**Original Article**

**Assistive Technology for Visual Impairment and Trainers at Schools for the Blind in Delhi**

**Abstract:**

The aim of the study was to assess the availability of assistive technology (AT) for visual impairment and trainers in schools for the blind in Delhi. A cross-sectional study was conducted in 22 of the twenty-four schools (blind) in Delhi. The headteacher of each school was asked about availability of 52 ATs divided into writing, reading, math, sciences, sports, mobility, and daily living, using a questionnaire. Information on availability of trainers was also collected. Of the 52 ATs, the most frequently available were Braille slate with stylus and abacus (>90% of schools), followed by Taylor frame, long cane and talking watch (80 to 90% of schools). Only 11 of 52 AT devices were available in 60% or more of the schools. Tactile-based ATs were more available than vision-based ATs. In the 22 schools, 63 trainers for reading & writing were available (80% of posts), 18 for sciences (59%), 25 for maths (70%), and 11 for mobility (50% of posts). Except Braille slate and stylus, there is a huge shortage of AT in these schools. The educational needs and performance of students could be helped by developing and using a list of priority Assistive Products for example the WHO AP list.

**Key Words:** Assistive technology, students with visual disability, school for the blind, Delhi

**Introduction**

India has the highest number of visually impaired people in the world (Bourne et al., 2017). As well providing services for people with treatable visual impairment it is important that persons with untreatable visual impairment receive education and rehabilitation services particularly young people with severe visual loss and blindness, so that they get the same education opportunities as their sighted peers.

The World Bank in India reported that children with disability are five times more likely to be excluded from schools than sighted children. It has also been reported that the illiteracy rate is high among children with visual loss reaching nearly 80%(O’Keefe, 2007).

However, students with severe visually challenged can be taught academic and non-academic skills with the support of Assistive Technologies for Visual Impairment (ATVI). There is evidence that use of ATVI improves skills and performance in handwriting, motor skills, reading capacity, maths, science, spatial memory and problem-solving (Hutinger, Johanson, & Stoneburner, 1996, Lovie-Kitchin, J. E., Bevanm, J. D., & Hein, 2001, Dick, T., & Kubiak, 1997), and significant improvement in non-academic skills like social inclusion, communication, motivation, self-esteem and mobility among visually disabled children (Todis B, 1993), (Hu, Chen, Zhai, Gao, & Fan, 2019).

In current pedagogical practice, there are a range of ATs for students with visual disabilities (Ghaleb Alnahdi, 2014, Noman, Shehieb, & Sharif, 2019), therefore students in schools for the blind need to have access to a range of ATVI to assist their education and activities daily living, including instrumental daily living. Apart from a study on low vision optical magnifiers (Pal N, Titiyal JS, Tandon R, 2006) there is a paucity of studies on the availability of ATVI in schools for the blind in India. The current study aimed to assess the availability of assistive technology for visual impairment as well as teachers trained in its use in schools for the blind in Delhi. As visually impaired students can spend a considerable time in school, this study’s findings will help in planning and prioritizing what ATs are needed to enhance academic and non-academic skills.

**Methods**

***Schools for the blind in Delhi***

In Delhi, there are 24 schools for the blind, all of which except one are run by non-government organizations affiliated to Government education system. All these schools provide free education, accommodation and food, with a range of 80 to 150 visual impaired students per school. Any student having a certificate of more than 40% visual disability can seek admission in these schools (Disability division, Empowerment, 2017, Ministry of Social Justice & Empowerment, Govt. of India).

***Study design***

A cross-sectional study was conducted in 22 of the 24 schools for the blind in Delhi during June to July 2018; two schools were not visited because permission was not granted.

***Study tools***

We used the term Assistive Technologies (AT) as defined by the World Health Organization (WHO, 2011 & International Standard Organization 9999, 2016). A questionnaire was developed to assess the availability of 52 ATs for people with visual impairment, categorized into seven domains, based on school activities - “Reading-9”, “Writing-12”, “Maths-8”, “Sciences-4”, Games & sports-6”, “Mobility-6” and “Activities of Daily Living-7” (Annex 1). A brief description of each ATVI device was explained to the principal of the school, and a pictorial booklet of ATVI was developed so as to avoid confusion about terminology (Figure 1). The ATVI were also classified into vision-based ATs (VAT),e.g. large print books and magnifiers, etc., and tactile or sound based ATs (TAT), e.g. Braille, or DAISY (Digital Accessible Information System) books depending on whether the AT use needs vision or visual substitution skills like sound or touch. Students with some residual vision, binocular best corrected visual acuity (BCVA) less than <6/18 to 1/60 can often benefit from VAT.

