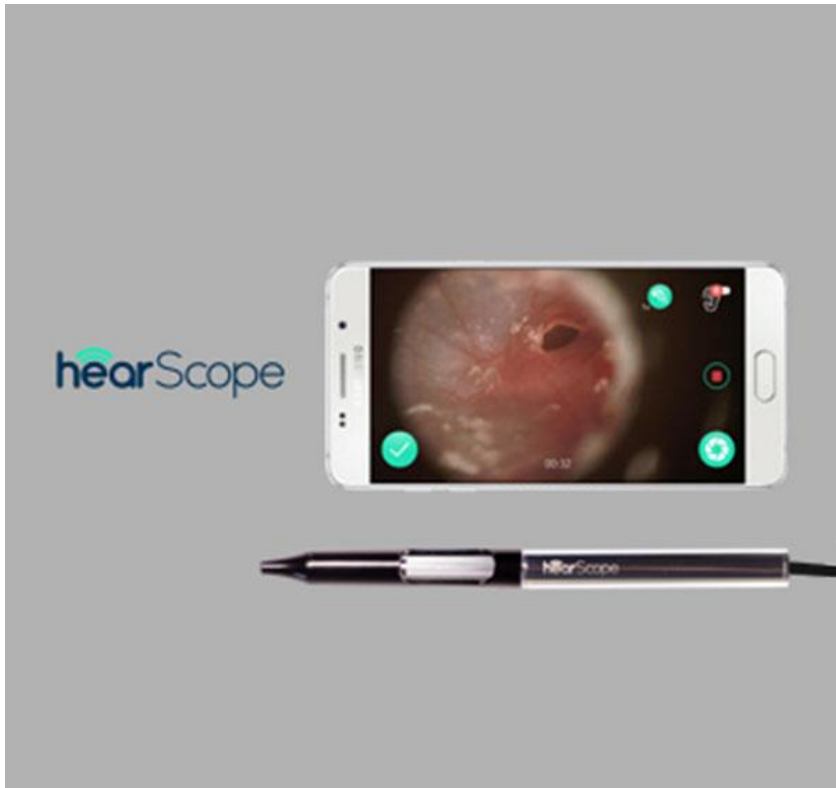
Results: App store search queries returned 30 apps that could be used for ear and hearing assessments, the majority of which are for performing audiometry. The literature search identified 11 eligible validity studies that examined 6 different apps. uHear, an app for self-administered audiometry, was validated in the highest number of peer reviewed studies against gold standard pure tone audiometry (n=5). However, the accuracy of uHear varied across these studies.

Conclusions: Very few of the available apps have been validated in peer-reviewed studies. Of the apps that have been validated, further independent research is required to fully understand their accuracy at detecting ear and hearing conditions.

Included tools

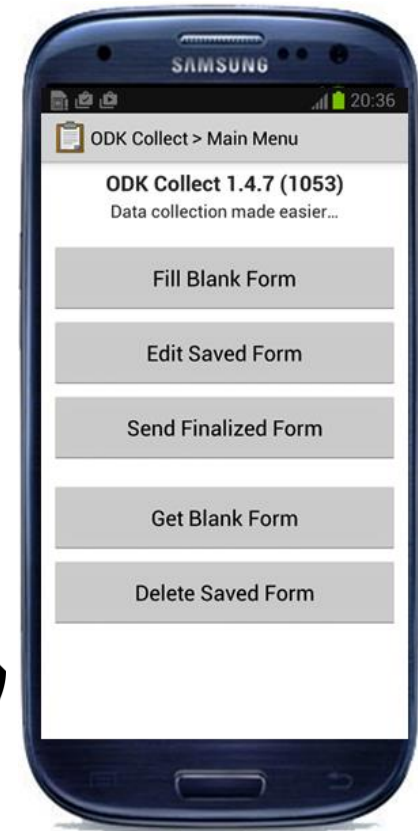
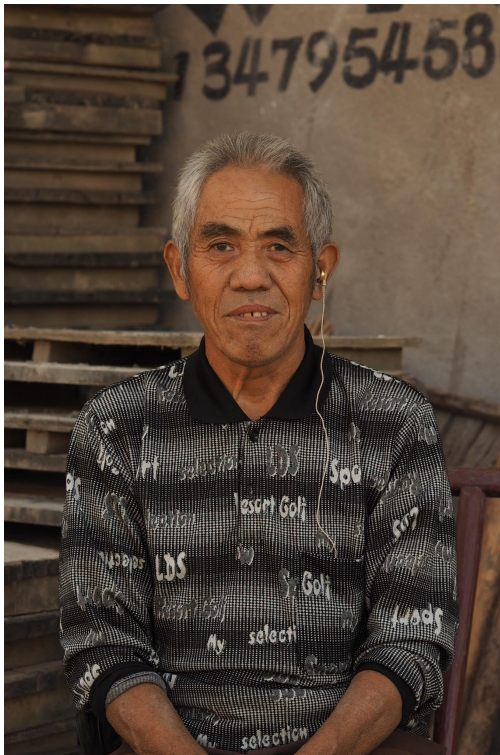


Other outstanding questions



Rapid Assessment of Hearing Loss

- Population-based survey of hearing loss and its causes in people aged 50+
- How is it rapid?



