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# A self-administered dietary assessment website for use in primary health care: usability testing and evaluation

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**Background:** A dietary assessment website for use in the primary health care setting has been developed. The website allows patients, referred from their general practitioners (GP), to self-report their dietary intake. Data from the website feeds to a dietitian who develops individualised dietary advice for the patient. **Aim:** The aim of this article is to describe the usability testing of the dietary assessment website with its potential users. **Methods:** Testing was broken into two phases. Forty-two free-living adults with metabolic syndrome volunteered, 17 completed phase 1 and 10 completed phase 2, with a 64% rate of completion. Phase 1 participants spoke aloud as they progressed through the self-administered dietary assessment website under researcher observation. Observed difficulties in website use and need for assistance was recorded and the website underwent modifications between phases. Only four participants in phase 1 required large amounts of assistance. Phase 2 participants progressed through the website without observation or using the think-aloud protocol. This simulated the environment in the GP practice within which the website was to be implemented. All participants completed pre- and post-use questionnaires assessing feelings toward use, computer experience and problems encountered. **Findings:** Questionnaires were thematically analysed for relationships between website use and participant feelings. Time taken to use the website was recorded automatically. Website features were grouped into 'action classes', for example selecting food items, and times taken were calculated for each class. Comparisons (*t*-tests) were made between the action classes for the two phases. Average time taken to select the food items was 31 min and 24 min for phases 1 and 2, respectively. Total time taken was approximately 1 h and varied by 4 min between phases. Time taken to complete the dietary assessment was comparable to a face-to-face diet history with a dietitian. The website was found to be highly user friendly with little assistance being required for most levels of computer experience. Dietary management may be overlooked by GPs, yet by offering different methods of accessing dietitians, management may improve.

**Key words**: assessment; diet; human–computer interaction; Internet; nutrition; primary care

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## Introduction

Human–computer interaction (HCI) is the study of the phenomena surrounding an area of research dealing with designing, evaluating and implementing interactive computer programmes and/or systems and their development for human use (Gulliksen and Lantz, 2003). An extensive body of research exists on a range of topic areas, for example a study by Phillips *et al*. (2001) addressing cursor use, found arrowhead cursors to affect the ability to direct and locate a cursor. Barriers to computer use within the HCI research have been identified as those of

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gender, level of education, socio-demographic background, level of income, disabilities and age. These combined with the varied lifestyles and attitudes of the general public create a broad number of challenges for the computer programmer. Further, challenges exist when combining computer programme development with the field of nutrition.

Generally interventions using computerised dietary software have demonstrated a high degree of subject acceptance especially when under supervision and once subjects have been shown how to point and click food choices (Heath *et al*., 2000). Perceptions of 'enjoyable' and 'easy to use' were rated highly in many computerised diet programmes (Turner *et al*., 2000). The main limitation of computerisation in the health care setting includes the patients' ability to answer questions about their own health rather than their ability to use the computer (Sciamanna *et al*., 2002).

The ability to use computers is frequently assessed and studies have found that in 2002 only 13% of 40-year olds had never used a computer (Sciamanna *et al*., 2002). Other studies have found 50% had taken an entry level computer course in school (average age $28 \pm 4$ years female, $29 \pm 5$ years male) (Fong and Kretsch, 1990), indicating a moderate level of general computer exposure. Lack of computer experience however is a key indicator of negative enjoyment of computerised dietary programmes (Nebel *et al*., 2002), yet experience is not related directly to acceptance of use, and should be concurrently assessed.

Acceptance of technology has been described by Davis in terms of the technology acceptance model (Davis, 1989; 1993; Davis and Venkatesh, 1996). This model describes the interactions of the external environment alongside the perceived usefulness and perceived ease of use of the technology. These three factors relate directly to the attitude of the user to the technology and their behavioural intentions during system usage. Positive outcomes for participants of diabetes education and assessment were found. Increased comprehension of nutrition messages and a higher degree of practicability were identified (Nebel *et al*., 2002). However, skills such as the ability to use a keyboard, mouse and/or menus of a computer system do need to be considered when developing a programme and determining its usability.

