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Development of a Computer-Assisted Dietary Assessment Tool for Use in Primary Healthcare Practice: Perceptions of Nutrition and Computers in a Sample of Older Adults with Type 2 Diabetes Mellitus

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Keywords

Qualitative research, Nutrition, User-computer interface, Software design, Diabetes mellitus

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RUNNING HEAD: DEVELOPMENT OF A COMPUTER ASSISTED DIETARY ASSESSMENT

Development of a computer assisted dietary assessment tool for use in primary healthcare practice: perceptions of nutrition and computers in a sample of older adults with type 2 diabetes mellitus.

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Abstract

As part of a larger study developing dietary software, this study aims to evaluate a sample of potential users for their experience and comfort with computers and assess the preferred program design and navigation features for the development of the automated diet history interview. A telephone-based questionnaire and focus groups were employed to evaluate the perceptions, beliefs and attitudes of thirty-seven older adults with type 2 diabetes mellitus. Participants were also shown a range of existing dietary assessment programs and asked to state their perceptions of each. Data was coded and thematically analysed based on computer use, software features, dietary assessment and nutrition programs using N-Vivo software. Three participants had never used a computer, yet participants had used computers, were comfortable using them. For navigation about the program, a preference toward text was identified whilst photographs were preferred for determining food portion sizes. Reduction in the complexity of screen layouts was important and the time to be spent using the program varied widely with a minimum of 10 minutes reported. Development of the computerised dietary assessment program must ensure simplicity of the interface design and flexibility of the locations of use for the older computer user.

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Introduction

This study formed part of a larger research project focusing on the development of dietary computer software for the primary healthcare setting. The software was designed to assess usual dietary intake by applying an automated version of the diet history interview. The target patient group (end-users) were those with metabolic syndrome invited by their general practitioner (GP) to use the program. Once the program was in place, these patients would report their dietary intake through self-administered interaction with the computer. Dietary data from the program would be sent to dietitians who would analyse the data and send a dietary prescription to the patients' GP. The inclusion of an automated assessment process would allow for a greater focus on analysis and advice generation by the dietitian and for the involvement of the GP in the nutrition management process. The research outcomes would also assist in the dietary management of metabolic syndrome, a condition of increased prevalence worldwide (American Heart Association, 2004). The study reported here investigated the computer interface preferences and technological support needs of end-users (patients).

Type 2 diabetes mellitus (T2DM) is generally found in the older population (Marks, Coyne, & Pang, 2001). The importance of dietary management of T2DM has been documented for many decades (Arnold, Funnell, Herman, Brown, Merritt, Fogler, & Halter, 1996; Campbell, 1990; Horwath, 1991; Weitzman, 1996) with dietary assessment programs focusing their advice specifically toward this increasing group (Glasgow & Toobert, 2000; Marrero, 2000; Nebel, Bluher, Starcke, Muller, Haak, & Paschke, 2002). These programs however are based on education or analysis of nutrients only and do not incorporate the nutrition interview or diet history process. Assessment of usual dietary intake is presently based on a diet history interview to obtain a spectrum of the foods normally eaten by the individual. These time-consuming

interviews are limited by the props and utensils available (Elmstahl, Gullberg, Riboli, Saracci, & Lindgarde, 1996) and the ability of the health professional to ask questions (Tapsell, 2000) specific to the desired outcome. The traditional diet history assessment begins with questions about a usual day's intake. Once a food list has been determined the dietitian will ask the individual to decide how often each food is eaten and the amount consumed, adding additional foods to the list which may not be consumed daily. Finally once a complete picture of the diet has been achieved (approximately 28 days) the dietitian will analyse the nutrients in the diet quantitatively and develop advice specific to the individual. This process however has a number of limitations including the memory of an individual (Armstrong, MacDonald, Booth, Platts, Knibb, & Booth, 2000; Tapsell, Pettengell, & Denmeade, 1999), the tendency to over- or under-report particular foods (Black & Cole, 2001; Johansson, Solvoll, Bjorneboe, & Drevon, 1998) and the degree of food literacy (Macario, 1998; Martin, Tapsell, Batterham, & Russell, 2002; Tapsell, 2000; Tapsell, Pettengell, & Denmeade, 1999).

