Research Article

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Does a smartphone application make it easier to evaluate the dizziness handicap inventory?

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Abstract

Objective: The Dizziness Handicap Inventory (DHI) is a questionnaire that is frequently used for patients with vestibular system disorders. The aim of this study was to evaluate the feasibility and reliability of the "e-DHI" smartphone application, which calculates DHI scores.

Methods: Web-based iOS and Android smartphone applications (e-DHI) were developed to evaluate the DHI. After completing the questionnaire, the DHI total score and subscores (physical, functional and emotional) were assessed and results were noted and sent to the e-mail address. Twenty-five otorhinolaryngologists and neurologists were enrolled in the study to apply the DHI to the authors sequentially using the conventional assessment method and the e-DHI (randomized by priority). The questionnaire was applied by both methods, and for each method, the time required to complete the questionnaire, to calculate the DHI score, and the total time required were noted.

Results: Three of the 25 doctors were excluded from the study due to a calculation error with the conventional evaluation method. The mean total time required for completing and scoring the questionnaire was shorter when the DHI was evaluated with the e-DHI application (160±32.2 seconds) compared with the classic assessment method (289±65.9 seconds) ($p<0.001$). There was no significant difference between the two methods in terms of the time taken to complete the questionnaire ($p=0.269$). However, the calculation periods were statistically significantly shorter with the digital application compared with the conventional method ($p<0.001$).

Conclusion: The present study showed that the DHI could be applied more quickly, more comfortably, and safely (with higher accuracy) using the e-DHI smartphone application.

Keywords: Dizziness, dizziness handicap inventory, smartphone application, vertigo

INTRODUCTION

The World Health Organization defined electronic health (eHealth) as the use of information and communication technologies locally and at a distance, and concluded that it was low-cost, secure for data exchange and communication, and could also be used in healthcare, public health assessment, surveillance, literature, education, and health promotion (1). Mobile health (mHealth) is a new innovative subheading in eHealth and includes using wireless devices such as smartphones, patient monitoring devices, and personal digital assistants (2). mHealth includes voice calls or short message service, and the use of a global positioning system (GPS), Bluetooth® or smartphone applications (2). Smartphone applications constitute an important part of mHealth and are increasing rapidly in application stores (3).

The prevalence of vertigo and imbalance, which is difficult to follow up and requires long-term treatment, is estimated to affect between 15% and 30% of adults annually in large population-based studies (4). A questionnaire that is often used in patients with vertigo and/or dizziness is the Dizziness Handicap Inventory (DHI), as described by Jacobson and Newman in 1990 (5). The DHI consists of 25 items and measures the patient's physical, emotional, and functional disabilities caused by dizziness. Each item can be assigned as "Yes" (4 points), "Sometimes" (2 points)

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or "No" (0 points), and the subgroup and total scores are calculated separately. Twenty-five items may be difficult to calculate because of the subgroups, and takes a long time. The greatest handicap to achieving a reliable calculation is that it must be performed carefully and the evaluation may take a long time.

The aim of the present study was to evaluate the functionality, feasibility, and reliability of the 'e-DHI' application developed by the authors through comparison with the conventional method.

METHODS

Smartphone Application: e-DHI

A Linux web-based (with 128-bit encryption) DHI application (e-DHI) was developed for smartphones and tablets using the iOS and Android operating systems. In order to be suitable for international and national use, validated surveys are acceptable in English and Turkish languages (5, 6). For applications to work, smartphone/tablets must have an internet connection. The application can be downloaded free-of-charge from major application stores such as the Apple App Store (iOS: https://itunes.apple.com/us/app/e-dhi/id1435766558) and Google Play Store (Android: https://play.google.com/store/apps/details?id=com.orlist.edhi). After opening the application, DHI items are seen after the language has been chosen (Figure 1a, b). DHI results (total and subgroup scores) are displayed on the third page after the 25 items have been answered (Figure 1c). If the name, age, and sex information for the patient, and the doctor's name and email address are completed (Figure 1d), a summary of the questionnaire, scores, and information on the patient and doctor are sent to the specified email address.

Participants

In total, twenty-five otorhinolaryngologists and neurologists applied the DHI to the authors (UU, DU, OÇ) using both the conventional DHI form and the e-DHI application consecutively, which were randomized to determine with which method they would start. In order to avoid any difference between both methods, the authors responded according to two different predetermined responses randomly. The time taken to complete the form or enter the data in the application, and the total time taken including the calculation of scores were compared in both procedures. In addition, a survey that evaluated the functionality and reliability of the application was administered to the participating doctors (Table 1). Consent forms were signed by the participants.

