Original article

Use of electronic devices by people attending vision rehabilitation services in Italy: a study based on the Device and Aids Registry (D.A.Re)

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Conflict of interest: Federico Bartolomei, Eliana Costanzo, Ruth E. Hogg, John G. Lawrenson, Elisabetta Falchini, Alessia Di Simone, Valentina Pastore, Chiara Mastrantuono, Giovanni Sato, Filippo Amore, Ilaria Biagini, Giovanni L. Ciaffoni, Mauro Tettamanti, and Gianni Virgili have nothing to disclose.

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Key-points:

1) The Italian Device and Aids Registry (D.A.Re.) collects individual data from several vision rehabilitation services in Italy and provides detailed and extensive information on both the users and the technology.
2) The use of low-vision electronic devices, smartphones and tablets, contributes to improved vision-related quality of life in people attending vision rehabilitation services, as assessed with the Instrumental Activity of Daily Living (IADL).
3) Smartphones and tablets are used across different users' group, regardless of the use of optical or electronic low-vision aids, as well as of age and employment status.

Abstract

Purpose: To investigate the characteristics of electronic device users, specifically smartphones and tablets, in the Device & Aids Register (D.A.Re), from several low-vision rehabilitation services in Italy.

Methods: We collected general and clinical information about ocular and systemic diseases, visual function, reading speed and Instrumental Activities of Daily Living (IADL) questionnaire score. Technological details of each optical and electronic device, (including screen size, touch-screen and OCR functions, text-to-speech function) were also collected.

Results: 1218 patients (752 females and 466 males) were included in our analysis, mean age 71.5 (±18.8) years. Users of electronic aids (n.237) were slightly younger (67 vs 72 years, $p<0.001$) than non-users (n.981), had a worse reading speed (38 vs 65 words/minute), critical print size (43 vs 28 print size, $p<0.001$), poorer visual acuity (VA)(1.0 logMAR or less: 30% non-users vs 73% users, $p<0.001$) and more commonly visual field restriction within 10° (23% vs 14%, $p=0.001$). A similar proportion of users and non-users were retired (about 70%) and about 16-17% were employed. The use of portable electronic devices (5''or less, $p<0.001$; 6'' to 18'' screen size, $p=0.017$) was associated with better IADL scores, and the use of stand devices with worse IADL score ($p<0.001$); Furthermore, using smartphones and tablets (193 subjects) was strongly associated with better IADL scores.

Conclusion: We found that using electronic devices, and especially smartphone and tablets, were associated with better vision-related quality of life in low-vision people attending rehabilitation services. While this association does not mean causality, these findings seemed robust to confounder adjustment.

Introduction

Vision impairment affects an estimated 285 million people worldwide, according to data published over a decade ago (1) and these estimates are rising for several eye conditions (https://www.who.int/multi-media/details/world-report-on--vision-infographic-page-1).

People affected by low-vision, experience difficulty in common near activities such as reading or writing,(2, 3) and the use of low-vision aids (LVAs) (including optical, non-optical and digital/electronic) could help these patients overcome the social, physical and psychological limitations they face in daily activities.(2)

The use of optical LVAs and, more recently, the introduction of electronic alternatives, may enhance the performance of low-vision patients in their distance and near tasks.(2). Common LVAs include optical (e.g., hand magnifiers, stand magnifiers, and telescopes), non-optical (e.g., large print books, reading stand, typoscopes, and sunglasses), and digital (e.g., closed-circuit television [CCTV] and portable digital magnifiers) devices.(3, 4) These instruments are particularly useful for near tasks such as reading, writing, repairing and cooking.(5)

Portable (hand-held) electronic vision enhancement systems (p-EVES) are electronic devices, widely available, that represent additional aids that are specifically designed for patients with visual impairment. In addition to specifically designed p-EVES, personal smartphones or tablets can be used to perform low vision functions both Android and iOS devices come preloaded with various features as standard and a plethora of applications (apps) are now available for download aimed at low-vision users.