As adults age, they experience changes in functional abilities that affect their interactions with technology. These changes in sensory-perceptual processes, motor skills, response speed, and cognitive abilities are important considerations for computer system design of adults once they reach 65 years and over (Czaja & Lee, 2003). Seniors lose visual acuity, contrast sensitivity, and experience more problems with screen glare, small icons, and complex screens. They have a slower response time, disruption in coordination, difficulty double-clicking a mouse due to changes in motor skills, take longer to process information, more time to respond to questions, and have difficulties remembering sequences of actions (Zajicek, 2001). With increase in age, older adults also experience a decline in working memory and text comprehension. Similarly, time becomes an issue in computer system design for older adults, as they tire easily (Kressig

and Echt 2002), suggesting the need for certain design features, Table 1. [INSERT TABLE 1] Although computer system designers are becoming more aware of the older adult computer user's characteristics and needs (Marks, Coyne, & Pang, 2001), programs for self assessment of the diet that incorporate these guidelines still remain scarce. As the project reported here targeted the older population, it was important to consider factors affecting computer use to facilitate the uptake of the technology.

Computerisation has allowed for the dietary assessment process to be completely automated (Probst & Tapsell, 2005), however programs are generally based on the nutrient analysis of a food list (Esha Research, 2003) or food record. Currently there are a limited number of computer packages available for this automated assessment of the 'usual' diet utilising the diet history technique (Centrax Corporation, 2003). The most common form of automation used in dietary assessment to date, is that of Computer Assisted Survey Interviewing (CASI) (de Leeuw & Nicholls, 1996) in which an interviewer is present for operation of the computer program. The interviewer may be a dietitian or other health professional asking the questions of the individual and keying in the responses. This form of dietary assessment has been utilised in a number of studies worldwide (Dixon, 1999; Slattery, Caan, Duncan, Berry, Coates, & Kerber, 1994; Slimani, Deharveng, Charrondiere, van Kappel, Ocke, Welch, Lagiou, van Liere, Agudo, Pala, Brandstetter, Andren, Stripp, van Staveren, & Riboli, 1999). Few programs have been developed to allow self-administered dietary data entry by the individual themselves, and is therefore the focus of the larger study. Restrictions to having the health professional enter the data during the interview includes a decreased willingness for an individual to respond truthfully to a question. Self-administration of such data on the other hand has been found to reduce the rate of non-responses to socially undesirable questioning, as an individual does not feel they are

being judged (de Leeuw & Nicholls, 1996). This is often due to an increased degree of privacy and anonymity and therefore increased self-disclosure when compared with face-to-face interviewing. Accuracy of reporting is therefore predicted to decrease due to the design of the program allowing patients to self-report their intake without the presence of a dietitian/interviewer (de Leeuw & Nicholls, 1996; Riley, Chaisson, Robnett, Vertefeuille, Strathdee, & Vlahov, 2001; Wright, Aquilino, & Supple, 1998). Use of computerised dietary assessment, especially of a self-administered format also adds additional benefits including meal cues to assist in the recall of the total diet, use of images to improve motivation and relieve potential boredom, low cost, standardised questioning sequences and the ability for the participant to check over the data they have entered (Kohlmeier, Mendez, McDuffie, & Miller, 1997).

Researching these issues presents a challenge. Qualitative approaches allow for issues to be described, and focus groups are a standard methods applied for this purpose. The use of focus groups is often criticised due to the limited power that may be obtained for statistical validity, however their ability to generate rich in-depth qualitative output, often outweighs these limitations (Javidi, Long, Vasu, & Ivy, 1991).When compared with many forms of experimental research in which repeat measures are performed to minimise the rate of error, the variability of error within focus groups may appear high due to factors such as interviewer bias, context effect, biased questioning and errors relating to analysis and coding (Javidi, Long, Vasu, & Ivy, 1991). However the breadth of the output obtained enables the research to capture a range of perceptions (Durack-Bown, Giral, d'Ivernois, Bazin, Chadarevian, Benkritly, & Bruckert, 2003), beliefs (Fade, 2003) and attitudes (Thompson, Thompson, Thompson, Fredickson, & Bishop,

2003) using only a small sample size and in turn minimising the added costs associated with many forms of repeat measurement.

