

Watch Your Head, Mind Your Step: Mobility-Related Accidents Experienced by People with Visual Impairment

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Abstract

Walking without sight brings forth the risk of falls and collisions. This contribution reports the result of a survey interview with more than 300 legally blind or blind individual, focusing on the frequency, nature and causes of head-level and fall accidents.

Introduction

Vision loss increases the risk of unintentional injury (Legood et al., 2002; Felson et al. 1989; Arfken et al., 1994; Ivers et al., 1998; Lord, 2006; Glynn et al., 1992; Roberts & Roberts, 1995). Previous research has highlighted the correlation between the type, severity and frequency of injuries and the type and degree of vision loss. The categories of injuries normally considered are falls, occupational injuries, and traffic-related injuries. A thorough review of the literature (Legood et al., 2002) established that the risk of unintentional injury due to falls is higher for those with visual impairment than for the general population. Other than the literature about falls, though, very few studies were found relating visual impairment to other types of injuries, including occupational and traffic-related injuries. Only one other study (Arfken et al., 1994) briefly addresses the risk of collision against obstacles, which is one of the main themes of this contribution. In that study, each subject in a cohort of elderly subjects was asked to provide a visual self-assessment with questions that included whether the subject bumped into objects that he or she missed seeing. It was shown that bumping into objects was not correlated with visual acuity, and was only weakly correlated with limited ambulation due to poor vision. Bumping into objects, however, was shown to be a good predictor of falls and recurrent falls.

This article is concerned with two specific categories of injuries: head-level accidents (bumping into things at chest height or higher) and falls while walking. It reports the results of a survey interview with more than 300 legally blind or blind respondents. The questions in the survey focused on the frequency, nature and causes of head-level and fall accidents, along with other factors such as the level of blindness, the type of mobility aid used, and the frequency of independent trips. The quantitative and qualitative data that emerged from this survey may be useful to Orientation & Mobility professionals and researchers or practitioners in Assistive Technology alike.

Motivation and Research Questions

Walking without sight brings forth the risk of falls and collisions. Although mitigated by the use of mobility aids such as the long cane and the dog guide, this risk needs special consideration. The first research question addressed by this paper is whether accidents involving a blind ambulator in a "static" environment (that is, accidents that are not due to traffic or to moving objects or persons near the blind person) represent a significant aspect of the experience of walking without sight, or if they should be considered sporadic and inconsequential incidents. This question should be relevant, among others, to anyone involved in the development of new mobility tools for people with visual impairments (such as Electronic Travel Aids or ETA). Of course, other types of accidents (e.g., traffic-related accidents) are also important and should be addressed by appropriate research; they are, however, outside the scope of

this work. A second research question concerns the difference in the rates of accidents between cane users and dog guide users. These two mobility aids are intrinsically different, and so it is interesting to ascertain whether they provide the same level of protection, or if one proves superior to the other in this particular context. A third question relates to whether persons who venture out to unfamiliar routes are more likely to experience this type of accidents. This information may help identify which population segments may be more in need of technology to prevent injuries associated with independent ambulation.

Data Collection

The survey is comprised of four main sections: (1) demographics; (2) travel habits, including the type of mobility aid and the frequency of travel outside one's residence and outside familiar routes; (3) occurrences of head-level accidents, their frequency, circumstances and consequences; (4) occurrences of trips resulting in a fall, their frequency, circumstances and consequences. Part of the questions called for a quantitative answer, and part were open-ended. The survey could be taken on the Internet (using SurveyMonkey, an accessible online service providing secure data transfer) or on the phone. Online surveys are appealing because of their characteristics of flexibility, speed and timeliness, and convenience (Evans & Mathur, 2005). Those with no access to the Internet or not willing to use the online survey tool could opt for a phone survey interview with the same questions as the online survey. The only inclusion criteria were for the participants to be blind (at most light perception) or legally blind, and to be at least 18 years old. The survey, which ran from October 13th to December 15th, 2009, was announced by email to multiple organizations working with visually impaired persons throughout the U.S. To encourage participation, a random draw for two US\$100 Amazon gift certificates was announced and later conducted on December 15th, 2009. A total of 307 persons participated to the survey, of whom 268 took the survey online and 39 over the phone. Some who participated online were unable to complete the survey due to incompatibility with their screen reader. In these cases, all of the completed answers were considered in the subsequent analysis. All who took the survey over the phone completed the survey. 289 respondents were located in the U.S. (32 different states were represented). 10 respondents were located in Canada, 2 in New Zealand, 2 in Bulgaria, 1 in Mexico, 1 in Indonesia, 1 in the U.K., and 1 in Germany.

