Assistive Technology for Children with Disabilities: Creating Opportunities for Education, Inclusion and Participation

A discussion paper

unicef

World Health Organization

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Assistive Technology for Children with Disabilities

PREFACE

Children with disabilities are among the most stigmatized and excluded groups of children around the world. They are likely to have poorer health, less education, less economic opportunity when they grow up, and are more likely to live in poverty and deal with greater inequalities than their peers without disabilities. Furthermore, girls with disabilities face even more discrimination due to gender, disability and other compounding factors such as poverty and ethnicity.

It is estimated that approximately 1 in every 10 children in the world has a disability and less than 10% of children with disabilities in low-income countries go to school. Besides poverty and prejudice, the lack of access to assistive technology, as well as inaccessible transport and school environments are major barriers, which restrict children with disabilities to access education and to participate in the community.

Article 7 of the Convention on the Rights of Persons with Disabilities (CRPD) obliges States Parties to take all necessary measures to ensure the full enjoyment of all human rights and fundamental freedoms by children with disabilities on an equal basis with other children. In addition, the CRPD in several other articles also recognises the importance of access to assistive technology and urges Member States to ensure its availability at an affordable cost. Assistive technology has been found to be the first step for any next steps: for a child with a disability to play with other children; go to school and be educated; and to become a successful citizen and contributing member of society.

Recognising the long-term collaboration between WHO and UNICEF, this discussion paper highlights the importance of assistive technology and how it can make a critical impact on the lives of children with disabilities and enable them to enjoy opportunities like any other children. This discussion paper draws on a wide range of research, studies and evidence while discussing the key issues around assistive technology and factors to be considered to ensure that such technologies can be accessed by girls and boys with disabilities around the world.

Countries need to do more to ensure true implementation of the CRPD, to ensure universal access to assistive technologies in particular. There is also a need for all actors including Member States, UN agencies, civil society organisations, disabled people's organisations, parents of children with disabilities and people with disabilities themselves to work together to ensure access to assistive technology. Article 32 of the CRPD specially asks for international cooperation to improve access to assistive technology—this UNICEF-WHO discussion paper is a definite step towards it.

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EXECUTIVE SUMMARY

When children with disabilities are given opportunities to flourish as any other children, they have the potential to lead fulfilling lives and to contribute to the social, cultural and economic vitality of their communities. Yet surviving and thriving can be especially difficult for children with disabilities. All too often they are isolated and excluded, cut off from health, education and social services, and with limited opportunities to participate in family and community life. This frequently impacts on their future employment opportunities and participation in civic life.

One of the most important requirements for children with disabilities to flourish is their access to assistive technology. For many children, assistive technology represents the difference between enjoying their rights or being deprived of them. However, in many low-income countries only 5–15 percent of those who need assistive technology are able to obtain it. There is an urgent need to address this situation.

Assistive technology includes products and related services that improve the functioning of children with disabilities. It can be instrumental for children's development and health, as well as for participation in various facets of life. These include communication, mobility, self-care, household tasks, family relationships, education, and engagement in play and recreation. Assistive technology can enhance the quality of life of both children and their families. Recognizing its importance, the Convention on the Rights of Persons with Disabilities (CRPD) urges governments to ensure the provision of affordable assistive technologies and related services in several of its articles.

Too often, assistive technology has been a missing link in the chain of prerequisites that enable children with disabilities to lead a life where they can enjoy and exercise their rights. While national governments have primary responsibility to ensure that persons with disabilities can access assistive products, international cooperation in the area of assistive technology can also be a critical catalyst. This UNICEF-WHO discussion paper is a way forward to foster international cooperation to improve access to assistive technology, especially for children with disabilities.

To improve access to assistive technology, all related stakeholders need to maintain a high level of commitment to realizing the mandate of the CRPD - to develop national plans, policies and programmes for provision of assistive technology. The stakeholders include governments, United Nations (UN) agencies, development organizations, disabled people's organizations, service providers, academic institutions, the

private sector, communities, and children with disabilities and their families.

It is estimated that there are more than 150 million children with disabilities under the age of 18 globally. Children with disabilities frequently face challenges to their enjoyment of academic, social, and community participation and are subjected to discrimination and social exclusion based on their age, gender, social status, language, ethnicity, religion, and living environments. Girls with disabilities are particularly at risk of discrimination and abuse. Girls and boys with disabilities have lower rates of primary school completion than those without disabilities and in many cases their lack of access to assistive technology is a contributing factor.

Assistive technology is one of the key elements to advancing inclusion of children with disabilities together with additional supports such as personal assistance, sign language interpreters and removal of barriers. Access to assistive technology for children with disabilities is critical for many to access and benefit from education.

Access to assistive technology is a precondition for achieving equal opportunities, enjoying human rights and living in dignity. Girls and boys with disabilities are entitled to available and affordable assistive technology.

Based on evidence, examples (case studies), and a range of information the UNICEF-WHO discussion paper proposes a set of recommendations and actions to ensure every child with a disability has access to quality assistive technologies so that they can flourish and become productive members of society. Some recommended key actions are:

- Estimate needs and map resources
- Adopt legislation, policies and strategies
- Provide funding and increase affordability
- Set up assistive technology service provision systems
- Ensure supply of quality assistive products
- Train personnel
- and establish partnerships

Appropriate assistive technology can be a powerful tool to increase a child's independence and improve their participation. It can help children become mobile, communicate more effectively, see and hear better, and participate more fully in learning and play activities. Assistive technology supports children to access and enjoy their rights and participate in things they value - and it bridges the disparities between children with and without disabilities.

An educated child with a disability supported by assistive technology will have greater opportunities for employment, resulting in less dependence on welfare and social security measures, and their greater contribution to the country's economy. Consequently by taking action to address the desperate and urgent need for assistive technology, there will be a return on investment that goes beyond an individual family to the larger nation and society in general.

1. INTRODUCTION

For most people, technology makes things easier.
For people with disabilities, technology makes things possible.
—Mary Pat Radabaugh (1)

Children with disabilities experience different forms of exclusion, which may cut them off from health, education and social services, and limit their participation in family, community and society. This isolation can have lasting effects on future employment opportunities and participation in civic life. Supportive services and technology can enable children with disabilities to take their place in society and contribute to their family and community (2).

Assistive technology includes products and related services that improve the functioning of people with disabilities. It can be instrumental for children's development and health, as well as for participation in various facets of life. These include communication, mobility, self-care, household tasks, family relationships, education, engagement in play and recreation. Assistive technology can enhance the quality of life of both children and their families (3-10). See box 1.

Box 1. **Benefits of using assistive technology**

Sarah has difficulty walking and was left indoors with little chance to attend school, to play with other children, and to accompany her family outside home. When she got her wheelchair, she began moving around by herself, interacting with others, attending school and participating in family activities. Her physical and mental health improved as a result of better posture, physical activity and new opportunities. This reduced her family members' stress and worries related to her current and future situation. They no longer had to carry her—a task that had become more difficult as she grew. This freed up time for them to work, rest and otherwise improve the family's living conditions and quality of life.
(Continues in Box 3.)