The term ‘availability’ in this study is defined as any AT being present and usable at the time of the visit to the school by the researcher; non-functioning, broken ATs were not termed available.

***Data collection***

An optometrist and a medical social worker obtained the information from the principal of each school using the questionnaire. Data collection was numerical only and entered into EpiData version 3.1. and data analysis was undertaken using STATA 15 (StataCorp 2015, Stata Statistical Software: Release 14. College Station, TX: StataCorp LP). Confidentiality of data was maintained throughout the study in encrypted and password protected devices. Ethical clearance was taken from ethics committee of London School of Hygiene & Tropical Medicine, London and All India Institute of Medical Sciences, New Delhi before the study.Permission as well as written consent was also obtained from the principal of school for the blind.

**Results**

Twenty-two headteachers (22 schools) completed the questionnaire. Of the fifty-two ATs (Table 1), the most frequently available were Braille slate with stylus and abacus (>90% of schools); Taylor frame, long walking cane, and talking watch (80 to 90% of schools); Braille reading books and large print play cards (70 to 80% of schools); and Braille type writer, adaptive paper, large print games and Braille chess (60 to 70% schools). The remaining 41 ATs were available in less than 60% of the schools. (Table 1).

**ATs for Reading**

Braille reading books were available in 17 schools (77.3%), audio format digital recorders (13 schools), and large print books (10 schools). Only four schools possessed optical magnifiers, and two schools had electronic magnifiers.

**ATs for Writing**

Braille slate with stylus was available in 21 schools (95.5%) and Taylor frame in 19 (86.4%), Braille typewriter and adaptive paper were in 14 schools. Only one school had screen readers (NVDA or JAWS), multiple window typoscope and Braille notetaker.

**ATs for Mathematics & Sciences**

Abacus was available in all schools. Twelve schools had tactile geometric kit (54.5%), and Braille ruler and talking calculator were available in 9 schools. The AT for sciences learning, e.g. tactile maps was present in 11 schools (11%) whereas 3D model learning was available in only 1 school.

**ATs for Mobility**

Six different types of mobility canes, including GPS navigation App, were included in the question. All schools had at least one or more mobility canes. Of the six canes, walking long cane was present in 18 schools (81.8%) and children mobility canes in 12 schools. Smart cane was available in 9 schools (40.9%).

**ATs for Games and Sport**

Sixteen schools had large print cards, and 14 schools had Braille chess.

**ATs for Daily Living Activities**

Nineteen schools had talking watch and 10 schools had simplified mobile phones. The rest of ATs for daily living were available in a limited number of schools (Tab. 1).

**Trainers in AT for visual impairment**

In the 22 schools for the blind, there were 63 special educators out of 75 available positions for reading, and 64 out of 74 for writing. However only 11 mobility trainers were available in these schools i.e. only 50% of positions were filled and 25 special educators for maths and 18 for sciences were present (Table 1).

**Discussion**

*Available education for students with visual impairment and blindness*

Blindness and visual impairment can severely affect educational and academic opportunities (Mathers, Stevens, Mahanani, & et al., 2017). ATVI can play an important role in overcoming difficulties in learning, and so enhancing academic and non-academic performance in visually challenged students (Noman et al., 2019), (Ghaleb Alnahdi, 2014)

2014).

In India, students with visual disability can be enrolled in special schools for the blind or regular schools (inclusive or integrated education). The special schools for the blind are a separate system of academic institution outside the mainstream education system, which aim to have special resources (teachers and devices) that are not readily available in mainstream schools. Inclusive education aims to remove barriers and promote the full participation of children with visual impairment in regular schools. It emphasizes provision of a conducive learning environment for all children, regardless of differences in socio-economic background or ability. (UNICEF, 2004, National Council Of Educational Research And Training, Department of Education of Groups with Specials Needs, Government of India,” New Delhi).