Usability of dietary software has been related to ease and speed of entry, ability to assign different weight measures to the food items, ease of editing food lists and limitations on the number of food entries (Lee *et al*., 1995). Usability testing has long been used in software and web design to determine the ability of the end user to operate the system allowing major or minor changes to be made to the system prior to implementation. Usability testing commonly involves the use of a researcher to observe the end user as they work through the system. This researcher may be involved by asking the participant questions and providing assistance or only taking notes and remaining silent during the trial. In order to determine the participant responses to the system, another commonly employed technique is the use of think-aloud exercises during which the participant is asked to speak their thoughts as they use the system (Simpson, 1990; Jaspers *et al*., 2004). Whether retrospective (after the event) or concurrent (during the event), the use of think-aloud exercises provide an insight into the mind of the user, supplying researchers with high-quality usability data helping to understand and anticipate potential problems (Dillow, 1997; van den Haak *et al*., 2003).

The aim of this article is to describe the usability testing of the dietary assessment website with its potential users. The testing intended to assess participants' ability to use a prototype of the website, determine the approximate time to be spent using the website and collect information on the processes involved in reading and understanding questions and providing responses. The website development was based on automation of the diet history interview that a dietitian would conduct with a patient. It is divided into four key sections. The first section asks demographic information about the subject, the second asks about the broad food categories eaten, the third asks details about the food categories selected in the previous section and the final stage asks about the frequency of consumption and portion size of each of the selected food items. After usability testing the website will be implemented in the primary health care setting. General practitioners (GPs) will refer patients who require dietary advice to the website. When the patient finishes using the website the electronic data is sent to a dietitian who develops an individualised dietary prescription for the patient. This model will allow increased access to dietary services for patients in rural locations or in areas where long waiting lists exist for the dietitian.

## Methods

Usability testing was broken into two phases. Phase 1 was conducted under traditional usability testing conditions with think-aloud protocols in a laboratory setting under researcher observation. Phase 2 usability testing mimicked the health care setting allowing users to interact with the website without observation or assistance to create a context-based usability test.

### Participants

Participants with diabetes were recruited by convenience sampling from focus group discussions run previously to determine the design aspects of the website (Probst *et al*., 2005). These participants were asked during the focus groups whether they would like further contact and were recruited for this study via telephone. An internal e-mail to all staff at the University of Wollongong was also used for recruitment. These two forms of recruitment were selected, to ensure a wide mix of socio-economic backgrounds and varied levels of computer experience (most focus group participants were beginners or intermediate computer users). Despite the two different forms of recruitment, the participants were demographically similar, covered a range of levels of computer experience and therefore were not considered separately. Participants who were not literate in English were excluded. Participants recruited for phase 1 were randomly divided into two groups: A and B (Figure 1). Group A participants had assistance available to them, whilst group B participants did not. This allowed the researchers to determine whether assistance would be required when the website was implemented in the primary health care setting. Additional participants were recruited for phase 2 to test modifications to the website after phase 1 testing. As the study aimed to test the usability of the programme, power calculations for sample size were not performed.

### Phase 1 testing

Phase 1 participants were asked to think aloud while using the website. Prior to use of the programme participants were given a practice exercise to become accustomed to thinking aloud. This exercise involved an unrelated topic area and lasted for approximately 5 min.

*Pre-testing questionnaire*: Participants from both groups A and B were first asked to complete a questionnaire about their perceived barriers to the programme, computer use and experience. Using the theoretical approach of the technology acceptance model (Davis, 1989; 1993; Davis and Venkatesh, 1996), the pre- and post-usability testing questionnaires aimed to assess the feelings and beliefs of the participants both before and after use of the website. Questionnaires were developed to allow comparisons between the pre- and post-testing of the website. The questions were a combination of matched open-ended questions and multiple-choice questions. The number of questions was kept to a minimum (11 in total) to decrease subject burden. The questions prior to testing addressed computer use, computer experience, feelings about testing the nutrition website and perceived usefulness of the software. After testing the questions related to first impressions of the website, difficulties and how these were overcome, website appearance, suggested changes and feelings after testing the nutrition website. Questionnaires were internally validated within the research team ($n = 5$) prior to use during the usability testing.

