# **Estimating assistive product need in Cameroon and India: results of population-based surveys and** comparison of **self-report and clinical impairment assessment approaches**

Dorothy Boggs1, Hannah Kuper1, Islay Mactaggart1, GVS Murthy1,2, Joseph Oye3, Sarah Polack1

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

2 Indian Institute of Public Health, Plot No #1, A.N.V. Arcade, Amar Co-op Society, Kavuri Hills, Madhapur, Hyderabad, 500033, India

3 Sightsavers, Yaounde, Cameroon

**Corresponding Author:** Dorothy Boggs, c/o International Centre for Evidence in Disability (ICED), London School of Hygiene & Tropical Medicine, Keppel St, London WC1E7HT, United Kingdom, dorothy.boggs@lshtm.ac.uk

**Keywords:** Assistive product (AP); data; surveys; population; need.

## ABSTRACT

### Objectives

To i) estimate population need and coverage for distance glasses, hearing aids and wheelchairs in India and Cameroon; ii) explore the relationship between assistive product (AP) need measured through self-report and clinical impairment assessment.

### Methods

Population based surveys of approximately 4000 people each were conducted in Mahabubnagar district, India and Fundong district, Cameroon. Participants underwent standardised vision, hearing and musculoskeletal impairment assessment to assess need for distance glasses, hearing aids, wheelchairs. Participants with moderate or worse impairment and/or self-reported difficulties in functioning were also asked about their self-reported AP need.

### Results

6.5% (95% CI 5.4-7.9) in India and 1.9% (95% CI 1.5-2.4) in Cameroon of the population needed at least one of the three APs based on moderate or worse impairments. Total need was highest for distance glasses [3.7% (95% CI 2.8-4.7) India; 0.8% (95% CI 0.5-1.1), Cameroon] and lowest for wheelchairs (0.1% both settings; 95% CI 0.03-0.3 India, 95% CI 0.04-0.3 Cameroon). Coverage for each AP was below 40%, except for distance glasses in India which was 87% (95% CI 77.1-93.0). The agreement between self-report and clinical impairment assessment of AP need was poor. For instance, in India, 60% of people identified through clinical assessment as needing distance glasses did not self-report a need. Conversely, in India, 75% of people who self-reported needing distance glasses did not require one based on clinical impairment assessment.

### Conclusions

There is high need and low coverage of three APs in two low-and middle-Income settings. Methodological limitations highlight the need for improved survey methods compatible with the international classification of functioning, disability and health to estimate population-level need for AP and related services to inform advocacy and planning.

## INTRODUCTION

Assistive Technology (AT) includes both *assistive products* (AP) and the *systems* and *services* related to AP delivery. Estimates suggest at least 1 billion people in the world are in need of AT, and, with population ageing and an increase in non-communicable diseases, this is expected to reach up to two billion people by 2030.(1, 2) People who might benefit from AT include older people, people with disabilities, and people living with chronic health conditions, non-communicable diseases, and communicable diseases, including coronavirus-19 (COVID-19) survivors who may have long-term health and rehabilitation needs*.*(1, 3, 4) Access to AT is a fundamental human right(5-7) and is essential for achieving the each of the 17 Sustainable Development Goals (SDGs).(8) AT can be instrumental in facilitating active and independent participation in key life areas including livelihoods, education, and social engagement.(1, 2, 8)However, according to World Health Organization (WHO) the majority of people who need AT do not have access to it, particularly in low-and middle-income countries (LMIC).(1)

Reliable data on population-level AT need/unmet need is essential for evidence-based advocacy and planning of programmes to increase provision and access to AT. However, few robust population-level surveys of AT exist globally and among those that do, methods vary considerably. Global AT estimates are based on extrapolations from sparse data and may therefore not be reliable.(9, 10) The recognition of need for this data has increased over the past ten years with the growth in global initiatives to scale up AT access, such as the WHO Global Cooperation on Assistive Technology (GATE) initiative(11) and more recently ATscale.(12, 13)ATScale focuses on five priority APs which include: glasses, hearing aids, wheelchairs, prosthetics, and smart personal digital assistants and tablets with accessible software/applications.(12)

The WHO International Classification of Functioning, Disability and Health (ICF) (**Figure 1**) identifies that people may have an impairment as a result of a health condition, which can lead to activity difficulties and participation restrictions. This relationship is mediated by personal factors, such as education, and environmental factors, such as AT, which can enhance participation among people with impairments (**Web appendix Table 1**).(14, 15)AT is typically considered an ICF environmental factor. However, determining an individual’s *need* for AT requires understanding of the impairment as well as activities, participation and personal and environmental factors, as illustrated in **Figure 1**. AT need is therefore complex to assess and particularly within population-based surveys which require standardised measurement approaches completed within time and resources constraints. Different approaches have been used which often define, conceptualise and measure impairment, AT and functioning in different ways.

This paper, which is adapted from the authors’ broader WHO GReAT Consultation 2019 conference paper on AT assessment in population surveys(16), uses an ICF lens to consider two different approaches used in population-based surveys to assess AP need: i) self-report and ii) clinical impairment assessment. The first method involves the participant’s own assessment of their functional limitations (usually assessed by self-reported activity limitations) and associated need for AT. This method is typically quick to administer, lower cost and considers individuals’ reported need in their own environment. The second adopts standardised clinical methods to assess the presence of impairment followed by a clinician’s assessment of AT needs based on type, cause and severity of the impairment. The impairment approach can provide more reliable data for planning of related health services, but is more resource intensive. There are therefore advantages and disadvantages of these approaches (**Table 1**). There is little evidence on the relationship between the AP data generated by these two approaches, although it would help to improve survey methodology to collect much-needed data on population-based AP need.

In this paper, we undertake a secondary analysis of data from two population-based disability surveys conducted in one district each of Cameroon and India(17, 18), in order to:

1. Estimate use, unmet need and coverage for three ATScale priority APs assessed: distance glasses, hearing aids and wheelchairs.
2. Explore the relationship between participant self-report and clinical impairment methods for assessing AP need within population surveys.

