Assistive technology use is associated with reduced capability poverty: a cross-sectional study in Bangladesh.

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Abstract

Purpose: About half of all people with disabilities in developing countries live in extreme poverty. Focusing on the ends rather than the economic means of human development, the capability approach offers an alternative view of poverty. The purpose was to explore the relation between assistive technology use and capability poverty in a low-income country.

Method: Self-reported data on food intake, health care, education, politics, self-determination, self-respect, family relationships and friendships were collected in Bangladesh through interviews of people with hearing impairments using and not using hearings aids, and people with ambulatory impairments using and not using manual wheelchairs (N=583). Differences in outcomes between users and non-users of assistive technology were analyzed using logistic regression.

Results: Assistive technology users were more likely than non-users to report enhanced capabilities, hearing aid users to a larger extent than wheelchair users. Synergistic effects between assistive technology use and education were found.

Conclusion: The use of assistive technology is predictive of reduced capability poverty in Bangladesh. Lack of wheelchair accessibility and the nature of selected outcomes may explain the limited association in the ambulatory group. Enhancing the effects of the other, there is support for providing education in combination with hearing aids.

Introduction

Does the use of assistive technology by people with disabilities in developing countries contribute to reducing their poverty? Statistics indicate that about half of all people with disabilities in developing countries live in extreme monetary poverty, i.e. on less than USD 1.25 a day [1-3]. The situation is aggravated by the fact that the use we can make of incomes depends on personal and social circumstances, including disability [4]. Evaluations of poverty based on income therefore lead to an underestimation of the needs of households with members with disabilities [4, 5]. A recent study reported that people with disabilities in two European countries needed an income level of 1.5-2 times higher than other people to enjoy the same level of economic satisfaction [5]. Thus, the actual economic situation of people with disabilities in developing countries is likely to be worse than current statistics indicate.

Low income is but one way of viewing poverty. During the past two decades, human development has increasingly been seen as enlarging not only a single freedom – income – but all human freedoms, including economic, social, cultural and political [6]. Through the capability approach, Nobel laureate Amartya Sen suggests that these freedoms are evaluated in the form of individual capabilities to do things that a person has reason to value. The approach is based on the concepts ‘functionings’ and ‘capability’. Functionings are things a person may value doing or being. They ‘may vary from elementary ones, such as being adequately nourished and being free from avoidable disease, to very complex activities or personal states, such as being able to take part in the life of the community and having self-respect’ (p 75). Capability is the alternative combinations of functionings that are feasible for a person to achieve. The evaluative focus of the capability approach can be either on things a person choose to do, i.e. realized functionings, or things a person is substantively free to do, i.e. the capability set. Sen emphasizes choice and exemplifies its significance by an affluent person who fasts. He or she may have the same realized functioning in terms of nourishment as a destitute person who starves. The affluent person has a different capability set as he can choose to eat while the destitute person is forced to starve. According to the capability approach, poverty is seen as deprivation of basic capabilities rather than merely low income [4].

Disability and poverty are both characterized by social, economic and political exclusion [7]. The capability approach has gained interest in the disability field as poverty in terms of capability deprivation has some similarities with disability. It has been argued that among a number of disability models the bio-psychosocial model in the International Classification of Functioning, Disability and Health (ICF) [8] comes closest to understand disability as promulgated under the capability approach [9]. In recent years, scholars have explored how the capability approach can improve our understanding of disability and how it can be applied in practice, e.g. [5, 10-13]. The ICF uses the constructs 'capacity' to indicate a person's ability to execute a task or an action, particularly in a standardized environment, and 'performance' to describe what a person does in his or her current environment. Partly drawing from references [9-11], a diagram that visualizes the relationship between capacity, capability, performance, and realized functioning is presented in figure 1. As choice is a vital element of the capability approach it has been included in the diagram. Influences from the individual and the environment are indicated using the ICF constructs health condition, body functions and structures, personal factors, and environmental factors. In the diagram, the understanding of capacity and performance has been broadened to cover both doings and beings.

The perspective represented in figure 1 finds support in a study of what children with cerebral palsy could do in terms of motor activities in a standardized environment (capacity), what they could do in their daily environment (capability) and what they actually did do in their daily environment (performance/realized functioning). The study concluded that capacity, capability and performance are different constructs, and that environmental factors (physical and social environment) and personal factors (such as motivation) influence their relations [14].

Insert figure 1 about here.

The socioeconomic situation of people with disabilities in developing countries has attracted attention from the research and human development communities, and different strategies to address poverty and human development have been suggested [15-22]. Two such international strategies are reflected in the Convention on the Rights of Persons with Disabilities (CRPD) and the Standard Rules on the Equalization of Opportunities for Persons with Disabilities (Standard Rules) [23, 24]. Although these

international documents require assistive technology interventions to facilitate full enjoyment of human rights, an estimated 85%-95% of those who need assistive technologies have no access to them [3, 25]. The lack of assistive technologies is aggravated by the fact that associated services are rarely considered [26]. Findings in Africa indicate that the largest discrepancy between self-reported needs for rehabilitation services and received rehabilitation services was for assistive technology services [27]. Despite being designed to improve the performance of people with disabilities, reports on outcomes of assistive technology use in low-income countries are scarce. Certain benefits in areas such as health, mobility and education have been reported [28-30].

