Interactive computer nutrition system for elderly

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N. Naveh-Deutsch, S. Ish-Shalom, G.S. Rozen, N. Bitterman. Interactive computer nutrition system for elderly. Gerontechnology 2007; 6(4):236-240. E- health is a developing area of major social, medical and economic importance, especially for the elderly population and citizens of remote areas. Nutrition is recognized as an important factor in influencing the functional outcome of aging and its control can mostly benefit using E- health services. The aim of our study was to define the optimum interactive computer interface for self-reporting of dietary intake suitable for use by elderly people. Three experimental interactive interfaces designated to assess nutrient intake were built, backed by hidden computer tracking programs: (i) an 'ABC list' website in which food items were presented in alphabetical order, (ii) a 'Food Groups' website, and (iii) a 'Structured' website based on recall dietary protocol. Two groups of experienced Internet users participated: older adults (73.75 ± 7.3 years) and middle-aged adult (55.32 ± 4.7) (n=20 for each group, equal number of females and males). Participants were asked to insert the content of their daily breakfast in the three experimental websites. Experimental parameters were; time for task completion (total and per food item), number and types of operations, errors, usability, satisfaction and personal preference. Time for task completion and per food item selection were significantly longer in older participants compared to middle-aged adults ($p < 0.05$), demonstrating a significant positive correlation between time and age in all experimental websites. The shortest time for task completion was measured in the 'Food Groups' website in both age groups. Our results suggest that the most appropriate nutritional interface for older adults and middle-aged adults in terms of time and efficiency is the 'Food Groups' website, while the worst performance was at the 'Structured' website.

Keywords: interactive healthcare services, telemedicine, dietary assessment

Interactive health services (E- health, E-care) are a developing area of major social, medical and economic importance[1]. Interactive health services are expected to improve the chain of treatment, decrease healthcare expenses, enhance quality and efficiency of healthcare, and increase the fairness and equality of the distribution of medical services, particularly for citizens living in remote areas and for the elderly population[2-4].

Interactive computer systems and home health care systems can significantly assist elderly patients in self-monitoring, collection, storage, and retrieval of personal clinical data (especially for chronic diseases), including feedback and decision capabilities. However, most of the existing interactive computer systems and health care websites, even those oriented for the older population, do not take into account the sensory, motor, and cognitive changes

that are part of the aging process, and therefore limit the use of the technology in reaching its fullest potential [5]. Health information was found to be among the most interesting fields for the elderly in using the Internet[6].

Nutrition has been recognized as an important factor in influencing the functional outcome of aging[7-9]. It is therefore extremely important to develop adequate and helpful means to assist the elderly in self-controlling their nutritional state while healthy, and when managing chronic diseases such as diabetes and hypertension[10].

Our objectives were to define user models and visualization methods for nutritional interactive interfaces for elderly people. At the first stage, we studied the interface for self-reporting of dietary intake of food consumed at breakfast eaten on the experimental day.

Methods

Participants

The study included 40 participants from two age groups: the older adult group ranged from 65 to 88 years (73.75 ± 7.32, mean ± SD) and the middle-aged adults ranged from 43 to 63 years (55.32 ± 4.74), with an equal number of males and females in both age groups. All participants had previous experience with computers and the Internet. Experiments were carried out at the participants' home or at a residential center for senior population during morning hours.

Experimental setup

Three experimental websites based on different user models and visualization methods for data entry of food intake and nutritional management were constructed and equipped with hidden tracking programs, for fully recording the participants' steps and navigation routes.

Participants were asked to insert the ingredients of their daily breakfast and the exact amount consumed into each of the three different experimental websites (it was explained to the participants that their usual eating habits were not to be examined in this experiment). The three different experimental websites were arranged according to three different models:

(i). The 'ABC list' website with food items presented by their name in alphabetical order, and the participants are asked to choose the consumed items from the ABC menu.

(ii). The 'Food Groups' website with food items shown according to nine different categories of food (vegetables, fruits, bread and pastry, dairy products, etc.) and in each group arranged in descending alphabetical order.