## METHODS

Population surveys in one district each in India and Cameroon were conducted in 2013-14.(17-25) In India, the study was conducted in the Mahabubnagar District, Telangana State, India, where the majority (85%) of the population live in rural areas and approximately 48% are literate.(25) In Cameroon, the study was undertaken in Fundong Health District in the North-West region, a predominately rural (63% of the region) mountainous area and one of two English-speaking regions in the country.(25) Details of survey findings on disability and impairment prevalence are published elsewhere: In summary, in India and Cameroon respectively, overall prevalence of disability was estimated to be 10.5% (95% CI 9.4-11.7) and 8.4% (95% CI 7.5-9.4); moderate/severe vision impairment (VI) 3.5% (95% CI 2.7-4.4) and 2.3% (95% CI 1.8-3.0); moderate/severe hearing impairment (HI) 4.4% (95% CI 3.7-5.2) and 3.6% (95% CI 2.8-4.6), and moderate/severe musculoskeletal impairment (MSI) 3.5% (95% CI 2.9-4.3) and 3.4% (95% CI 2.7-4.4).(17-24)

Two stage cluster-sampling with probability proportionate to size and compact segment sampling were used to identify approximately 4,000 participants per setting using 2011 and 2005 census data for the sampling frame from India and Cameroon respectively. Data was collected as part of a wider survey of disability which was powered to detect an all-age prevalence of disability of 4%. This required a sample of 4,056 per country, assuming precision of 20%, 95% confidence, a design effect of 1.4 and 20% non-response.

Participants were interviewed using the 21-item Washington Group (WG) extended set (ES, ages >17 years), and the 23-item Child Functioning Module (CFM, for ages 2-17).(26-30) These tools ask about limitations in different functional domains using a four-point response scale: no difficulty, some difficulty, a lot of difficulty and cannot do.All participants also underwent standardised clinical assessment for VI, HI and MSI using Rapid Assessment of MSI (RAM).(31) Participants with visual acuity (VA)<6/18 (moderate VI) in Cameroon or VA<6/12 in India (mild VI) which improved to 6/18 or 6/12 in India and Cameroon respectively with pinhole were classified as having uncorrected refractive error (URE) and needing distance glasses. Participants identified as having HI or MSI were examined by relevant clinicians to determine cause and associated referral/AT needs, including need for hearing aids and wheelchairs (**Table 2**).

People were defined as having a disability if they had a moderate or more severe impairment (definitions in **Table 2**) and/or reported “a lot of difficulty” or more with core domains of the WG questions. They were asked about their self-reported need for and use of different APs including glasses and hearing aids.

We used STATA 15.0 to analyse the data. The ‘svy’ command was used to derive proportion estimates accounting for cluster sampling. The definitions for AP use, unmet need, total need and coverage according to clinical impairment assessment are listed in **Table 3**. Estimates of ‘total need’ for distance glasses and hearing aids were stratified by age and sex. This was not possible for wheelchairs because of the low numbers. We compared self-reported AP need to that identified through clinical impairment assessment making the assumption that clinical assessment provides more reliable data (**Table 3**).

### Ethical considerations

Ethical Approval for the study, including this secondary analysis, was granted by: The London School of Hygiene & Tropical Medicine (UK); National Ethics Committee for Research in Human Health (CNERSH, Cameroon); Cameroon Baptist Convention Health Board Institutional Review Board (Cameroon); Indian Institute of Public Health Hyderabad Institutional Ethics Committee (India); Government of India Health Ministry Screening Committee (India). Written (signature or thumb print) informed consent was obtained from all participants. Caregivers provided consent for participants aged <18 in India and <21 in Cameroon.

## RESULTS

In India, 4,125 people were enumerated and 3574 participants were screened and assessed for distance glasses, hearing aids and wheelchairs (response rate 88%). Of those who did not participate, 540 (13.1%) were unavailable and 11 (0.3%) refused. In Cameroon, 4,080 people were enumerated and 3567 participants were screened and assessed for the three APs (response rate 87%). Of those who did not participate, 521 (12.7%) were unavailable and 17 (0.5%) refused.

### Objective 1: Estimated population AP use, unmet need and coverage

**Table 4** presents estimated use, unmet need, total need and coverage of each AP in the two settings derived from clinical impairment assessment. In accordance with the original survey method these estimates are based on AP need for people with moderate or worse vision, hearing and musculoskeletal impairments. The exception is in India, which also assessed need for distance glasses for mild or worse VI.

#### Distance glasses

In India the prevalence of distance glasses use was 3.2% (95% CI 2.4-4.3, n=114), while this was lower in Cameroon at 0.3% (95% CI 0.2-0.5, n=10). The prevalence of glasses need based on moderate VI was 3.7% (95% CI 2.8-4.7, n=131) in India and 0.8% (95% CI 0.5-1.1, n=27) in Cameroon. The prevalence of unmet glasses need based on moderate VI was 0.5% in both settings (n=17; 95% CI 0.3-0.9 India, 95% CI 0.3-0.8 Cameroon). In India, need for people with mild vision loss or worse was 7.2% (95% CI 6.2-8.5, n=259) and unmet need was 4.1% (95% CI 3.2-5.1, n=141). There was high coverage of glasses (for vision loss of moderate/worse) in India (87%, 95% CI 77.1-93.0), but was lower (37%, 95% CI 20.3-57.5) in Cameroon. In India including people with mild vision loss in India, coverage was 44% (95% CI 34.1-54.2).

#### Hearing aids

Hearing aid use was low in both India (0.1%, 95% CI 0.1-0.3, n=5) and Cameroon (0.1%, 95% CI 0.03-0.3, n=3). The prevalence of need for hearing aids was 3.1% (95% CI 2.4-4.1, n=112) in India and 1.2% (95% CI 0.9-1.6, n=43) in Cameroon, while unmet need was 3.0% (95% CI 2.2-4.0, n=107) in India and 1.1% (95% CI 0.8-1.5, n=40) in Cameroon. Coverage was low in both settings: 4.5% (95% CI 1.8-10.6) in India and 7% (95% CI 2.2-20.3) in Cameroon.