Harnessing the potential of assistive technology is a viable and achievable means to fulfilling many obligations under the Convention on the Rights of the Child (CRC) (11) and the Convention on the Rights of Persons with Disabilities (CRPD) (12). For many children with disabilities, assistive technology means the difference between inclusion and exclusion, between rights enjoyment and rights deprivation (13).

This UNICEF-WHO discussion paper aims to provide an understanding of the needs for and benefits of assistive technology for children. It offers a basis for developing strategies and collaboration aimed at improving the development and participation of children with disabilities through effective use of assistive technology.

2. CHILDREN WITH DISABILITIES

Who are children with disabilities?

According to the CRPD, children with disabilities includes children "who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others" (12).

Depending on the definition and measure of disability, estimates of the prevalence of children with disabilities vary widely across and within countries (14). To give an indication of the magnitude of the situation, a WHO prevalence estimate from 2004 indicates that about 93 million children aged 14 or younger live with a moderate or severe disability (15). The following year, UNICEF estimated the number of children with disabilities under age 18 at 150 million (16). Examples of common impairments include autism, blindness, brain injury, cerebral palsy, congenital anomalies, Down syndrome, hearing loss, intellectual and learning disabilities, muscular dystrophy, spina bifida, traumatic spinal cord injury, speech impairments and visual loss (17).

The CRPD calls for measures to address disability at different levels: health services; habilitation and rehabilitation services; assistive technology services; and accessibility (12). For example, clubfoot may be corrected surgically; through physiotherapy; or through the use of a foot orthosis. If clubfoot is not treated successfully, long-term use of a wheelchair may be needed. Other impairments require other types of assistive technology for example a hearing aid or low-vision glasses to overcome their functional impairments.

What are the rights of children with disabilities?

The CRC and the CRPD spell out the rights that all children have, including children with disabilities. Some of these rights are particularly relevant to assistive technology. The CRC includes rights to protection and care necessary for well-being; to survival and the highest attainable standard of health; to facilities for the rehabilitation of health; to develop to the fullest; to education; to freedom of expression; to access information and material

from a diversity of sources; and to participate fully in family, cultural and social life. In Article 23, the CRC specifically recognizes the right of children with disabilities to special care and assistance, which should be provided free of charge whenever possible (11).

Further, Article 23 states that children with disabilities should enjoy a full and decent life in conditions, which ensure dignity, promote self-reliance, and facilitate the child's participation in the community. They have the right to free special care whenever possible. Assistance should be designed to ensure that children with disabilities have effective access to and receive education, training, healthcare services, rehabilitation services, preparation for employment, and recreation opportunities in order for them to achieve their fullest possible social integration and individual development (11).

The CRPD underscores several of the rights outlined in the CRC. Article 7 asserts "States Parties shall take all necessary measures to ensure the full enjoyment by children with disabilities of all human rights and fundamental freedoms on an equal basis with other children." In addition to this, the CRPD says that children with disabilities are to be provided appropriate assistance in order for them to exercise their right to express their views freely on all matters affecting them. For children with disabilities to live independently and participate fully in all aspects of life, the CRPD requires States Parties to ensure access to the physical environment, to transportation, to information and communications, and to other facilities and services open to or provided to the public. Their personal mobility and rights with respect to family life should be ensured. Further, they have a right to an adequate standard of living and continuous improvement of living conditions (12). Examples of how assistive technology can help children exercise their rights are given in box 2.

What barriers do children with disabilities experience?

Children with disabilities face extreme disparities and daunting challenges to the enjoyment of academic, social, and community participation in low and middle income countries (14). They are subjected to additional discrimination and social exclusion based on age, gender, social status, language, ethnicity, religion, living in conflict zones and other factors. Girls with disabilities are particularly at risk of discrimination and abuse (17).

Girls and boys with disabilities have lower rates of primary school completion than those without disabilities and in many cases assistive technology can enable them to further develop their learning capacity (2). Children with disabilities are more likely to be unemployed and to live in poverty in adulthood than their peers without disabilities (14). Households with a member with a disability are at higher risk of living below the poverty line (2). Lack of

Box 2. Examples of assistive technology that can help children attain their rights

- Protective headgear can ensure the physical well-being of children with epilepsy and enable them to participate in activities important for social well-being.
- A pressure relief cushion in a wheelchair can protect a child with paralysis from pressure sores and associated fatal infections.
- Ramps and handle bars can help children to access health facilities, and a hearing aid can help a child with a hearing impairment to use health services.
- Parallel bars can help children with balance challenges to develop balance and strength.
- A communication board can support a child with speech difficulties to express herself.
- A screen reader can make it possible for a child who cannot see to access information on the web.
- A splint can enable a child to join the family at a cultural event.
- An alternative way of showing time can help a child with an intellectual disability to meet with friends on time.

accessibility and support leads to greater dependency, and family members may lose additional income because they become primary caregivers. In some cases, siblings have to play the role of caregivers, depriving them of the opportunity to go to school and participate in the community.

As indicated in the CRPD, disability can be addressed by changes to the environment. Environmental factors make up the physical, social and attitudinal environment in which children live. At the individual level, environmental factors include physical and material features of immediate environments, such as home and school settings, as well as direct contact with family, peers and others. At the societal level, environmental factors include formal and informal social structures, services and overarching approaches or systems in the community or society that have an impact on individual children. Examples include services related to school environment, community activities, government agencies, communication and transportation services, and informal social networks, as well as laws, regulations, rules, attitudes and ideologies.

An environment with barriers and without enablers restricts a child's potential; other more enabling environments increase the opportunities. Society may hinder a child's potential because it creates barriers (for example, negative attitudes or inaccessible buildings) or it does not provide enablers (for example, unavailability of assistive technology) (18). This can be illustrated by an example from education. Children with disabilities face numerous barriers to attending school and receiving an education. See box 3. Without assistive technology and accessible environments, children with disabilities may be unable to go from home to school, see what is written on the blackboard, hear and understand the teacher, read the textbooks, use

sanitation facilities, participate in sports and recreation, and interact with classmates. Assistive technology is one of the key elements to advancing inclusion of children with disabilities in combination with other supports such as personal assistance, sign language interpreters and barrier removal. Meaningful access to assistive technology and accessible technology for children with disabilities is critical for many to access and benefit from education (19).

Box 3. Barriers faced by Sarah to using assistive technology *(Continued from Box 1.)*

One of the main reasons for Sarah to get a wheelchair was to be able to attend school. But Sarah and her family soon realized that a wheelchair alone would not be sufficient. First they got help to repair the holes in the road to the school. Still Sarah finds it hard to get to school during the rainy season, as the road gets muddy where it is not paved. Her friends usually push her across those parts. There is an option to go by bus, but it is impossible for her to enter the bus.

Sarah's parents talked to the principal of the school about the needs for making the school accessible. Although a bit reluctant in the beginning, the principal is now cooperative and has ensured that a ramp has been built at the entrance, narrow doorways have been replaced and a bathroom has been extended. As there is no elevator in the school building, Sarah's classes are all on the ground floor. A specific place has been allocated for her in the classrooms with a desk under which she can enter with her wheelchair. She would like to move around more in the classrooms but there is currently no space between the desks and seats used by her classmates. Although Sarah still encounters accessibility problems in certain areas, she continues using the wheelchair as the benefits outweigh the remaining problems.