The aim the study reported here was to describe the computer experience of potential end-users of a computer assisted dietary assessment program and to identify their perceptions, beliefs and attitudes towards computer use in the primary healthcare context.

Methods

Participants

Participants were recruited from volunteers in an earlier study with the target population at the University of Wollongong where all participants had consented to further contact. Of the 58 participants able to be contacted, 37 volunteered to participate. Thirty-six took part in the telephone questionnaire and 33 agreed to participate in focus group sessions. As the previous study had not involved the use of computers by the participants, a broad range of computer skills, knowledge and attitudes were anticipated.

Design

Upon recruitment, participants were asked to complete a multi-option telephone questionnaire to ascertain self-reported health status, socioeconomic situation, living conditions, level of education of the group, range and levels of computer experience within the group and whether participants have access to a computer in the home. Participants were also asked to part take in a focus groups to be held at the university. In total 5 focus groups of 6-8 participants were formed. Ethics approval for the study was granted by the University of Wollongong Human Ethics Committee. Consent was obtained from all participants prior to participation.

Main outcome measures

Using a predetermined facilitation script the focus groups investigated the ability to use computers, general acceptance and comfort when using computers, the preferred assistance methods for problems incurred during computer use and preferences towards software attributes such as scroll bars, radial buttons, graphics and text entry for program navigation and design. Program design focussed on the key phases of a diet history interview – recall of food items,

food portion identification and nutrient analysis and feedback. Participants were shown screen images of well-known dietary assessment programs as examples and asked to comment on the colour, space utilisation, aesthetic appeal and concepts of use when faced with the screen shots. Focus group sessions were tape-recorded using micro-cassette recorders for each session.

Data coding and analysis

Telephone questionnaires were coded and analysed using Microsoft Excel (2002 edition, Microsoft Corporation, USA) to determine the proportion of responses per category. Reported height and weight were used to determine BMI for each participant (BMI = weight kilograms/height metres^2) and a group mean.

Focus group data was transcribed verbatim and de-identified. An external assistant checked all transcripts for accuracy. The framework for the thematic analysis was developed prior to analysis, Table 2. Text relevant to each theme was extracted and sorted separately by each moderator using QSR NVivo qualitative analysis software (v2.0.161, QSR International, Australia). An external assistant checked all data for similarities and differences. Differences were discussed and the most suitable sorting utilised [INSERT TABLE 2]

Results

Participant demographic data

Demographic data for the questionnaire and focus groups are given in Tables 3 and 4 [INSERT TABLE 3] [INSERT TABLE 4]

General computer skills

A broad range of ages, balance of genders and wide spread of suburbs (data not shown) were represented. Most participants had used the computer to at least a minimal level of word processing or playing games. A large proportion of participants had also been involved in programming, database development and software manual design. The level of computer experience within the individual focus groups varied extensively with at least each group having one participant with minimal or no experience. Approximately 11% of participants reported in the focus groups as having never used a computer before. This also included never having used automatic teller machines at a bank. The questionnaire identified 14% of 37 participants as one of the participants did not wish to part-take in the focus groups. The general level of experience ranged between beginner and intermediate levels. The use of Internet, e-mailing, Microsoft Word, Microsoft Excel, Mind Your Own Business (MYOB) accounting software and playing games were a common occurrence in assessment of the computer experience of the participants. For those who had used a computer previously, all felt comfortable when using one yet preferred to have a contact known to them who they could call on if help was needed. Assistance when using a computer varied between participants as outlined below.

> I always look back, my son is a programmer and if I get into trouble, he's only a phone call away and I get information.

> I mean if it is a new program I'd, it would be good to have a sort of introductory session where somebody does the what's going on, just to explain the capabilities of the program.
>
> I think ideally a sort of hands on session is the best way to learn. If it's just up on the screen, you don't really find out what the, what buttons you have to click or what screens you have to fill out. If you're given an introduction and then a bit of a few practical exercises to do with it, with the instructor there, then I think that's probably the best way to learn a new program.