#### Wheelchairs

Only one participant in India and none in Cameroon used a wheelchair. Wheelchair need was also low; with two participants in India (0.1%, 95% CI 0.01-0.2) and four in Cameroon (0.1%, 95% CI 0.04-0.3) identified as needing a wheelchair. Coverage was therefore 33.3% (95% CI 0.1-99.7) in India and 0% in Cameroon.

#### Need across the three APs

In total, 119 people (3.3%, 95% CI 2.5- 4.3) used at least one of the three devices in India and 13 (0.4%, 95% CI 0.2-0.6) in Cameroon. Based on moderate/worse impairment, the number who needed at least one of the three APs was 234 (6.5%, 95% CI 5.4-7.9) and 69 (1.9, 95% CI 1.5-2.5) in India and Cameroon respectively, and this total need increased in India to 334 (9.3%, 95% CI 8.0-10.9) if mild VI was included. Based on moderate/worse impairment, the number who had unmet need for at least one device was 124 (3.5%, 95% CI 2.7-4.5) in India and 57 (1.6%, 95% CI 1.2-2.1) in Cameroon. Extending the criteria to include people with mild VI in India (VA<6/12) increased unmet need to 224 (6.3%, 95% CI 5.1-7.7). Overall coverage of at least one AP was moderate in India (50.9%, 95% CI 41.5-60.2), decreasing if mild VI was included (35.6%, 95% CI 27.7-44.4), and low in Cameroon (18.8%, 95% CI 11.1-30.2).

#### Total need for distance glasses and hearing aids by age and gender

The need for distance glasses and hearing aids increased significantly with age (p<0.001) (**Table 5**)so that 8.2% (95% CI 5.7-11.7) and 4.4% (95% CI 2.8-6.8) of adults aged over 60 needed glasses and 20.7% (95% CI 15.9-26.6) and 7.7% (95% CI 5.5-10.7) needed hearing aids in India and Cameroon respectively. In India the need for distance glasses (mod VI) was significantly higher among women (4.7%, 95% CI 3.5-6.2) compared to men (2.6%, 95% CI 1.8-3.7, p<0.01).

#### Unmet need for distance glasses and hearing aids by age and gender

The unmet need for distance glasses and hearing aids increased significantly with age (p<0.001) (**Table 5**)so that 2.0% (95% CI 0.9-4.5) and 3.1% (95% CI 1.8-5.2) of adults aged over 60 needed glasses and 20.7% (95% CI 15.9-26.6) and 7.7% (95% CI 5.5-10.7) needed hearing aids in India and Cameroon respectively. There was no significant difference in unmet need by gender.

### Objective 2: Relationship between AP need measurement approaches

Figures 2 and 3 present findings on the relationship between the two different approaches for assessing distance glasses and hearing aids need.

#### Self-reported need for distance glasses among people with URE (VA<6/18)

In India, of the 10 people with URE (VA<6/18), 6 (60%) reported they did not need distance glasses (see **Figure 2A1**). In Cameroon, of the 15 people with URE, 6 (40%) reported not needing distance glasses (see **Figure 2A2**).

In India, of the 60 people who self-reported needing distance glasses, 15 (25%) actually needed distance glasses based on clinical impairment assessment, while 28 (47%) needed cataract surgery and 17 (28%) didn’t have a VI according to the study definition (see **Figure 2B1**). In Cameroon, of the 69 people who self-reported needing distance glasses, 6 (9%) actually needed distance glasses based on clinical assessment, 14 (20%) needed cataract surgery, 14 (20%) had other eye conditions (e.g. posterior segment disease) and 45 (51%) didn’t have moderate or worse VI. (see **Figure 2B2**).

#### Self-reported need for hearing aids among people who were clinically assessed

In India, of the 102 people who were clinically assessed to need hearing aids, 4 (4%) use one, 62 (61%) reported needing one, 26 (26%) reported not needing one and 10 (10%) reported not knowing what it was (see **Figure 3A1**). In Cameroon, of the 38 people who were clinically assessed to need hearing aids, 18 (47%) reported needing one, 9 (24%) reported not needing one and 11 (29%) reported not knowing what it was (see **Figure 3A2**).

In India, of the 90 people who self-reported needing hearing aids, 62 (69%) actually needed hearing aids based on clinical assessment and 28 (31%) did not (see **Figure 3B1**). In Cameroon, of the 54 people who self-reported needing hearing aids, 18 (33%) actually needed hearing aids based on clinical assessment and 36 (66%) did not (see **Figure 3B2**).

## DISCUSSION

### Estimated population AP use, unmet need and coverage

This study, using data from population-based surveys based on clinical impairment assessment, found evidence of relatively high need and low coverage of three priority APs (distance glasses, hearing aids and wheelchairs) in India and Cameroon. In total, based on impairments of moderate or worse severity, 6.5% (95% CI 5.4-7.9) and 1.9% (95% CI 1.5-2.5) of the population needed at least one of the three APs in India and Cameroon, respectively. This prevalence increased in India to 9.3% (95% CI 8.0-10.9) if mild VI was included. Total need was highest for distance glasses and hearing aids and considerably lower for wheelchairs. Total need and unmet need for glasses and hearing aids increased rapidly with age in both settings, and in India total need was significantly higher among females compared to males for distance glasses (mod VI).

The total need was low for wheelchairs in both settings (0.1%; 95% CI 0.03-0.3 India, 95% CI 0.04-0.3 Cameroon). Our estimates were lower than estimates from Canada and United States (between 0.6%-0.8%)(32) which may reflect differences in environmental factors; for instance, the study area in Cameroon was largely rural and hilly and uneven terrain was common so wheelchairs might not have been considered by the clinicians, while other mobility devices (e.g. walking devices) might have been considered more appropriate. Differences in the age distributions of populations or availability of services are other likely explanations.(32) The lower estimates have implications for survey sample size calculations when estimating AP need associated with mobility and also emphasises the need to further develop tools to improve and standardise the complexities of mobility impairment and AP assessment which is generally more complex compared to hearing and vision.