Results

Demographics

Gender distribution was 65.5% female and 34.5% male. Ages ranged from 18 to 83 years (mean = 47 years, standard deviation = 15.2 years). Fig. 1 compares the age distribution of the respondents with the age distribution of U.S. population with "vision trouble" as reported in the National Health Interview Survey (Pleis & Lucas, 2009). It can be noted that the age distribution of the survey respondents is skewed towards younger age groups. This can be attributed to the fact that this survey focused on independent ambulation and therefore naturally attracted the younger and more mobile segment of the visually impaired community. It should also be noted that the survey restricted participation to respondents who were legally blind or blind, representing only a subset of the population with "vision trouble" considered in the National Health Interview Survey (Pleis & Lucas, 2009), where "vision trouble" was defined as "trouble seeing, even with glasses or contact lenses".

58.3% of the respondents affirmed to be blind (with at most some light perception) and 41.7% affirmed to be only legally blind (not blind). Compared with national statistics, which indicate that about 20% of legally blind persons have light perception or less (Leonard, 1999), it is seen that the community of blind individuals were over-represented in this survey. In the remainder of this paper the term "blind" refers to "at most some light perception", while the term "legally blind" indicates "legally blind but not blind".

Respondents reported a wide variety of causes of vision loss, including birth defects such as retinopathy of prematurity, retinitis pigmentosa, retinoblastoma, Leber's congenital amaurosis, and age-

related impairment such as cataract and glaucoma. 68 respondents (22%) had other impairments affecting their ability to walk, the most common being bad balance and arthritis. 52 respondents (17%) were retired, either due to age or disabilities, 15 (5%) were unemployed, while the remaining ones were either employed or students.

One question in the survey considered the use of mobility aids. 55% of the respondents used a long cane but not a dog guide, 12% used a dog guide but not a cane, and 26% used both a dog guide and a cane, possibly at different times of their life. Some of the respondents confused what technically is considered a wayfinding aid for a mobility aid. 29 respondent (9%) stated that they used GPS, which is normally considered a wayfinding device. All of the GPS users also used a cane or a dog guide. 29 respondents (9%) stated that they also use aids such as monoculars, telescopes, TalkingSigns, tactile maps, or sighted companions. For subsequent statistical analysis, only two populations were considered: those who used a long cane only, and those who used dog guide, possibly complemented by a long cane. Legally blind respondents accounted for 45% of long cane users and for 35% of dog guide users.

It should be clear that this sample is not representative of the distribution of mobility aid usage within the general visually impaired community. For example, only about 42% of the blind persons in the U.S. used a cane in 1990 (Demographic Update, 1994), and only 2% used a dog guide (Demographic Update, 1995). The high ratio of persons using a mobility aid in this survey may be explained by the fact that the vast majority (96%) of the respondents were independent travelers, meaning that they were able to walk independently outside of their house, and thus were very likely to use a mobility aid. The reason for the disproportionately high ratio of dog guide users among the respondents is not clear. It could be conjectured that the survey received good advertisement by dog guide organizations, or that persons who use a dog guide are more likely to also use computers and therefore to be informed about the survey (via email) and take the survey online.

One possible measure of a blind person's experience with independent mobility is the amount of time this person has been using a mobility aid. Fig. 2 shows the distribution of duration of use of mobility aids across respondents. Some respondents used different mobility aids during different periods of their life. In these cases, the cumulative duration of use of all mobility aids was recorded.

Travel habits

Two open-ended questions in the survey addressed the travel habits of persons with visual impairments:

Q1: In a typical week, how often do you travel alone outside your house/apartment/garden?

Q2: How often do you travel alone outside your familiar routes?

Question Q2 generated a substantial number (35) of answers containing what could be termed "conjecture words" ('about', 'maybe', 'probably', etc). Question Q1 only generated 5 such conjecture words. It seems that the notion of "familiar route" is not well defined, or that it was difficult for the respondents to clearly assess how often they travel outside familiar routes.