The capability approach acknowledges that income and commodities are important means to capabilities. At the same time, enhanced capabilities tend to expand a person's ability to be more productive and earn a higher income, which can be particularly important to reduce income poverty [4]. Thus, the capability approach indicates that assistive technology as a commodity may contribute to enhanced capabilities and, eventually, reduced income poverty [10]. The purpose of this study was therefore to explore the relation between assistive technology use in a low-income country and poverty from a capability perspective.

Method

Context

Data for this study was collected in Bangladesh, which has an estimated population of about 164 million living on 147 thousand square kilometres of land. In 2009, it ranked 146 out of 182 countries on the Human Development Index. The life expectancy at birth was 65.7 years, the adult literacy rate was 53.5% and the GDP per capita was PPP US$ 1,241. About 40% of the population live below the national poverty line and about 50% live on less than $1.25 a day [31, 32].

A recent study indicates a disability prevalence rate in Bangladesh of about 6%, which corresponds to approximately 10 million people [33]. Disability has been reported to have a devastating effect on quality of life, particularly on educational attainment and employment [34]. In 2001, Bangladesh adopted the Persons with Disability Welfare Act, which was followed by the ratification of the CRPD in 2007 and its Optional Protocol in 2008. Thus, in principle the country supports equal rights and

opportunities for people with disabilities. However, for most of them these rights have not been realized as their access to development programmes, social benefits, and health and rehabilitation services is limited [35, 36]. To promote the rights of people with disabilities, 46 Focal Points have been established in different ministries and departments, and a committee has been set up to monitor the implementation of the CRPD. In addition, a Disability Rights Watch Group has been formed with representatives from civil society and the Parliamentarians' Caucus on Disability. Progress has been made in developing a new law for persons with disability based on human rights.

According to the World Health Organization (WHO), an estimated 1.6 million people in Bangladesh would need a wheelchair and about 0.8 million people would need an orthotic device [37, 38]. Further, based on the situation in countries like Indonesia and Nigeria, an estimated five million or more Bangladeshis would benefit from using a hearing aid [39]. Less is known about other types of assistive technology. Although there has been some government, non-government and private initiatives to make assistive technology accessible, the needs for assistive technology are far from being met [40, 41]. In addition to services being physically, geographically and economically inaccessible, lack of trained personnel also accounts for this gap. This may be exemplified by comparing the current some 50 orthopaedic technicians working in Bangladesh with a required number of 5,000 personnel trained at different levels to conform with WHO recommendations [38].

Sample

The sample in this study was derived from a survey which aimed at exploring the relationship between use of assistive technology and enjoyment of human rights and economic situation of people with disabilities. The survey was cross-sectional using an interviewer-administered structured questionnaire to collect quantitative data. The inclusion criteria included people with hearing impairments using or not using hearing aids or people with ambulatory impairments using or not using manual wheelchairs in the age-group 15-55 years.

Due to the lack of government registers of people with disabilities in general – and users of assistive technology in particular – the non-governmental Centre for Disability in Development (CDD) was contacted in order to find eligible respondents. CDD is the largest disability oriented, national resource

and training centre in Bangladesh with over 300 partner organizations across the country, through which it has access to locally maintained registers of people with disabilities, including users of assistive technology. The way people had been included in the registers varied across and within the organizations. The primary means of identifying people with disabilities were: community meetings attended by people with disabilities, information provided by community residents, home visits based on information from local residents and authorities, people with disabilities voluntarily approaching the organizations, people with disabilities referring other people with disabilities, and surveys. However, there was no obvious difference in the chance to be included in those registers because of use of assistive technology or not.

A sample from four typical areas of Bangladesh was sought; the area in and around the capital Dhaka, the countryside, areas prone to flooding and hilly regions. Minimizing the number of involved organizations in the selected areas in order to achieve a total of about 600 respondents, eight organizations were selected for the collection of data from people with ambulatory impairments and ten organizations were selected for the collection of data from people with hearing impairments across eight districts (Bogra, Chittagong, Dhaka, Gaibandha, Jhenaidah, Lalmonirhat, Meherpur, and Savar). The sample was recruited by eight and ten interviewers, respectively. First, the interviewers selected registered users of assistive technology meeting the inclusion criteria. Second, where ever possible, the interviewers matched each user of assistive technology with the closest living registered person with the same impairment, of the same sex and of similar age (+/- 5 years). The final sample size was 583: 136 users and 149 non-users of hearing aids, and 149 users and 149 non-users of wheelchairs.