3. ASSISTIVE TECHNOLOGY FOR CHILDREN

What is assistive technology?

Assistive technology is used as an umbrella term for both assistive products and related services. Assistive products are also known as assistive devices.

There are various definitions of assistive technology: two of them are presented here. The International Classification of Functioning, Disability and Health (ICF) defines assistive products and technology as any product, instrument, equipment or technology adapted or specially designed for improving the functioning of a person with a disability (20). Drawing from the ICF, the International Organization for Standardization (ISO) defines assistive products more broadly as any product, especially produced or generally available, that is used by or for persons with disability: for participation; to protect, support, train, measure or substitute for body functions/structures and activities; or to prevent impairments, activity limitations or participation restrictions. This includes devices, equipment, instruments and software (21).

Services related to assistive products include referral, assessment of the child, prescription, funding, ordering, product preparation, fitting/adjusting of the product to the child, training of the child or family members, follow-up, and maintenance and repairs. Medical devices and clinical expertise may also be required to diagnose and monitor underlying conditions that impair functioning. Each type of assistive technology requires its assessment methods—for example, its ways of adapting, modifying or fitting the product. It is important that the personnel involved in the service delivery have the necessary knowledge to prevent potential harm associated with incorrect assessment and fitting. Appropriate services can have a substantial impact on the outcomes of using assistive technology (22-24).

There exists a vast range of assistive technology stretching along a continuum from low- to high-tech (25). Examples of assistive technology of various complexities are given in table 1. ISO classifies such products according to the following: personal medical treatment, training in skills, personal care and protection, personal mobility, housekeeping, communication and information, handling objects and devices, environmental improvement and assessment, employment and vocational training, and recreation, as well as splints and artificial limbs, and furnishings and adaptations to homes and other premises (21).

What are the benefits of assistive technology?

When appropriate to the user and the user's environment, assistive technology is a powerful tool to increase independence and improve participation (14, 26). It helps individual children become mobile, communicate more effectively, see and hear better, and participate more fully in learning activities (27). Moreover, assistive technology supports children to access and enjoy their rights; do things they value; and bridges disparities between children with and without disabilities (14, 25, 28-31). It provides the means of access to and participation in educational, social and recreational opportunities; empowers greater physical and mental function and improved self-esteem; and reduces costs for educational services and individual supports (19).

Benefits in areas such as health, mobility and education have been linked to the use of assistive technology (4, 7, 32). By improving access to education and increasing achievement in school, assistive technology can have a positive socioeconomic effect on the lives of children with disabilities (33, 34). See box 4.

Examples of assistive technology (from (2)).
These examples are meant to be illustrative only.

Category	Product examples
Mobility	Walking stick, crutch, walking frame, manual and powered wheelchair, tricycle
	Artificial leg or hand, leg or hand splint, clubfoot brace
	Corner chair, supportive seat, standing frame
	Adapted cutlery and cooking utensils, dressing stick, shower seat, toilet seat, toilet frame, feeding robot
Vision	Eyeglasses, magnifier, magnifying software for computer
	White cane, GPS-based navigation device
	Braille systems for reading and writing, screen reader for computer, talking book player, audio recorder and player
	Braille chess, balls that emit sound
Hearing	Headphone, hearing aid
	Amplified telephone, hearing loop
Communication	Communication cards with texts, communication board with letters, symbols or pictures
	Electronic communication device with recorded or synthetic speech
Cognition	Task lists, picture schedule and calendar, picture based instructions
	Timer, manual or automatic reminder, smartphone with adapted task lists, schedules, calendars and audio recorder
	Adapted toys and games

By facilitating the participation and inclusion of children with disabilities in all aspects of life, assistive technology can impact on self-image, self-esteem and sense of self-worth (37, 38). In a study in Bangladesh, the use of assistive technology was associated with better attitudes from community members (31). "Given opportunities to flourish as others might, children with disabilities have the potential to lead fulfilling lives and to contribute to the social, cultural and economic vitality of their communities" (2).

Assistive technology reduces costs when it supports early childhood development and educational achievement, and avoids repetition of learning missed due to educational barriers. It reduces costs by supporting

independent functioning and access to healthcare in lieu of personal support services, and independent community living in lieu of institutionalization. Assistive technology may "reduce the need for formal support services, ... reduce the time and physical burden for caregivers, ... [and prevent] falls, injuries, further impairments and premature death" (26).

The link between school dropout and unemployment is clear, and frequently leads to high costs for society (36). An educated child with a disability supported by assistive technology will have better opportunities for employment (27). This results in less dependence on welfare and social security measures, greater contribution to the country's economy and gross domestic product (GDP), and a return on investment that goes beyond an individual family to the larger nation. For example, in Sweden, the cost for assistive technology for a student is recovered if he or she is able to enter the labour market just one month earlier due to this technology (36). Thus, assistive technology is an important part of any development strategy (39).

Box 4. The effects and cost-effectiveness of assistive technology for schooling

The correlation between low education outcomes and having a disability is often much stronger than the correlations with other characteristics (for example, gender or household income (35). Assistive technology has been found to improve the achievement of students with disabilities (33, 34, 36).

A socioeconomic analysis of students with cognitive impairments, school failure and the job market in a welfare state concluded that the cost of providing assistive technology to a student was recovered if he or she avoided a month delay in entering the job market. Also, if as little as 1% of the students avoided lifelong exclusion from the job market, the total intervention would be profitable. The study noted that at individual level, poor achievement in school may result in reduced salary throughout a person's working life (36).

Providing assistive technology to children as early as possible will facilitate their development and prevent secondary conditions such as deformities. For example, correction of a clubfoot by the means of a simple foot orthosis at an early age may reduce the need for costly surgery at an older age.

Some children with severe disabilities that are unable to attend school can access education from home and communicate with others with the help of assistive technologies, accessible information and communication technologies (ICTs) or cloud-based services. ICTs offer new ways to break down accessibility barriers and provide children with disabilities the opportunities to exchange knowledge and information, and to communicate in ways they otherwise have not been able to do. ICT tools and applications are paving the way for children with disabilities to access educational materials and resources in different formats and to engage in the same academic activities as their peers without disabilities (40).

What are the needs for assistive technology?

The global need for assistive technology for children has not yet been adequately quantified. Estimates indicate that about 0.5% of a population need prosthetic or orthotic devices, about 1% need a wheelchair, and about 3% need a hearing aid (24, 41, 42). These needs vary between countries as well as between regions within a country due to factors such as variations in age distribution and prevalence of various impairments. In developing countries, up to 0.6% of children have hearing impairments within the neonatal period (43). However, hearing aids are not always an appropriate solution. In Chile and China, about 7-9% of school aged children would benefit from using properly prescribed eyeglasses (44, 45). In Sweden, about 0.2% of all children aged 0-17 years use wheelchairs (46).

In some African countries, the largest discrepancy between self-reported needs for and received rehabilitation services was found to be in the area of assistive technology (47). WHO estimates that only 5-15% of assistive technology needs are met in many developing countries (48). In fact, more than 97% of those that would benefit from using a hearing aid do not have one (49). Studies in Malawi and Namibia indicate that more than 80% of those who need assistive technology do not have it (50, 51). A study in Afghanistan reported that children were less likely than adults to access assistive technology indicating that their unmet needs are even greater (52).