All 307 respondents to Q1 provided quantitative data. Answers to Q2, however, were often qualitative in nature ('frequently', 'rarely', 'occasionally', 'as needed'). Since it is impossible to clearly quantify such responses, these answers were discarded before subsequent quantitative analysis, resulting in only 177 answers to Q2 containing quantitative data. Based on these quantitative answers, it was decided to group replies to Q1 and Q2 into the following categories: 'Never'; 'Once a month or more'; 'Once a week or more'; 'Five times a week or more'; 'More often than once a day'. The results are shown by the histogram of Figs. 3 and 4. Note that about 6% of the respondents said that they never take trips outside their familiar routes (Q2). A smaller number of respondents (4%) never leave their residence (Q1).

Chi square analysis of this data reveals the following (please note that for all of the statistical analysis in this paper, results with $p < 0.05$ are considered significant):

- The distribution of frequencies of travel outside one's residence (Q1) for legally blind respondents is consistent with the same distribution for blind respondents (Pearson's Chi-square = 2.809, df=3, p=0.422). A similar result (Pearson's Chi-square = 3.940, df=3, p=0.268) is obtained comparing the distribution of frequencies of travel outside familiar routes (Q2) for legally blind and for blind respondents. This seems to indicate that the willingness and ability to travel outdoors is not affected by whether one is legally blind or blind.
- The distribution of frequencies of travel outside one's residence (Q1) for long cane users and dog guide users are not consistent (Pearson's Chi-square = 10.193, df=3, p=0.017). Thus, the data supports the claim that the type of walking aid influences the frequency of travel outside one's residence. The histogram of travel frequencies for the two populations (long cane users and dog guide users), shown in Fig. 5, strongly suggests that using a dog guide results in significant increase in the frequency of outside walks.
- The distribution of frequencies of travel outside familiar routes (Q2) for long cane users and dog guide users are not consistent (Pearson's Chi-square = 7.909, df=3, p=0.048). This data suggests that the type of walking aid may influence the frequency of travel outside familiar routes. However, no clear pattern emerges from visual observation of the histograms of travel frequencies for the two populations, shown in Fig. 6.

The respondents' ages are negatively correlated with the frequencies of travel outside one's residence (Spearman's rho = -0.173, p=0.033). This result is perhaps not surprising, as it suggests that the younger respondents travel more often outside their residences than older respondents. It is interesting to notice that age does not appear to be correlated with the frequency of travel outside familiar routes (Spearman's rho = -0.042, p=0.581).

Head-level accidents

A question in the survey asked about the frequency of "head-level accidents", loosely defined as "bumping one's head against an unexpected obstacle". The possible answers were: 'Never'; 'Once a year or less frequently'; 'Once a month or less frequently'; 'More often than once a month'. Fig. 7 shows the distribution of frequencies reported. Additionally, the respondents were invited to describe (in an open-ended comment) the head-level accidents they experienced. 300 participants responded to this question.

Chi square analysis of this data reveals the following:

- The distribution of frequencies of head-level accidents for legally blind and blind respondents are not consistent (Pearson's Chi-square = 19.065, df=3, p=0.000). Visual analysis of the two histograms, shown in Fig. 8, reveals a larger variance of frequencies of head-level accidents for the legally blind population than for the blind population. Note that, among the blind respondents, only 2% never experienced head-level accidents, versus 12% of the legally blind population. Note also that legally blind respondents were twice as likely to experience frequent head-level accidents (more than once a month) than blind respondents (with a proportion of 18% and 9%, respectively).
- The distribution of frequencies of head-level accidents for dog guide users and cane users are consistent (Pearson's Chi-square = 2.792, df=3, p=0.425). This suggests that the type of mobility aid has little influence on this type of accidents.

The frequency of head-level accidents is not significantly correlated to the frequency of travel outside one's residence (Spearman's rho = 0.045, p=0.563) or outside of familiar routes (Spearman's rho = 0.048, p=0.538).

Analysis of the qualitative data provided by the respondents sheds light on the different environments in which accidents are likely to occur. An overwhelming 86% of the head-level accidents happened outdoors, with 8% of the respondents reporting accidents both indoors and outdoors, and 6%

only indoors. Outdoor accidents were due to tree branches (the majority), poles and signs, construction equipment and trucks. Indoor accidents were typically due to doors and cabinets left ajar, shelf and tables, staircases (hit from the side) and walls.