When selecting types of assistive technology to be included in this study, we sought a variation based on types of impairments represented and required degree of accessibility of the physical environment for efficient use. The main reason for limiting the study to hearing-aids and wheelchairs was that other types of assistive technology were not commonly used or available in Bangladesh. Achieving a reasonable number of respondents using other types of assistive technology to allow for meaningful comparisons was not possible due to the constraints imposed by time and budget limitations.

Instrumentation

The questionnaire used for collecting data consisted of seven parts: demographics, human rights, economy, participation, disability, environment and assistive technology. Only users of assistive technology answered the last part. The questions were partly based on the ICF, a WHO questionnaire [42] and a questionnaire used in livelihood studies in Africa [21], and partly developed by the authors.

Procedure

The questionnaire was developed in English and translated into Bangla. The translation was reviewed by native and non-native speakers of Bangla, including an expert on communication in simple Bangla. After revision, the questionnaire was pre-tested on 30 people representing various respondent groups, which resulted in a minor revision.

An instruction manual for interviewers was developed and ten interviewers were recruited. All interviewers worked with the rehabilitation of people with disabilities in their respective organization. They participated in a four-day training session on interviewing and data collection techniques, including one day of practice interviewing using the questionnaire. Following input from the training, the questionnaire was finalized. Supervised by a coordinator, the interviewers collected data between 6 November 2009 and 1 February 2010.

Interviews were conducted at the respondent's home. To protect confidentiality, family members and neighbours were requested not to be present. In interviews where the interviewer was unable to communicate with a participant, data was collected from a proxy. Chi-square tests revealed a statistically significant difference in the rate of proxy reporting between users and non-users of hearing aids, while there were no such difference between users and non-users of wheelchairs. Among non-users and users of hearing aids, 109 (73.2%) and 47 (34.6%) of the questionnaires, respectively, were completed with the help of proxies.

Ethical considerations

As there is no authority in Bangladesh that grants ethical approvals, the University of Dhaka was consulted and their ethical research praxis was followed. Potential participants were informed about the study and invited to participate. Only those giving verbal consent were interviewed. Written

informed consent could not be used due to the high rate of illiteracy. Respondents could refuse to answer any question or discontinue the interview at any time. No incentives for participation were offered.

Outcome variables

Although recognizing the necessity of including specific functionings in analyses, Sen has not suggested any particular set of indicators [4]. For the purpose of this study, therefore, functionings that people may have reason to value were selected. Realized functionings were studied in the areas of food intake, health care, education, politics, self-determination and self-respect, while capabilities were studied in relationships. Food intake was measured by asking the respondents if they eat three times a day until full. Health care was measured by asking them if they get necessary medical care. Self-determination was measured by asking them if they make their own important decisions about their lives. Responses to these three questions were indicated on a 4-point Likert-type scale ranging from 1=Never to 4=Always. Education was measured by completion of primary school, i.e., grade level 5. Realization in the area of politics was measured by voting in the 2008 general election among respondents aged 19 or older. As negative views of the self among people with disabilities in India have been found to be rooted in, inter alia, negative attitudes of others [43], 'attitudes of neighbours' was therefore used as an outcome proxy indicator to Sen's functioning 'achieving self-respect' [44]. Attitudes of neighbours was measured by asking the respondents how they would describe the general attitudes of their neighbours using a 5-point Likert-type scale ranging from 1=Very bad to 5=Very good. The capabilities to create and maintain family relationships and to make friends and maintain friendships were measured using a 5-point ICF-based Likert-type scale ranging from 1=Complete problem to 5=No problem.

Predictor variables

The predictor variable for people with hearing impairments, 'hearing aid user', indicates whether a respondent uses hearing aid(s) or not. Similarly, 'wheelchair user' indicates whether a respondent with ambulatory impairment uses wheelchair or not. In order to analyze possible interaction, a dummy predictor variable was created by coding combinations of assistive technology use and primary education.

Potential confounding variables

Realized functionings and capabilities were analyzed with respect to possible confounding variables, including sex, age, place of living and financial situation [4, 44]. To determine place of living the two categories ‘village’ and ‘town/city’ were used. To measure the financial situation, the perception of how well the respondent’s household managed financially during the past year was indicated on a self-reported 4-point Likert-type scale ranging from 1=Poorly to 4=Very well.

Although not adjusted for, hearing capacity and ambulating capacity of the respondents could potentially affect the outcomes. They were measured as self-reported level of difficulty hearing or walking or moving around in the current environment without assistance (i.e. without support from assistive technology, other persons, etc.) indicated on an ICF based 5-point Likert-type scale ranging from1= Unable to 5=No difficulty.