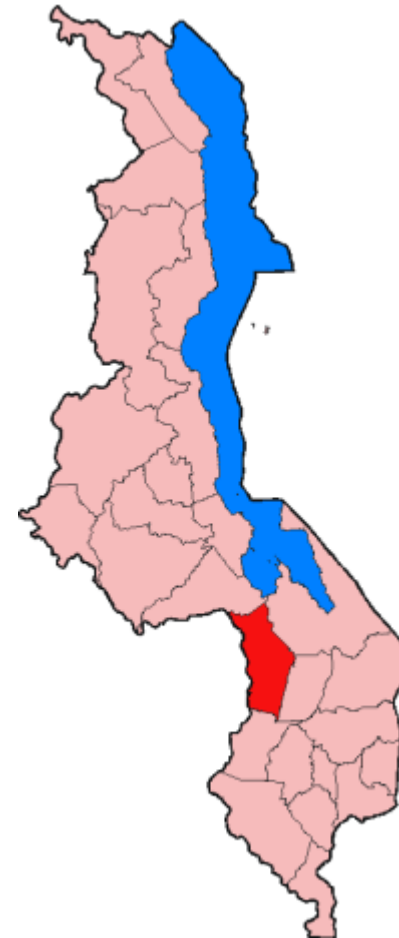
Field-testing in China and Malawi



China: Gao'an County



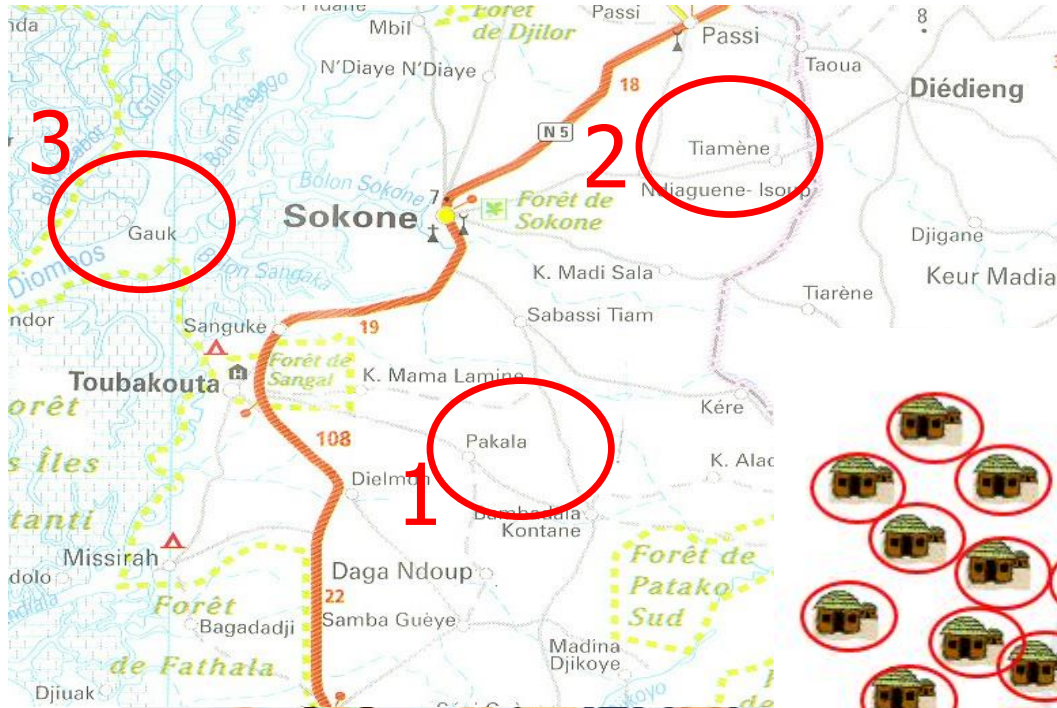
Malawi: Ntcheu District



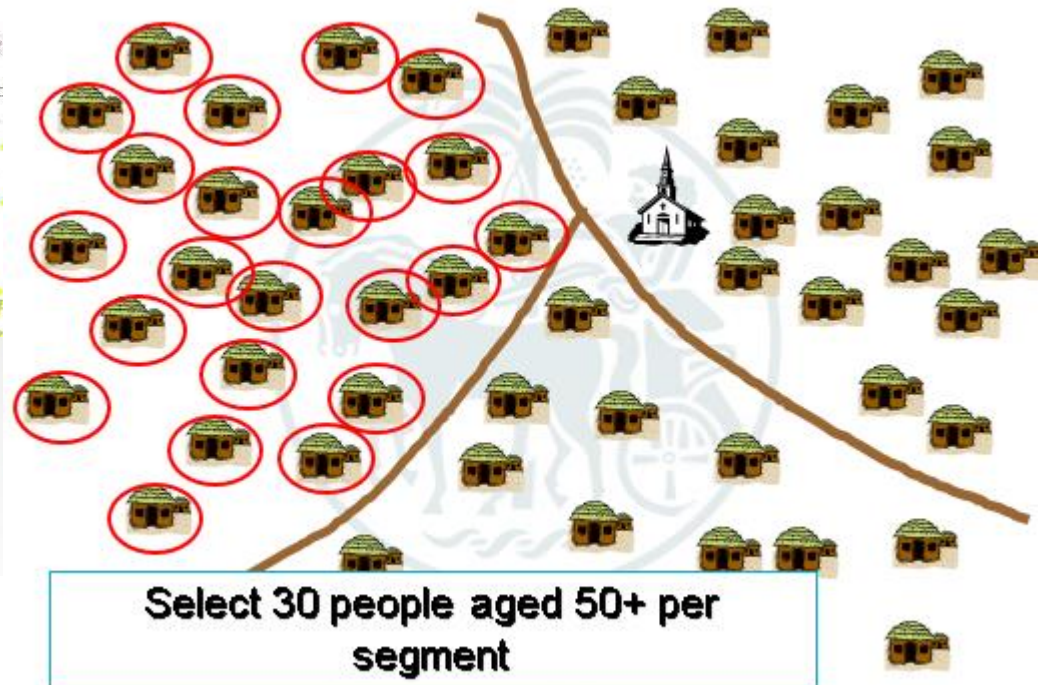
Brief overview of RAHL methods

1. Sampling
2. Teams
3. Data collection procedures
4. Actions

Sampling: 2 stage cluster sampling



Probability proportionate to size



Diagnostic accuracy of non-specialist versus specialist health workers in diagnosing hearing loss and ear disease in Malawi

Tess Bright¹, Wakisa Mulwafu^{2,3}, Mwanaisha Phiri², Robbert J. H. Ensink⁴, Andrew Smith¹, Jennifer Yip¹, Islay Mactaggart¹ and Sarah Polack¹

¹ International Centre for Evidence in Disability, London School of Hygiene & Tropical Medicine, London, UK

² Audiology Department, Queen Elizabeth Central Hospital, Blantyre, Malawi

³ Department of Surgery, University of Malawi, Blantyre, Malawi

⁴ Department of Oto-rhino-laryngology, Gelre Hospitals, Zutphen, The Netherlands

Abstract

OBJECTIVE To determine whether a non-specialist health worker can accurately undertake audiometry and otoscopy, the essential clinical examinations in a survey of hearing loss, instead of a highly skilled specialist (i.e. ENT or audiologist).

METHODS A clinic-based diagnostic accuracy study was conducted in Malawi. Consecutively sampled participants ≥ 18 years had their hearing tested using a validated tablet-based audiometer (hearTest) by an audiologist (gold standard), an audiology officer, a nurse and a community health worker (CHW). Otoscopy for diagnosis of ear pathologies was conducted by an ENT specialist (gold standard), an ENT clinical officer, a CHW, an ENT nurse and a general nurse. Sensitivity, specificity and kappa (κ) were calculated. 80% sensitivity, 70% specificity and kappa of 0.6 were considered adequate.