Statistical Analysis

The data were analyzed using the IBM Statistical Package for the Social Sciences Statistics for Mac v.20.0 software package (SPSS IBM Corp.; Armonk, NY, USA). The analysis of results was performed using the Wilcoxon test and Spearman's correlation test. P values less than 0.05 were considered to indicate a statistically significant difference between the groups.

RESULTS

Of the twenty-five physicians who took part in the survey, three were excluded from the study as an error was made with score calculations using the conventional DHI procedure. The mean age of the 22 participants (8 females, 14 males) was

Figure 1. a-d. The e-DHI application. (a) Language selection page, (b) Questionnaire page, (c) Results page with total and subgroup scores of dizziness handicap inventory, (d) Total score and patient/physician information

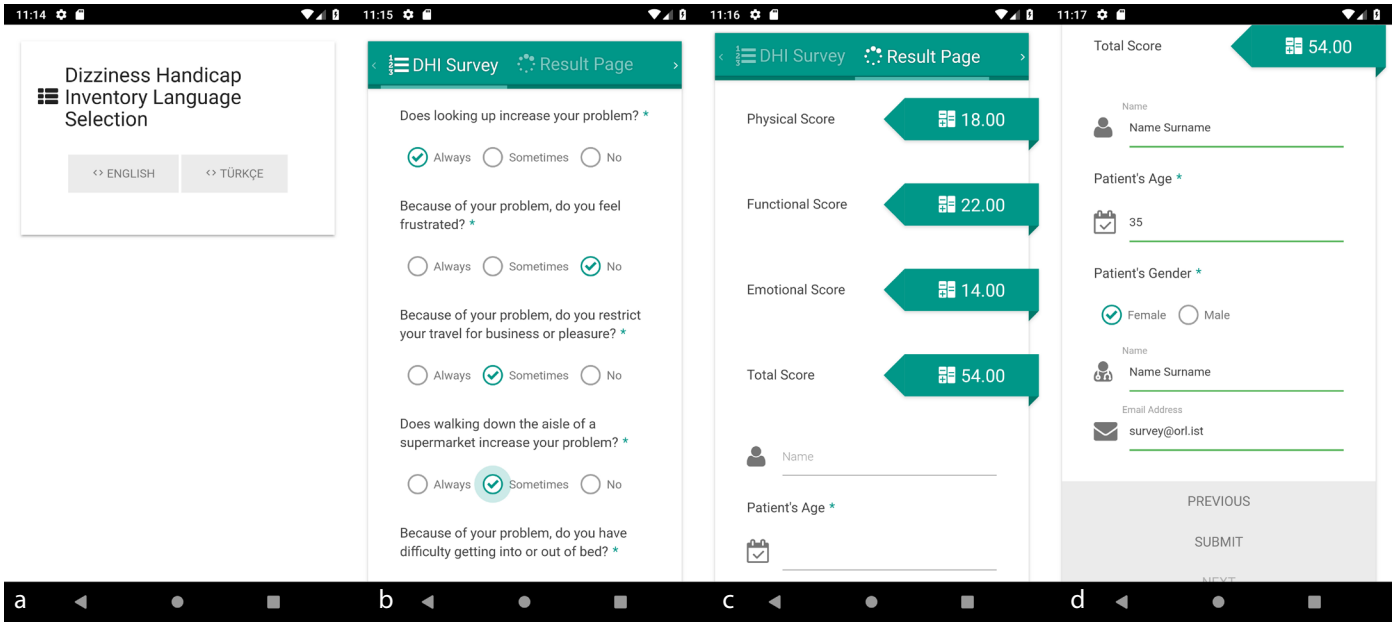

Table 1. Questions put to the participating physicians

	Yes	No
1. Is the e-DHI application easier to calculate than a conventional written questionnaire?		
2. Do you find the e-DHI application to be safe?		
3. Do you think the e-DHI application is faster than the conventional method to calculate the scores of the questionnaire?		
4. Does the e-DHI application provide an advantage over conventional methods to observe the patients' previous dizziness disability levels?		
5. Do you think other otologic-neurotologic questionnaires should include smartphone applications?		
6. Would you recommend the e-DHI application to another physician?		

e-DHI: the smartphone application of dizziness handicap inventory

Table 2. Duration of conduction of DHI with conventional and e-DHI methods (n=22)

	Method		
	Conventional	e-DHI application	p
Completion time for the DHI (seconds)	134±19.7	129±27.5	0.269
Calculation time for the DHI (seconds)	155±62.8	31±11.2	<0.001
Total survey time (completion and calculation) for the DHI (seconds)	289±65.9	160±32.2	<0.001