Analyses

Questionnaire responses were recorded in a Microsoft Access database and analyzed using Statistical Package for Social Sciences (SPSS) version 17.0 statistical software. The analysis was carried out on three levels. First, descriptive statistics and t-tests and the Mann-Whitney U tests were used to report on differences in profile characteristics and outcome scores between respondent groups with significance level set at 5%. Second, crude odds ratios (OR) and 95% confidence intervals (CI) were calculated to explore associations between assistive technology use and the outcome variables, which were dichotomized if not already binary. Third, multivariate analysis by logistic regression was performed to investigate the potential importance of various confounders and to analyze whether use of assistive technology can predict differences in capability poverty. To avoid overfitting, i.e., having less than 10-15 events per predictor and confounding variables [45], dichotomization points were chosen to maximize the number of events in the smallest group, see table 1. Due to limited number of responses, multivariate analysis of participation in the 2008 election was not performed. Because of statistically significant differences in the rate of proxy reporting among participants with hearing impairments, logistic regression with proxy reporting as a potential confounder was performed.

Insert table 1 about here.

Results

The characteristics of the respondents are given in table 2. There were statistically significant differences between users and non-users of hearing aids regarding mean age, economic situation and place of living, while there were no such differences regarding hearing capacity and sex distribution. Among respondents with ambulatory impairments there were no statistically significant differences in these characteristics. The means of non-dichotomous outcome variables indicate that users of assistive technology generally score higher than non-users. The outcome means also indicate that non-users of hearing aids and wheelchairs score about the same, while users of hearing aids score higher than users of wheelchairs. The differences in mean scores between users and non-users of hearing aids are all statistically significant, while differences between users and non-users of wheelchairs are statistically significant for food intake, attitudes of neighbours and family relationships. The amount of missing data is presented in table 3.

Insert table 2 about here.

Insert table 3 about here.

Distribution of dichotomized outcomes by respondent category is presented in part A of table 4. Crude odds ratios for studied outcomes for users of assistive technology compared with non-users are provided in part B of table 4.

Insert table 4 about here.

Odds ratios regarding use versus no use of hearing aids and wheelchairs, after adjusting for sex, age, place of living and financial situation, are presented in part C of table 4. The use of hearing aid or wheelchair was not statistically significantly associated with higher food intake or more frequent access to health care when necessary, although the adjusted odds ratio indicated that hearing aid users were more likely to report more frequent health care at p=0.051. Hearing aid users were more likely than non-users to be educated at the primary level, OR=3.7 (2.1-6.6), to be self-determined,

OR=4.4 (2.2-8.8), to report positive attitudes from neighbours, OR=3.3 (1.9-5.7), to have less difficulty in creating and maintaining family relationships, OR=6.3 (3.3-12), and making friends and maintaining friendships, OR=5.4 (2.9-10). There were no statistically significant differences among respondents with ambulatory impairments except that wheelchair users were more likely than non-users to report positive attitudes of neighbours, OR=2.6 (1.6-4.4).

In part D of table 4, odds ratios regarding use versus no use of hearing aids after adjusting for sex, age, place of living, financial situation and proxy reporting are presented. Users of hearing aids were statistically significantly more likely than non-users to report high food intake, OR=2.9 (1.4-6.4), frequent health care, OR=2.8 (1.4-5.8), completion of primary education, OR=2.2 (1.2-4.2), good attitudes from their neighbours, OR=4.0 (2.2-7.6), less problem in family relationships, OR=4.2 (2.1-8.2), and less problem in friendships, OR=4.6 (2.4-8.9). Compared to proxy responses, self responses were statistically significantly less likely to be associated with high food intake, OR=0.3 (0.2-0.6), and health care when needed, OR=0.4 (0.2-0.7), while they were statistically significantly more likely to be associated with primary education, OR=3.5 (1.9-6.6), self-determination, OR=6.8 (3.4-14), and less problem in family relationships, OR=2.7 (1.4-5.1).

Crude odds ratios for combinations of assistive technology use and primary education indicated overall positive synergistic effects of hearing aid use and primary education, and rather weak evidence of synergistic effects between wheelchair use and primary education. The corresponding odds ratios, after adjusting for sex, age, place of living and financial situation, showed that the described pattern remained relatively unchanged, see table 5. In the hearing and ambulatory groups, both primary education and assistive technology use were independently associated with higher capability outcomes – hearing aid use to a greater extent than primary education, and wheelchair use to a lesser extent than primary education. In the hearing group, there were synergistic effects of hearing aid use and primary education regarding self-determination, the attitudes of neighbours, family relationships and friendships, while a synergistic effect of wheelchair use and primary education was found for self-determination.

Insert table 5 about here.

Discussion

Based on data collected in Bangladesh, this study has explored the association between assistive technology use and poverty in terms of capability deprivation and unrealized functionings for eight selected functionings people may have reason to value. After adjusting for possible confounders, the findings indicate that users of assistive technology are less likely than non-users to experience capability deprivation and unrealized functionings.