RESULTS Six hundred and seventeen participants were included. High sensitivity ($>90\%$) and specificity ($>85\%$) in detecting bilateral hearing loss was obtained by all non-specialists. For otoscopy, sensitivity and specificity were $>80\%$ for all non-specialists in diagnosing any pathology except for the ENT nurse. Agreement in diagnoses for the ENT clinical officer was good ($\kappa = 0.7$) in both ears. For other assessors, moderate agreement was found ($\kappa = 0.5$).

CONCLUSION A non-specialist can be trained to accurately assess hearing using mobile-based audiometry. However, accurate diagnosis of ear conditions requires at least an ENT clinical officer (or equivalent). Conducting surveys of hearing loss with non-specialists could lower costs and increase data collection, particularly in low- and middle-income countries, where ENT specialists are scarce.

keywords hearing loss, community health worker, epidemiology, prevalence, diagnostic accuracy

Introduction

Data on the prevalence and causes of hearing loss are lacking in many low- and middle-income countries (LMICs). A systematic review of studies conducted in sub-Saharan Africa found only eight published studies from the region [1]. Recent WHO estimates suggest that approximately 5% of the global population – or 466 million people – have disabling hearing loss (hearing loss of moderate or greater degree in the better ear) [2]. The estimates provide evidence that hearing loss is very common, however, many of the studies contributing to these estimates were conducted more than 10 years ago [3]. Only

Assembly passed a new resolution on hearing loss which called for member states to collect country-specific data on the prevalence and causes of hearing loss [4].

In low-resource settings, there are several challenges in conducting an all-age population-based survey of the prevalence and causes of hearing loss. The cost of surveys is a significant barrier – which is driven by the large sample size required, the high costs of specialist equipment and the costs of human resources to carry out the survey.

One way to reduce the costs of a survey and increase data collection could be to develop a rapid survey method. A rapid method is appropriate when data are needed quickly, and there are substantial barriers (in

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

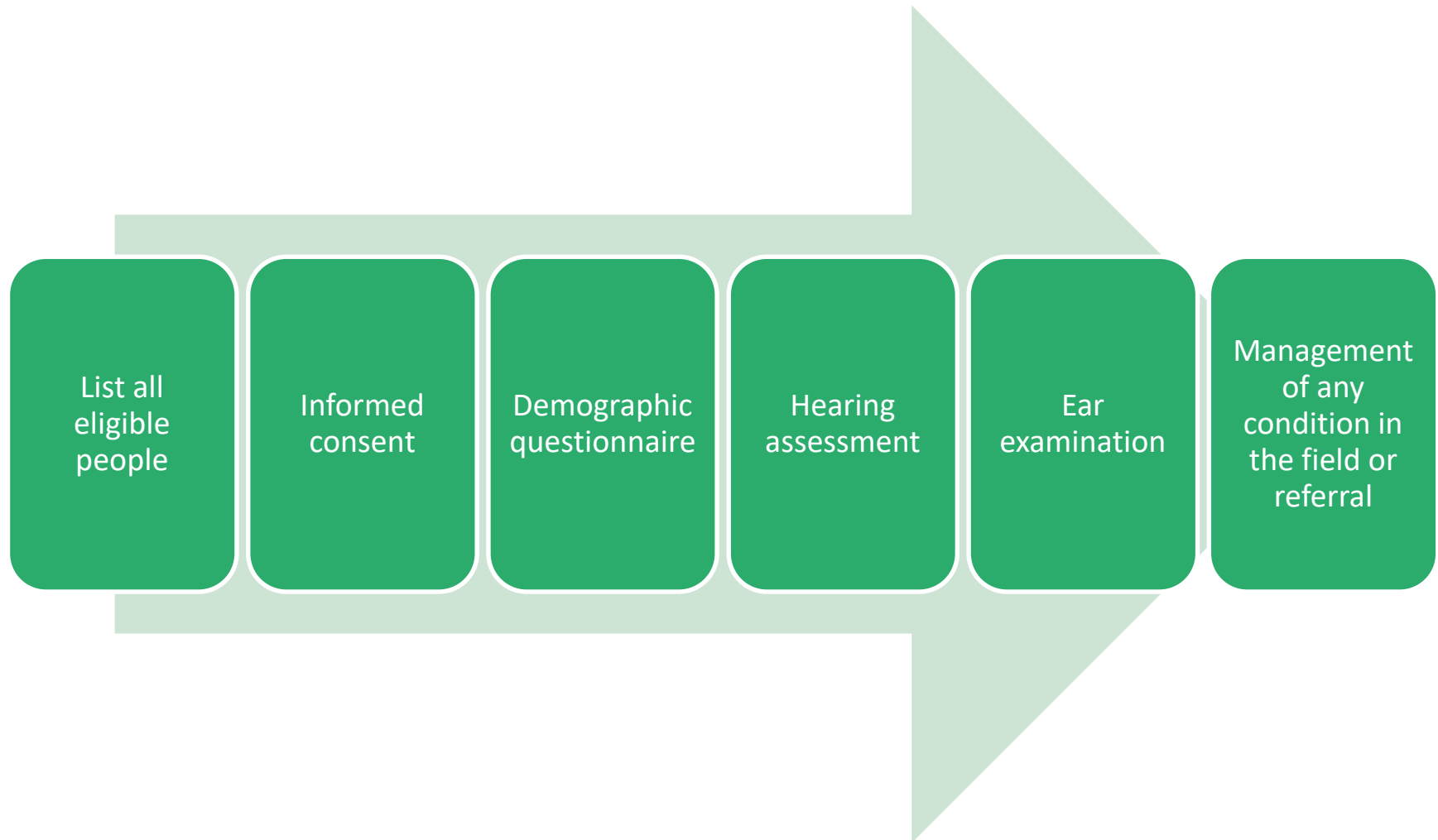


Hearing tests:
Nurse, and
audiology officer



Ear examination
and diagnosis: ENT
Clinical officer

Data collection procedures



Questionnaires completed on Open Data Kit (mobile data collection)



| SECTION A: GENERAL QUESTIONNAIRE | | | |
|----------------------------------|---|----------------|--------------|
| Number | Question | Response | Skip pattern |
| A1 | Date (DD/MM/YY) <u>Tsiku (DD/MM/YY)</u> | | |
| A2 | Interviewer name <u>Dzina la yemwe akufunsa</u> <u>mufunso mukafukufukuyu.</u> | | |
| A3 | Cluster name <u>Dzina la gulu</u> | | |
| A4 | Participant name <u>Dzina la yemweakutenga</u> <u>nawo mbali</u> <u>mukafukufukuyu.</u> | | |
| A5 | Participant initials <u>Dzina la yemwe akutenga</u> <u>nawo mbali</u> <u>mukafukufukuyu.</u> | | |
| A6 | Sex <u>Ndiwa mkazi kapena</u> <u>wamwamuna</u> | Male Female | |