*Need for assistance*: Both groups A and B had a researcher with them in the room observing and taking notes. Group A participants had the researcher available for questioning and assistance, while Group B participants were requested not to ask questions of the researcher, nor did the researcher ask questions of them. If the participant was unable to progress further in the website, the researcher could then assist and recorded this occurrence. Although the researcher was known to the majority of participants (due to recruitment methodologies), a prompting script was provided to decrease bias.

*Time data*: For use of the computer (approximately 60 min) participants worked individually to recall their dietary intake. The website tracked the time spent by each participant on the various functions. Time was recorded as each item was selected on screen.

The website was modified between phases based on the responses from phase 1 questionnaires and field notes from the researcher.

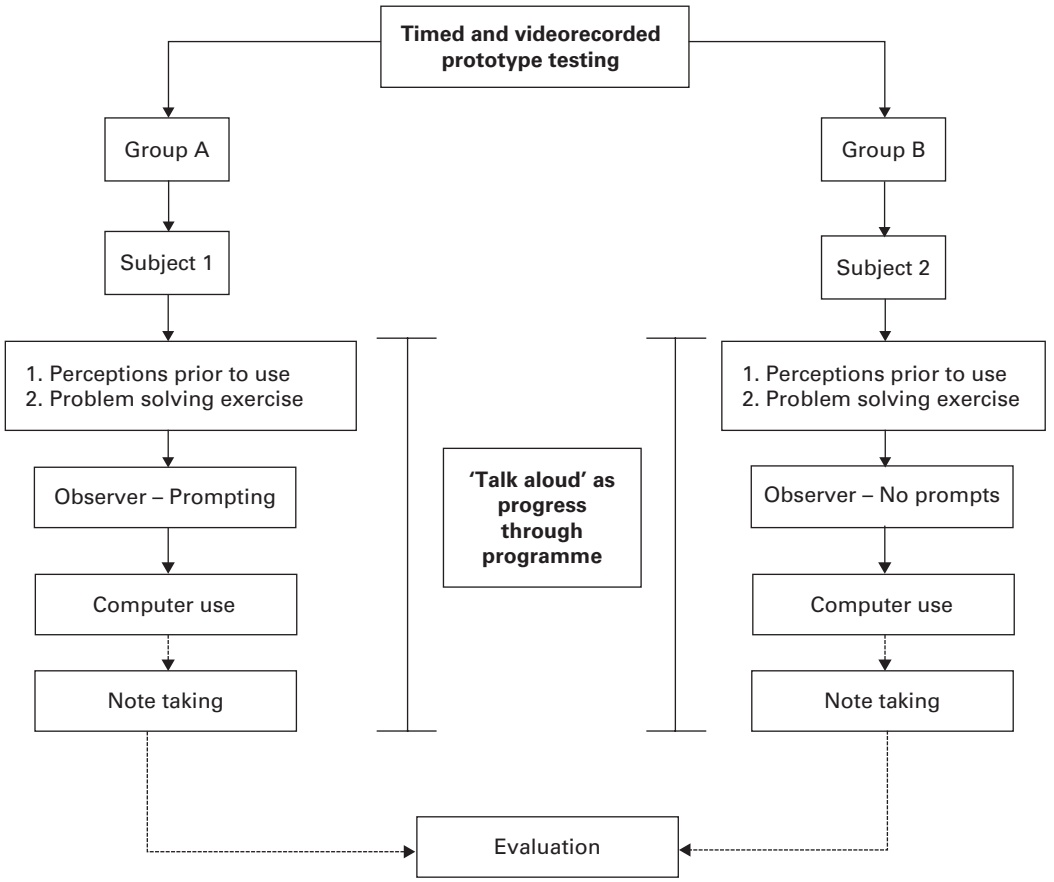


**Figure 1** Observational study design for phase 1 testing

## Phase 2 testing

The phase 2 participant group tested the website and completed the same questionnaires before and after testing. Phase 2 participants however, were not under observation to mimic the setting in primary health care. Time data was recorded by the website as described in phase 1.

