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An evaluation of automated dietary
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development, implementation and
evaluation of Computer-Assisted Survey
Technology as an adjunct to professional
dietary consultation

Yasmine Christa Probst
University of Wollongong

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University of Wollongong

AN EVALUATION OF AUTOMATED DIETARY ASSESSMENT:

***A Case Study into the Development, Implementation and Evaluation of
Computer-Assisted Survey Technology as an Adjunct to Professional
Dietary Consultation***

A thesis submitted in fulfilment of the
requirements for the award for the degree

DOCTOR OF PHILOSOPHY

from

UNIVERSITY OF WOLLONGONG

by

YASMINE CHRISTA PROBST

BSc(Nutr), MSc(NutrDiet), GradCertBus, APD

SMART FOODS CENTRE

SCHOOL OF HEALTH SCIENCES

2006

Certification

I, Yasmine Probst hereby declare that the work comprising this thesis submitted in fulfilment of the requirements for the award of Doctor of Philosophy for the School of Health Sciences, University of Wollongong, is my own work and the result of original research. To the best of my knowledge it does not contain work previously published by another author unless due acknowledgement has been made in the text. This material has not been submitted for a higher degree at any other University or Institution

Yasmine Probst

October 2006

Dedication

This thesis is dedicated to my grandparents

Günter & Dagmar Meschede

and

Wolfgang & Christel Probst

For all the happy times we have shared together

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Conferences and publications

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Owen AJ, Batterham MJ, Probst YC, Grenyer B, Tapsell LC. Low plasma vitamin E levels in major depression: diet or disease? *European Journal of Clinical Nutrition*; 2005 59(2):304-306.

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Glossary of abbreviations

ABS	Australian Bureau of Statistics
ADSL	Asymmetric Digital Subscriber Line
AIHW	Australian Institute of Health and Welfare
APA(I)	Australian Postgraduate Award – Industry scholarship
BMI	Body Mass Index
BMR	Basal Metabolic Rate
CAPI	Computer-Assisted Personal Interviewing
CASI	Computer-Assisted Self Interviewing
CAST	Computer-Assisted Survey Technology
CATI	Computer-Assisted Telephone Interviewing
CD	Compact Disk
CEO	Chief Executive Officer
CHO	Carbohydrate
CURF	Confidential Unit Record Files
DAA	Dietitians Association of Australia
DASH	Dietary Approaches to Stop Hypertension
DH	Diet History
DI	Dietitians Interface
DVD	Digital Video Disk
EE	Energy Expenditure
EI	Energy Intake
FFQ	Food Frequency Questionnaire
FR	Food Record
FSANZ	Food Standards Australia and New Zealand
g	Gram
GB	Gigabyte
GI	Glycaemic Index
GP	General Practitioner
HREC	University of Wollongong Human Research Ethics Committee
IDF	International Diabetes Federation
IFG	Impaired Fasting Glucose
IGT	Impaired Glucose Tolerance

IT	Information Technology
IMM	Interactive Multimedia
KB	Kilobyte
kJ	Kilojoule
L	Litre
Ltd	Limited
MB	Megabyte
mg	Milligrams
mL	Millilitre
mmHg	Millimetres of Mercury
mmol/L	Millimoles per litre
MUFA	Monounsaturated Fatty Acid
n	Sample Size
n-3	Omega-3 fatty acid
n-6	Omega-6 fatty acid
NNS95	National Nutrition Survey of Australia 1995
NSW	New South Wales
PAL	Physical Activity Level
Pty	Proprietary
PUFA	Polyunsaturated Fatty Acid
QLD	Queensland
RDI	Recommended Dietary Intake
SAQ	Self-Administered Questionnaire
SD	Standard Deviation
SES	Socio-Economic Status
TAFE	Technical and Applied Further Education
TAM	Technology Acceptance Model
T2DM	Type 2 Diabetes Mellitus
UI	User Interface
UK	United Kingdom
UOW	University of Wollongong
USA	United States of America
USDA	United States Department of Agriculture
VAS	Visual Analogue Scale
WHO	World Health Organisation