RISK FACTOR SCREEN

| | | |
|-----|--|---|
| A28 | Have you ever been involved in activities where you were exposed to sounds for more than 4 hours a day, several days per week? <u>Loud noise means so loud that you need to raise your voice to be heard</u> <u>Munayamba mwagwira ntchito kapena munayamba mwapezeka pa malo poti panali phokoso kwanthawi yokwana maola anayi kapena kuposera apo patsiku kapena kwa masiku angapo musabata limodzi?</u> | 1=Yes 2=No |
| A29 | For how long have you been exposed at work to loud sounds for more than 4 hours a day, several days a week? <u>Kodi munagwira ntchito kwanthawi yayitali bwanji pamalo a phokoso lamachini lomwe linali lopitilira maola anayi pa tsiku?</u> | 1=Less than 1 year 2=1 year or more 1= Nthawi yosachepera chaka |



Simplified examination protocol



Determining causes

Assessment of hearing loss



Thresholds obtained at 500, 1000,
2000, 4000

(van Tonder et al. 2017)

Image credit: hearX; PATH medical; CoolClips; Simply Psychology

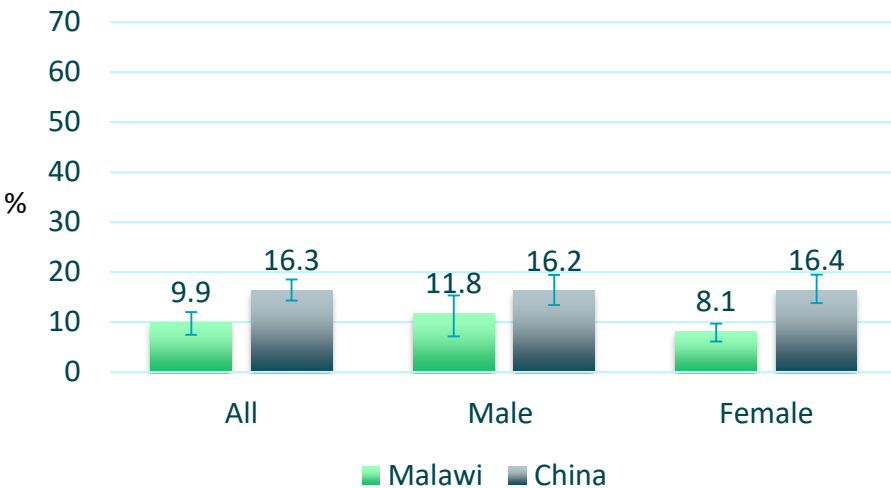