Ethics approval was given by the Human Research Ethics committee of the University of Wollongong. All participants were mailed written information about the study prior to attendance at the university. Prior to use of the computer, informed consent forms were collected from all participants.

## Data analysis

*Pre- and post-test questionnaires*: The questionnaires completed before and after the testing for both phases 1 and 2 were analysed using NVivo qualitative analysis software (version 2.0.161, 2003: QSR International, NSW, Australia). Thematically categories were developed to group responses from the pre- and post-testing questionnaires. The categories were developed based on the content of the questions, that is feelings before testing, feelings after testing, first impressions, difficulties with website, overcoming difficulties, website appearance and website improvements. These categories were developed by the research team who developed the website. Relationships between categories were explored by mapping positive and negative links.

*Need for assistance*: Field notes from the researcher were transcribed and used to identify areas of the website where problems or difficulties



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occurred. A collation of these areas was used to modify the website after phase 1 testing was completed. Field notes also recorded the number of times assistance was requested or required by each participant. This was tallied for phase 1 groups A and B.

*Time data*: From the time data, total time spent using the website could be determined. Time data was then categorised into action classes. These classes were based on grouped functions of the website such as selection of foods and movement between screens, to determine the area where the most time was spent during use of the website. This allowed for comparisons between phases of testing as it provided the ability to separate the computer-related 'actions' from the dietary assessment-related 'actions' for comparisons with dietary assessments performed by a dietitian. Time data for each of the action classes was given for the total time per class (hh:mm:ss) and the proportion of total time (%) spent using the website per participant. The total time data and proportion time data for each action class was then transferred into SPSS for Windows (version 11.5.0, 2005: Lead Technologies, Chicago, USA). Descriptive statistics were generated for each class for phases 1 and 2. Data was tested for normality using the Shapiro-Wilks test following which two-tailed *t*-tests were performed for parametric data analysis and Wilcoxon signed ranks tests for non-parametric data analysis at $P < 0.05$. This allowed the researchers to determine whether the modifications made between phase 1 and 2 improved use of the website, that is decreased time spent on navigation action classes compared with dietary assessment action classes. Data was also assessed for outliers for each action class.

## Results

### Demographic data

Forty-two volunteers agreed to participate. Of these 26 were to be involved in phase 1 and 16 were to be involved in phase 2. Of the 26 participants who volunteered to participate in phase 1 testing, a total of 9 participants withdrew (2 work commitments, 1 illness, 4 family issues and 2 unknown withdrawals). This resulted in 8 group A and 9 group B participants. Seventeen participants completed phase 1 testing. Of the 16 participants who volunteered to participate in phase 2 testing, 2 participants needed to be excluded as they did not fulfil the inclusion criteria. Four participants were unable to participate due to work commitments. In total 10 participants completed phase 2 testing. A total of 27 (64%) participants completed usability testing (Table 1).

Participants were primarily male, born in Australia and university educated. Computer experience varied from beginner to advanced in phase 1 and from intermediate to advanced in phase 2. A high degree of computer ownership was also found throughout the study, though this was not related directly to computer experience level.

### Phase 1 testing

*Pre- and post-test questionnaires*: Responses did not differ widely between phase 1 and 2 participants, therefore, data analysis for the questionnaires was aggregated. All participants were positive prior to using the website. Qualitative data analysis found a trend between experiences with the website and the description of emotions as a result of using the website. For example a negative experience with the website led to negative feelings after use and a positive experience led to positive feelings after use. This appeared to be independent of feelings before use. Level of computer experience also did not appear to influence feelings before and after use (Table 2).

*Need for assistance*: Of the 8 participants in group A, 4 required assistance at an average of 5 times. Of the 9 participants in group B 7 participants required assistance at an average of 4 times. This figure was skewed by the results of one subject who required assistance 20 times. Excluding the outlier, assistance was requested between 0 and 8 times. The assistance provided primarily related to the participants not reading the screen instructions correctly and the need to restart the computer due to server difficulties during the testing sessions.