In situations of crisis and emergency, children with disabilities suffer from a triple disadvantage: they experience the same impact as others, they are less able to cope with deterioration of the environment, and responses to their needs are postponed or disregarded (53). To reduce the impact of crisis and emergencies, children may need assistive technology to be alerted or to escape a danger before it strikes, or to be able to carry out activities of daily living important to their survival and health.

What rights do children have to assistive technology?

Access to assistive technology is regarded as a precondition for achieving equal opportunities, enjoying human rights and living in dignity (54). Girls and boys with disabilities are entitled to available and affordable assistive technology. Ensuring this right is first of all a national responsibility, but also an international responsibility. CRPD Article 32 calls for international cooperation among governments, international and regional organizations and civil society, in particular organizations of people with disabilities (12, 55), while CRC Article 23 calls for information exchange between

governments (11). Failure to provide assistive technology results in rights violations (55).

The CRPD requires States Parties to take effective measures to "undertake or promote research and development of, and to promote the availability and use of new technologies, including information and communications technologies ... and assistive technologies, suitable for persons with disabilities, giving priority to technologies at an affordable cost" (Article 4). It also recognizes the importance of international collaboration to support national efforts to make assistive technology available and affordable (12).

Assistive technology is frequently mentioned in the CRPD. Articles 4, 9, 20, 21, 24, 26, 29 and 32 of the CRPD make explicit mention of specific aspects of assistive technology, and an additional 17 articles require measures which may include assistive technology (12, 13). For example, Article 24 of the CRPD recognizes the right of children with disabilities to education. It requires States Parties to ensure that children with disabilities can access an inclusive, quality and free primary and secondary education on an equal basis with others in the communities in which they live, that reasonable accommodation and effective support measures are provided to meet their individual requirements, and that they receive the support required to facilitate their effective education. It also requires States Parties to facilitate the learning of Braille, alternative script, augmentative and alternative modes, means and formats of communication, and orientation and mobility skills (12).

What are the barriers to assistive technology?

As indicated earlier, disability is the outcome of the interaction between a child with an impairment and an environment with barriers that hinder his or her participation on an equal basis with others. Assistive technology can reduce or eliminate such barriers. However, obtaining such technology is not always possible due to product and service related barriers.

Lack of awareness

Many people with disabilities and their families have limited awareness of assistive products and services (26, 56, 57). This makes it difficult for children and their families to know what assistive technologies are available or suitable and how they can be beneficial.

Lack of governance including legislation, policies and national programmes

The 2005 'Global survey on government action on the implementation of the Standard Rules on the Equalization of Opportunities for Persons with Disabilities' found that of the 114 responding countries 50% had not passed relevant legislation and 48% did not have policies in place relating to the provision of assistive technology (58). This indicates that for many States the provision of assistive technology is a relatively low area of priority.

Lack of services

Assistive technology services are often in short supply and located far away from where children with disabilities live (26). In the above mentioned global survey, 53% of the 114 responding countries had not initiated programmes relating to the provision of assistive technology (58). Non-governmental organizations rarely have the financial means or capacity to develop country-wide sustainable service delivery systems (26). With limited geographical coverage, their services often focus on specific types of assistive technology or disabilities (59).

Current service delivery is not equitable. Inequities have been found not only between people living in different countries or regions of a country, or under different economic conditions: they have also been found among people with different impairments, genders, ages, languages and cultures. Children are often less likely than adults to access assistive technology. In addition to reduced financial means, it is culturally impossible for girls in certain regions to access assistive technology when services are staffed only by male personnel (3, 32, 47, 50, 52, 60-62).

Lack of products

In many countries, there is no production of assistive products—or production occurs on a small scale. It is small not only in terms of quantity, but also in terms of the range of types, models and sizes of the products. Limited access to the materials and equipment needed to produce assistive products can hamper production. Market-related factors can also limit production. Limited awareness of assistive technology or purchasing capacity leads to a limited demand. This results in few incentives to engage in production. Local production may not be cost-effective where local markets are small. Moreover, duty and import taxes associated with assistive technology can discourage

Box 5. Producers and suppliers of assistive technology

Major producers and suppliers of assistive technology in developing countries vary from country to country. A combination of government, non-government, private sector and disabled people's organizations supplying products in a country is common. To meet the demand, maintain high sustainability and achieve maximum impact, complementing small-scale manufacturing with large-scale domestic production and import has been suggested (67). Combining standard components with individually adapted components is a common way to reduce production costs while maintaining fit. For example, an imported hearing aid manufactured elsewhere with locally made individual ear mold. Whirlwind Franchise Network is an example of combining regional wheelchair manufacturing with provision and assembly centres around the globe (68).

local businesses to import materials, equipment or assistive products (26). Box 5 gives some examples on how the lack of products can be addressed.

Although a wide range of types of assistive products are available globally, they are not available everywhere, and all designs are not appropriate in all settings. Therefore, product research and development is still required (63). Unless the design of an assistive product meets a child's and the family's needs and preferences, and is suitable in their physical, social and cultural environment, there will continue to be a low demand for products (38, 64-66).

Inaccessible environments
Physically or cognitively inaccessible environments act as barriers to assistive technology. For example, inaccessible transport systems or service centres prevent children from having easy access to the services and products they need. Physical barriers include stairs or poor lighting, while cognitive barriers include texts that are not clear or symbols that are difficult to understand. Further, regardless of the cost or availability of a wheelchair, a child will not be able to use it in an inaccessible house, road or school. Barriers are often exacerbated during natural disasters and conflicts (26).

Lack of human resources
Another barrier to assistive technology is a lack of personnel properly trained in manufacturing or adapting products, or delivering services (69-72). Many countries report inadequate numbers of rehabilitation personnel (14). Box 6 indicates ways to address the current lack of personnel adequately trained in assistive technology.

Box 6. **Addressing lack of human resources**

Successful provision of assistive technology typically involves a multi-disciplinary approach. To take advantage of assistive technology, existing training programmes for professionals such as occupational therapists, physiotherapists and special teachers can increase their course content on assistive technology services. Similarly, courses for other rehabilitation workers may include elements of provision of assistive technology. Universities across the globe offer courses and sometimes complete programmes that relate to designing innovative, usable and useworthy assistive technology products. In several countries, international and national non-government organizations offer formal and informal courses on different aspects of the provision of assistive technology. Professional organizations, such as the International Society for Prosthetics and Orthotics (ISPO); the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA); and the International Society of Wheelchair Professionals (ISWP); contribute to developing the competence of assistive technology professionals.

Box 7. **Sources of funding**

Every child who needs assistive technology is entitled to it, regardless of the ability to pay for it. Funding mechanisms to ensure this include (24):

- Government, insurance, donor or charity funding
- Assistive technology fund (which may channel above mentioned funds)
- Contributions from families
- Income generation by selling other products or services that subsidize the provision of assistive technology
- Voucher system to the value of assistive technology that meets minimum standards. If the child and the family want more expensive assistive technology they have to arrange to pay the additional funds themselves.