AP coverage was relatively low with less than 40% of people who needed distance glasses, hearing aids or wheelchairs actually using them. This aligns with previous assertions that many people in need of AP in LMICs do not have access to them(9, 10) and highlights the urgent need to scale up AP service provision and access. The exception was the high coverage of distance glasses in India (87%, 95% CI 77.1-93.0) which may reflect availability and access to eye care services in this setting; however, it is noted a study in the same region at a similar time reported lower spectacle coverage (38%).(33)

There are limited studies available for comparison, emphasising the AT data gap. While population-based clinical impairment studies provide estimates of impairment type, cause and severity, many do not explicitly measure or present specific AP need.(34) Other studies of population level AP need estimates only use self-reported AP methodology, limiting comparison with our findings such as Pryor et al.’s study in two districts in Bangladesh using WHO GATE’s rapid assistive technology assessment (rATA).(35)

### Relationship between AP need measurement approaches

We compared findings of self-reported AP need to clinical impairment assessment.

Advantages of the self-report approach include that it is rapid, lower cost, and is based on a person’s reported functioning in his/her own environment. Though self-report may indicate a need for clinical care, our findings suggest self-report may give an unreliable estimate of AP need. A key concern is that people were over-reporting their need for AP when they actually required curative treatments, such as cataract surgery or the removal of impacted ear wax(24), or had other conditions/impairments that would not benefit from the AP. On the other hand, under-estimations of need also occurred due to low awareness of having an impairment and of knowledge about the AP. For instance, in Cameroon, 29% of people needing a hearing aid were unaware of what one was. For other less common devices, such as gesture to voice technology, AP awareness is likely to be even lower.

This study used clinical impairment assessment as the ‘gold standard’ method of assessment for AP to compare self-reported AP need. However, this approach also has limitations. It is more expensive and requires personnel that may be limited in number. Most importantly, need is classified only on the basis of ‘impairment’ and doesn’t take into account participants’ activities, participation and contextual factors which can be key in determining their AP requirements.(25) People with the same impairment may have different AP needs which may explain some of the discrepancy between the two measures. For example, a person’s need for glasses may be different in a rural agricultural setting versus urban so even if he/she has a clinical ‘need,’ he/she may not have a perceived need.

### Gaps and opportunities for AP need measurement approaches

This study has highlighted some key gaps and opportunities in methods of population level assessment of AP for improvement.

First, a limitation of both approaches is an absence of comprehensive clinical functional assessment which provides holistic overview of individuals’ abilities and daily living skills important for determining the extent to which they may benefit from AP in their contexts. This approach usually assesses factors related to individuals’ physical, sensory, cognitive and psychosocial functioning, and support available.(14, 36) Functional assessments are commonly used by rehabilitation professionals and can use a variety of approaches, including indirect, observational, and experimental/functional analysis procedures to determine treatment plans, follow up services and AP need.(36, 37) However, most existing functional assessment tools are time intensive and primarily designed for use at individual level, and few exist for population-level measurement in LMIC settings. Of the limited number of population-based assessments, most are disability tools that either measure self-reported functioning and AP need only or do not assess AP need. For example, the WHO Disability Assessment Schedule 2.0 (WHODAS 2)(38)and WHO Model Disability Survey (MDS)(39, 40) ask functioning questions across multiple domains, however the former does not collect data on AP need and the latter only assesses AP need through self-report.

There is therefore a gap in multi-domain clinical functional assessment methodology for use in population-based surveys. Future research is needed to develop and test tools to ensure the essential integration of *all* ICF components and that a standardised approach to clinical reasoning for determining service and AP need is used within the context of population-based surveys (e.g. unilateral versus bilateral impairments and assessment of each service and AP).(25) Within this, research could explore capturing clinicians’ clinical reasoning and analysis through using decision trees following an algorithm.(41)

Secondly, this study only presented data on three APs, however there are 50 priority APs included in the WHO GATE priority assistive product list (APL).(1) In the vision domain for example, it is possible that some participants without visual impairment (according to distance VA assessment) who self-reported distance glasses need may have been experiencing difficulty with near vision, contrast sensitivity or other low vision impairments not assessed by VA assessment alone and could have benefitted from other AP, such as short distance, filter and protection, or low vision glasses.(1) Further work is required to determine if additional clinical assessments to identify specific referral service and AP needs would be beneficial to include.

Thirdly, in this study, AP need was assessed only for people with moderate or worse impairments (with the exception of vision for India) and based on bilateral (not unilateral) vision and hearing loss. As people with milder impairments may also benefit from AP this is likely to have resulted in underestimates of need. This was evident in the India survey where including milder cases of VI (VA<6/12) increased the prevalence of need to 4.1% (95% CI 3.2-5.1) compared to only 0.5% (95% CI 0.3-0.9) for moderate VI (VA<6/18). There is a need for further research to identify appropriate cut-off impairment severity for determining AP need. It is important to recognise that people who might benefit from AP and related services includes, but is not limited to, people with disabilities.(17)

Fourthly, the all-age AP prevalence estimates were low among children, and it is noted that the WG CFM is only for children aged 2-17.(27) Although the prevalence is low, long term impact is potentially great so therefore there is a need to explore additional measurement tools and other methods to collect data on this age group.

Finally, there is also a need to develop standardised AP definitions with pictorial aids to ensure more consistent AP data collection within and across settings.(1, 42, 43) Alongside APs, it is also essential to define and collect data on related services, such as rehabilitation, so prevalence data can be used for planning AT.