***Study Findings***

This study reports on the availability of a comprehensive list of ATs (52) classified into seven domains (Table 1) in schools for the blind in Delhi. The study shows limited availability of ATVI and trained human resources, with only 11 of the 52 ATVI being available in 60% or more schools for the blind in Delhi. Most ATVI were unavailable in a sizeable number of schools. Of particular concern is that vision-based ATs like magnifiers which students with residual vision could use to see print are not available in most schools and instead students with useful vision are positioned to use Braille technology (TAT). A previous study in these schools showed that 28% of students had best corrected vision acuity of <6/18 to 1/60 in the better eye indicating that there was potential to learn to read and write using normal or large print texts or VAT technology. (Senjam, Foster, Bascaran, Vashist, & Gupta, 2019). It is of paramount importance that children with useful residual vision are given access and appropriate training to use vision-based ATs. Very few comparable studies exist in India and other countries on the availability of such a wide range of ATVI in schools for the blind.

A study conducted on need of computer related ATVI like screen readers, speech synthesizers or screen magnifies, among special teachers in Sao Paul, Brazil reported that nearly 90% of teachers indicated the need of adequate such technologies at their schools for the blind (Alves, Monteiro, Rabello, Gasparetto, & Carvalho, 2009). In the same study, 84% of special teachers declared ATVI are very important to enhance writing and reading skills as well as communicate with rest of the world.

The study also indicated inadequate availability of various type of mobility canes, particularly the children’s canes and guide canes which is a concern. Mobility canes with appropriate length per se help in travelling safely and independently in or outside the school environment. Students can also improve their pace of movement using an appropriate length of the canes (Foley & Masingila, 2015).

Learning mathematics and sciences is an important activity for everyone because it helps in many daily activities like estimating distances, buying & paying bills, measurement, calculation, financial management, logical reasons, and problem solving, etc. Students who are visually challenged need to understand the basics of mathematics and sciences in order support their independent living and play a role in the society. In the present study, Abacus is available in all schools which will certainly help students to know the basics of mathematics like addition and subtractions. Evidence showed the Abacus can improve the mathematics learning in students with visual impairment (Daroni, Gunarhadi, & Legowo, 2018), (Herwanto, 2013).

***Trainers in ATVI***

The study also shows that there is a lack of special educators trained in the use of ATs, especially mobility trainers. Delhi has one training institution under The Rehabilitation Council of India (RCI) that provides a Bachelor or Master course in special education for visual impairment. To address the shortage of special educators, the RCI has agreed for non-governmental organizations to start new courses in the special education for visual impairment (Rehabilitation Council of India, Government of India). There is no institute in Delhi which provides a formal training in mobility (Diploma or Master). The 5 mobility trainers in the 22 schools had received a short-term mobility training in the National Institute of the Empowerment for Person with Visual Disabilities in Uttarakhand. From personnel interaction with the mobility trainers, it is evident that there is no secure job in the government sector. Those with training must join private or non-government organizations for work.

***Reasons for lack of availability of ATVI***

Several factors may account for the non-availability of ATVI and lack of trained human resources. First, at the school level lack of awareness, information and knowledge about ATVI among principals and special teachers especially in developing countries. Other study conducted elsewhere also reported that lack of competency among teachers is one of important barriers on effective use of ATVI. For example, in Singapore a study reported a significant gap in AT knowledge and skills among teachers in schools (Wong & Cohen, 2016), and a reluctance to change from the well-known Braille technology to more recently developed ATs. Second, at the policy level, lack of collaboration between relevant ministerial divisions under Govt. of India. The Ministry of Human Resource & Development is responsible for the education system, The Ministry of Social Justice and Empowerment is responsible for the welfare of people with disabilities (Ministry of Social Justice & Empowerment, Govt. of India), and The Ministry of Health & Family Welfare (MoHF&W) is responsible for the national health program and the health care delivery system (Ministry of Health and Family Welfare Govt of India). There is a very real risk that these vulnerable children fall through the net because of lack of collaboration between these three ministries to have a clear policy on the provision of ATVI to optimise their education.

Although it is not a part of this study, it is an important to investigate what facilitates adoption and use of ATs among students with visual loss, for instance, physical characteristics of ATs or soft or hard technology. The psychosocial aspects or students’ experiences can be important in the adoption of ATs, for example self -image and peer or social reaction can affect AT use both negatively and positively. A study found that even if students appreciated the benefits of AT, they sometimes rejected AT provided to them due to negative experiences particularly feeling or looking different from others, so called ‘negative reaction’ towards AT (Hemmingsson, Lidström, & Nygård, 2009). Using smartphone and software application may be more acceptable. However, further qualitative study is warranted to explore the factors affecting AT adoption.