When faced with a problem participants were more inclined to be shown or opt for a trial and error method. Program manuals were the least preferred as "they are written for people who know how to solve the problems!" Similarly if faced with a new program or new concept the participants preferred to be shown or refer to the help screens within the program, again the manuals were least preferable "…you get really desperate you start diving into the manuals."

Program navigation

The use of radial buttons was the second preference, Figure 1, due to the speed at which a program can be used or questionnaire can be completed. [INSERT FIGURE 1] The radial buttons if used for food item identification need to relate to clear food categories that are easily understood rather than individual food items. Check boxes were equally preferred. Drop down menus were only seen to be necessary if used to view items included within a category. A combination of the graphics and text received a slightly favourable response as the participants felt that those who could not read English well (represented in the focus groups) would find this easier.

Program design

There was a wide degree of variation regarding the time participants were willing to spend entering their dietary data. The range varied from 10 or 20 minutes to "if it takes a while, then [pause] it's [for] your health". However an increased willingness to enter data at the computer at home as opposed to a public place was found. For those who had never or minimally used a computer, touch screens were favoured although most reported the ability to use a mouse.

Selection of food items: For selection of a food item, participants unanimously preferred text, as opposed to pictures, as the pictures could be confusing. Given a hypothetical situation where graphics were to be used for food item selection, photographs were preferred when compared with drawings as the "photograph… looks more like the real thing, yes."

Food portion identification: As participants had been involved in a previous food study in which three-day food records were required, initially there was a strong preference toward using only the gram, cup and millilitre measures for food portion identification. When informed that the computer program is for use by patients who have not necessarily been involved in dietary intervention studies, a preference toward food photographs prevailed. A need for clarity of the food items and a view of the depth of the items needs to be visible in the photo. A particular preference was seen for the ability to increase and decrease portion sizes on a plate. Some participants felt that displaying the foods on a plate however was confusing and food would be better displayed in a measuring cup, teaspoon, or tablespoon to allow for a reference size. "[T]he most awkward thing is for me, translating how many peas you had in that quarter of a cup to when they were spread out on the plate." A large proportion of participants felt that all food portion photographs needed a standard of reference.

Nutrient analysis and nutritional feedback: Participants were questioned on their desire for feedback upon completion of a self-administered dietary assessment. Instant feedback from the program was well received. This output was not to include the composition of nutrient values, although 2 of 28 participants preferred highly detailed nutrient outputs. The majority of participants favoured simple outputs such as bar graphs representing the number of servings eaten per food group and whether an increase or decrease in the intake is recommended. Participants felt that dietary information should be sent through to a dietitian who then would e-mail the patient back with the results.

Assessment of existing programs

The design of the computer interface was assessed using demonstration versions of currently developed computer programs available from the Internet. A summary of the key comments given for the screen shots displayed to the participants are shown in table 5. [INSERT TABLE 5]

Discussion

The current study saw a high degree of acceptance of computers and a high level of computer experience amongst older adults. The level of computer ownership and computer experience sees similarities with the Australian Bureau of Statistics (ABS) 2001 census data (Australian Bureau of Statistics, 2003). The ABS identified older adults as a group of the population who are readily increasing their computer use. This study also saw similarities with the preferred methods of assistance when participants are faced with problems as the computer and preferred methods of navigation.

A study by Kressig (2002) conducted with 36 free-living adults aged 60 years and older assessed their ability to use a computerised exercise promotion tool. The study found that approximately half an hour is a suitable amount of time for a healthy, educated, older adult to interact with a computerised questionnaire (Kressig & Echt, 2002). These age-related changes are imperative factors in designing a user interface for an older population. This recommended 30 minute time frame for use of computerized questionnaires identified by Kressig (Kressig & Echt, 2002) was not specifically reached when time preferences were discussed and therefore the aim of the program must be to retain the interest of the user whilst capturing the necessary information.

The software functions need to allow speedy progress through the dietary recall and be easy to use. Participants in this study showed a preference for using text over pictures to select food choices. Large text (>12 font) would be a suggested interface characteristic to allow for speedy progress as this older population of computer users' visual acuity is decreasing and small font would prevent easy navigation.