*Time data*: When assessing the actions performed during use of the website the primary changes were the details of the action rather than the overall action itself. For example selection of individual food items varied between participants yet as a whole all participants were selecting food items that they ate. As a result thirty action classes were developed. Each of these action classes were

**Table 1** Self-reported participant profiles from phase 1 and 2 of usability testing

| Demographic variable | Phase 1 ($n = 17$) | | | Phase 2 ($n = 10$) |
|---|---|---|---|---|
| | Total ($n = 17$) | Group A ($n = 8$) | Group B ($n = 9$) | |
| Age (years ± SD) | 56.0 ± 9.7 | 57.1 ± 10.7 | 55.0 ± 9.1 | 41.5 ± 8.4 |
| Male (number, %) | 15 (88.2) | 7 (87.5) | 8 (88.9) | 4 (40.0) |
| Female (number, %) | 2 (11.8) | 1 (12.5) | 1 (11.1) | 6 (60.0) |
| Born in Australia (number, %) | 12 (70.6) | 6 (75.0) | 6 (66.7) | 6 (60.0) |
| In paid work full time (number, %) | 10 (58.8) | 6 (75.0) | 4 (44.4) | 9 (90.0) |
| University education (number, %) | 9 (52.9) | 6 (75.0) | 3 (33.3) | 8 (80.0) |
| Own a computer (number, %) | 15 (88.2) | 7 (87.5) | 8 (88.9) | 9 (90.0) |
| Slightly uncomfortable computer user (number, %) | 3 (17.6) | 0 (0.0) | 3 (33.3) | 0 (0.0) |
| Comfortable computer user (number, %) | 5 (29.4) | 2 (25.0) | 3 (33.3) | 2 (20.0) |
| Very comfortable computer user (number, %) | 9 (52.9) | 6 (75.0) | 3 (33.3) | 8 (80.0) |
| Beginner computer experience (number, %) | 3 (17.6) | 1 (12.5) | 2 (22.2) | 0 (0.0) |
| Intermediate computer experience (number, %) | 5 (29.4) | 2 (25.0) | 3 (33.3) | 4 (40.0) |
| Advanced computer experience (number, %) | 9 (52.9) | 5 (62.5) | 4 (44.4) | 6 (60.0) |

**Table 2** Sample of positive and negative feelings/experiences with the website as reported in the pre- and post-test questionnaire

| Website experience | Experience (computer comfort) | Feelings before website use | Feelings after website use |
|---|---|---|---|
| Negative | Intermediate (comfortable) | I am relaxed and interested in any faculties that can help me with nutrition admin | Terrible |
| Positive | Beginner (slightly uncomfortable) | I feel that it is good to keep in touch with what you should be eating instead of getting too far off into things that you like rather than things that are good for you | I have enjoyed the experience |

applied to the subject time data for phases 1 and 2 providing details of how long each section of the website was taking to complete. Phase 1 took an average of 1:04:37 ± 0:13:47 h. During this time period 6 of the 17 participants completed the entire questionnaire with a wide range of finishing times (Table 3). One participant was an outlier in the dataset for total time taken, taking 1:33:18 h to use the website.

## Website modifications

The primary area identified by the participants' needing change, was the selection of sandwiches as a food item. A sandwich can generally be classified as a recipe (ie a food item composed of more than one component food) and is highly variable in its composition. The initial version of the website used during phase 1 testing asked about sandwiches in terms of each of the component food items. Participants were asked about the bread, butter/margarine and each of the fillings separately. This caused many problems for participants who consumed a range of different fillings and multiple sandwiches in one sitting. Participants for phase 2 testing saw a modification to this food item. Sandwiches for phase 2 testing were grouped by generic fillings with the type of bread and margarine/butter still required.