Glossary of terminology

ABS codes	Codes given to food items and food groups from the NNS95 2-digit = equivalent to CAST categories 3-digit = equivalent to CAST subcategories 4-digit = equivalent to CAST food types
Associated food type	A more detailed but still broad grouping of food items that are eaten with the food type items selected
Associated subcategory	A less coarse grouping of foods that are eaten with the subcategory food items selected
Associated food	A food item eaten with or on another food item
AUSNUT	Database of food and nutrient data of 4500 foods consumed in Australia updated regularly by FSANZ.
Automated assessment	Dietary assessment utilising computer technology
CAST codes	Unique codes given to food items and food groups for the CAST project to aid with identification
Category	Very coarse level food grouping for display only on screen. These foods will not be selected by the patient they will simply be a means for sorting on screen
Computer literacy	The ability to use and/or understand basic concepts relating to computer use and function
CURF	Confidential Unit Record Files used for the statistical analysis. These files can only be accessed by limited parties and have been obtained from the National Nutrition Survey (NNS95).
Demographic data	Questions to give a profile of the user including education, SES, anthropometry and computer use. Questions are to be asked after the introduction prior to assessment of intake
Diet	Intake of foods rather than the restriction of particular food items
Dietary prescription	Dietary advice prepared by a dietitian sent to the GP of the patient
Dietitian interface	Nutrient analysis program which accepts the information from the website and analyses the nutrient composition. To be referred to be dietitian during follow up interview.
Eating pattern questions	Limitations/changes people have made to their food intake e.g. Vegetarian eating. This will also include questions about default types of foods used as a checklist for the dietitian eg milk, oil.

Follow up interview	Telephone call between the dietitian and the patient to revise/edit information that had been entered into the UI by the patient
Food frequency	The amount of times a Food Type is eaten during the period of one week. (3w indicates 3 times per week, 3d indicates 3 times per day)
Food literacy	The level of understanding of foods and their nutrient interactions
Food type	A more detailed but still broad grouping of food items based on the identifying different types of the same food item. These items will be selected by the user during Pass 3. Not all subcategories will be required to have a food type.
Introduction	An introduction/welcome to the CAST interface, identification of the user and eating pattern questions
Meal	Breakfast, lunch, dinner, snacks (morning tea, afternoon tea, supper)
Pass	Time taken to complete one complete cycle of the meals for one day at varying levels of detail
Pass 1	Meal frequency questioning
Pass 2	Sub-category questioning
Pass 3	Food Type questioning
Pass 4	Food frequency and portion size questioning
Portion size	The amount of food that is eaten using the most common measure for the food item e.g. Bread = Slices
Recipe	A combination of food items or ingredients to compose a dish or meal. To be used in the dietitian interface with default versions that may be modified. These will link with the eating pattern questions to ensure individualisation of the recipe for the specific user
Subcategory	A less coarse grouping of food items based on common characteristics. These items will be selected by the user during Pass 2.
Traditional assessment	The manual pen and paper face-to-face dietary interview of the dietitian with a patient
User interface	Website into which patients enter their dietary information in the GP practice/at home

Executive Summary

Dietary assessment has changed dramatically with time, progressing from face-to-face interviews and hand calculated nutrient intakes to the use of computer technology to automate various parts of the process. The most common application is the use of software packages to calculate nutrient intake data obtained from dietary interviews. The development of technology to automate the interview process will allow for clinicians to spend more time focussing on patient education and counselling. The central hypothesis tested in this thesis was that automated dietary assessment would prove to be a feasible adjunct to the professional consultation in the primary healthcare setting.