23% of head-level accidents carried some medical consequences, of which 60% required assistance by medical professionals, and 60% required home rest. The most prevalent treatment for those needing medical attention was the application of stitches or staples (in one case, there was the need for plastic surgery), and dental treatment for broken teeth. 12% of head-level accidents resulted in time lost, which includes missed appointments or the need to take time off work. (It should be noted that some of the respondents did not count visits to the emergency room or to the doctor's office as time lost, and therefore their answers only referred to time off work or missed appointments.) 43% of these accidents resulted in the respondents changing their walking habits after experiencing an accident, with most respondents stating that they walked more slowly and raised their arms whenever possible to protect their head against unexpected obstacles. In 26% of the times, a head-level accident affected the respondent's confidence as an independent traveler, with some avoiding certain areas and others opting for a sighted companion for their travels.

Trip/fall accidents

Another question in the survey (which was answered by 289 respondents) asked for the frequency of "tripping resulting in a fall". The set of possible answers was the same as in the previous question. The results are summarized in Fig. 9. Among the blind respondents, only 8% never experienced this type of accidents. This number grows only slightly (10%) for the legally blind population surveyed.

Similarly to the case of head-level accidents, legally blind respondents were twice as likely to experience frequent fall accidents (more than once a month) than blind respondents (with proportions of 10% and 5%, respectively). Chi square analysis reveals that the distribution of frequencies of this type of accident are consistent between blind and legally blind respondents (Pearson's Chi-square = 5.392, $df=3$, $p=0.145$) and between long cane and dog guide users (Pearson's Chi-square = 1.494, $df=3$, $p=0.684$). The frequency of fall accidents is not significantly correlated to the frequency of travel outside one's residence (Spearman's rho = 0.053, $p=0.505$) or outside of familiar routes (Spearman's rho = -0.062, $p=0.431$).

Qualitative answers suggest that the main causes of falls are: 1) Lack of attention to the surroundings or to warnings from the dog guide; 2) Unexpected obstacles where there were no obstacles before; 3) Misjudgment of distances or angles. The descriptions provided by the respondents were mostly in terms of "activities" (that led to a fall), whereas in the answers related to head-level accidents, descriptions were mostly in terms of "objects" (representing obstacles).

36% of the respondents stated that accidents resulting in falls had medical consequences. 63% of these required assistance by medical professionals, and 14% required home rest. A wide variety of treatments were reported by those who needed medical attention, ranging from stitches to orthopedic surgery to rehabilitation. In 22% of the cases reported, an accident of this type results in time lost. 51% of the respondents said that they changed their walking habits as a consequence of one such accident, and 30% reported loss in confidence as independent travelers.

Statistical analysis shows that the frequency of head-level accidents and of trips resulting in a fall are correlated (Spearman's rho = 0.221, $p=0.006$). This suggests that persons who bump into things more often are also those who are more at risk of falls. This result is consistent with the findings of Arfken et al. (Arfken & al, 1994) who reported that bumping into objects predicts falls and recurrent falls.

Conclusions

This survey interview has highlighted some of the risks and issues related to independent mobility. Referring to the Research Questions stated above, analysis of the respondents' data provides a number of interesting insights:

- Head-level and fall accidents represent a non-negligible risk associated with walking without sight. 13% of the respondents experienced head-level accidents at least once a month; 7% experienced falls while walking at last once a month. These accidents often require medical attention. A substantial portion of respondents stated that these types of accidents changed their walking habits and reduced their confidence as independent travelers.
- The type of mobility aid used does not have a significant effect on the frequency of accidents. Use of a dog guide does not seem to provide better protection against head-level or fall accidents than proper use of a long cane.
- Individuals who travel more frequently outdoors do not seem to be at higher risk of head-level or fall accidents than those who leave their house less frequently.

These results should be interpreted with consideration to the population interviewed, which was skewed towards younger age groups, expert travelers (with several years of experience using mobility aids), and dog guide users (representing 38% of the respondents).