Financial barriers
The costs of purchasing, maintaining and replacing assistive products, and associated services and traveling costs constitute a major barrier (3, 26, 59). Costs can be especially prohibitive in the case of children, as they need their assistive products replaced or adjusted as they grow (2). In the global survey among 114 countries, 36% had not allocated financial resources for developing and supplying assistive technology (58). Box 7 describes some strategies to address financial barriers.

Box 8. **Addressing the need for research and development**

Users, services and products are three intertwined dimensions of assistive technology research, which are undertaken by governments, universities, non-government and private actors. To be able to plan and implement cost-effective services, governments find research on users and services particularly relevant. However, there are also instances when they support product related research and development through grants to universities and product developers.

In resource-limited settings, national and international organizations often play an instrumental role in developing knowledge about assistive technology users, services and products.

In Thailand, for example, a government organization undertakes research to address the needs for assistive technology for education among children (www.nectec.or.th). In Qatar, a public private partnership established a non-profit organization that provides assistive technology services as well as undertakes assistive technology research (mada.org.qa). In yet another country—Sweden, the government supported a special initiative to promote the development of assistive technology for children, and a touring exhibition of assistive technology for children has been taken to dozens of countries in Europe and Asia (www.hi.se).

Improved training opportunities, availability of quality products, and increased availability of services are very important. The current major bottlenecks are recognition of assistive technology in national and organizational plans/policies, and resourcing of assistive technology in practice (73, 74). Research and development in the field of assistive technology is also very beneficial (see box 8).

What principles should guide the provision* of assistive technology?

Assistive technology for children needs to be appropriate for them. This means that the products should meet children's needs and environmental conditions. It also means that they should be safe and durable, and, when applicable, they provide proper fit and support. Finally, they should be available, obtainable and maintainable, and the services sustained in the country at the most economical and affordable price (24).

Strategies for providing assistive technology need to consider the principles of **5A&Q** - availability, accessibility, affordability, adaptability, acceptability and quality (26).

Availability
Services and products are available in sufficient quantity as close as possible to children's communities.

Accessibility
Services and products are accessible to every child who needs them. Their delivery should be equitable to avoid discrepancies between genders, impairment groups, socioeconomic groups and geographic regions.

Accessibility includes physical and cognitive access to services and information. Physical accessibility means that, for example, buildings are accessible, lighting is appropriate, signs are available in Braille, and noise levels are low. Cognitive accessibility means that verbal and written information and instructions are clear and simple, language and symbols are concrete rather than abstract, and products are intuitive and easy to use—all from the perspective of children. Ensuring accessibility is required by the CRPD (12).

Affordability
Services and products are affordable to the family of every child who needs them. Many of them will not afford assistive technology unless it is provided free of charge or subsidized (54).

Adaptability
Services and products are adapted and modified to ensure they are appropriate to the needs and requirements of individual children. They need to accommodate differences in terms of individual factors (for example, health condition, body structure, body function, capacity, gender, age, ethnicity and preference) as well as environmental factors (for example, physical environment, psychosocial environment, climate and culture). In addition, physical changes of children as they grow and develop need to be accommodated. How often a child should change an assistive product depends on how fast he or she develops and grows, which will vary over time as well as between children. It is important to prevent new and secondary health problems such as pressure sores, pain, and deformities due to poorly adapted products (24).

Acceptability
Services and products are acceptable to children and their families. This is facilitated by involving them in the provision process and by considering their needs, preferences and expectations (38). Factors such as efficiency, reliability, simplicity, safety, comfort and aesthetics should be taken into account to ensure that devices and related services are acceptable to children and their families. Although needs, preferences and expectations are individual, particularly regarding comfort and aesthetics, available designs should satisfy those of both girls and boys.

Accessibility of the environment is necessary for using certain types of assistive technology and therefore influence the acceptability of a product (23). The CRPD stipulates that governments are responsible to ensure access to the physical environment, to transportation, to information and communications, and to other facilities and services open or provided to the public. This includes housing, schools, medical facilities, roads and transportation as well as information and communication services (12). See box 3.

Quality
Services and products are of an appropriate quality. Product quality can be measured through applicable technical standards or guidelines in terms of strength, durability, capacity, safety and comfort. If national standards have not been adopted, products would preferably comply with relevant international standards of the International Organization for Standardization (ISO). See box 9. Specific service qualities can be measured in terms of compliance with staff training requirements and service guidelines, while overall quality of services can be measured in terms of outcomes, user satisfaction and quality of life.

* Provision of assistive technology includes the design, production and supply of products and delivery of services (24).

Box 9. **An example of WHO Wheelchair Guidelines**

The WHO Guidelines on the provision of manual wheelchairs in less resourced settings (24) highlights the importance of quality products for less resourced settings and advocates for product testing, field trials and long-term follow-up. The need to involve wheelchair users in the design process is highlighted, as they are the most knowledgeable about their physical, environmental, social and cultural needs.

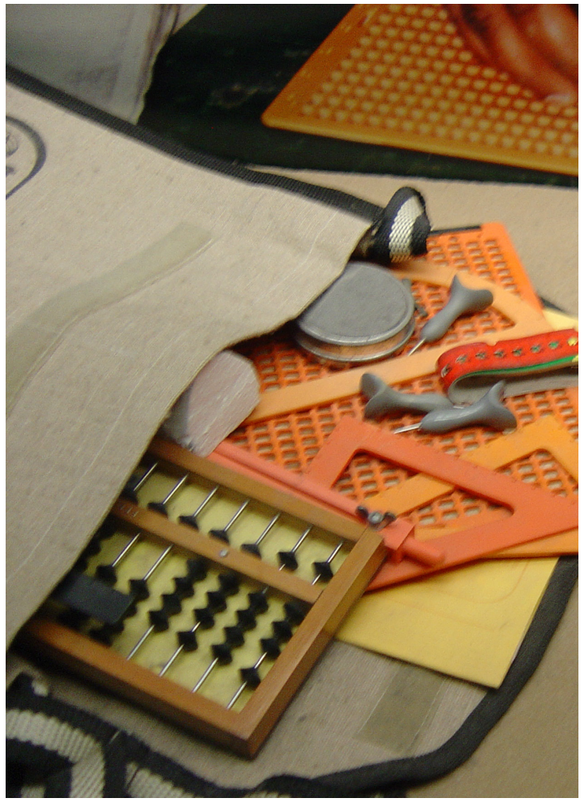
The Guidelines go further and encourage governments to develop and adopt national wheelchair standards to ensure a reasonable level of quality, for instance by using the ISO 7176 series of wheelchair standards as a basis.

Making assistive technology available, accessible, affordable, adaptable, acceptable and of appropriate quality requires efficient use of often limited resources. The resources are interrelated and include people, materials, manufacturing methods and service delivery systems. Available materials and human resources often determine possible manufacturing methods. Available service delivery systems, particularly for repair and maintenance, determine what materials and manufacturing methods can be used. It is important to choose materials and manufacturing methods that as far as possible allow for local repair and maintenance at an affordable cost. The market size determines whether it is possible to take advantage of economies of scale.