While reviewing demonstration versions of currently developed computer programs, participants provided feedback on the screen layout of each program (Table 5). They mentioned some interfaces being too crowded and too busy, while others were simple and easy to understand. This reflects the literature that older adults need simple user interfaces. It is important to minimise irrelevant screen information because older adults take longer to process incoming information (Czaja & Lee, 2003). Development of a self-administered diet history program must therefore ensure simplicity of the interface design.

Finally one must consider the location for using the computerised dietary assessment tool. Participants showed an increased willingness to sit at a computer at home as opposed to a public place. This agrees with other reports that older computer users tend to lack confidence in using computers (Gregor, Newell, & Zajicek, 2002) in public. Completing the survey at home would provide less chance for embarrassment and increased likeliness for completing of the assessment.

Overcoming limitations to traditional dietary assessment methods, by the implementation of a computerized program is expected to see a similar if not decreased measure of error due to the ability to incorporate large amounts of information into computer packages. The traditional dietary assessment process, currently a lengthy procedure when performed manually from beginning to end (approximately 45 to 60 minutes) can be completely or partially automated to allow the health professional to focus on the dietary advice and recommendations rather than coding and analysis of the food intake data. The time taken to complete a dietary assessment is predicted to decrease due to the ability to include visual prompts throughout the program. The limitations of memory and food literacy will however, remain the key obstacles as well as the added limitation of computer literacy

Conclusion

This study saw higher rates of computer use in the older population than originally anticipated. The study also resulted in a change in the original development of a desktop computer software package to the development of a web-based interview to allow users the ability to use the program at home.

Drawings and photographs would be used to capture the user's attention and help the user to create a mental picture of their diet. Participants expressed a need for clarity of food items and a 3-dimensional representation of the items by comparing to a standard (measuring cup, ruler, etc). By giving users a visual image of the food in a measurement device, it facilitates creating a mental picture, which is already difficult for older adults to do with declining cognitive abilities.

A self-administered dietary assessment program using the diet history concept was accepted by the target population and intent to use was identified. The complexity of the interface and its differences from an interview with a dietitian will need to be addressed. The differences in the nutritional features of the program are vital in its development and can be the resultant issue as to whether a program is enjoyed by its users. The current study concurred with the literature that older adults are willing to learn computer technology (Stadler & Teaster, 2002), yet place a wider degree of importance on personal support. The program will need to ensure that it is intuitive to the majority of computer users with help options for those who are having difficulty.

By incorporating the key concepts of interface design and the participants' preferred computer program attributes, the design of a self-administered nutrient assessment tool for use by an older population will allow for future papers of this study to report the processes involved in the systematic progression of the development of a nutrient assessment program and the

interactions of the end-user with the program features. Comparisons of automated and traditional assessment processes may also be made to find out which is the preferred method of assessment.

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References

Tables & Figures

Total Number of Tables – 5

Total Number of Figures - 1

Table 1: Interface design guidelines for older adults [Adapted from Czaja (Czaja & Lee, 2003)]

Changes with Age	**Interface Suggestions**
Loss of contrast sensitivity	Maximize the contrast between characters and screen background
Decreased visual acuity	Avoid small targets and character fonts (fonts < 12)
Increased time required to process incoming information	Minimize irrelevant screen information
Slowing of cognitive abilities	Present screen information in relevant locations (e.g. error messages)
Slowing of cognitive abilities	Adhere to principles of perceptual organization (e.g. grouping)
Decline of sensory-perceptual processes	Highlight important screen information
Loss of contrast sensitivity	Avoid colour discriminations among colours of the same hue or in the blue-green range
Decreased motor abilities	Maximize size of icons
Slowing of cognitive abilities	Use icons that are easily discriminated and meaningful; label icons if possible
Decline in working memory	Minimize demands on spatial memory

Table 2: Thematic categorisation of focus group responses

NVivo coding tree	
Computer Use	Dietary Assessment
o Skill Level	o Frequency
o Tasks	o Portion Size
o Comfort	• Text
o Learning	• Weights of food
o Problems	• Graphics
Software features	o Other
o Drop down lists	Nutrition programs
o Typing text	o Use
o Word selection (buttons)	o Functionality
o Graphical selection	o Looks