### Study strengths and limitations

In terms of strengths, the surveys were population-based, included all ages and used standardised clinical impairment assessment procedures. The inclusion of self-reported AP need enabled comparisons between two approaches for three priority APs. However, there were also limitations. Firstly, the surveys were not initially designed or powered statistically to assess AP need and to compare AP measurement approaches. The sample size for overall estimates of AP need is adequate for at least one of the three APs in India, but underpowered in Cameroon and for estimates for individual APs. The relatively wide confidence intervals should be noted and some caution in interpretation is warranted, while also acknowledging that this study provides some data to inform adequate power future studies. Secondly, with the exception of VA in India’s, the surveys did not assess for mild impairments, limiting comparison of AP need by impairment severity in the three domains. Further only presenting, and not uncorrected, visual acuity was assessed. Additionally, this study did not fully explore the reasons for self-reporting not needing AP, such as if age/severity were reasons, and only focused upon the three ATScale priority APs that were assessed. Finally, a lack of standardised AP definitions were used in data collection and it is important to note that the met need for the three APs is temporary given further services would still be needed for these individuals for training, follow up, maintenance and repair.

## CONCLUSIONS AND RECOMMENDATIONS

This study highlighted the high need and low coverage of three APs in two LMIC settings, as well as limitations in methodology used to assess AP need. There is an urgent need to build up the AP evidence base, and this will require the development of ICF-compatible tools to estimate the population-level AP need, unmet need and coverage, alongside estimating the need for essential related services. Such a tool would help to generate data that are comparable between settings and over time in order to inform evidence-based policy making and planning of appropriate services, and support national and global programmes during this SDG era to scale up AT provision as we progress towards 2030.

**Acknowledgements**

The authors are grateful to the project teams and the participants who contributed to these surveys. This paper is adapted from the authors’ broader WHO GReAT Consultation conference paper “Estimating assistive technology need through population-based surveys: An analysis of data from Cameroon and India” with permission for republication and copyright held by the journal. The conference paper was presented on 22 August 2019 and published in Layton N, Borg J, Ed. “Global perspectives on assistive technology: proceedings of the GReAT Consultation, Volume A.”(16) The survey study was funded by CBM International, and this secondary analysis was funded by the Department for International Develop (DFID) through the AT2030 programme.

**Declarations of Interest**

None to declare.

## REFERENCES

1. World Health Organization. Priority assistive products list. Geneva: WHO. 2016.

2. World Health Organization. Assistive technology factsheet: WHO; May 2018 [cited 2020 27 April]. Available from: <http://www.who.int/news-room/fact-sheets/detail/assistive-technology>.

3. Falvey JR, Ferrante LE. Flattening the disability curve: Rehabilitation and recovery after COVID-19 infection. Heart & Lung: The Journal of Cardiopulmonary and Acute Care. 2020.

4. Pan American Health Organization (PAHO). Rehabilitation considerations during the COVID-19 outbreak. Washington, DC: PAHO, 2020.

5. United Nations. Transforming our world: the 2030 Agenda for Sustainable Development. Geneva: United Nations General Assembly, 2015.

6. United Nations. Convention on the Rights of Persons with Disabilities (CRPD) New York: UN; [cited 2020 27 April]. Available from: <https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html>.

7. Borg J, Lindström A, Larsson S. Assistive technology in developing countries: national and international responsibilities to implement the Convention on the Rights of Persons with Disabilities. The Lancet. 2009;374(9704):1863-5.

8. Tebbutt E, Brodmann R, Borg J, MacLachlan M, Khasnabis C, Horvath RJG, et al. Assistive products and the sustainable development goals (SDGs). 2016;12(1):79.

9. Matter R, Harniss M, Oderud T, Borg J, Eide AHJD, Technology RA. Assistive technology in resource-limited environments: A scoping review. 2017;12(2):105-14.

10. Global Disability Innovation Hub. Assistive technology scoping research executive summary. London: University College of London, 2018 July 2018. Report No.

11. World Health Organization. Assistive technology: making Universal Health Coverage inclusive. Geneva: WHO.

12. ATscale. ATscale: global partnership for assistive technology [cited 2020 27 April]. Available from: <https://atscale2030.org/>

13. Global Disability Innovation Hub. AT2030 University College London [cited 2020 27 April]. Available from: <https://www.disabilityinnovation.com/at-2030>.

14. World Health Organization. International classification of functioning, disability and health 2001 [27 April 2020]. Available from: www.who.int/classification/icf/en.

15. World Health Organization. World Report on Disability Geneva: World Health Organization; 2011.

16. Boggs D, Kuper H, Mactaggart I, Oye J, Murthy G, Polack S. Estimating assistive technology need through population-based surveys: an analysis of data from Cameroon and India. In: Layton N, Borg J, editors. Global perspectives on assistive technology: proceedings of the GReAT Consultation, . Vol. A. Geneva: World Health Organization; 2019. p. 52-78.

17. Mactaggart I, Kuper H, Murthy G, Oye J, Polack S. Measuring Disability in Population Based Surveys: The Interrelationship between Clinical Impairments and Reported Functional Limitations in Cameroon and India. PLoS One. 2016;11(10):e0164470.

18. Mactaggart I, Kuper H, Murthy G, Sagar J, Oye J, Polack S. Assessing health and rehabilitation needs of people with disabilities in Cameroon and India. Disability and rehabilitation. 2015:1-8.

19. Mactaggart I, Polack S, Murthy G, Kuper HJOe. A population-based survey of visual impairment and its correlates in Mahabubnagar district, Telangana State, India. 2018;25(3):238-45.

20. Smythe T, Mactaggart I, Kuper H, Murthy G, Lavy C, Polack S, et al. Prevalence and causes of musculoskeletal impairment in Mahabubnagar District, Telangana State, India: results of a population-based survey. J Transactions of The Royal Society of Tropical Medicine PLOS One. 2017;111(11):512-9.

21. Smythe T, Mactaggart I, Kuper H, Oye J, Sieyen NC, Lavy C, et al. Prevalence and causes of musculoskeletal impairment in Fundong District, North‐West Cameroon: results of a population‐based survey. J Tropical medicine international health PloS one. 2017;22(11):1385-93.