(iii). A 'Structured' website based on a recall dietary protocol with the choice of the food items conditioned by answering questions such as: have you eaten bread or pastry? (yes/no). If yes, another window is opened presenting different types of bread. The participant will select the specific sort of bread and define the exact quantity consumed. A question about the spread over the bread will follow, and so on.

All experimental websites were similar in their level of complexity and color-

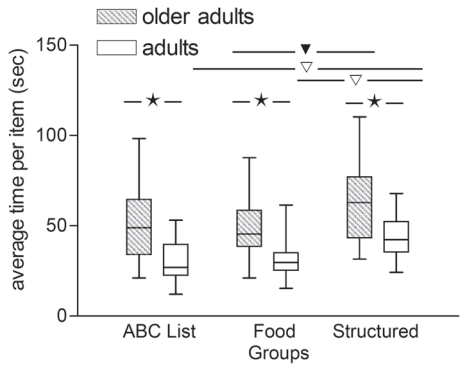

Figure 1. Average time in seconds for nutrition data input for each age group in the three experimental websites in a box plot demonstrating extremes, interquartile range (25% - 75%) and median; n=20 for each age group; ★ p<0.05 in Mann-Whitney test in comparison between older adults and the adult participants;-▽▼ p<0.05 Tukey-Kramer test comparison within age group

scheme, and differentiated only by their user models and/or visualization methods. The different websites were presented randomly to the participants to avoid the possibility of learning between interfaces. The design of the experimental websites was adapted to the requirements of the elderly users, relying on existing guidelines and recommendations for effective elderly website design.

Experimental parameters

Functional parameters: Time for task completion (total time and time per food item), accuracy (difference between verbal report and actual nutritional items fed into the computer), and number and types of operations (clicks) all derived from the integrated tracking program.

Subjective parameters: Usability (ease of performance and satisfaction) assessed by the System Usability Scale (SUS)[11], and personal preference, derived from questionnaires and interviews completed at the end of each experiment.

Statistical analysis

Continuous variables were expressed as mean ± SD, and categorized variables as percentages. The chi-square (χ^2) or Fisher's exact test were used for comparison of categorized values. Comparisons between age groups in each study for each display configuration were carried out by t-test or Mann-Whitney U-test.

Differences between websites within each age group were carried out by repeated measures analysis of variance, followed by ad hoc testing using a Duncan or Tukey test. A value of $p<0.05$ was considered significant.

Results

Differences between age groups

There were no significant differences between number of food items reported to be consumed at breakfast by both age groups (6.3 ± 2.8 vs 6.05 ± 1.5 items; mean ± SD (t-test, p=0.729).

The average time for insertion of food item was significantly longer for the older adults compared to the middle-age adults in all three experimental websites ($p < 0.05$, Mann-Whitney U-test) (*Figure 1*). A significant positive correlation was demonstrated between the average time per insertion of food item and age in all websites (*Figure 2*).

The total number of omitted food items was significantly higher in the older adults group compared to the middle-aged participants. The items most frequently omitted were water, sugar, milk, butter and salt.

There were no significant differences between age groups in ranking of satisfaction

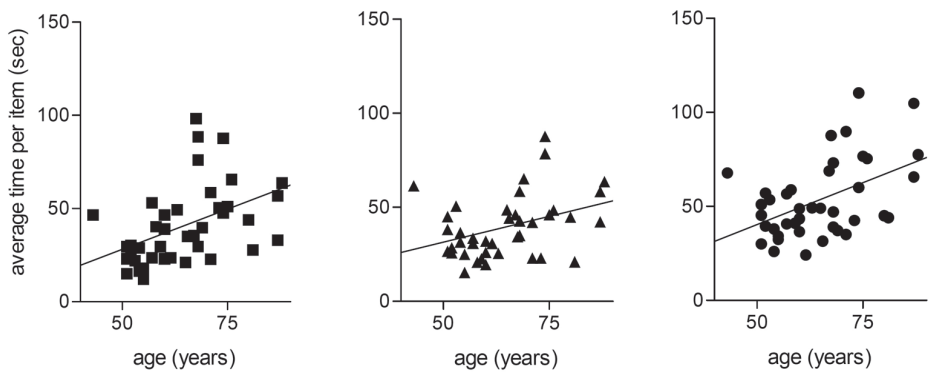

Figure 2. Correlation between age (years) and time (sec) for nutrition data input for the three experimental websites; n=40; r^2=0.2286, p=0.0018; r^2=0.1359, p=0.0193; r^2=0.2063, p=0.0032, respectively

and usability assessed by the SUS score (*Figure 3*), or in preferences of websites.