Disability and income poverty are commonly viewed as elements of a vicious circle, where poverty may lead to disability and disability may lead to poverty [7, 16, 46]. As mentioned in the introduction, the capability approach offers a mirrored view – a virtuous circle – where enhanced capabilities may lead to reduced income poverty, which in turn may result in further enhanced capabilities [4]. In this perspective, it is therefore likely that assistive technology can contribute to transforming vicious disability-poverty circles into virtuous capability-poverty reduction circles.

As could be expected, the strongest associations of hearing aid use were found for outcomes where verbal communication is common, such as in relationships with family and friends, when making decisions, and education. The latter supports previous findings in the neighbouring country India, where regular hearing aid use was found to have a positive impact on the performance of students [29]. Although positive, the relationships between hearing aid use and food intake and health care – functionings whose realization may be more dependent on income than communication skills – were not statistically significant.

Separately, both primary education and hearing aid use significantly increased the capabilities of the participants. Further, the synergistic effects of education and hearing aid use indicate that individuals with at least primary education benefit considerably more from using assistive technology, or hearing aid users benefit comparatively more from their education than those who do not use hearing aids. Synergistic effects of wheelchair use and primary education were not found to such an extent.

Use of assistive technology was statistically significantly associated with respondents reporting better attitudes from their neighbours. This finding is supported by a complementary analysis of neighbour attitudes among assistive technology users. When hearing aid and wheelchair users used their respective assistive technology, they experienced better attitudes of their neighbours compared to when they did not use assistive technology ($p<0.001$). It is not unlikely that positive attitudes among neighbours can contribute to people achieving a higher level self-respect, as negative attitudes of others in a South Asian context can be a cause of negative views of the self [43]. This may have a detrimental effect on development, as negative attitudes not only among others but also among people with disabilities seem to discourage their entering the labour market [47].

Based on findings from Uganda, it has been suggested – in line with the capability approach – that assistive technology for mobility would provide opportunities for education [48]. However, this study and a study in India and Peru indicate that such opportunities do not directly materialize [28]. A likely reason for this is the lack of accessible roads and school buildings in Bangladesh [49]. Assessing and ensuring physical accessibility is necessary to ensure that users can benefit from a wheelchair [37]. However, it is uncertain if the degree of physical accessibility fully explains why wheelchair users are not more likely to report positive outcomes than non-users do in this study. Another plausible reason could be the nature of studied functionings, which are not much dependent on mobility.

The question of causality between assistive technology use and capabilities is of interest. Therefore, at the risk of recall bias, participants using assistive technology were asked how much the device, during the past two weeks, had helped in the situation where they most wanted to hear or move around better before they got the device. Ninety-four out of 136 (69%) hearing aid users and 111 out of 149 (74%) wheelchair users answered that they had been helped quite a lot or very much as compared to being helped not at all, slightly or moderately. They were also asked how much the device had changed their enjoyment of life. One hundred and twenty-one (89%) of the hearing aid users and 136 (91%) of the wheelchair users responded that the enjoyment of life had become quite a lot or very much better as compared to worse, no change or slightly better. These findings are indicative of a positive causal relation between assistive technology use and outcomes related to quality of life.

Although multivariate analysis of participation in the 2008 election could not be performed, both descriptive and bivariate analyses indicate no major differences between users and non-users of assistive technology.

Limitations

The study has several limitations which should be considered when interpreting the findings. An inherent limitation of a cross-sectional design is its inapplicability in exploring cause and effect relationships. Therefore, longitudinal studies are needed to confirm whether assistive technologies enhance capability freedom as indicated above.

Like most countries, Bangladesh does not maintain a national register of users of assistive technology, and as the prevalence of assistive technology use is very low, it was impossible to achieve a representative sample within the resource constraints of this research. It is often difficult to obtain representative samples in low-income countries, particularly when hidden and vulnerable population groups are involved [50, 51].

As the sample in this study was not randomly selected, there is a risk of selection bias. It can be noted, however, that in every sampling area all registered and eligible users of hearing aids and wheelchairs were included. As there were more non-users of assistive technology in the areas, each user of assistive technology was matched with a non-user as far as circumstances allowed. Additionally, there was no obvious difference in the chance of being selected due to one's use of assistive technology or not. As indicated in table 2, no statistically significant differences of key-characteristics between users and non-users of wheelchairs were found, while such differences occurred between users and non-users of hearing aids in terms of age, place of living and financial situation.

If the capacity of non-users of assistive technology were to exceed the capacity of users, it is likely that any differences in outcomes would have been underestimated given that assistive technology benefits its user. On the contrary, if the capacity of users had exceeded the capacity of non-users, it is likely that any differences in outcomes would have been overestimated. Although no statistically significant

differences in self-rated capacities between users and non-users of assistive technology were found, the lack of objective assessment of the respondents' capacities constitutes a limitation of the study.