22. Oye J, Mactaggart I, Polack S, Schmidt E, Tamo V, Okwen M, et al. Prevalence and Causes of Visual Impairment in Fundong District, North West Cameroon: Results of a Population-Based Survey. 2017;24(6):394-400.

23. Bright T, Mactaggart I, Kuper H, Murthy G, Polack SJE, hearing. Prevalence of Hearing Impairment in Mahabubnagar District, Telangana State, India. 2019;40(1):204-12.

24. Ferrite S, Mactaggart I, Kuper H, Oye J, Polack S. Prevalence and causes of hearing impairment in Fundong Health District, North‐West Cameroon. Tropical medicine & international health. 2017.

25. Zuurmond M, Mactaggart I, Kannuri N, Murthy G, Oye JE, Polack S. Barriers and Facilitators to Accessing Health Services: A Qualitative Study Amongst People with Disabilities in Cameroon and India. International journal of environmental research public health. 2019;16(7):1126.

26. Washington Group on Disability Statistics Secretariat. Washington Group on Disability Statistics Hyattsville, MD: National Center for Health Statistics; 2019 [cited 2020 27 April]. Available from: <http://www.washingtongroup-disability.com/>.

27. UNICEF. UNICEF/ Washington Group on Disability Statistics Module on Child Functioning Concept Note. Available from: <https://data.unicef.org/wp-content/uploads/2017/03/UNICEF-WG-Module-on-Child-Functioning-Concept-Note.pdf>: 2016.

28. Washington Group on Disability Statistics. Development of Disability Measures for Surveys: The Extended Set on Functioning. Available From: <http://www.cdc.gov/nchs/data/washington_group/Development_of_Disability_Measures_for_Surveys_The_Extended_Set_on_Functioning.pdf>: 2011.

29. United Nations Economic and Social Council. Disability Statistics Report of the Secretary-General and the Washington Group. 2016.

30. Washington Group on Disability Statistics. Understanding and interpreting disability as measured using the WG short set of questions. Hyattsville: 2009.

31. Atijosan O, Kuper H, Rischewski D, Simms V, Lavy C. Musculoskeletal impairment survey in Rwanda: design of survey tool, survey methodology, and results of the pilot study (a cross sectional survey). BMC musculoskeletal disorders. 2007;8(1):30.

32. Smith EM, Giesbrecht EM, Mortenson WB, Miller WC. Prevalence of wheelchair and scooter use among community-dwelling Canadians. Physical therapy. 2016;96(8):1135-42.

33. Marmamula S, Khanna RC, Narsaiah S, Shekhar K, Rao GN. Prevalence of spectacles use in Andhra Pradesh, India: Rapid Assessment of Visual Impairment project. Clinical & experimental ophthalmology. 2014;42(3):227-34.

34. Atijosan O, Rischewski D, Simms V, Kuper H, Linganwa B, Nuhi A, et al. A National Survey of Musculoskeletal Impairment in Rwanda: Prevalence, Causes and Service Implications. PLoS ONE. 2008;3(7):e2851.

35. Pryor W, Nguyen L, Islam Q, Jalal F, Marella MJIjoer, health p. Unmet Needs and Use of Assistive Products in Two Districts of Bangladesh: Findings from a Household Survey. 2018;15(12):2901.

36. Quinn T, McArthur K, Ellis G, Stott D. Functional assessment in older people. Bmj. 2011;343:d4681.

37. Desrochers M, Fallon M. Instruction in functional assessment; Chapter 2: The Methodology of Functional Assessment: Open SUNY Textbooks; 2013 [cited 2019 29 June]. Available from: <https://milnepublishing.geneseo.edu/instruction-in-functional-assessment/chapter/chapter-2the_methodology_of_functional_assessment/>.

38. World Health Organization. WHO Disability Assessment Schedule 2.0 (WHODAS 2.0) Geneva: WHO. Available from: <https://www.who.int/classifications/icf/more_whodas/en/>.

39. World Health Organization. Model Disability Survey Geneva: WHO; [cited 2020 27 April]. Available from: <https://www.who.int/disabilities/data/mds/en/>.

40. World Health Organization. Model Disability Survey (MDS): survey manual. Geneva: WHO, 2017.

41. Bae J-M. The clinical decision analysis using decision tree. J Epidemiology and Health. 2014;36.

42. World Health Organization, USAID. Standards for Prosthetics and Orthotics: Part 1 Standards; Part 2 Implementation manual. World Health Organization, 2017.

43. J Borg, Khasnabis C, (Eds.). Guidelines on the provision of manual wheelchairs in less-resourced settings. Geneva: World Health Organization, 2008.

## Tables

**Table 1**: Measuring population-based AT through self-report and clinical impairment assessment: methodology advantages, disadvantages and examples(17,18)

| METHOD | ADVANTAGES | DISADVANTAGES | EXAMPLES |
| --- | --- | --- | --- |
| Self-report | Simple and rapid.Fewer cost and resources to administer.Doesn’t require clinical expertise or equipment.Based on participants’ reported need in their own environment. Gathers information on participants’ experience and impact. | Risk of underestimate due to low awareness of APs (e.g. hearing frequency modulation system). Risk of overestimate due to poor awareness of underlying cause (e.g. people reporting functional limitations with vision due to cataracts which can be treated by a simple operation).Limited reliability for use planning services and interventions. | WHO Model Disability Survey(MDS): asks people what they do, or do not do, in their daily lives focusing on functioning in multiple domains well-aligned with the ICF and a series of questions regarding domain-specific and participation-specific AT use, need and barriers through self-reported questions using show cards as AT picture prompts.(39,40)WHO GATE’s rapid Assistive Technology Assessment (rATA): measures AP need and unmet need using adapted Washington Group Short Set as initial screening and AT images alongside each.(34) |
| Clinical impairment assessment | Impairment type, severity and causality assessed (e.g. assessing the need for cataract surgery or wax impaction for hearing).Reliable impairment estimates. | Costly.Time and resource intensive, often requiring presence of clinician.Only focuses on one ICF component, providing a more limited medical view of disability.Lacks broader functioning assessment with consideration of personal or environmental factors. | Standardised population-based assessment methods for examining the presence of impairment.* *Vision*: visual acuity (VA).
* *Hearing*: pure tone audiometry.
* *Mobility*: comprehensive clinical examination.
 |