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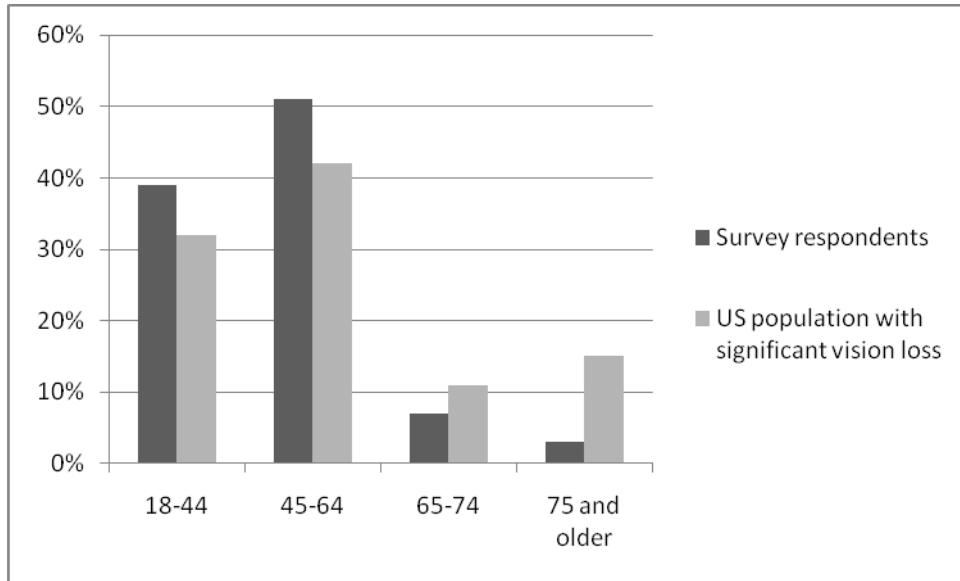


Fig 1. Distribution of ages for survey respondents and for the US population with significant vision loss.

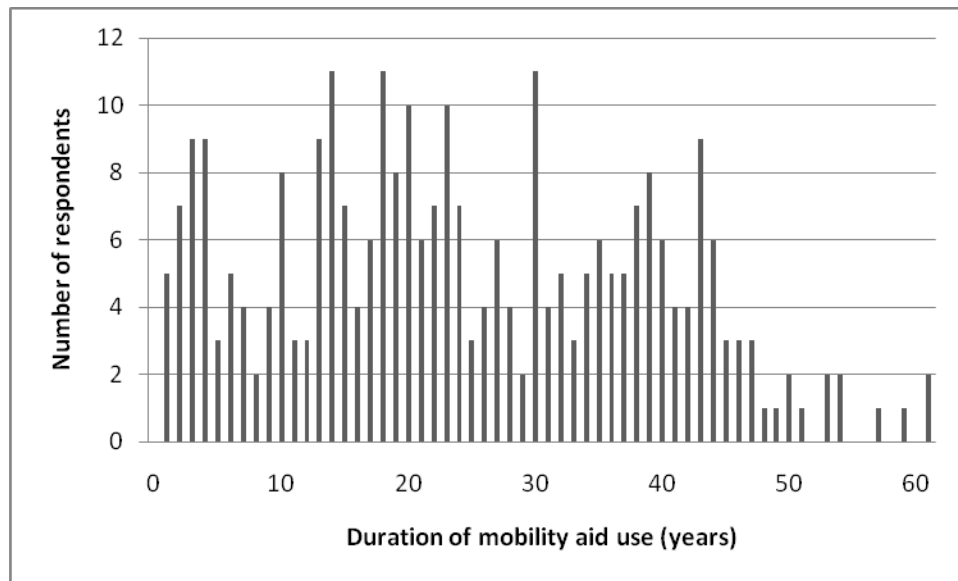


Fig 2. Distribution of duration of use of mobility aids.