Compared to other categories, relatively large amounts of data were missing for family relationships and friendships, particularly among people with ambulatory impairments, which may introduce bias. The characteristics of respondents missing for these outcomes were therefore analyzed. Comparisons between respondents with similar sex, age, place of living and financial situation who used and did not use assistive technology indicated that the strength of the associations would likely not be reduced if the missing respondents would have responded similarly to those with the same characteristics.

Employing an administered questionnaire can result in systematically biased answers as responses may be given to satisfy the interviewer; but as we only compare data provided by respondents within this single country context, such bias may not significantly affect the conclusions. Further, we relied on self- and proxy-reported data and do not know how closely the responses correlate with objective measures. Understanding of Likert-type scales may vary, which may influence individual responses.

Evidence for the validity of using perceived attitudes of neighbours as a proxy indicator of self-respect in a South-Asian context has not been found. Although it is generally agreed that how one thinks and feels about oneself often depends on the attitudes of others, it has been argued that self-respect does not necessarily require respectful treatment from others [52]. This idea finds support in an Indian study of self-concept among people with disabilities, which reported that positive views of the self were largely a consequence of internal factors, while negative views were rooted in external factors, such as poverty and attitudes of others [43]. Thus, as several factors are at play, any inference between the findings on attitudes of neighbours and achieved self-respect need to be drawn cautiously.

Self-reported financial situation of the household was included as a possible confounder rather than personal or household income. The main reason for this is that the use individuals can make of incomes varies [4], and that the subjective perspective of how well a household copes financially is expected to include this variation to some extent.

To avoid overadjustment, no potential confounders considered being on causal paths between the predictors and studied outcomes were included, with one possible exception: the use of proxy reporting as a potential confounding variable. It is plausible that the use of hearing aids enables self-reported responses, which was predictive of a high level of self-determination. This possibility needs to be considered when interpreting the findings.

Using the capability approach to explore associations between assistive technology use and poverty is novel, which limits the scope to discuss the findings in light of similar research. Changes in calculated odds ratios after adjusting for sex, age, place of living and economic situation support the notion of the capability approach that characteristics of the individual and the environment do have an effect on the capability and consequently on realized functionings [4, 44].

Sen's functionings carry similarities with the activities and participation of the ICF, as well as certain human rights. To allow for comparisons between future studies, it would be necessary to agree on which functionings should be included and how to measure them.

Conclusion

Assistive technology use was positively associated with reduced poverty in terms of capability deprivation and unrealized functionings in Bangladesh. However, there were differences between types of assistive technology. Hearing aid use was positively associated with more outcomes than wheelchair use, which may be explained by the nature of the studied functionings and poor wheelchair accessibility. Further studies are needed to understand what factors affect the relation between assistive technology use and capability in order to find effective strategies to reduce such poverty.

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Declaration of interest

The authors report no declarations of interest.

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Figure 1. Relationship between constructs of the capability approach and the ICF.

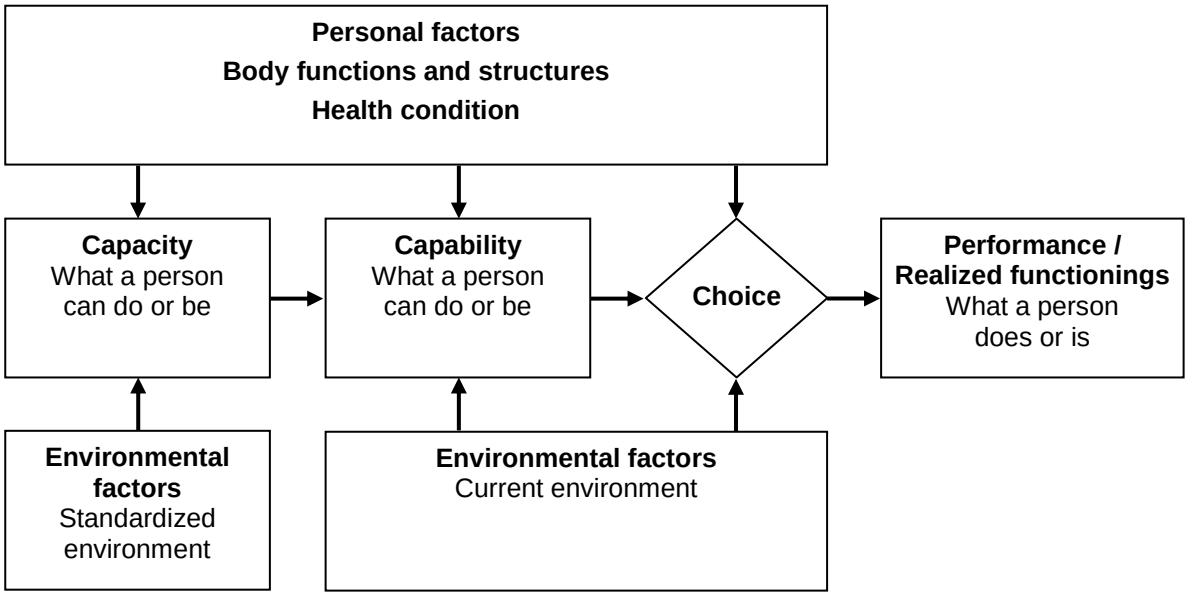

Table 1. Dichotomization points of outcome variables.