**Table 2:** Clinical impairment assessment methods for vision, hearing and musculoskeletal impairments and related assistive product assessment methods.

|  |  |  |  |
| --- | --- | --- | --- |
| IMPAIRMENT | CLINICAL ASSESSMENT METHODS | MODERATE IMPAIRMENT DEFINITION | ASSISTIVE PRODUCT NEED ASSESSMENT |
| Vision | 1. Presenting visual acuity (VA) assessed using a tumbling E-chart. 2. Pinhole vision assessed for people with vision impairment (VI) to identify uncorrected refractive error (URE) and therefore need for distance glasses. * India: VI defined as VA<6/12 (‘mild’ VI) in either eye.
* Cameroon: VI defined as VA<6/18 (‘moderate’ VI) in either eye.

3. Participants with vision loss not due to URE underwent examination with an ophthalmoscope by an ophthalmologist/ophthalmic nurse to determine the cause. | Participants with presenting visual acuity (VA) <6/18 in the better eye. | Distance glasses: URE indicating VA improved with pinhole to 6/18 or 6/12 for VA<6/18 (‘moderate’ VI) and VA<6/12 (‘mild’ VI) in India only respectively. |
| Hearing | 1. All participants screened using Otoacoustic Emissions Testing. 2. Participants ages >4 years old who failed this underwent Pure Tone Audiometry at 0.5, 1, 2, and 4 kHz to assess for presence and severity of hearing loss (HL). 3. Participants with disabling HL (using WHO’s definition of disabling hearing impairment >31dB HL for children 4 to 17 years of age and >41dB HL for adults ≥18 years of age) in the better ear underwent examination by ENT specialist using an otoscope to assess cause and service/intervention needs, including hearing aids. | Participants with >31dB Hearing loss (HL) for children 4 to 17 years of age and >41dB HL for adults ≥18 years of age. | Hearing aid: clinician assessed based on cause, severity and diagnosis. |
| Musculoskeletal (MSI) | 1. Participants were asked six validated screening questions from the Rapid Assessment of MSI (RAM).(31) 2. Anyone who screened positive underwent a standardized examination by a physiotherapist using the RAM to assess presence, severity, cause, diagnosis and need for services and APs, including wheelchairs. The RAM includes head and neck, upper limb, lower limb and pelvis, trunk and spine assessment. | Participants determined to have moderate impairment assessed using RAM.(31) | Wheelchair: clinician assessed based on cause, severity and diagnosis. |

**Table 3:** Definitions of proportions for measuring population-based assistive product (AP) use, unmet need, total need and coverage and comparing self-report and clinical impairment assessment AP need measurement approaches

|  |  |
| --- | --- |
| STATISTIC | DEFINITION |
| AP proportions through clinical impairment assessment |
| Use | Proportion of the study population who were using the AP. |
| Unmet need | Proportion identified in the study population as needing, but not using, AP. |
| Total need | Proportion identified in the study population as using and/or needing the AP. |
| Coverage | Proportion of people who actually use the AP by the total number of people who need the AP, calculated as ‘use’ divided by ‘total need’. |
| AP need proportions exploring the relationship between self-report and clinical impairment assessment |
| 1. Proportion of people identified as needing an AP through clinical impairment assessment (e.g. distance glasses) who reported ‘no difficulty’ with functioning using the WG questions in the corresponding domain (e.g. vision). This was to assess how many people who could benefit from an AP would be captured through using self-report of functional difficulty alone (i.e. no clinical assessment). |
| 2. Proportion of people identified as needing distance glasses or hearing aids through clinical impairment assessment who also self-reported a need for the corresponding AP. |
| 3. Among people who self-reported needing distance glasses, the distribution of the causes of vision loss identified through clinical impairment assessment. |

**Table 4:** Three assistive product use, unmet need, total need and coverage estimates in India and Cameroon

|  |  | INDIA |  |  |  | CAMEROON  |   |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | N=3574+ |  |  | N=3567 |  |  |
|  | USES | UNMET NEED | TOTAL NEED | COVERAGE++ | USES | UNMET NEED | TOTAL NEED | COVERAGE++ |
|  | *N* *[% (95% CI)]* | *N* *[% (95% CI)]* | *N**[% (95% CI)]* | *(USES/**TOTAL NEED) %**(95% CI)* | *N**% (95% CI)* | *N**% (95% CI)* | *N**% (95% CI)* | *(USES/**TOTAL NEED) %**(95% CI)* |
| Glasses <6/12(mild VI) | 114\*[3.2 (2.4-4.3)] | 145\*\*[4.1 (3.2-5.1)] | 259[7.2 (6.2-8.5)] | 44%(34.1-54.2) |  |  |  |  |
| Glasses <6/18(moderate VI) | 114\*[3.2 (2.4-4.3)] | 17\*\*[0.5 (0.3-0.9)] | 131[3.7 (2.8-4.7)] | 87% (77.1-93.0) | 10\*[0.3 (0.2-0.5)] | 17\*\*[0.5 (0.3-0.8)] | 27[0.8 (0.5-1.1)] | 37% (20.3-57.5) |
| Hearing aids | 5[0.1 (0.1-0.3)] | 107[3.0 (2.2-4)] | 112[3.1 (2.4-4.1)] | 4.5% (1.8-10.6) | 3[0.1 (0.03-0.3)] | 40[1.1 (0.8-1.5)] | 43[1.2 (0.9-1.6)] | 7%(2.2-20.3) |
| Wheelchairs | 1[0.03 (0.004-0.2)] | 2[0.1 (0.01-0.2)] | 3[0.1 (0.03-0.3)] | 33.3%(0.1-99.7) | 0[0] | 4[0.1 (0.04-0.3)] | 4[0.1 (0.04-0.3)] | 0%[0] |
| TOTAL 3 APs (moderate VI) | 119[3.3 (2.5-4.3)] | 124[3.5 (2.7-4.5)] | 234[6.5 (5.4-7.9)] | 50.9% (41.5-60.2) | 13[0.4 (0.2-0.6)] | 57[1.6 (1.2-2.1)] | 69[1.9 (1.5-2.5)] | 18.8%(11.1-30.2) |
| TOTAL 3 APs (mild VI) | 119[3.3 (2.5-4.3)] | 224[6.3 (5.1-7.7)] | 334[9.3 (8.0-10.9)] | 35.6% (27.7-44.4) |  |  |  |  |