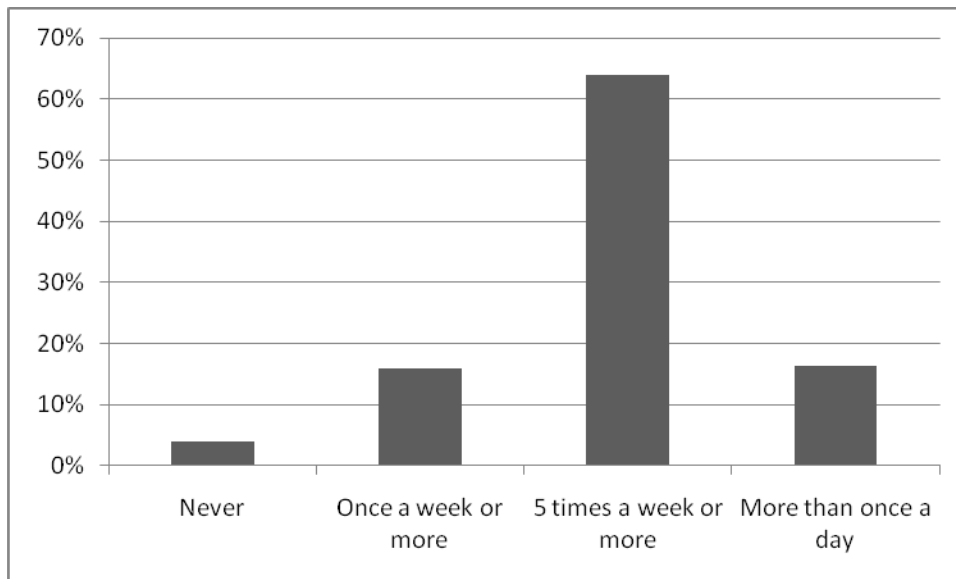


Fig 3. Distribution of frequencies of travel outside one's own residence.

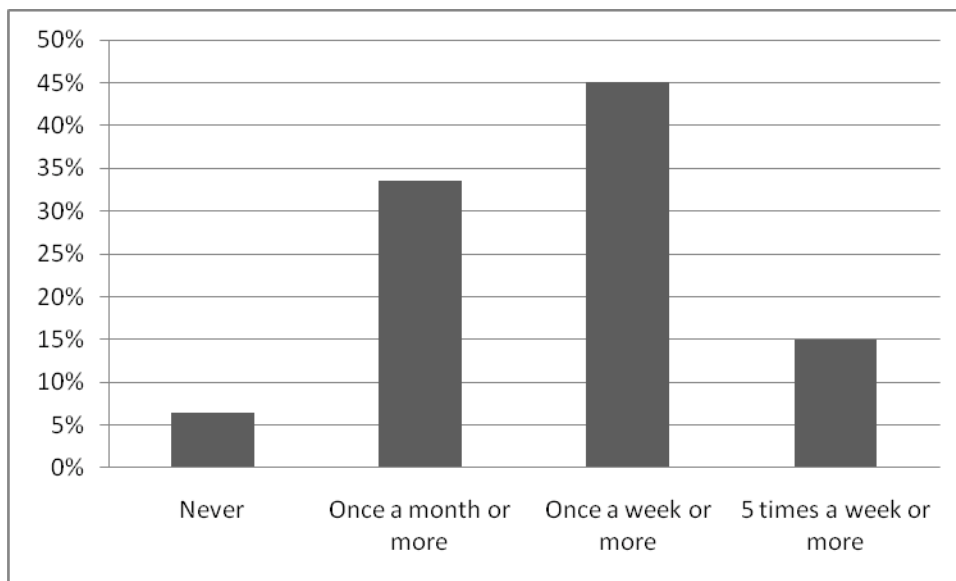


Fig 4. Distribution of frequencies of travel outside of familiar routes.

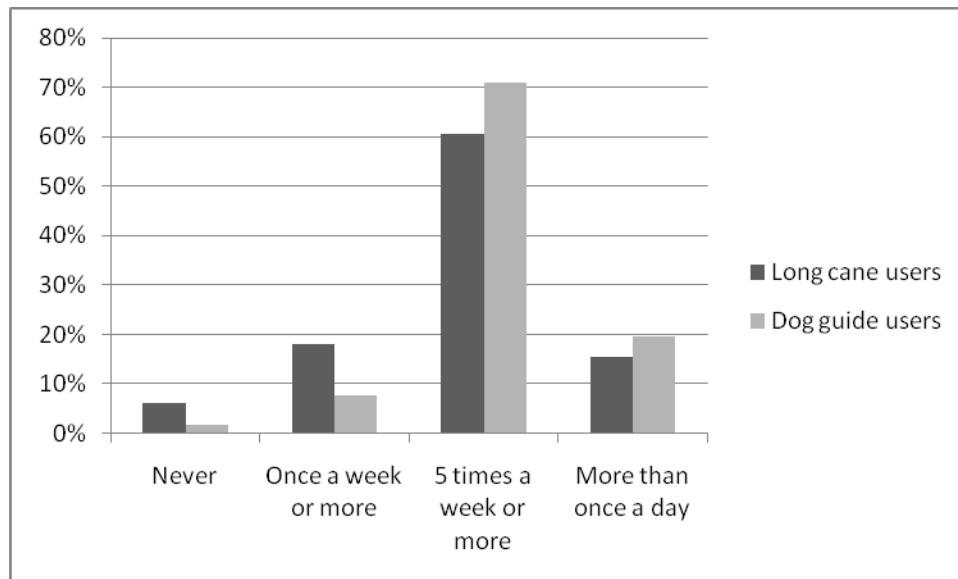


Fig 5. Distribution of frequencies of travel of outside one's own residence for long cane users and for dog guide users.