Outcome	**Values**
Food intake	
High	Always *or* Most of the time
Low	Seldom *or* Never
Health care	
Often	Always *or* Most of the time
Rarely	Seldom *or* Never
Primary education	
Yes	Yes
No	No
Self-determination	
High	Always *or* Often
Low	Seldom *or* Never
Attitudes of neighbours	
Good	Very good *or* Good
Bad	Moderate, Bad *or* Very bad
Voted 2008	
Yes	Yes
No	No
Creating and maintaining family relationships	
High	No *or* Mild problem
Low	Moderate, Severe *or* Complete problem
Making and maintaining friendships	
High	No *or* Mild problem
Low	Moderate, Severe *or* Complete problem

Table 2. Characteristics and outcome scores of non-users and users of hearing aids and wheelchairs.

(SD = Standard deviation. Bold = Significance level at p<0.05)

Characteristics and outcomes	Non-users	Users	*p*-value
Respondents with hearing impairment	N=149	N=136	
Age (years)	30.4 SD 11.6	26.5 SD 13.3	**0.010**
Sex (Man)	55.7% (n=83)	62.5% (n=85)	0.296
Place of living (Village)	84.6% (n=126)	64.7% (n=88)	**<0.001**
Financial situation (1-4)	1.58 SD 0.71	2.00 SD 0.91	**<0.001**
Listening capacity (1-5)	1.89 SD 0.69	2.03 SD 0.68	0.078
Food intake (1-4)	2.78 SD 0.85	3.26 SD 0.82	**<0.001**
Health care (1-4)	2.51 SD 0.87	3.07 SD 0.90	**<0.001**
Self-determination (1-4)	2.01 SD 0.91	2.37 SD 1.07	**0.003**
Attitudes of neighbours (1-5)	3.14 SD 0.74	3.65 SD 0.65	**<0.001**
Family relationships (1-5)	3.14 SD 1.03	4.05 SD 1.05	**<0.001**
Friendships (1-5)	3.10 SD 1.01	4.11 SD 1.04	**<0.001**
Respondents with ambulatory impairment	N=149	N=149	
Age (years)	32.1 SD 12.4	31.8 SD 13.1	0.853
Sex (Man)	63.8% (n=95)	73.8% (n=110)	0.080
Place of living (Village)	79.9% (n=119)	71.1% (n=106)	0.106
Financial situation (1-4)	1.52 SD 0.65	1.70 SD 0.78	0.057
Ambulatory capacity (1-5)	2.07 SD 0.76	2.00 SD 0.71	0.501
Food intake (1-4)	2.74 SD 0.89	2.97 SD 0.93	**0.031**
Health care (1-4)	2.42 SD 0.76	2.59 SD 0.93	0.090
Self-determination (1-4)	2.21 SD 1.02	2.36 SD 0.95	0.199
Attitudes of neighbours (1-5)	2.93 SD 0.82	3.41 SD 0.79	**<0.001**
Family relationships (1-5)	3.16 SD 1.35	3.58 SD 1.22	**0.010**
Friendships (1-5)	3.19 SD 1.42	3.49 SD 1.29	0.114

Table 3. Number of cases with missing data or 'not applicable' responses by outcome.

Outcomes	Hearing aid non-users	Hearing aid users	Wheelchair non-users	Wheelchair users
	N=149	N=136	N=149	N=149
Food intake	0	0	0	0
Health care	1	1	1	1
Primary education	0	0	0	0
Self-determination	1	0	0	0
Attitudes of neighbours	1	0	1	1
Voted 2008[1,2]	1	1	7	6
Family relationships[2]	10	6	29	20
Friendships[2]	16	16	46	36

1. As the election was held on 29 December 2008, responses from respondents below 19 years of age at the time of the interview were not included. They constituted 22, 60, 23 and 24, respectively, of the respondents in each group.
2. 'Not applicable' responses.