Box 10. **Examples of organizations promoting international cooperation**

Examples of international cooperation to promote access to assistive technology include:

- The International Society of Prosthetics and Orthotics (ISPO) and the Federation of African Orthopaedic Technologists (FATO) are an example of cooperation to promote access to prosthetic and orthotic services—one at global level and another for Africa only. ISPO and FATO are working together in Africa to promote the assistive technology sector: prosthetics, orthotics, and wheelchairs in particular.
- The International Society of Wheelchair Professionals (ISWP). With a mission that wheelchair users are provided the best technology with the best service worldwide, ISWP is built around a federation of regional and international affiliate members and partners which help ensure the activities are culturally relevant, timely, and focused on the most important wheelchair-related issues. ISWP is an outcome of long-term international cooperation on wheelchair provision.
- Global Cooperation on Assistive Health Technology (GATE). GATE is a partnership among UN Agencies, international organizations, donor agencies, professional organizations, academia and organizations of/for persons with disabilities. Its goal is to improve access to high quality affordable assistive technology.



4. CONCLUSION AND NEXT STEPS

Too often, assistive technology has been a missing link in the chain of pre-requisites that enable children with disabilities to lead a life where they enjoy and exercise their rights rather than being deprived of them. While national governments have primary responsibility to ensure that persons with disabilities can access assistive products, international cooperation in the area of assistive technology can also be a critical catalyst. See boxes 9 and 10.

Box 11. **Example of bilateral cooperation**

Nearer to the end of the last century, agencies in Thailand and Canada jointly worked on developing a culturally and nationally appropriate assistive technology service delivery system in Thailand. They first developed a strategic plan, which was then implemented and followed up. They noticed that it was a complex task requiring concerted efforts, involving interaction with Ministries such as Education, Public Health, Social Welfare and Labour. The service delivery system needs to be compatible with the country and its infrastructure, and it requires substantial professional training. Involvement of disabled people's organizations and non-government organizations is essential (75).

RECOMMENDATIONS

To make assistive technology of an appropriate quality available, accessible, affordable, adaptable and acceptable to children and their families, stakeholders need to maintain a high level of commitment to realizing the provisions of the CRC and the CRPD. The stakeholders include governments, United Nations (UN) agencies, development organizations, disabled people's organizations, service providers, academic institutions, the private sector, communities, and children with disabilities and their families (14).

Drawing from the State of the World's Children 2013 and the World Report on Disability (2, 14), UNICEF and WHO recommend concerned stakeholders to:

- Ratify and implement the CRC and the CRPD with regards to assistive technology for children, particularly CRC Article 23, and CRPD Articles 4, 9, 20, 21, 24, 26, 29 and 32.
- Involve children with disabilities and their families in related assistive technology activities, including the development of policies, and the design and evaluation of services and products.
- Enable children with disabilities access to all mainstream policies, systems and services (for example, health facilities, early childhood centres, schools, public transport and playgrounds) through assistive technology and accessibility measures as required.
- Include access to assistive technology in the education policy and programmes.
- Include assistive technology for children in disability strategies and plans of action.
- Invest in assistive technology programmes for children with disabilities.
- Procure priority assistive products and ensure they reach children in need.
- Improve human resource capacity in the provision of assistive technology for children with disabilities.
- Provide adequate funding to improve availability and affordability of assistive technology for children with disabilities.
- Increase awareness and understanding about assistive technology for children with disabilities.
- Improve data collection and support research on assistive technology for children with disabilities.
- Where applicable, develop a multi-sectoral taskforce across Ministries of education, health and social welfare (or similar) to ensure that children with disabilities have access to appropriate assistive technology.

The main aim of this UNICEF-WHO discussion paper is to provide an understanding of the need for and benefits of assistive technology for children with disabilities. It offers a platform to stimulate discussion, planning and action on issues related to the provision of assistive technology to children. The following sections provide a basis for future efforts in this regard.

Actions

As a basis for discussion and consultation on the implementation of the recommendations above, a number of urgent actions are needed as proposed below (13, 26, 59).

Estimate needs and map resources

Estimating children's needs for assistive technology and mapping available resources are a prerequisite for planning equitable services. In the absence of available data, 3–5% of children in any population can be used as a baseline to calculate the number of people who need assistive technology. It is important that the needs of children with all types of disabilities are considered, including those with physical, cognitive and sensory disabilities. Existing systems for the collection of health or educational data may be utilized.

Box 12. **Examples of policies on the provision of assistive technology**

The Government of India has adopted a scheme that makes assistive technology available free of charge to people with disabilities in families earning up to a certain level, and subsidizes assistive technology to people with disabilities in families with earnings below a slightly higher level (76). Similarly, to realize The Persons with Disabilities Act in Kenya, the National Fund for the Disabled of Kenya supports the provision of assistive technology, with the exception of expensive technology (77).

Adopt legislation, policies and strategies

Provision of assistive technology to children needs to be incorporated into existing or new legislation, strategies and policies (see box 11 for examples). These documents also need to address issues of physical and cognitive accessibility to assistive products and services, as well as to public in- and outdoor environments and facilities. It is important that children can use their assistive technology in their homes; to and from school; in school; in playgrounds; and in other public environments.

Provide funding and increase affordability

Ensuring effective implementation of policies requires budgeting and allocation of necessary funding. Assistive technology for children needs to be identified and made available at an affordable price. The development of a list of essential assistive products may facilitate this process. Examples of funding mechanisms include government funding, donor funding, national or private insurance schemes, public or private assistive technology funds,

user contributions, tax reduction, duty exemption on imported materials and products, corporate social responsibility schemes and micro-funding schemes (24, 40).

Set up assistive technology service provision

Each country needs to set up assistive technology services that are accessible to children and capable of responding to identified needs in their specific contexts. Equitable provision of assistive technology calls for national approaches. Although applied service models may vary between user groups or geographic areas, the absence of a national perspective is likely to result in fragmented and inequitable services, uncoordinated and parallel service delivery systems, and inefficient use of available resources (59).

In some countries, the provision of assistive technology is an integral part of healthcare. In others, assistive technology is provided by the government through rehabilitation, vocational rehabilitation, social welfare or special education agencies, insurance companies, and charitable and non-governmental organizations (14). When setting up new service delivery systems in less resourced settings, it may be cost-efficient to utilize already

existing systems and infrastructure; for example, healthcare, education, and community-based rehabilitation (CBR). See box 12. Determining needs for and facilitating access to assistive technology, as well as ensuring maintenance, repair and replacement, are important activities of CBR (39). In Thailand, for example, the school system is used to ensure that students with disabilities get necessary assistive technology (75, 78). In particularly challenging environments—such as disaster areas, conflict areas and refugee camps—innovative and flexible service systems may be required to ensure prompt delivery of assistive technology to children (53).

Box 13. **Providing assistive technology services in less resourced settings**

One strategy to provide assistive technology in less resourced settings is Community Based Rehabilitation (CBR). CBR is frequently the vehicle to meet assistive technology needs among more vulnerable groups, including younger people. Thus, assistive technology providers may learn from CBR strategies such as awareness raising and service delivery at community level, the use of local resources, collaboration and coordination, and the consideration of cultural factors (79).

Supply products

Assistive products of appropriate quality and sufficient quantities need to be supplied to assistive technology services. User benefits, local employment situations and the skills of service providers as well as the long-term supply of spare parts need to be considered when choosing supply strategies. These may vary between different products and contexts.