Difference between websites

The average time for inserting a certain food item was significantly longer in the 'Structured' website compared to the 'Food Groups' and 'ABC list' websites in the middle-aged group (Tukey test, $p < 0.05$). In the older adults group the average time per food item was significantly longer in the 'Structured' website compared to the 'Food Groups' (Tukey test, $p < 0.05$) (*Figure 1*).

No significant differences were found in satisfaction and usability level assessed by the SUS score (*Figure 3*), or in preferences between websites in each age group.

A significant positive correlation was found between usability assessment (SUS index) and preference level in the 'ABC list' and 'Structured' websites ($r=0.4628$, $p=0.0026$; $r=0.5349$, $p=0.0004$, respectively) but not in the 'Food Groups' website ($r=0.2665$, $p=0.0965$).

Discussion

Our results demonstrate a positive correlation between time for self-reporting dietary intake and age in assorted experimental websites, based on different user models. The results suggest that slowing is an age-related functional effect or may reflect a deliberate effort by elderly participants to minimize errors by slowing task performance, as has been observed elsewhere[12,13].

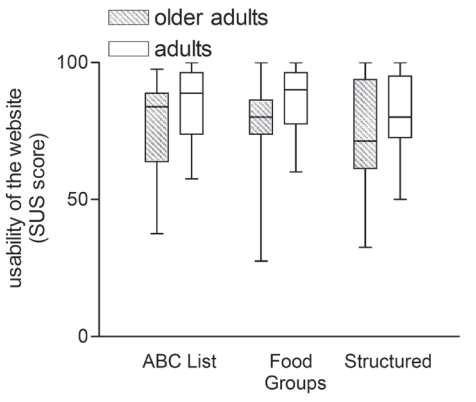

Figure 3. Usability scores for the three experimental websites of the two age groups in a box plot display demonstrating extremes, interquartile range (25% - 75%) and median; n=20 for each group

We selected three common models of protocols for assessment of dietary intake - the 'ABC list' which is based on recognition alone, the 'Structured website' based on recall methodology, and the 'Food Groups' combining both recognition and recall strategy. Our original assumption that the 'Structured website' based on recall would be the best model for the elderly, guiding them by directed questions and helping to overcome memory deteriorations, was not supported by our results. The best website was the 'Food Groups' for both age groups, either because of combining recall and recognition strategies or being the most familiar model for food assessment.

The lack of a relationship between usability and preference in the 'Food Groups' website, although it was the most effective interface, supports other findings that show that users do not always know what is best for them[14] and emphasizes the need to include objective measures when designing Internet-based systems.

Underreporting of food particles (omissions) was significantly higher among the older adults than among the middle-aged adults, although not related to a specific website configuration. The food items most frequently omitted in our study were water, sugar, milk, butter and salt. These food particles are not stand-alone items but complementary to other ingredients, for instance, coffee and tea, and frequently may appear more than once in the meal, such as salt. Our findings are in accordance with the literature[15].

Our study checked a simple text-only web design for a single meal (breakfast). Further experiments are needed to assess the effect of adding icons and pictures, which are believed to reduce the memory requirements and improve performance[16], and expand the study into a 24-hrs food assessment task.

A dietary website should not only be used for food intake follow-up, but also as an effective nutrition and general health education website, enabling individuals to improve their health, and prevent diet–related chronic physical and mental diseases induced by malnutrition. Further suggestions include the use of a medication follow-up diary and household and shopping lists.

Our belief is that personalization and tailoring of interactive nutrition systems and other medical interfaces, according to the capabilities and limitations of elderly patients based on the results of dedicated controlled experiments, will make this technology more accessible for a large population of elderly people, along with upgrading and improvement of home-care services.

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