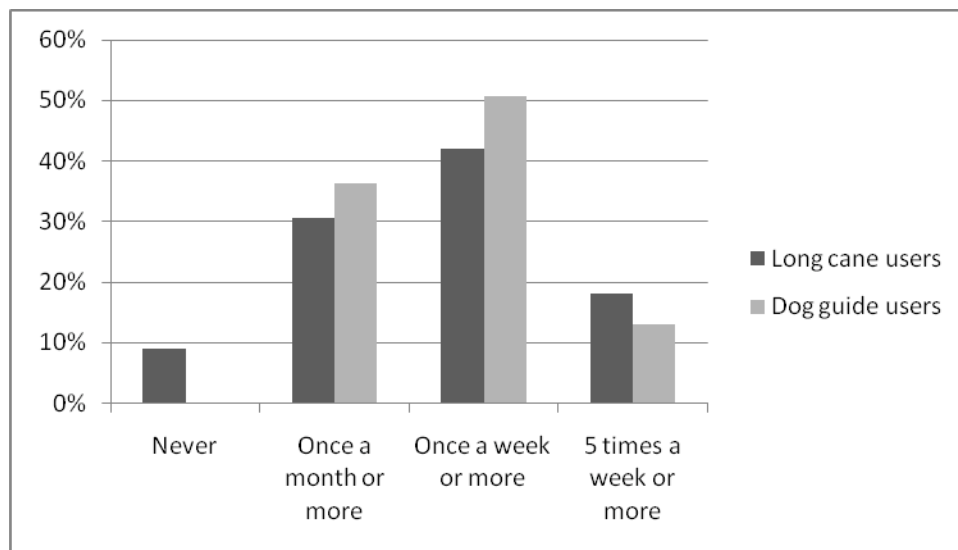


Fig 6. Distribution of frequencies of travel of outside of familiar routes for long cane users and for dog guide users.

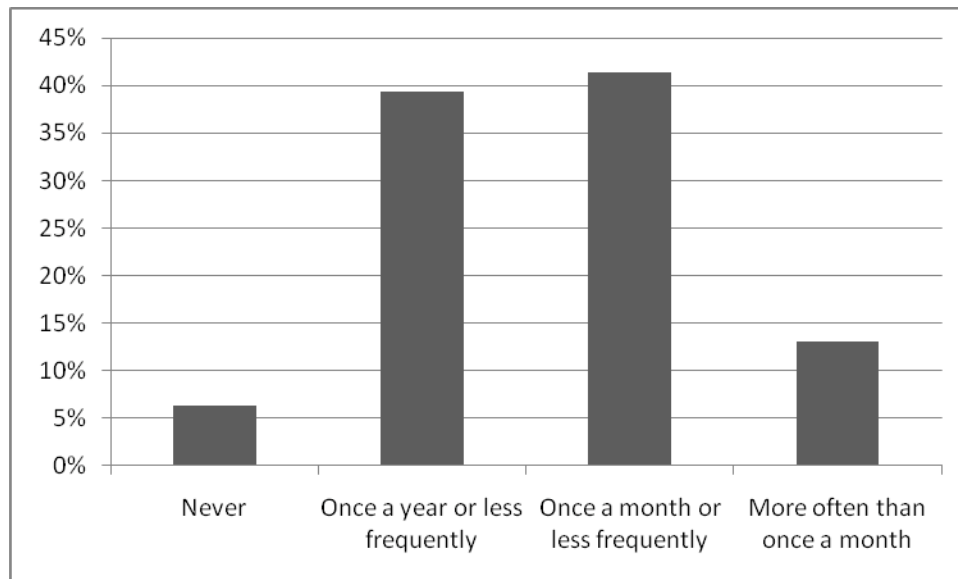


Fig 7. Distribution of frequencies of head-level accidents.