Train personnel

Decision makers and personnel at all levels require appropriate training to effectively develop and implement all aspects of a system for the provision of assistive technology to children. Accredited training programmes may be established. For example, WHO, academic institutions and other organizations have developed guidelines, training materials and courses on the provision of various types of assistive technology (24, 39, 41, 42, 80).

Establish partnerships

The development of partnerships among stakeholders supports national efforts, coordination and collaboration, and helps prevent duplication (26). Besides partnerships at the national level, collaborations may also include agencies from other countries, international organizations or other entities that have committed to the CRPD and Article 32 on international cooperation (55, 59). Platforms for sharing information, including research and best practices, may be established (26).

REFERENCES

1. Radabaugh MP. Assistive Technology: Independent Living Centre NSW; 2014 [May 27, 2014]. Available from: http://www.ilcnsw.asn.au/home/assistive_technology/assistive_technology.
2. UNICEF. The state of the world's children 2013. Children with disabilities. New York: United Nations Children's Fund; 2013.
3. May-Teerink T. A survey of rehabilitative services and people coping with physical disabilities in Uganda, East Africa. Int J Rehabil Res. 1999;22(4):311-6.
4. Shore SL. Use of an economical wheelchair in India and Peru: Impact on health and function. Medical Science Monitor. 2008;14(12):71-9.
5. Parving A, Christensen B. Clinical trial of a low-cost, solar-powered hearing aid. Acta Otolaryngol. 2004;124(4):416-20.
6. Olusanya B. Self-reported outcomes of aural rehabilitation in a developing country. International Journal of Audiology. 2004;43(10):563-71.
7. Joseph P. A study on certain factors influencing language performance of hearing impaired students. Asia Pacific Disability Rehabilitation Journal. 2003;14(2):201-8.
8. Adolfsson M. Applying the ICF-CY to identify everyday life situations of children and youth with disabilities. Jonkoping: Jonkoping University; 2011.
9. Murchland S, Parkyn H. Using assistive technology for schoolwork: the experience of children with physical disabilities. Disability and Rehabilitation: Assistive Technology. 2010;5(6):438-47.
10. Nicolson A, Moir L, Millsteed J. Impact of assistive technology on family caregivers of children with physical disabilities: a systematic review. Disability and Rehabilitation: Assistive Technology. 2012;7(5):345-9.
11. Convention on the Rights of the Child. New York, United Nations, 1989.
12. Convention on the Rights of Persons with Disabilities. New York, United Nations, 2006..
13. Borg J. Assistive technology for children. In: UNICEF, editor. The state of the world's children 2013 Children with disabilities. New York: UNICEF; 2013.
14. WHO. World report on disability. Geneva: World Health Organization; 2011.
15. WHO. The global burden of disease. 2004 update. Geneva: World Health Organization; 2008.
16. UNICEF. The state of the world's children 2006. Excluded and invisible. New York: United Nations Children's Fund; 2005.
17. WHO & UNICEF. Early childhood development and disability: A discussion paper. Geneva: World Health Organization; 2012.
18. WHO. International classification of functioning, disability and health (ICF). Geneva, Switzerland: World Health Organization; 2002.
19. Alquraini T, Gut D. Critical components of successful inclusion of students with severe disabilities: Literature review. International Journal of Special Education. 2012;27(1):42-59.
20. WHO. ICF Browser. Chapter 1 Products and technology: World Health Organization; [June 9, 2014]. Available from: http://apps.who.int/classifications/icfbrowser/.
21. ISO. ISO 9999:2011 Assistive products for persons with disability – Classification and terminology Geneva: International Organization for Standardization; 2011.
22. Lindström A. Appropriate technologies for assistive devices in low-income countries. In: Hsu JD, Michael JW, Fisk JR, editors. AAOS Atlas of othoses and assistive devices. Philadelphia: Mosby Elsevier; 2008.
23. Scherer M, Jutai J, Fuhrer M, Demers L, Deruyter F. A framework for modeling the selection of assistive technology devices (ATDs). Disability and Rehabilitation: Assistive Technology. 2007;2(1):1-8.
24. WHO. Guidelines on the provision of manual wheelchairs in less-resourced settings. Geneva: World Health Organization; 2008.
25. Bouck EC, Flanagan S, Miller B, Bassette L. Rethinking everyday technology as assistive technology to meet students' IEP goals. Journal of Special Education Technology. 2012;27(4):47-57.
26. WHO. Joint position paper on the provision of mobility devices in less -resourced settings: a step towards implementation of the Convention on the Rights of Persons with Disabilities (CRPD) related to personal mobility. Geneva: World Health Organization; 2011.
27. Netherton DL, Deal WF. Assistive Technology in the Classroom. Technology Teacher. 2006;66(1):10-5.
28. Ground A, Lim N, Larsson H. Effective use of assistive technologies for inclusive education in developing countries: Issues and challenges from two case studies. . International Journal of Education & Development using Information & Communication Technology. 2010;6(4):5-26.
29. Scherer MJ. Assistive technology and persons with disabilities. In: Marini I, Stebnicki M, editors. Professional counselor desk reference New York: Springer Publishing Co; 2009. p. 735-46.
30. Borg J, Larsson S, Östergren P-O, Rahman ASMA, Bari N, Khan AHMN. Assistive technology use and human rights enjoyment: a cross-sectional study in Bangladesh. BMC International Health and Human Rights. 2012;12(18).
31. Borg J, Ostergren PO, Larsson S, Rahman AA, Bari N, Khan AN. Assistive technology use is associated with reduced capability poverty: a cross-sectional study in Bangladesh. Disability and rehabilitation Assistive technology. 2012;7(2):112-21.
32. Matsen SL. A closer look at amputees in Vietnam: a field survey of Vietnamese using prostheses. Prosthet Orthot Int. 1999;23(2):93-101.
33. Parette HP, Peterson-Karlan GR. Facilitating student achievement with assistive technology. Education and Training in Developmental Disabilities. 2007;42(4):387-97.
34. Beijen J, Mylanus EAM, Snik AFM. Education qualification levels and school careers of unilateral versus bilateral hearing aid users. Clin Otolaryngol. 2007;32(2):86-92.
35. Filmer D. Disability, Poverty, and Schooling in Developing Countries: Results from 14 Household Surveys. The World Bank Economic Review. 2008;22:141-63.
36. SIAT. Technology support in school. A socioeconomic analysis of youth, failures in school and the labour market. (In Swedish: Teknikstöd i skolan. Socioekonomisk analys av unga, skolmisslyckanden och arbetsmarknaden.). Stockholm: Swedish Institute of Assistive Technology; 2013.

37. Scherer MJ, Glueckauf R. Assessing the benefits of assistive technologies for activities and participation. Rehabilitation Psychology. 2005;50(2):132-41.

38. Scherer MJ, Sax C, van Biervliet A, Cushman LA, Scherer JV. Predictors of assistive technology use: The importance of personal and psychosocial factors. Disabil Rehabil. 2005;27(21):1321-31.

39. WHO. CBR guidelines. Health component. Geneva: World Health Organization; 2010.

40. Samant D, Matter R, Harniss M. Realizing the potential of accessible ICTs in developing countries. Disability and Rehabilitation: Assistive Technology. 2013;8(1):11-20.