Development phase

A series of studies were conducted examining various aspects of computer-assisted survey technology (CAST) applied to dietary advice in the primary healthcare setting. The research is presented as a case study, using action research methodology. Items in the dietary survey were developed from data reduction of food lists reported in the 1995 Australian National Nutrition Survey (NNS95), in conjunction with professional interpretation and judgement. The opinions and beliefs of patients from focus group interviews shaped development of the user interface and a dynamic website was developed to best allow for a diversity of eating patterns.

Testing phase

Video-recorded usability testing found the website to be user friendly with the time taken to complete the survey comparable to the time taken for a dietitian to interview and assess a patient's food intake. The website was then implemented in the primary healthcare setting over a period of twelve months. Computers were set-up in fourteen medical practices in the Illawarra region of NSW, Australia. Doctors recruited patients with metabolic syndrome to use the website. Data was sent to a dietitian in the research team for development of an individualised dietary prescription, which was then sent back to the doctor to discuss with the patient.

Implementation phase

A cross-section of 200 patients revealed the majority of users were aged between 46 and 65 years, overweight and physically inactive. Computer ownership was identified in 80% of the users, with only 8% of patients having never used a computer previously. The computer located in the medical practice was the least preferred location of use and patients with a higher BMI were 1.9 times ($p=0.04$) more likely to use the computer in the home or an alternate location than at the medical practice. Reported nutrient data was highly variable. Under-reporting was observed in 46 patients (32.2%), over-reporting in 31 (21.7%) of patients and 66 patients (46.2%) reported their intakes on target. No relationships were found for the reporting status of the patients and their age, BMI or gender.

A repeatability study with $n=38$ patients revealed a learning effect which led to increased understanding of the website functions with time. Compared to a 3-day weighed food record, data from the website produced stronger correlations than a face-to-face diet history assessment. Patients using the website achieved an average 25% of their dietary goals within six weeks, despite a preference for face-to-face contact with the dietitian. Stakeholder evaluation established acceptance of the technology by dietitians, doctors and patients and provided insights into their positions within the healthcare system.

Evaluation phase

The research found that computerised assessment of dietary intake was a feasible addition to daily practice in the primary healthcare setting. Automating the diet history interview via the internet allowed increased patient access to dietitians whilst improving the doctors' awareness of the nutrition needs of their patients. This is especially important in the growing light of metabolic syndrome worldwide.

Diet Advice

Computer-Assisted Survey Technology (CAST)
development, implementation and evaluation

1

CHAPTER 1

Computer-Assisted Survey Technology (CAST) development, implementation and evaluation

1.1 Introduction

This chapter provides an overview of the need to automate the dietary assessment interview for the purpose of dietary assessment. Referred to as Computer-Assisted Survey Technology (CAST) this chapter also offers an overview of the CAST case study and its relation to the work of this thesis.

1.2 The process of dietary assessment

Assessment of the usual dietary intake is primarily based upon a diet history (DH) interview. The interview is used to identify a spectrum of the foods usually eaten by an individual. Time consuming to complete, the interviews are limited by the available props and utensils (1) such as food models, and the ability of the professional, generally a dietitian, to ask questions specific to the desired outcome (2).

Beginning with the first meal of the day, the dietitian asks the person which foods were eaten, recording progressively as the person speaks freely (3). Following the natural flow of conversation (2), the dietitian gains a 'snapshot' of what the person normally consumes, as well as the food preference and food preparation practices. Questions would then be asked to determine types of foods and recipes eaten, including the amounts and frequencies of consumption (4). The reference time span of the interviews generally covers a period of 28 days and takes approximately one hour to complete, though they have been known to last for up to two hours (5).

Following the interview, the dietitian is then faced with the task of entering each individual food item into a dietary analysis package, or with calculating by hand the amounts of nutrients and the percentage of energy provided by the foods eaten. It is only then that dietary advice for the person may be formulated. Thus, the current dietary assessment process is limited by the speed with which the DH interview is processed and is based strongly on the ability of the dietitian. The assessment may also be restricted by the knowledge and level of experience of the dietitian.