DHI: dizziness handicap inventory

35±7.79 years. The mean total survey time (duration of questionnaire completion and calculation) for the conventional method (289±65.9 seconds) was statistically significantly longer than the total survey time with the e-DHI application (160±32.2 seconds) (p<0.001) (Table 2). With regard to just completing the DHI questionnaire, there was no statistically significant difference between the two methods (conventional=134±19.7 seconds, e-DHI=129±27.5 seconds; p=0.269). In contrast, the score for just the calculation time was significantly faster using the application (31±11.2 seconds) compared with the conventional method (155±62.8 seconds; p<0.001). There was no correlation between age or sex and the mean total survey time for both methods ($rho_{age\text{-}conventional}$= –0.255, p=0.253; $rho_{age\text{-}e\text{-}DHI}$=-0.011, p=0.96; $rho_{sex\text{-}conventional}$=–0.120, p=0.596; $rho_{sex\text{-}e\text{-}DHI}$=–0.195, p=0.384).

The participants were asked six questions about the availability and reliability of the digital application and all questions in the questionnaire were answered as "Yes" (Table 1).

DISCUSSION

A number of validated questionnaires are used to monitor the progression or regression of patients with vestibular system disorders. Questionnaires can be effective even in the planning of patients' treatments. Unfortunately, however, the use of these surveys in practice has not reached the desired levels and is generally used on the basis of studies. One of the greatest problems in the conduction of surveys is that the physician needs extra time and effort (7). The electronic questionnaires are quick to conduct and calculate, so it is considered to be a simpler and cheaper method than the classic questionnaire methods (7). Therefore, digital surveys have become more popular nowadays (8).

The DHI is used to assess the dizziness and vertigo of patients who have vestibular symptoms. It is composed of 25 items, and has three subgrouped domains: physical, functional, and emotional (5). Although the total score of the DHI is relatively easy to calculate, the calculation of subdomain scores is complex because items are not in a certain order. In the present study, calculating scores with the conventional method lasted for more than 2 minutes compared with the calculation with the application (about 30 seconds). In addition, three of the 25 participants made score calculation errors with the conventional method, whereas there were no errors with the digital application. The e-DHI is faster and more reliable than the conventional method, and can provide simplicity for physicians in clinical conditions. Also, medical and health-related applications such as the e-DHI, which save time and are convenient for healthcare professionals, are increasing in number and are expected to become more popular in the future (3).

The participants said that the conduction of the DHI using the e-DHI was more reliable, faster, and easier than with the conventional method. They also stated that new applications should be developed to replace similar conventional neurotologic questionnaires and would recommend the e-DHI application to other physicians. Similar to the present study, many studies have shown that digital applications are fast, reliable, and easier for evaluation of patients with neurotological diseases, and different situations could be tested with the applications (9-16). Liu et al. showed that a questionnaire study with a smartphone application had a positive effect on seizure self-management in patients with epilepsy (12). In addition, electronic visual analogue scales for pain, fatigue, anxiety, and quality of life in patients with multiple sclerosis were found to be reliable and useful (13). Schmidt et al. reported the effects of atmospheric

pressure and humidity on the frequency of Ménière's disease occurrences using a smartphone application using a GPS information for the patient (14). However, a valid questionnaire was not used in that study, only vertigo, aural fullness, tinnitus, hearing loss, and attack prevalence were evaluated. The period and frequency of tinnitus of patients were evaluated using the 'Track Your Tinnitus' application and data for 857 patients were shared in the literature (15). The combination of music therapy with a smartphone application and Gingko treatment ameliorated the tinnitus handicap inventory in patients with tinnitus (16). In the present study, on the recommendation of physicians, patients could conduct the DHI by themselves at certain time intervals and both physicians and patients could easily follow the progression and regression of vertigo.

Easily accessible smartphone applications may replace some primary healthcare screening tests in the future (17). In addition, healthcare systems could save both time and money with the popularization of these applications (18). The conduction of the DHI with the application is faster and more reliable than with the conventional method and it allows movement away from paper-based patient files. New technological developments increase the quality of life of patients, make the workload easier for health professionals, and allow them to develop systems themselves. However, it should be kept in mind that the safety of patient information is a priority in these technological developments. In the present study, 128-bit data encryption (the most efficient and standard encryption method) was used to encrypt the patient's information (19).

In conclusion, the e-DHI is an easily accessible free application that could be applied anywhere, is easy to evaluate, provides more reliable results, and eliminates the paper burden. Conversely, the conventional method of DHI is difficult to evaluate and takes time to conduct. The e-DHI may also contribute to the standard database for monitoring and evaluating treatment efficacy in patients with vertigo and/or dizziness.

Ethics Committee Approval: This article is conducted with physicians and does not contain any studies with patients or animals. Therefore, the ethical approval was not required.

Informed Consent: Written informed consent form was obtained from the participants in this study.

Peer-review: Externally peer-reviewed.

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