It was noted by the researcher that many of the participants did not actively read the instruction page of the website, affecting their understanding of the sections later in the website. As a result emphasis of key information was made by enlarging



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**Table 3** Minimum, maximum and average time taken for navigation and dietary assessment action classes appearing in both phase 1 and 2 usability testing

| Action class | Phase 1 | | | | | Phase 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *n* | Minimum (hh:mm:ss) | Maximum (hh:mm:ss) | Mean (hh:mm:ss) | SD (hh:mm:ss) | *n* | Minimum (hh:mm:ss) | Maximum (hh:mm:ss) | Mean (hh:mm:ss) | SD (hh:mm:ss) |
| Total time taken | 17 | 0:39:37 | 1:33:18 | 1:04:37 | (±0:13:46) | 10 | 0:47:04 | 2:01:01 | 1:08:55 | (±0:23:26) |
| Introduction | 17 | 0:00:00 | 0:06:37 | 0:02:12 | (±0:01:47) | 9 | 0:00:00 | 0:04:10 | 0:01:48 | (±0:01:55) |
| *Navigation* | | | | | | | | | | |
| Click next batch | 17 | 0:01:53 | 0:33:33 | 0:10:24 | (±0:08:04) | 10 | 0:07:39 | 0:49:22 | 0:17:22 | (±0:12:22) |
| Click previous batch | 8 | 0:00:09 | 0:01:19 | 0:00:34 | (±0:00:21) | 6 | 0:00:14 | 0:02:08 | 0:00:45 | (±0:00:42) |
| Click next meal | 17 | 0:00:51 | 0:03:33 | 0:01:49 | (±0:00:45) | 9 | 0:00:57 | 0:04:01 | 0:02:11 | (±0:00:51) |
| Click previous meal | 6 | 0:00:04 | 0:00:34 | 0:00:14 | (±0:00:11) | 3 | 0:00:00 | 0:00:20 | 0:00:12 | (±0:00:11) |
| Login/logout | 17 | 0:00:17 | 0:10:57 | 0:03:13 | (±0:03:53) | 10 | 0:00:03 | 0:16:29 | 0:03:42 | (±0:05:29) |
| Stage 3 navigation | 14 | 0:00:23 | 0:11:59 | 0:04:36 | (±0:03:28) | 10 | 0:00:17 | 0:06:58 | 0:03:09 | (±0:02:18) |
| Website navigation | 17 | 0:00:55 | 0:14:49 | 0:04:38 | (±0:03:36) | 10 | 0:03:12 | 0:22:06 | 0:08:16 | (±0:05:59) |
| *Dietary assessment* | | | | | | | | | | |
| Demographic information | 17 | 0:03:03 | 0:18:34 | 0:06:42 | (±0:03:30) | 10 | 0:00:00 | 0:16:06 | 0:06:07 | (±0:04:49) |
| Meal selection | 17 | 0:00:21 | 0:02:03 | 0:00:59 | (±0:00:27) | 9 | 0:00:18 | 0:01:30 | 0:00:57 | (±0:00:23) |
| Stage 1 food selected | 17 | 0:02:44 | 0:13:17 | 0:07:57 | (±0:02:55) | 10 | 0:01:07 | 0:29:46 | 0:03:42 | (±0:07:45) |
| Stage 2 food selected | 17 | 0:03:13 | 0:22:42 | 0:11:54 | (±0:04:50) | 10 | 0:02:16 | 0:17:52 | 0:09:55 | (±0:05:12) |
| Stage 1 associated food selected | 17 | 0:01:09 | 0:19:56 | 0:05:11* | (±0:04:21) | 10 | 0:00:00 | 0:03:50 | 0:01:42 | (±0:01:28) |
| Stage 2 associated food selected | 16 | 0:00:00 | 0:07:54 | 0:03:42 | (±0:02:16) | 10 | 0:00:00 | 0:08:34 | 0:02:33 | (±0:02:36) |

*Significant difference between phase 1 and 2, $P = 0.05$.

the font and changing its colour for the next phase of testing.

### Phase 2 testing

*Time data*: Phase 2 took an average of 1:08:55 ± 0:23:26 h. During this time 6 of the 10 participants completed the entire questionnaire with a wider range of time taken than in phase 1 (Table 3). No outliers were identified.

## Discussion

The automated dietary assessment website was found to be user friendly at a range of computer experience levels. The website did not require any major changes to its design as a result of the testing. The main changes made to the website were to improve the users, understanding of food item selections. It may be observed that the changes made improved the speed of website use as discussed below.