Due to the length of time taken by the assessment and nutrient analysis process, decreased time may be spent educating and counselling patients towards change. By automating the assessment process, dietitians would be able to spend increased amounts of time developing individualised advice for their patients. Automated assessments, however, require a different assessment approach to the more traditional forms. Traditional assessment forms allow the interviewer or dietitian to further clarify or prompt the individual, a feature not yet possible through computerised technologies. Automated assessments require well designed user interfaces (UI) that guide the user through the dietary assessment. Many automated programs therefore use a multiple pass approach in which the user is guided through the assessment in segments. Upon completion of each segment, further details are requested until a complete picture of dietary intake is obtained. By utilising this form of assessment, dietitians would have increased time to spend counselling them towards change.

1.3 The significance of automating healthcare

Despite early fears that technologies such as computers would interfere with doctor-patient relationships (6), use of such technologies are now accepted in the health professions. Many professions in the healthcare industry have used automation in their day-to-day work practices for many years. Professions including psychology (7), dentistry (8), radiology (9) and physiotherapy, are only a few examples. Computer programs in dietetics are presently focussed on the analysis of food nutrients, or are purely for nutrition education. Very few are used for assessment of dietary intake in the healthcare context. Currently, existing dietary programs are also limited within the Australian context for the increasing population of Australians with lifestyle diseases.

The development of dietary assessment technology would allow for self-administered assessments, thus assisting General Practitioners (GPs) with only limited time. The use of a computer-assisted program for the assessment of dietary intake would also aid in the time efficiency of the dietitian, and would allow for the assessment process to be standardised. Computerisation has allowed for the dietary assessment process to be completely automated, yet few programs exist which encompass the DH methodology (10, 11) for the assessment of 'usual' dietary intake. Programs are generally based on the nutrient analysis of a food list (12) or food record (FR).

The program would need to adequately assess the usual intake of a person's diet with equal or increased accuracy when compared with traditional dietary assessment presently used in dietetics. Given the limited availability of these automated DH programs, no comparisons have been made between traditional dietary assessment and automated dietary assessment (13). Therefore the question of whether people perceive the traditional DH to be equal to the automated DH is yet to be answered.