*New developments in ATVI*

Research in disciplines like computer science, communications engineering and mechanical engineering has led to development of innovative ATVI to improve functioning and quality of life for people living with visual loss (Bhowmick & Hazarika, 2017). Smartphone and tablets, are widely available in low middle-income countries and can provide a range of applications including magnification, contrast enhancement, optical character recognition, text to synthetic voice output and even navigation assistance tools (Hakobyan, Lumsden, O’Sullivan, & Bartlett, 2013). Such user-friendly digital technologies are quickly replacing the traditional low vision aids for individuals’ routine tasks like object identification, navigation, listening to audiobooks reading e-books, etc., in today’s society (Martiniello, Eisenbarth, Lehane, Johnson, & Wittich, 2019). Reading and writing for blind children can be enhanced using automated Braille learning technology, Refreshable Braille Display (Braille e-book) (Sutariya, Singh, Babariya, Kadiyar, & Modi, 2018), and FingerReader (Bicz & Bicz, 2016)- a small finger-worn device which enables blind users to read printed texts. The automated Braille tutor is designed to teach Braille skills to children with visual loss using voice feedback (Dias et al., 2009). There is also technology to assist bind people with mobility; a smart cane, smart glasses or Artificial Intelligences lenses for the blind and audio-based cane integrated with ultrasonic sensor can detect an obstacle and inform the user. (Khan, Khan, & Waleed, 2018,Hu et al., 2019). A hand free mobility tool- wearable cane with software application system, has successfully been developed and tested with a positive results among pre-school children (Ambrose-Zaken, FallahRad, Bernstein, Wall Emerson, & Bikson, 2019). Such innovative advancements in the ATVI offers a new perspective in terms of educational training, improvement of daily living tasks and also quality of life for people with visual impairment. A programmatic tactile display for geometric and spatial skills (Leo, Cocchi, & Brayda, 2017), audio-based mathematical Learning ATs, and MathTalk applications are also available which can help visually impaired students (Daroni et al., 2018), (Akpan & Beard, 2014).. Using such new technologies will facilitate students with a visual loss in learning mathematical concepts.

*Limitations of the study*

First, students may have their own personnel ATVI at home which were not assessed in the study. Second, we relied on responses from headteachers and did not interview other teachers. Third, there was no physical verification of available ATs so it is possible that there might be misinformation. Four, we did not collect information about any training course, certified or informal, undertaken by the special teachers.

***Key Recommendations***

1. Every effort should be made to teach students with residual vision (BCVA of 1/60 or better) to read and write normal or large print (not braille), ideally in regular schools.
2. Schools for the blind and schools offering inclusive education should have a list of priority assistive products (APL) which are made available to students with visual impairment (World Health Organization, 2017).
3. It is vital that teachers of students with special education needs are exposed to modern ATs including smartphone applications and acquire the relevant knowledge to teach their students.
4. There needs to be collaboration between the three ministries (education, health and welfare) to ensure the education, health and rehabilitation needs of these children with visual disability are met, including the access to appropriate ATs.

**Conclusion**

Blindness and visual impairment can have a severe negative impact on the education and development of children. Students with visual impairment require ATs for academic and non-academic skills development. The present study provides information on availability of ATVI and trained human resources in schools for the blind in Delhi. The study indicates there is a huge shortage of ATVI and particularly children who require VATs are not having their needs met. To improve education among these children, the schools should give priority to ensuring accessibility to an appropriate range of ATVI, and the three relevant ministries should work together to ensure a policy, including resourcing, is in place and implemented to assist these vulnerable children.