Table 4. Distribution of dichotomized outcomes (A), crude odds ratios (B), and adjusted odds ratios (C) and (D). (Bold = Significance level at p<0.05)

Outcome:	Food intake *High*	Health care *Often*	Primary education *Yes*	Self-determination *High*	Attitudes of neighbours *Good*	Voted 2008 *Yes*	Family relationships *High*	Friend-ships *High*
A. Distribution of dichotomized outcomes, % (n)								
Hearing aids								
Users	76.5 (104)	70.4 (95)	58.1 (79)	52.9 (72)	66.2 (90)	86.7 (65)	61.5 (80)	62.5 (75)
Non-users	57.0 (85)	43.9 (65)	22.8 (34)	30.4 (45)	33.8 (50)	81.0 (102)	23.7 (33)	22.6 (30)
Wheelchairs								
Users	65.8 (98)	48.0 (71)	39.6 (59)	47.0 (70)	49.3 (73)	83.2 (99)	47.3 (61)	41.6 (47)
Non-users	53.7 (80)	35.8 (53)	36.2 (54)	42.3 (63)	27.7 (41)	79.0 (94)	35.8 (43)	35.9 (37)
B. Crude odds ratios (95% CI)								
Hearing aid use	**2.45**	**3.03**	**4.69**	**2.04**	**3.84**	1.53	**5.14**	**5.72**
vs. no use	(1.47-4.08)	(1.86-4.96)	2.81-7.82)	(1.25-3.31)	(2.34-6.27)	(0.69-3.41)	(3.04-8.70)	(3.30-9-91)
Wheelchair use	**1.66**	**1.65**	1.15	1.21	**2.54**	1.32	1.61	1.27
vs. no use	(1.04-2.64)	(1.04-2.63)	(0.72-1.84)	(0.77-1.91)	(1.57-4.12)	(0.69-2.53)	(0.97-2.67)	(0.73-2.20)
C. Odds ratios (95% CI)adjusted for sex, age, place of living and financial situation								
Hearing aid use	1.79	1.84	**3.74**	**4.35**	**3.30**	-	**6.29**	**5.41**
vs. no use	(0.92-3.48)	(1.00-3.38)	(2.12-6.60)	(2.16-8.76)	(1.91-5.69)		(3.34-11.9)	(2.92-10.0)
Wheelchair use	1.35	1.42	0.91	0.96	**2.63**	**-**	1.52	1.11
vs. no use	(0.75-2.45)	(0.79-2.54)	(0.54-1.53)	(0.57-1.60)	(1.58-4.38)		(0.89-2.61)	(0.62-2.01)
D. Odds ratios (95% CI) adjusted for sex, age, place of living financial situation and proxy reporting Respondents with hearing impairments only.								
Hearing aid use	**2.94**	**2.85**	**2.23**	1.78	**4.04**	-	**4.18**	**4.59**
vs. no use	(1.36-6.35)	(1.40-5.80)	(1.20-4.16)	(0.78-4.06)	(2.15-7.59)		(2.12-8.27)	(2.37-8.87)
Self response	**0.30**	**0.35**	**3.52**	**6.85**	0.65	**-**	**2.68**	1.56
vs. proxy response	(0.15-0.63)	(0.17-0.73)	(1.87-6.62)	(3.38-13.9)	(0.34-1.22)		(1.42-5.06)	(0.80-3.03)

Table 5. Odds ratios (95% CI) for capability outcomes associated with assistive technology use and/or primary education versus no assistive technology use or primary education; adjusted for sex, age, place of living and financial situation. (Bold = Significance level at p<0.05.)

Outcomes	Food intake *High*	Health care *Often*	Self-deter-mination *High*	Attitudes of neighbours *Good*	Family relationships *High*	Friendships *High*
No hearing aid & No primary education	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
No hearing aid & Primary education	1.54 (0.56-4.27)	0.96 (0.37-2.49)	1.46 (0.54-3.96)	1.56 (0.67-3.60)	**2.98** (1.18-7.53)	1.19 (0.75-4.78)
Hearing aid & No primary education	1.74 (0.76-4.00)	1.48 (0.68-3.22)	2.39 (0.99-5.73)	**2.46** (1.21-4.98)	**5.57** (2.46-12.59)	**3.29** (1.46-7.38)
Hearing aid & Primary education	2.25 (0.96-5.26)	**2.18** (1.01-4.71)	**6.42** (2.80-14.7)	**6.24** (3.01-12.9)	**10.9** (4.94-24.2)	**10.8** (4.86-24.2)
No wheelchair & No primary education	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)	1 (Ref)
No wheelchair & Primary education	1.40 (0.58-3.38)	2.29 (0.96-5.49)	**2.67** (1.23-5.82)	**2.47** (1.13-5.40)	**2.35** (1.04-5.28)	**5.31** (2.07-13.6)
Wheelchair & No primary education	1.33 (0.65-2.70)	1.83 (0.86-3.86)	0.67 (0.34-1.33)	**2.85** (1.45-5.59)	1.42 (0.70-2.91)	1.44 (0.61-3.43)
Wheelchair & Primary education	1.67 (0.68-4.11)	2.00 (0.82-4.87)	**4.56** (2.00-10.4)	**5.46** (2.48-12.0)	**3.44** (1.55-7.64)	**4.69** (1.86-11.8)