1.4 A model of the CAST project

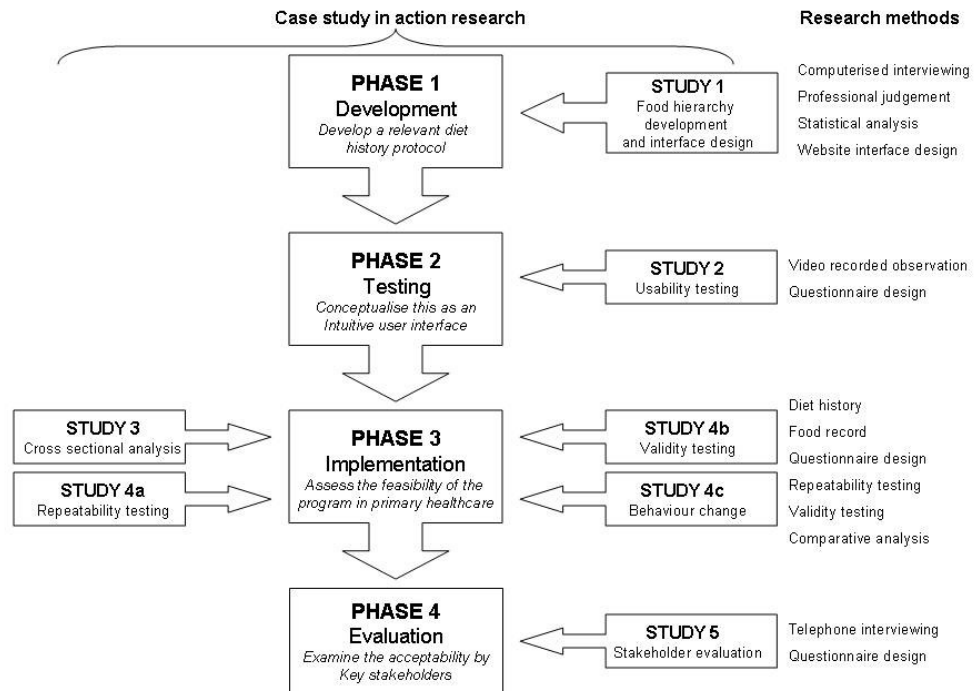


Figure 1-1 Overview of the CAST case study

The theory of technological determinism addresses the social contexts in which technology has become embedded, while social determinism sees technology as having a linear relationship with society. Therefore the movement from paper and pens to computer use does not change one single factor, but rather changes many factors (14). Dietitians are able to move away from the traditional face-to-face DH interview that leaves little time to spend educating and counselling the patient, and move towards an approach in which use of the computer speeds the assessment and analysis process, leaving more time for counselling and education towards change.

The case study of this thesis is based on the development of a computerised program to essentially shorten the professional dietary consultation. The CAST program was assessed in 14 different GP practices. The users of the computer program (patients) were selected by their GP. The patients entered their dietary information into the

programs ‘UI’ through a series of questions generated by the package. A dietitian then received the electronic dietary data from the program and develop an individualised dietary prescription using the program’s ‘dietitian’s interface’. This advice was sent in duplicate to the patients’ corresponding GP (Fig. 1.2).

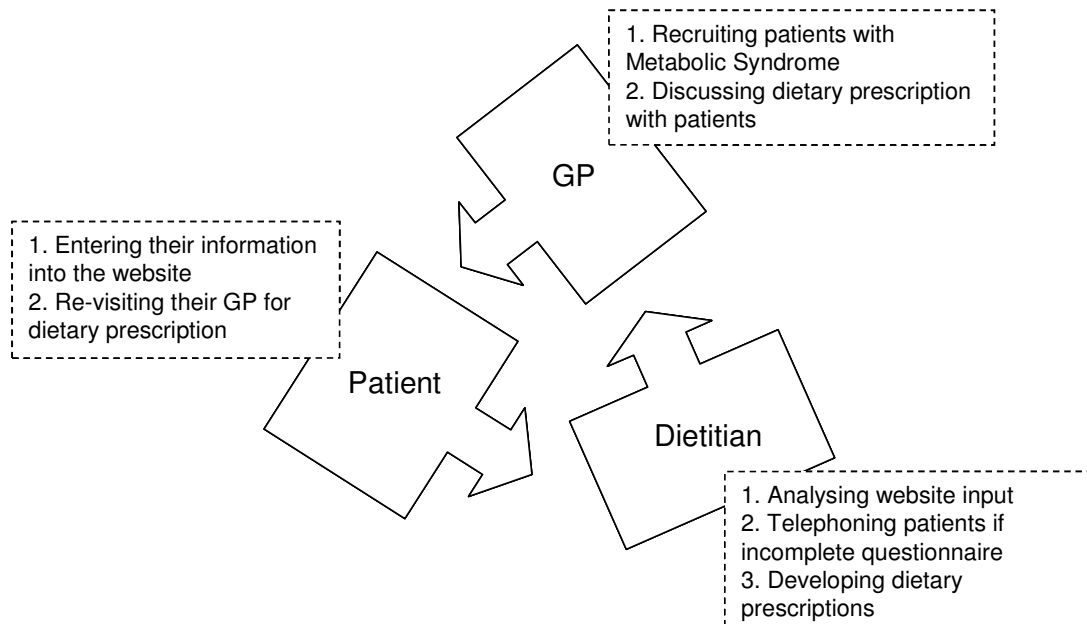


Figure 1-2 Model of the CAST case study

The case study was broken into key phases of development, testing, implementation and evaluation, upon which chapters within this thesis are based. The research began as a Master’s research project during which the feasibility testing and user perspectives were assessed. The remaining stages all related to the PhD research described in this thesis. Five different studies, each addressing one research objective, are presented in the following phases:

1.4.1 Development Phase

Study 1: Development of an interview schedule (food hierarchy) based upon the diet history interview process, that was suited to self-administered dietary assessment, catering for a broad range of food intake patterns.