An interest has recently emerged in the evaluation of smartphone and tablet use in people with vision impairment.(6) Interestingly, people defining themselves as severely sight impaired reported the use of smartphones and tablet computers as frequently as people with low vision.(6) The main facilitators for these devices were the text-to-speech function, the ability to enlarge text, the large screen and the use of camera flashlight as a spotlight and reduced stigma. On the other hand, the high cost, the lack of awareness of how useful these devices could be for people with vision impairment, and not having considered using these systems, could be considered barriers for the use of these devices.(6) Finally, smartphone and tablets are generally not provided freely to people with low-vision, at least in Italy.

The widespread interest in this topic led us to collect clinical and personal data of patients affected by low vision disability using low-vision devices in a specific national registry.(7) The Device & Aids Register (D.A.Re), was created in 2019 by the National Institute for Device and Technology Assessment (Istituto Nazionale Valutazione Ausili e Tecnologie, INVAT) to collect individual data from several low-vision rehabilitation centres, many of which are part of the Italian Union for the Blind and Visually Impaired (Unione Italiana Ciechi e Ipovedenti, UICI).(7)

The aim of this study is to investigate the characteristics of electronic device users, specifically of users of smartphones and tablets, as well as the reported Instrumental Activity of Daily Living (IADL) score and its associations with patients' characteristics in users and non-users of these devices.

Methods

Study population

This multicentre study involves different low-vision services affiliated with the Italian Union for the Blind and Visually Impaired, the study coordinator center was the University of Florence. The study protocol was approved by the Ethics Committee of the Area Vasta Centro-Careggi, Florence in May 2019.

The Device & Aids Register

The D.A.Re collects general information on all patients attending low-vision services, as age, gender, occupational status, blind registration status, general knowledge and use of computers and software, integrating with clinical information about ocular and systemic diseases, visual symptoms, visual acuity, reading speed (measured binocularly at 20 cm with appropriate correction by the Minnesota low vision reading [MNREAD] chart), critical print size (CPS) and type of visual impairment and, in addition, several details about the use of LVAs, knowledge of Braille, numerous details on type, brand and scope of use of low-vision devices in use (optical, electronic or others) and Instrumental Activities of Daily Living (IADL) score. The D.A.Re registry also collects technological details on each optical and, particularly, electronic device, including screen size, touch-screen and Optical Character Recognition (OCR) functions, text-to-speech function, or other specific functions for several different devices. The screen specification provided by manufacturers is the diagonal length, generally reported in inches. Subjects were considered users of a given devices only if this was reported at the time of the most recent clinical encounter. The Device & Aids Register (D.A.Re) data were collected in an anonymous standardised fashion. The characteristics of D.A.Re registry have been reported previously.(7)

Instrumental Activities of Daily Living (IADL) score

The IADL questionnaire is a validated method to measure the functional health and quality of life, in different clinical situations.(8, 9) Previous evidences indicates that evaluation of these measures helps to identify problems that require treatment or care.(10) The questionnaire consisted of eight questions regarding daily activities such as telephone use, shopping, cooking, housekeeping, laundry, use of public transport, responsibility for drug taking, financial management; different levels of autonomy were obtained for each question. A low IADL score indicates good autonomy.

Data analysis

In the current investigation, the severity of vision impairment was evaluated as a variable, no data on the duration of the vision impairment has been considered. Another variable included in the present analysis was the hearing impairment, as reported by the patient.

Tablets and smartphones were considered separately from special purpose p-EVES, as they are general purpose devices.

A challenge when reporting real-world data, including on vision rehabilitation, is the dynamic nature of the data. For example, people may report on their experience with using optical devices only at their first vision rehabilitation encounter, then be prescribed electronic devices, which will influence their assessment at the following visits. Furthermore, their vision can change between two assessments, and even their health status may be different. A strategy to manage this complexity is being developed. In the current study we will take a pragmatic approach and consider 'encounters' as the unit of analysis of interest, while accounting for within-subject correlation statistically using mixed models, with individuals as random effects. The number of patients with follow-up is still small in D.A.Re, and the choice of analytic approach is unlikely to affect the estimates significantly. Statistical analyses comparing different groups of LVAs users were conducted with linear or logistic mixed models, accounting for within-subject correlation in individuals with multiple encounters recorded. Both univariate and multivariate associations were calculated and presented. All analyses were conducted using Stata 17.0 software (StataCorp, College Station, TX).