Table 3: Demographic data of participants

Demographic factor		**Number of total participants (%) (n=36)**
Gender	Male	24 (67)
	Female	12 (33)
Age	>65 years	11 (31)
	55-64 years	15 (42)
	45-54 years	9 (25)
	<45 years	1 (3)
Marital Status	Single/divorced/separated	5 (13)
	Married/de facto	31 (82)
Food Shopping habits	Main shopper	20 (53)
	Do not shop for food	6 (16)
	Share the shopping with my partner	10 (26)
Current work status	In paid work – full time	12 (32)
	Un-paid work	6 (16)
	In paid work – part time/casual	7 (18)
	Retired/Other	11 (29)
Highest level of Education	Primary school	1 (3)
	High school	12 (32)
	TAFE	1 (3)

	University	9 (24)
	Other	12 (32)
	No answer	1 (3)
Computer ownership	No	4 (11)
	Yes	32 (84)
	Very comfortable	14 (37)
	Comfortable	9 (24)
Comfort level when using computers	Slightly uncomfortable	3 (8)
	Uncomfortable	9 (24)
	No answer	1 (3)
	Advanced	8 (21)
	Intermediate	15 (40)
Level of computer experience	Beginner	7 (18)
	Never used computer before	6 (16)

Table 4: Participant demographics for focus group sessions

Characteristic	**Total**	**FG1**	**FG2**	**FG3**	**FG4**	**FG5**
No. of Participants	29	8	5	4	6	6
No. Males	18	6	4	3	1	4
No. Females	11	2	1	1	5	2
Age (years)	59.6 (41-77)	61.50	63.2	59.0	62.0	57.3
Height (m)	1.7 (1.5-1.9)	1.7	1.7	1.7	1.6	1.7
Weight (kg)	84.6 (52.4-108.2)	85.9	83.8	83.7	74.7	94.3
BMI (kg/m^2)	29.6 (23.4-35.7)	29.5	29.5	29.2	28.9	31.0

Abbrev: FG – Focus Group.

Table 5: Summary of responses to existing nutritional software interfaces

Program Name	URL	Food Selection	Portion Size	Frequency	Screen layout	Feedback	Other
Diet History.com (Centrax Corporation, 2003)	www.diethistory.com	Use of graphics provided confusion, limitations and increased time to choose items, prefer selection by meals than times of day	Very useful method of increasing amount on a plate	Need to decrease the time frame, currently too broad	Food selection screens too busy	N/A	
Desktop diet (Electric Dream Inc., 2003)	www.electricdreams.ca/desktopdiet/index.htm	Categorisation of food items textually very useful, recent foods listing highly important		N/A		Macronutrient graphs easy to understand	Fitness and health options very useful
Kathleen's Diet Planner	www.betbyte.com/kdietDownload.htm	Categorisation of food items textually very useful	Too many options given	N/A	Too crowded with information	Too detailed for general public	
FoodWorks (Xyris Software Inc., 2003)	www.xyris.com.au	Ordering of food items needed	Standard serves very useful	Useful to be able to type in own frequency not select from a list	Simple and easy to understand, similar to diet sheets	Too many nutrients shown on screen	

Serve	www.serve.com.au	Easy to understand and ability to limit foods by name and category increases speed, concern for limitations of food lists		N/A	Colour separation of food items is distracting	Simple pie charts easy to understand	Inclusion of GI for limited foods is helpful
Daysworth.com	www.dayworth.com	Categorisation either by food or meal not both, food selection screen needs categorization or alphabetisation		N/A	Visually appealing opening screen		
Formula for life	www.formulaforlife.com.au	Very easy to perform selection and find foods	Easier if typed in by hand	N/A	Visually appealing opening screen	Strong preference for bar graph identifying intake of 5 food groups, and indication of too high or too low for nutrient	

Figure 1: Navigation preferences for computer programs

1. Text – free text entry to allow one to say exactly what is required
2. Radial buttons and check boxes – very easy to use and makes questionnaire completion faster
3. Drop down menu – organisation of long lists
4. Graphics – difficult to distinguish between foods if hand-drawn

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