1.4.2 Testing Phase

Study 2: Test whether the program can be used by the target group and determine the time taken for use of the program.

1.4.3 Implementation Phase

Study 3: Identify the types of program users and the influence of their self-reported demographic data on the nutrient data created from the assessment.

Study 4: Validate the program and compare user preferences to a face-to-face diet history interview. Determine whether reporting error and outcome measures for change vary for traditional and automated dietary assessments.

1.4.4 Evaluation Phase

Study 5: Gain an understanding of the acceptance of the automated interview by its users and healthcare providers.

1.4.5 Delimitations of scope and key assumptions

The program was piloted in the Illawarra region of NSW on a sample of adults with metabolic syndrome,. This group was selected as they have conditions which may be modifiable by dietary intervention. The primary assumptions of this thesis are that the general population would be able to use this computer package in the future and that GPs would assist in recruiting a representative sample of patients to the program.

1.5 Thesis outline

The cases study described in this thesis addresses both traditional and automated dietary assessment methods, the development and testing of dietary software, and an evaluation of the use of the automated dietary assessment program in the primary healthcare setting. The model aims to encourage patients to self-assess their dietary intake using a computer located in the local GP practice. This information feeds forward to dietitians who formulate dietary prescriptions and send them back to the patients' GP, allowing the patient and doctor to discuss the dietary changes needed.

1.5.1 Thesis structure

This thesis outlines the development, testing, implementation and evaluation of the program and its impact upon those involved in the healthcare system to enable dietary advice to be incorporated into the lives of those needing it within society. This chapter has so far provided an overview of the context of the project outlining its importance in today's clinical practice. It has briefly addressed the importance of technology in the healthcare field and the current status of the dietetic profession. A literature review described in Chapter 2 outlines in further detail, both the process of dietary assessment and the incorporation of computers into dietetics that began in the 1970s. An assessment of existing software packages is addressed, as well as the acceptance of computers, use of computers and attitude toward technology. Chapter 2 also explores metabolic syndrome, the clinical condition of reference in this thesis.

Chapter 3 introduces the methodology employed throughout the CAST case study. Including both qualitative and quantitative methods, this chapter provides an overview of each of the study methods used and the theory to which this thesis relates. Under the umbrella of action research, the theory of social methodology, dietary methodology and epidemiology, components of the research are explored. Beginning from statistical origins, the step-by-step process of UI development is described in Chapter 4. Utilising cluster analysis, association rules and bias calculations, the project began with the Australian Bureau of Statistics NNS95 data and formed a dietary assessment website after focus group discussion sessions, face validity testing and numerous multidisciplinary meetings. The dietetic professional judgement used in parallel with the statistical analysis and interface design is also detailed in this chapter. The usability testing of the website detailed in Chapter 5 saw a range of subjects testing the website under laboratory conditions. Utilising video observation, the study found that the website was highly user friendly and the automated interview was comparable in length to a traditional assessment.