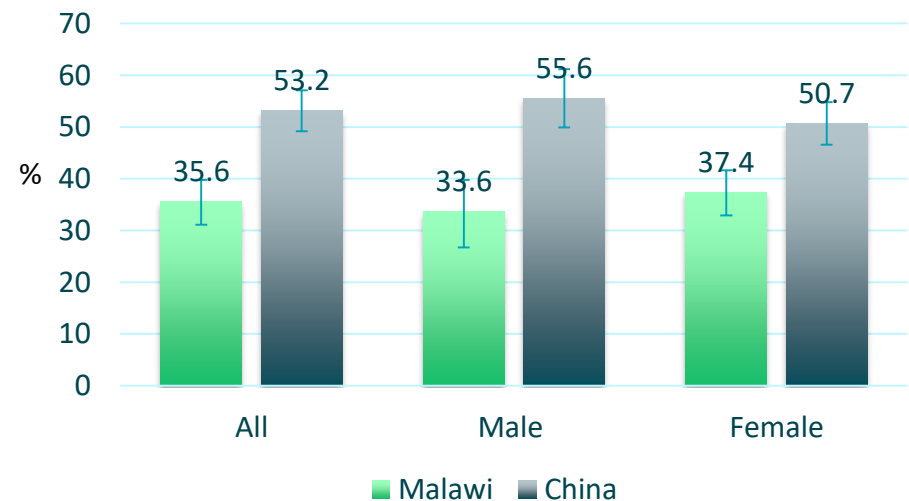


Prevalence of hearing loss

Moderate or greater hearing loss



Any level of hearing loss



Moderate or greater hearing loss

China

16.3%

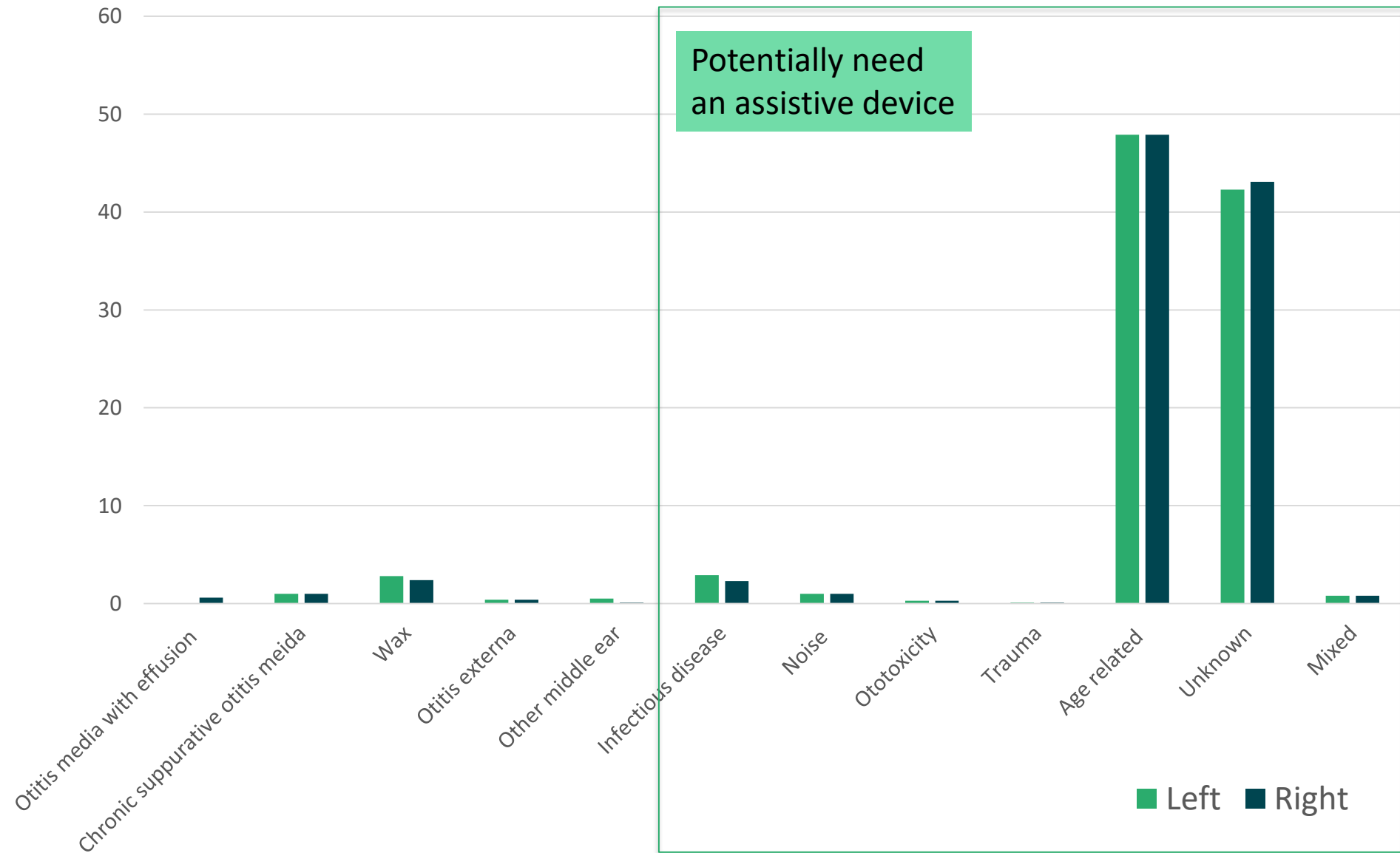


Malawi

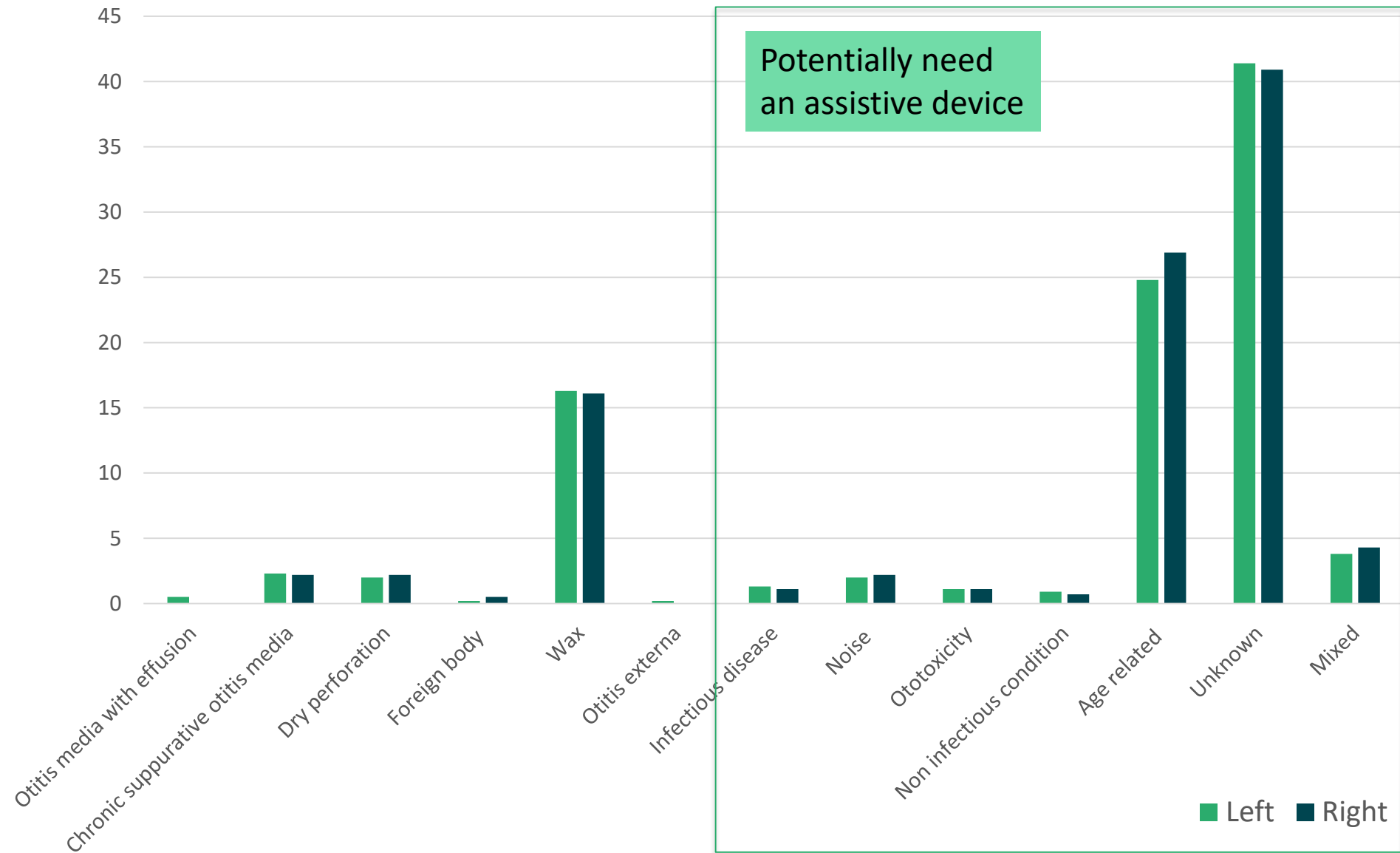
9.9%



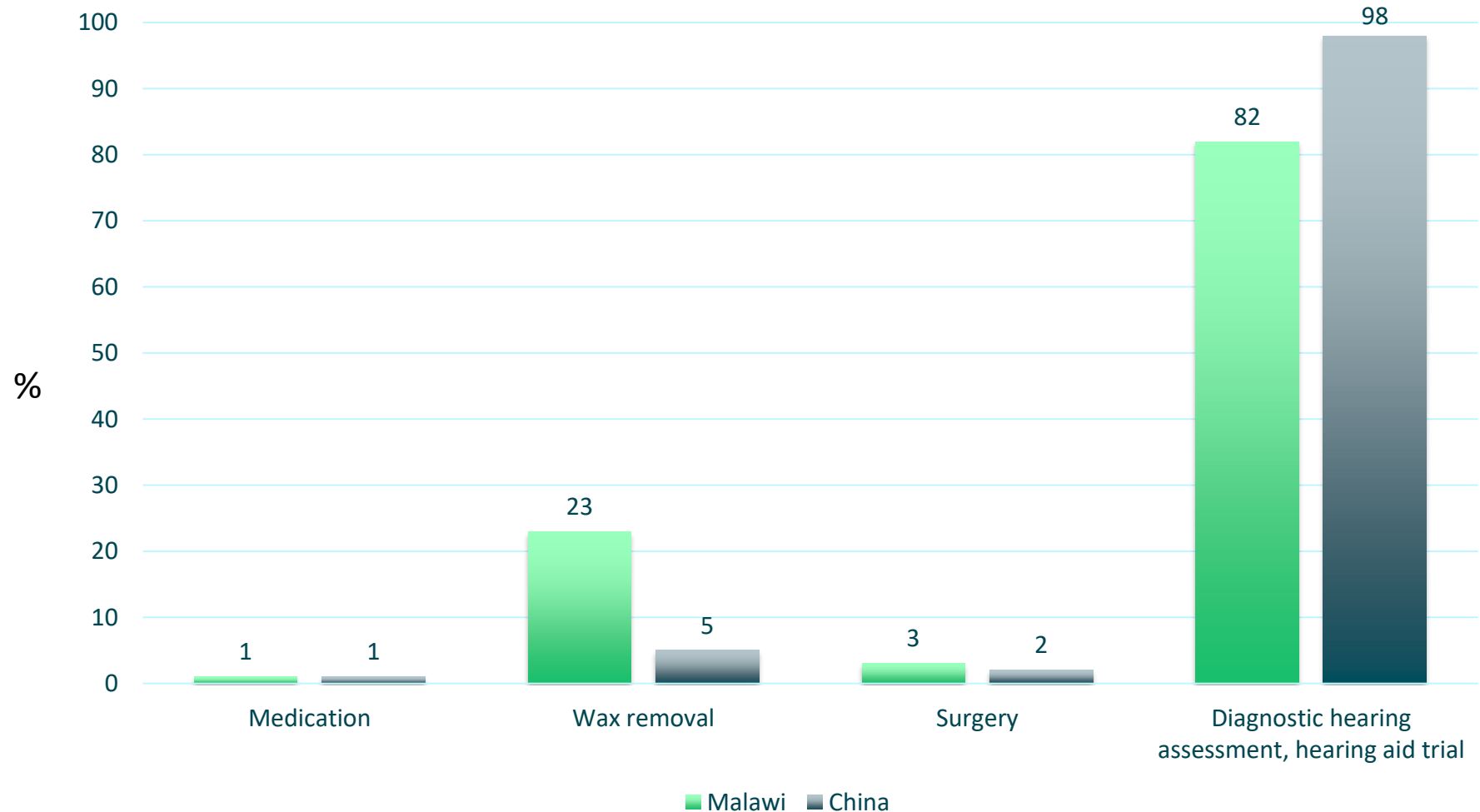
Probable causes of hearing loss: China



Probable causes of hearing loss: Malawi

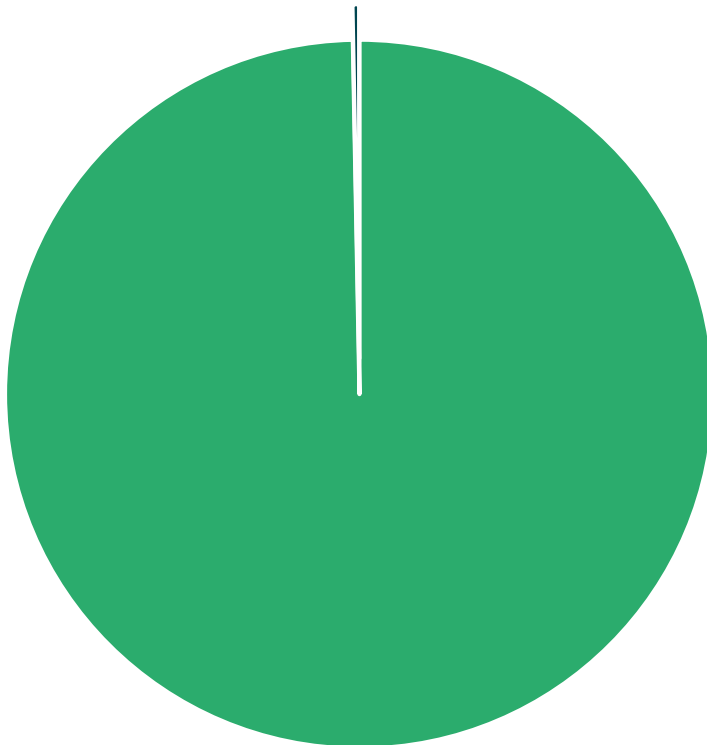


Service needs



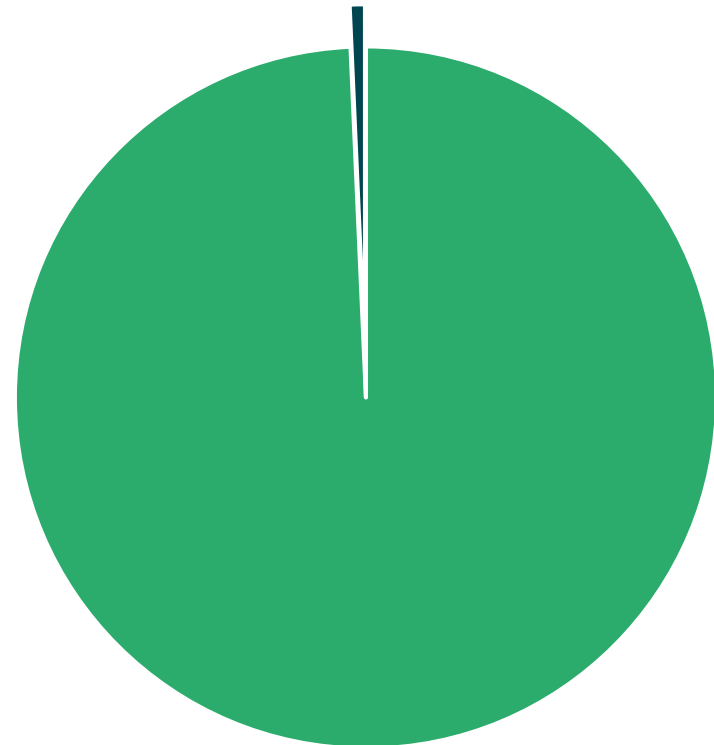
Hearing aid coverage

Ntcheu (Malawi)