41. WHO. Guidelines for hearing aids and services for developing countries. Geneva: World Health Organization; 2004.

42. WHO. Guidelines for training personnel in developing countries for prosthetics and orthotics services. Geneva: World Health Organization; 2005.

43. Olusanya BO. Addressing the global neglect of childhood hearing impairment in developing countries. PLoS Med. 2007;4(4):e74.

44. Zhao J, Pan X, Sui R, Munoz SR, Sperduto RD, Ellwein LB. Refractive error study in children: Results from Shunyi District, China. Am J Ophthalmol. 2000;129(4):427-35.

45. Maul E, Barroso S, Munoz SR, Sperduto RD, Ellwein LB. Refractive error study in children: Results from La Florida, Chile. Am J Ophthalmol. 2000;129(4):445-54.

46. SIAT. The assistive technology centres in Sweden (In Swedish: Hjälpmedelscentralerna i Sverige) Stockholm: Swedish Insitute of Assistive Technology; 2007.

47. Eide AH, Oderud T. Assistive technology in low-income countries. In: MacLachlan M, Swartz L, editors. Disability & international development: Towards inclusive global health. New York: Springer; 2009. p. 149-60.

48. WHO. Assistive devices/ technologies: what WHO is doing: World Health Organization; 2012 [19 June 2012]. Available from: http://www.who.int/disabilities/technology/activities/en/#.

49. WHO. Deafness and hearing impairment. Fact sheet no. 300: World Health Organization; 2012 [19 June 2012]. Available from: http://www.who.int/mediacentre/factsheets/fs300/en/index.html#.

50. Loeb ME, Eide AH, editors. Living Conditions among people with activity limitations in Malawi. A national representative study. Oslo: SINTEF Health Research; 2004.

51. Eide AH, van Rooy G, Loeb ME. Living conditions among people with activity limitations in Namibia. A representative, National survey. Oslo: SINTEF Unimed; 2003.

52. Francois I, Lambert M-L, Salort C, Bertrand F, Tonglet R. Causes of locomotor disability and need for orthopaedic devices in a heavily mined Taliban-controlled province of Afghanistan: issues and challenges for public health managers. Trop Med Int Health. 1998;3(5):391-6.

53. HI. Access to services for persons with disabilities in challenging environments. Lyon: Handicap International; 2010.

54. Standard Rules on the Equalization of Opportunities for Persons with Disabilities, (1993).

55. Borg J, Larsson S, Östergren P-O. The right to assistive technology: for whom, for what, and by whom? Disability & Society. 2011;26(2):151-67.

56. Kamaleri Y, Eide AH, editors. Living conditions among people with activity limitations in Lesotho: a national representative study. Oslo: SINTEF; 2011.

57. Eide AH, Kamaleri Y, editors. Living Conditions among people with disabilities in Mozambique: A national representative study. Oslo: SINTEF Health Research; 2009.

58. Development S-NCfDa. Global survey on government action on the implementation of the Standard Rules on the Equalization of Opportunities for Persons with Disabilities. Amman: Office of the United Nations Special Rapporteur on Disabilities, 2005.

59. 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;374:1863-65.

60. Bigelow J, Korth M, Jacobs J, Anger N, Riddle M, Gifford J. A picture of amputees and the prosthetic situation in Haiti. Disabil Rehabil. 2004;26(4):246-52.

61. Lindsay S, Tsybina I. Predictors of unmet needs for communication and mobility assistive devices among youth with a disability: the role of socio-cultural factors. Disability and Rehabilitation: Assistive Technology. 2011;6(1):10-21.

62. Eide AH, Loeb ME, editors. Living Conditions among people with activity limitations in Zambia. A national representative study. Oslo: SINTEF Health Research; 2006.

63. Borg J, Lindström A, Larsson S. Assistive technology in developing countries: a review from the perspective of the Convention on the Rights of Persons with Disabilities. Prosthet Orthot Int. 2011;35(1):20-9.

64. Lysack JT, Wyss UP, Packer TL, Mulholland SJ, Panchal V. Designing appropriate rehabilitation technology: a mobility device for women with ambulatory disabilities in India. Int J Rehabil Res. 1999;22(1):1-9.

65. Mulholland SJ, Packer TL, Laschinger SJ, Lysacks JT, Wyss UP, Balaram S. Evaluating a new mobility device: feedback from women with disabilities in India. Disabil Rehabil. 2000;22(3):111-22.

66. Mulholland SJ, Packer TL, Laschinger SJ, Olney SJ, Panchal V. The mobility needs of women with physical disabilities in India: A functional perspective. Disabil Rehabil. 1998;20(5):168-78.

67. Pearlman J, Cooper RA, Zipfel E, Cooper R, McCartney M. Towards the development of an effective technology transfer model of wheelchairs to developing countries. Disability and Rehabilitation: Assistive Technology. 2006;1(1):103-10.

68. Whirwind Wheelchair. Global Franchise Network 2015 [March 30, 2015]. Available from: http://www.whirlwindwheelchair.org/global-production-franchise/.

69. Pearlman J, Cooper RA, Krizack M, Lindsley A, Wu Y, Reisinger KD, et al. Lower-limb prostheses and wheelchairs in low-income countries: An overview. Engineering in Medicine and Biology Magazine, IEEE. 2008;27(2):12-22.

70. Jensen JS, Craig JG, Mtalo LB, Zelaya CM. Clinical field follow-up of high density polyethylene (HDPE)-Jaipur prosthetic technology for trans-femoral amputees. Prosthet Orthot Int. 2004;28(2):152-66.

71. Jensen JS, Craig JG, Mtalo LB, Zelaya CM. Clinical field follow-up of high density polyethylene (HDPE)-Jaipur prosthetic technology for trans-tibial amputees. Prosthet Orthot Int. 2004;28(3):230-44.

72. Magnusson L, Ramstrand N. Prosthetist/orthotist educational experience & professional development in Pakistan. Disability and Rehabilitation: Assistive Technology. 2009;4(6):385-92.

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

74. Layton N. Problems, Policies and Politics: making the case for better assistive technology provision in Australia. Disability and rehabilitation Assistive technology. 2015;10(3):240-4.

75. Phantachat W, Parnes P, editors. Implementing Assistive Technology Service Delivery System Internationally – A complex issue. i-CREATe 2007 Proceedings of the 1st international convention on rehabilitation engineering and assistive Technology: in conjunction with 1st Tan Tock Seng Hospital Neurorehabilitation Meeting; 2007.

76. Government of India. Scheme of assistance of assistance to disabled persons for purchase/fitting of aids/ appliances (ADIP Scheme). New Delhi: Government of India, Ministry of Social Justice and Empowerment; 2014.

77. NFDK. Guidelines for applicants. Nairobi: National Fund for Disabled of Kenya; 2011.

78. UNESCO. Case studies on the inclusion of children with disabilities. Bangkok: UNESCO Bangkok; 2009.

79. Borg J, Östergren P-O. Users' perspectives on the provision of assistive technologies in Bangladesh: awareness, providers, costs and barriers. Disability and rehabilitation Assistive technology. Early online:1-8.

80. WHO. Guidelines for training personnel in developing countries for prosthetic and orthotic services. WHO/RHS/90.1 - Geneva, WHO. Geneva: World Health Organisation 1990.

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