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**Table 1: Assistive technology in twenty-two schools for the blind in Delhi**

|  |  |  |  |
| --- | --- | --- | --- |
| **Assistive technologies** | **VAT or TAT** | **Total** | |
| **Yes** | **(%)** |
| 1. **Reading** |  |  |  |
| 1. Large print book | VAT | 10 | (45.5) |
| 1. Optical magnifier | VAT | 4 | (18.2) |
| 1. Typoscope (Single window) | VAT | 2 | (9.1) |
| 1. Braille reading books | TAT | 17 | (77.3) |
| 1. Electronic magnifiers aids | VAT | 2 | (9.1) |
| 1. Audio format materials (DAISY) | TAT | 13 | (59.1) |
| 1. Refreshable Braille displays | TAT | 2 | (9.1) |
| 1. Braille translator software (Braille 2000) | TAT | 6 | (27.3) |
| 1. Mobile App for reading | VAT | 8 | (36.4) |
| 1. **Writing** |  |  |  |
| 1. Braille slate and stylus | TAT | 21 | (95.5) |
| 1. Braille typewriter | TAT | 14 | (63.6) |
| 1. Typoscope (multiple window) | VAT | 1 | (4.5) |
| 1. Large computer keyboard | VAT | 6 | (27.3) |
| 1. Adaptive paper | TAT | 14 | (63.6) |
| 1. Handheld pen magnifiers | VAT | 2 | (9.1) |
| 1. Handheld held audio recorder | TAT | 12 | (54.5) |
| 1. Signature guide | TAT | 6 | (27.3) |
| 1. Braille notetaker | TAT | 1 | (4.5) |
| 1. Braille keyboard | TAT | 2 | (9.1) |
| 1. Taylor frame | TAT | 19 | (86.4) |
| 1. Screen readers (NVDA. JAWS) | TAT | 1 | (4.5) |
| **Mathematics** |  |  |  |
| 1. Abacus | TAT | 22 | (100) |
| 1. Braille compass | TAT | 8 | (36.4) |
| 1. Talking calculator | TAT | 9 | (40.9) |
| 1. Braille ruler | TAT | 12 | (54.5) |
| 1. Braille protractor | TAT | 6 | (27.3) |
| 1. Raised line graph | TAT | 8 | (36.4) |
| 1. Tactile geometric kits | TAT | 12 | (54.5) |
| 1. Braille cube | TAT | 10 | (45.5) |
| **Sciences** |  |  |  |
| 1. Tactile maps | TAT | 11 | (50) |
| 1. Tactile diagram set for sciences | TAT | 8 | (36.4) |
| 1. 3D Educational model | TAT | 4 | (18.2) |
| 1. Tactile globe | TAT | 1 | (4.5) |
| **Mobility** |  |  |  |
| 1. Walking (long) canes | TAT | 18 | (81.8) |
| 1. Children’s walking canes | TAT | 12 | (54.5) |
| 1. GPS Apps | TAT | 5 | (22.7) |
| 1. Guide cane | VAT | 2 | (9.1) |
| 1. Smart cane | TAT | 9 | (40.9) |
| 1. Symbol canes | VAT | 2 | (9.1) |
| **Games and Leisure:** |  |  |  |
| 1. Tactile dice | TAT | 11 | (50) |
| 1. Large print play cards | VAT | 16 | (72.7) |
| 1. Braille cards | TAT | 7 | (31.8) |
| 1. Large print games (puzzle, scrabble) | VAT | 14 | (63.6) |
| 1. Braille chess | TAT | 14 | (63.6) |
| 1. Audible balls | TAT | 9 | (40.9) |
| **Daily Living equipment** |  |  |  |
| 1. Liquid sensor | TAT | 1 | (4.5) |
| 1. Color detector | TAT | 1 | (4.5) |
| 1. Talking watch | TAT | 19 | (86.4) |
| 1. Pill organizers | TAT | 2 | (9.1) |
| 1. Simplified mobile phone | VAT | 10 | (45.5) |
| 1. Talking weight machine | TAT | 3 | (13.6) |
| 1. Audio labeller | TAT | 1 | (4.5) |

**VAT: Visual Based Assistive Technology, TAT: Tactile and Sound Based Assistive Technology**

**DAISY: Digital Accessible Information System, NVDA: Non-Visual Desktop Access, JAWS: Job Access with Speech**

**Table 2: Trainers in twenty-two schools for the blind in Delhi**

|  |  |  |  |
| --- | --- | --- | --- |
| **Trainers/Teachers** | **Total Post** | **Filled** | **(%)** |
| Mobility trainer | 22 | 11 | (50) |
| Math teachers | 36 | 25 | (69.5) |
| Science teachers | 31 | 18 | (59.1) |
| Teacher for reading | 75 | 63 | (84) |
| Teacher for writing | 74 | 64 | (86.5) |