■ Not covered ■ Covered

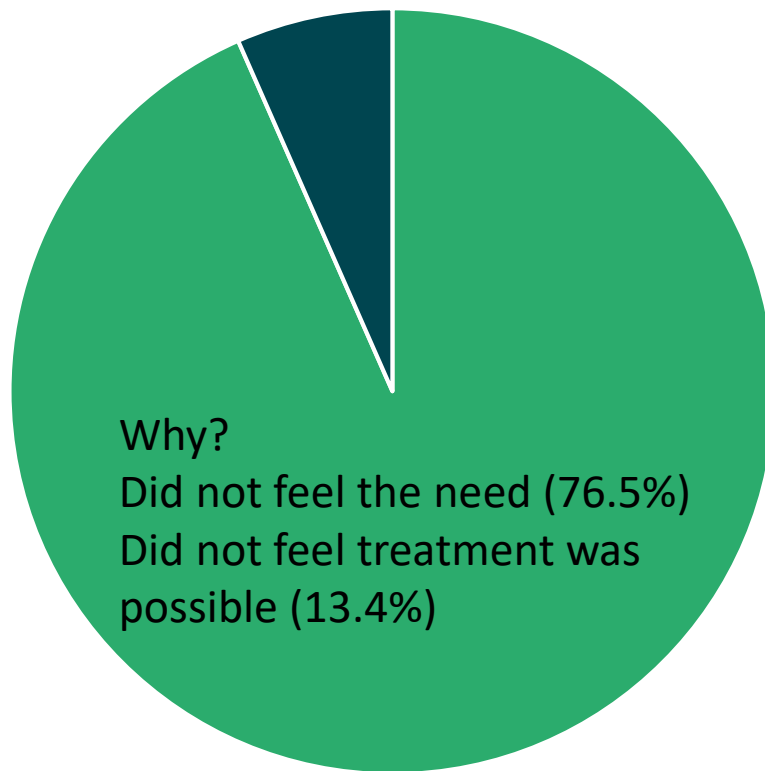
Gao'an (China)



■ Not covered ■ Covered

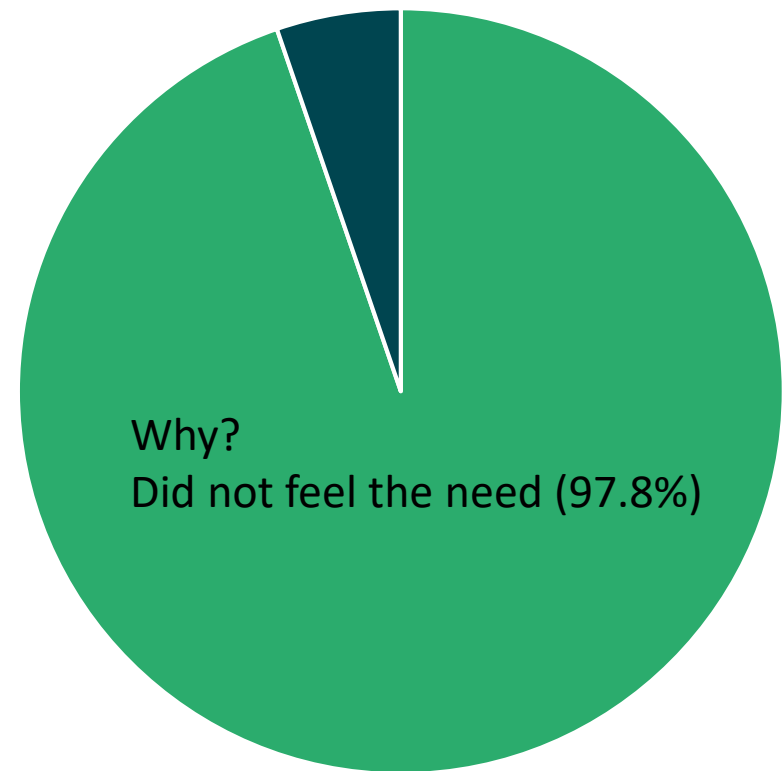
Previous care seeking

Ntcheu (Malawi)



■ Care not sought ■ Sought care

Gao'an (China)



■ Care not sought ■ Sought care

Feasibility findings

| | Malawi | China |
|--------------------|-----------------------------|------------------------------|
| Response rate | 93.7% | 94.6% |
| Sample size | 1080 | 1344 |
| Time taken | 24 days | 25 days |
| | 23.7 minutes/participant | - |
| Cluster completion | 13% needed return visits | 100% completed in one day |
| Background noise | No major problems | No major problems |

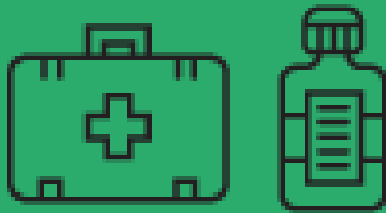
Rapid vs conventional survey



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

- **Bright, T; Mactaggart, I; Kim, M; Yip, J; Kuper, H; Polack, S;** (2019) Rationale for a Rapid Methodology to Assess the Prevalence of Hearing Loss in Population-Based Surveys. *International Journal of Environmental Research and Public Health*, 16 (18).
- **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;** Wallace, S; **Kuper, H;** (2018) *A Systematic Review of Access to Rehabilitation for People with Disabilities in Low- and Middle-Income Countries*. *International journal of environmental research and public health*, 15 (10). ISSN 1661-7827 DOI: <https://doi.org/10.3390/ijerph15102165>
- **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?

tess.bright@lshtm.ac.uk

Research Fellow | PhD Candidate | Audiologist
International Centre for Evidence in Disability
London School of Hygiene & Tropical Medicine

Parking lot

Assessment of causes

| Type | Cause | Method |
|---------------|--|---|
| Conductive | Acute otitis media Otitis media with effusion Chronic suppurative otitis media Wax impaction Foreign body Otitis externa <i>Rarer causes: cholesteatoma, mastoiditis, otosclerosis, tumours</i> | Clinical history Otoscopy <i>(+/-) tympanometry (tbd)</i> |
| Sensorineural | Presbycusis Noise exposure Ototoxicity Non-communicable diseases(diabetes, cardiovascular disease) Infectious disease (acquired) Congenital (in utero infection, birth complications, genetic) Trauma Unknown aetiology <i>Rarer causes: acoustic neuroma, Meniere's disease</i> | Clinical history |

| | Malawi | | China | |
|--------|------------------|-------------------|-------------------|-------------------|
| | Disabling | Any level | Disabling | Any level |
| All | 9.9 (7.8, 12.4) | 35.6 (31.4, 40.1) | 16.3 (14.3, 18.5) | 53.2 (49.2, 57.1) |
| Male | 11.8 (8.3, 16.5) | 33.6 (27.4, 40.5) | 16.2 (13.4, 19.4) | 55.6 (49.9, 61.2) |
| Female | 8.1 (6.5, 10.1) | 37.4 (33.2, 41.9) | 16.4 (13.8, 19.5) | 50.7 (46.6, 54.8) |