Results

A total of 1218 patients (752 females and 466 males) were included in our analysis, mean age 71.5 (±18.8) years. In this population we found 981 non-users of electronic devices (80.5%) and 237 users (19.5%), meaning for electronic devices all available devices and not only smartphones and tablet.

Considering the overall population, we found that 1025 out of 1218 patients (84.2%) were non-users of smartphones and tablet and 193 out of 1218 patients (15.8%) used smartphones and tablet.

Differences between users and non-users of electronic devices

Table 1 compares the characteristics of 237 (19.5%) electronic device users in 1218 subjects. The comparison of 193 (15.8%) users of smartphone and tablets with non-users is also shown, together with the comparison of 151 (64%) stand vs 86 (36%) portable electronic devices users.

Users of electronic aids were slightly younger than non-users (66.6 vs 72.1 years, $p<0.001$), had a worse MNREAD reading speed (42.4 vs 64.4 wpm, $p<0.001$) and CPS (44.2 vs 28.5, ($p<0.001$) and more commonly visual field restriction within 10° (27.1% of users vs 16.1% of non-users, $p<0.001$). Consistently, 77.6% users vs. 35.4% non-users of electronic devices had a visual acuity of 6/60 (1.0 logMAR) or less ($p<0.001$). Differences in employment status were non-significant between users and non-users of electronic devices, with about 1 in 6 being employed.

Comparing 237 users of stand (151 patients) vs portable (86 patients) electronic devices, age and sex were similar (see Table 1). The analysis of the users of portable devices showed better values for reading performance (59 wpm for users vs 32.3 wpm for non-users) and for distance visual acuity ($p<0.001$). Differences in employment status were statistically significant ($p=0.022$) but small, with slightly more employed subjects for users of portable electronic devices.

Finally, there were differences between users and non-users of smartphones and tablets, whether iOS or Android (193 subjects). Users were much younger (55 vs. 74 years, $p<0.001$), therefore less likely to be retired ($p=0.006$), and had less male dominance ($p=0.003$). Moreover, visual acuity and reading speed were slightly better in users compared to non-users of smartphones and tablets, but differences were minor, all details were reported in the Table 1. Figure 1 presents the overlapping in the use of optical devices, electronic devices, and smartphone/tablets as a Venn diagram.

Association with IADL score in all subjects

Table 2 presents univariate analyses and multivariate models 1 and 2 (excluding or including hearing impairment). As expected, in univariate analyses we found older age (0.13 per 10 years, $p<0.001$), better-seeing eye VA (0.67 per 1 logMAR, $p<0.001$) and field restriction within 10°

(1.12, p<0.001) were associated with worse (higher) IADL score. Reported hearing impairment was also strongly associated with IADL score (0.72, p<0.001). Among non-visual variables, being employed or a student was associated with better IADL than being retired (-0.96, p<0.001).

All the previous coefficients were confirmed in multivariable analyses, as shown in Table 2, with an attenuation of employment status subgroups, probably due to age-adjustment. We used screen size to group electronic device type as 5'' or less (n.57), 6'' to 18'' (n.34, nearly all portable devices) and 19'' or more (n.146, all stand devices). Compared to non-users of electronic devices, we found the use of portable devices (5'' or less, p<0.001; 6'' to 18'' screen size, p=0.017) was associated with better IADL score, and use of stand devices with worse IADL score (p<0.001). We also assessed the effect of using iOS or Android smartphones and tablets (190 subjects), they were strongly associated with better IADL scores when compared with non-users, with large effects also in multivariate analyses, and no difference between iOS and Android devices (p=0.783 in model 2).

Discussion

In this study, based on a large registry of vision rehabilitation in Italy (D.A.Re.), we found that patients using electronic devices, and especially smartphone and tablets, report better vision-related quality of life in. While this association does not mean causality, adjusting by age, severity of vision impairment and employment status, among other variables, did not alter the consistency of this finding, which supports the robustness of our findings.

Users of electronic devices had worse vision and MNREAD reading performance than non-users and were slightly younger. Users of smartphone and tablets differed from non-users in that they were more likely to be employed or in education and had a slightly better reading performance, although the electronic device user group contained a greater number of individuals who were severely sight impaired. This highlights the heterogeneity of individual characteristics and modality of use of electronic devices by different people. For example, severely sight-impaired subjects used stand electronic magnifiers and no portable magnifiers, but they also used more smartphones and tablets, likely due to their ability to perform text-to-speech and object identification functions. In other words, there was no apparent prevailing combination of use of optical devices, electronic devices, and smartphones and tablets.