A link was identified between the participant's preconceptions of the website and their experiences while using it. Those who had a positive preconception and few difficulties when using the website, gave positive feedback about their experience with the website and saw the potential for its use in the future. This parallels with the technology acceptance theory of Davis in which the perceived usefulness and the ease of use relate to the acceptance of a piece of technology (Davis, 1989; 1993; Bagozzi *et al*., 1992).

Need for assistance with the website could be related to whether a participant was being prompted (group A) or not prompted (group B) when using the website. On average participants being prompted felt a need to ask for assistance more often. This may be related to participants in group A feeling at ease and confirming that their understanding of use were correct.

Participants from both phases 1 and 2 were allowed approximately 1 h to complete the website seeing only $n = 6$ (35%) of phase 1 h participants complete the questionnaire compared with $n = 6$ (60%) from phase 2. This indicates that the modifications made between testing phases may have helped to improve the user interaction with the website. Phase 1 participants may also have progressed slower due to the need to speak aloud.

The time taken to complete the dietary assessment components of the website was comparable with a diet history interview conducted face to face with a dietitian. Interviews take approximately half-an hour in the primary health care setting to complete (1 h in the research setting), followed by additional time spent by the dietitian entering each food item into a database for nutrient analysis. Furthermore, the addition of instructions, demographic data questions and cognitive aids in the website could mean that completion of the dietary assessment may be taking longer than required; in addition, completion though may inversely be related to the speed of the internet connection at the time of testing.

The items that took the longest to complete in the website, that is the selection of stage 2 food items (detailed food items) is also comparable to a diet history interview with a dietitian. Although some action classes were not able to be compared due to the modifications made to the website (convert function, eating pattern questions) or limited use of the item (incorrect entry, reactivate stage 1 foods, reactivate stage 2 associated foods, stage 2 associated food unselected, stage 1 associated food unselected, stage 2 food unselected), it may be seen that these areas did not have a large influence on the proportion of time taken.

The numerous types of foods available for selection mean that increased time may be spent thinking about the selection when compared with the amount of time spent thinking about which meals are eaten on a daily basis. The navigation action classes for the 'next batch', similarly took a large proportion of the total time spent using the website. This can be traced back to the speed of the server while conducting the usability testing. Although no changes had been made to the server during the time of the study, large differences in the speed of processing were observed. Despite changes being made to the website between testing phases, significant differences were only found for one action class. This action class was the group within which the sandwich food selections had fallen for the phase 1 testing.

The participants volunteering for the study were generally university educated, in full time employment, owned a computer. Although computer experience ranged from beginner to advanced, the proportion of advanced users was greater. This may relate to the type of study for which the participants were volunteering, and a personal interest in

the area (Rosenbaum *et al*., 2005). The sample is therefore not representative of the general population. As recruitment was on a voluntary basis, these results were anticipated, as an interest in computers has been found to correlate with increased experience in the use of computers (Albert, 1987; Jacko *et al*., 2004). Albert (1987) also found these factors to be related to socio-economic status and computer confidence though these were not directly assessed in this study.

The primary limitation of this study was the small sample size completing phase 2. In total, however, 27 participants completed the usability testing which provided a broad amount of feedback about the website. Other studies have shown that use of 10 participants revealed 80% of problems and 20 participants revealed 95% of problems (Faulkner, 2003). The most commonly used number of participants is 5 (Faulkner, 2003). The greater percentage of advanced computer users is also a limitation though may have been a result of university-based recruitment methods. A larger number of intermediate computer users would be more likely to be seen when the website is implemented in the primary health care setting. However, the beginner computer users within this study had not used a computer before yet were able to use the website.

## Conclusion

Use of a self-administered dietary assessment website was found to be promising. No major difficulties were observed with use of the website. The time taken for the dietary assessment action classes was comparable to a face-to-face diet history interview with a dietitian. The dietitian would then be required to analyse nutrient composition of the foods, a process which is automated by the website. Although assistance was required by some participants, overall all levels of computer experience were able to progress through the website without added help. Dietary management of lifestyle conditions such as metabolic syndrome, may be overlooked, yet by offering different methods of accessing dietitians, this may be improved.

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