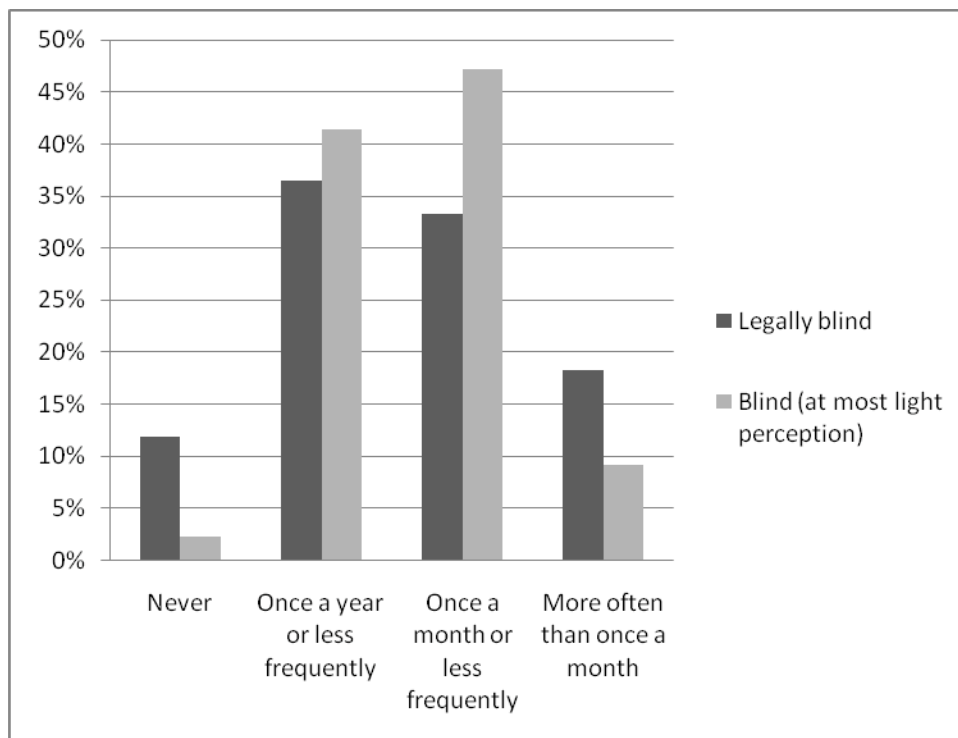


Fig 8. Distribution of frequencies of head-level accidents for blind and for legally blind respondents.

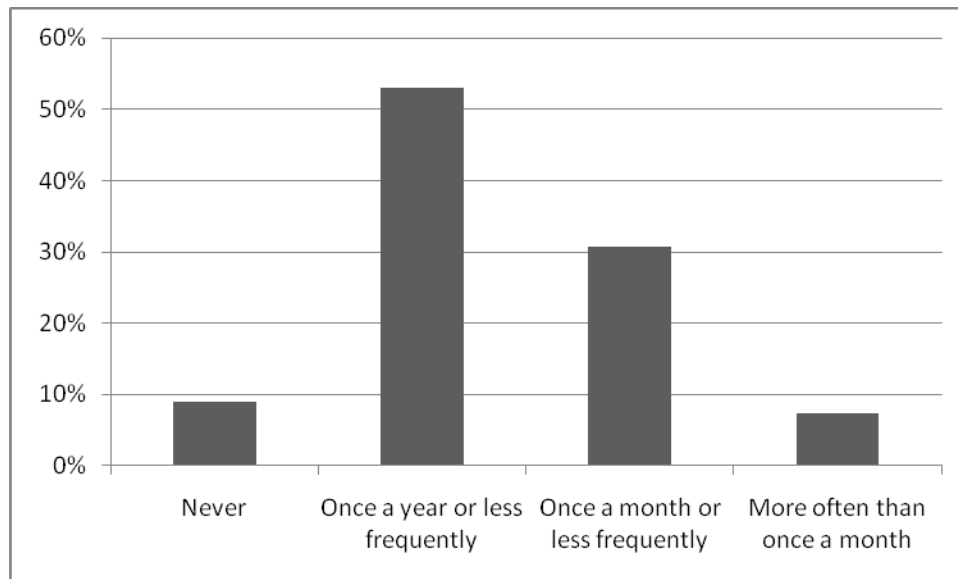


Fig 9. Distribution of frequencies of tripping resulting in a fall.