Once the effect of age, severity of vision impairment and employment status was accounted for, users of portable electronic devices and even more so users of smartphones and tablets had a better IADL score than non-users. A scoping review (11) found that smartphones are able to provide several facilities for severely visually impaired people such as: apps to learn Braille; alternative ways of keying on a smartphone in Braille; new navigation and obstacle detection systems for people with visual impairment; systems to improve magnification; apps for making calls easier, and monitoring health. The review concluded that there is a gap in the literature with limited research exploring the soft technology aspects of smartphones and apps, with a need for more training and learning support research. Moreover, insufficient information is available from app manufacturers regarding their capabilities. Service user involvement is critical when designing a new technology and this has not been addressed adequately in most research studies investigating smartphone technologies, including training in their use.

Previous qualitative research supports our findings. Yeo et al. (4) reported satisfactory use of smartphone devices by visually impaired people of different ages and diagnoses for tasks including face recognition, television or movie watching, near reading (newspaper, book, menu, or labels on medicine bottles), computer or smartphone watching, distance reading (distant signs or a clock), and letter writing. Abraham et al (12) found that a significant number of people living with severe vision impairment or blindness used smartphones; however, most users are unaware of its full functionality and assistive capabilities, as shown during vision rehabilitation. A number of free apps have proved useful in people with different levels of vision impairment across a range of needs,(13) including remote orientation and mobility instruction.(14) Multidisciplinary group training in the use of apps was shown to be beneficial in older people.(15, 16, 17)

In Italy, at this time, smartphones and tablets are not usually considered aids for visually impaired people and are not reimbursed by the Italian public healthcare system, unlike optical and electronic aids are provided freely to legally blind people. Since they are used by many blind and low vision people in their daily life, in this study we wanted to compare their use to that of special purpose electronic devices, which, in our database, include hardware devices (which may include installed software) e.g. video magnifiers (portable and stand), braille display, ebook readers, scanner/OCR devices.

An interesting aspect is that mobile technology (smartphone and tablet), are universally designed and are currently used also by people with no visual impairment, overcoming the social stigma of the visually impaired patient and improving the social impact. (18) This social aspect of visual rehabilitation becomes increasingly important concerning not only the LVAs' choice but the need to treat the visually impaired patient as a person and not as a disease to be treated, considering several aspects of social daily life.(19)

A strength of our study is the multicentre data collection in different low-vision services affiliated with the Italian Union for the Blind and Visually Impaired, using a standardised data collection which has previously been validated.(7) Moreover, since vision impairment is a dynamic condition, a pragmatic approach was adopted linking actual use of a given device at the moment of the clinical encounter to IADL and reading performance.

Our study based on the D.A.Re registry did not include children under 18 year-old, thus its applicability is limited to adults. Of interest, Gothwal et al(20) found that recruitment of children into a randomised controlled trial on the use of tablet computers is feasible in an international context.

In conclusion, we suggest that low-vision services should educate users to become users of electronic devices, particularly smartphone and tablets, considering their capacity and needs. Pragmatic randomised control trials should be conducted on the provision and training of apps for smartphone and tablets, including qualitative or mixed method research on how to personalise this intervention.

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Author contributions

Federico Bartolomei: conceptualization of the work, data acquisition, analysis and interpretation of the results, final approval. Eliana Costanzo: conceptualization of the work, data analysis and interpretation of the results, manuscript drafting and final approval. Mariacristina Parravano: data analysis and interpretation of results. Ruth E. Hogg: data analysis and interpretation of results, manuscript drafting. John G. Lawrenson: data analysis and interpretation of results, manuscript drafting. Elisabetta Falchini, Alessia Di Simone, Valentina Pastore, Chiara Mastrantuono, Giovanni Sato, Filippo Amore, Ilaria Biagini, Giovanni L. Ciaffoni: data acquisition and revision of manuscript. Mauro Tettamanti: draft revision. Gianni Virgili: conceptualization and design of the work, data analysis and interpretation of the results, manuscript drafting and final approval.

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