*Abbreviations: VI=vision impairment, CI=confidence interval;**+ Data from one participant is missing; ++ Coverage is defined as (uses/total need)%, for example the coverage of glasses <6/12 (mild VI) in India is calculated as (114/259)x100 which is 44%. \* Reports wearing glasses (and no refractive error); \*\* Uncorrected refractive error is case definition for the unmet need for glasses.*

**Table 5:** Distance glasses <6/18 (moderate VI) and hearing aids total need and unmet need stratification by age and gender in India and Cameroon

|  | DISTANCE | GLASSES | HEARING | AIDS |
| --- | --- | --- | --- | --- |
|  | *INDIA* | *CAMEROON* | *INDIA* | *CAMEROON* |
|  | *Total need**N* *% (95% CI)* | *Unmet need* *N* *% (95% CI)* | *Total need**N* *% (95% CI)* | *Unmet need**N* *% (95% CI)* | *Total need**N* *% (95% CI)* | *Unmet need**N* *% (95% CI)* | *Total need**N* *% (95% CI)* | *Unmet need**N* *% (95% CI)* |
| TOTAL | 1313.7 (2.8-4.7) | 17\*0.5 (0.3-0.9) | 270.8 (0.5-1.1) | 17\*[0.5 (0.3-0.8)] | 1123.1 (2.4-4.1) | 1073.0 (2.2-4.0) | 431.2 (0.9-1.6) | 401.1 (0.8-1.5) |
| GENDER |  |  |  |  |
| Male  | 442.6 (1.8-3.7) | 60.4 (0.2-0.8) | 130.9 (0.5-1.5) | 70.5 (0.2-1.0) | 482.8 (2.0-3.9) | 472.8 (2.0-3.8) | 221.5 (1.0-2.3) | 201.4 (0.9-2.1) |
| Female  | 874.7 (3.5-6.2) | 110.6 (0.3-1.2) | 140.7 (0.4-1.1) | 100.5 (0.3-0.9) | 643.4 (2.6-4.5) | 603.2 (2.4-4.3) | 211.0 (0.6-1.5) | 200.9 (0.6-1.5) |
| P-value | <0.01 | 0.3 | 0.4 | 0.975 | 0.1 | 0.3 | 0.2 | 0.2 |
| AGE GROUPS |  |  |  |  |
| 0 to 17 years | 121.0 (0.4-2.2) | 0[0] | 20.1 (0.03-0.4) | 20.1 (0.02-0.4) | 50.4 (.02-1.0) | 20.2 (0.04-0.7) | 20.1 (0.02-0.4) | 10.05 (0.01-0.4) |
| 18 to <60 years | 904.5 (3.4-5.6) | 100.5 (0.2-1.1) | 60.5 (0.2-1.1) | 20.1 (0.04-0.7) | 341.7 (1.1-2.7) | 321.6 (1.0-2.6) | 80.7 (0.3-1.3) | 60.5 (0.2-1.1) |
| 60+ years | 298.2 (5.7-11.7) | 72.0 (0.9-4.5) | 194.4 (2.8-6.8) | 133.1 (1.8-5.2) | 7320.7 (15.9-26.6) | 7320.7 (15.9-26.6) | 337.7 (5.5-10.7) | 337.7 (5.5-10.7) |
| P-value | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

*Abbreviations: VI=vision impairment, CI=confidence interval; \* Uncorrected refractive error is case definition for the unmet need for glasses.*

## Figures

**Figure 1:** Example International Classification of Functioning, Health and Disability diagram for health condition of diabetes(14)



**Figure 2:** Comparing reported versus clinical impairment measurement need for distance glasses

  **INDIA CAMEROON**

**Figure 3:** Comparing reported versus clinical impairment measurement need for hearing aids

**INDIA CAMEROON**

## Supplemental web appendix

**Web appendix Table 1:** International Classification of Functioning, Health and Disability (ICF) definitions

Definitions for the ICF terms that are used throughout this paper are provided below as defined in WHO and World Bank’s *World Report on Disability*.

| ICF TERM | DEFINITION |
| --- | --- |
| Disability  | An umbrella term for impair­ments, activity limitations, and participa­tion restrictions, denoting the negative aspects of the interaction between an indi­vidual (with a health condition) and that individual’s contextual factors (environ­mental and personal factors).(15) |
| Functioning | An umbrella term in the ICF for body func­tions, body structures, activities, and par­ticipation. It denotes the positive aspects of the interaction between an individual (with a health condition) and that indi­vidual’s contextual factors (environmental and personal factors).(15) |
| Impairment | Loss or abnormality in body structure or physiological function (includ­ing mental functions), where abnormality means significant variation from estab­lished statistical norms.(15) |
| Activity  | The execution of a task or action by an individual. It represents the individual perspective of functioning. |
| Participation  | A person’s involvement in a life situation, representing the societal perspective of functioning.(15) |
| Environmental factors  | A component of contextual factors within the ICF, referring to the physical, social, and attitudinal environment in which people live and conduct their lives – for example, products and technology, the natural environment, support and relationships, attitudes, and services, systems, and policies.(15) |
| Personal factors | A component of contextual factors within the ICF that relate to the individual – for example, age, gender, social status, and life experiences.(15) |