TABLE 2. Prevalence of disabling hearing impairment and any level hearing impairment by age, and gender, Mabhugnagar District, India, 2014

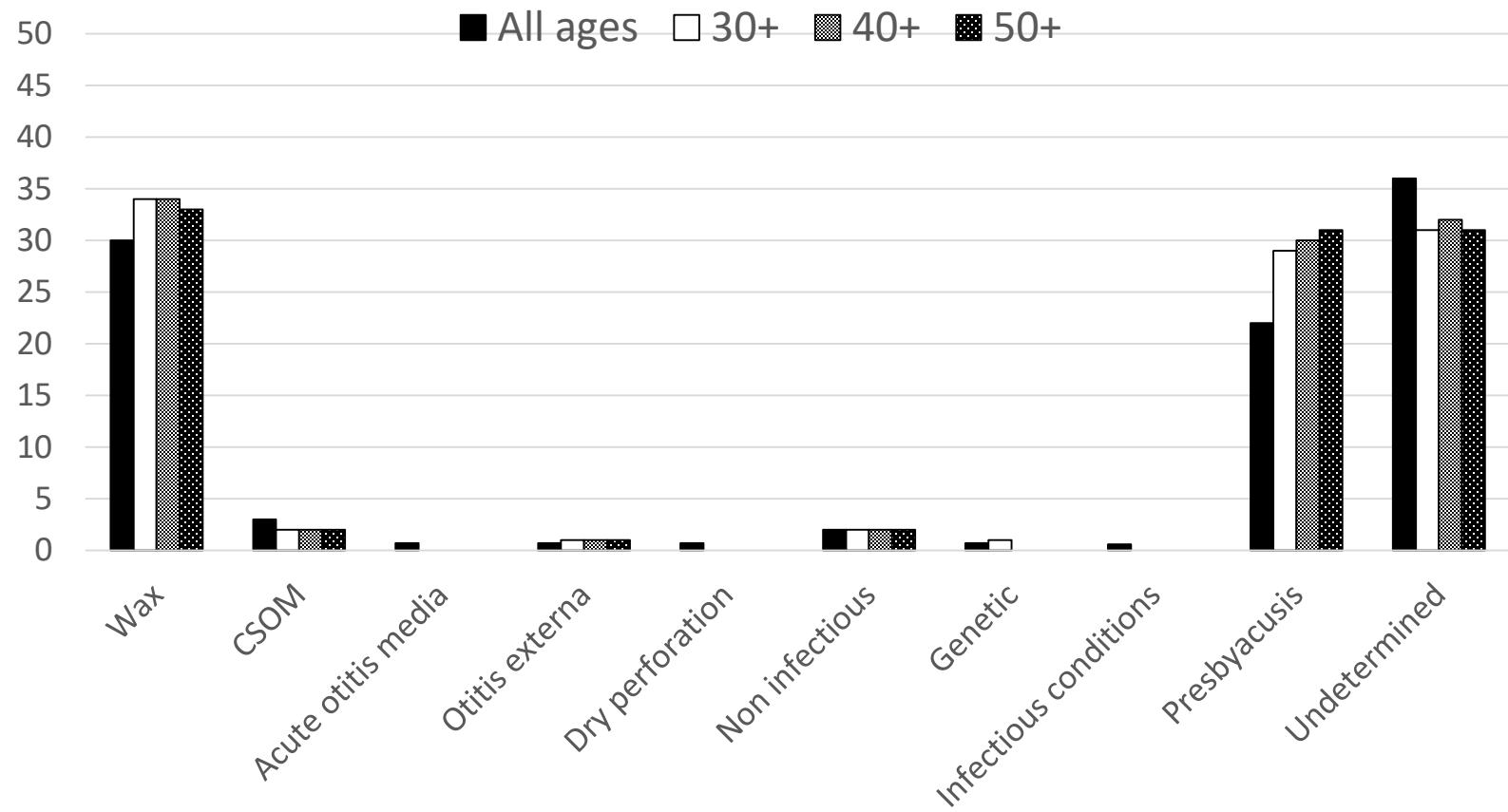
| Age Group (yr) | Total Number | Disabling Hearing Impairment | | | Any Level of Hearing Impairment | | |
|----------------|--------------|------------------------------|---------------------------|----------|---------------------------------|---------------------------|----------|
| | | No. Cases | Prevalence (%; 95% CI) | <i>p</i> | No. Cases | Prevalence (%; 95% CI) | <i>p</i> |
| All | 3573 | 160 | 4.5 (3.8–5.3) | — | 318 | 8.9 (7.5–10.5) | — |
| 0–3 | 280 | 5 | 1.8 (0.7–4.8) | <0.001* | 5 | 1.8 (0.6–4.8) | <0.001* |
| 4–17 | 943 | 4 | 0.4 (0.2–1.1) | — | 7 | 0.7 (0.3–1.5) | — |
| 18–35 | 1198 | 15 | 1.3 (0.7–2.2) | — | 34 | 2.8 (1.8–4.3) | — |
| 36–50 | 605 | 22 | 3.6 (2.3–5.7) | — | 72 | 11.9 (8.9–15.8) | — |
| 51–64 | 345 | 44 | 12.8 (9.1–17.7) | — | 94 | 27.2 (21.6–33.7) | — |
| Older than 65 | 202 | 70 | 34.7 (28.7–41.1) | — | 106 | 52.5 (45.3–59.5) | — |
| Males | 1707 | 74 | 4.3 (3.5–5.4) | 0.693† | 152 | 8.9 (7.4–10.7) | 0.993† |
| Females | 1866 | 86 | 4.6 (3.7–5.7) | — | 166 | 8.9 (7.3–10.8) | — |

0.9% <18 years

Sample size for children=11,765



Causes: Cameroon



Rapid vs conventional survey

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

Feasibility findings

| | Malawi | China |
|--------------------|--|---------------------------|
| Response rate | 93.7 | 94.6 |
| Sample size | 1080 | 1344 |
| Time taken | 24 days | 25 days |
| Cluster completion | 13% needed return visits | 100% completed in one day |
| Background noise | No major problems | No major problems |
| Costs | Tbd | Tbd |
| RAAB+RAHL | Feasible, but additional questions remaining | N/A |