Chapter 6 outlines the recruitment patterns of all GPs participating in the study. It also gives a cross-sectional profile of the patients recruited by the GPs to use the dietary assessment website, as well as the reporting status of their self-reported dietary intake

data. It provides the reader with an overview of the completion rates of the program during its 12 month implementation phase, and shows that the computer in the GP practice was not the most preferred method of access. Chapter 7 validates the dietary data obtained from the website. Using a 3-day FR and repeat use of the website within the primary healthcare setting, a comparison of the traditional and automated assessment methods for dietary analysis were also investigated using the same participant group. Repeatability of the data and user preference between the two assessment forms is addressed, and behaviour change as a result of the dietary advice was observed. The evaluation phase of the program is described in Chapter 8. It addresses an impact evaluation with key stakeholders in order to illustrate the perspectives of persons who would primarily be using the program. These stakeholder groups include the 'recruiting' and 'non-recruiting' GPs. All the case study's findings and their relevance to practice are the focus of Chapter 9, the concluding chapter. This chapter links practice with theory to detail its impact upon the dietetic profession.

Diet Advice

**Automated dietary assessment in the
primary healthcare setting**

2

CHAPTER 2

Automated dietary assessment in the primary healthcare setting *†‡

2.1 Introduction

Providing an outline of key components of the research, this chapter examines the literature surrounding dietary assessment for both the traditional and automated forms. From their introduction in the 1970s, computers in healthcare have had an impact upon the dietetic profession in a number of ways, from nutrition education through to nutrient analysis and coding. This chapter also focuses on the perceived attitudes and experiences that the general public has towards the use of computers, including a description of studies of computer use and interaction. The final component of this chapter addresses the target disease for the CAST case study, metabolic syndrome. A review of the dietary advice practises as well as the definitions of this disease is discussed.

2.2 Automating healthcare practice

2.2.1 Computers in general practice

Dietary assessment of the diet has been primarily performed by dietitians, yet the general public still has a wider degree of faith in the advice given by their GP (15). However, doctors feel that they cannot always provide the information that is required

* A significant proportion of section 2.2 has been published in a peer reviewed journal:
Probst Y., Krnavek C., Lockyer L., Tapsell L. Developing a self-administered computer-assisted dietary assessment tool for use in primary healthcare practice: Perceptions of nutrition and computers in older adults with T2DM. *Australian Journal of Primary Health*, 2005; 11(3):54-62.

† A significant proportion of section 2.3 has been published in a peer reviewed journal:
Probst, Y.C., Tapsell L.C. An Overview of Computerized Dietary Programs for Nutrition Education, Research and Practice. *Journal of Nutrition Education and Behavior*, 2005; 37(1) 20-26.

‡ Data from this chapter has been presented at the:
2004 National Dietitian's Association of Australia Conference, Melbourne Victoria, Australia and 2003 Wollongong University Biannual Research Day, Wollongong, NSW, Australia

(16, 17), primarily due to a lack of time, lack of nutrition knowledge and training, and a perceived inability to treat and give dietary advice (17-19). To reduce these barriers, studies such as NECTAR aimed to increase doctors' nutrition knowledge by using computerised nutrition education modules, yet are limited in the range of topics that may be covered (17). To overcome such problems, Brug (1999) suggests the inclusion of computer tailored diet assessments in the offices of GPs and other non-nutrition experts (16).

It has been identified that GPs are able to spend significantly less time giving dietary advice. The average consultation in Australian general practice was found to be 14.6 minutes and in America it is only eight minutes (20). This short period of time does not allow for in-depth discussions about food and nutrient interactions for disease management, and is the primary reason why many doctors opt for medical intervention or generic nutrition handouts for their patients (21-24).

The third Heelsum international workshop "Nutrition guidance of family doctors towards best practice 2001" (25), aimed to identify the key challenges with which doctors worldwide are faced. The primary topics identified were:

1. Use of dietary supplements, herbal preparations and functional foods
2. Patients as partners
3. Computers in the general practice
4. Evidence-based medicine
5. The Internet
6. The obesity epidemic

Of these topics, two of six relate to nutrition alone, indicating a key reason for the limited involvement of GPs in nutrition seen in past years. A further two topics relate to the use of technology, namely computers and the Internet. By targeting both of these areas, this study attempts to address the potential for improved practice.

The computer in particular can be aimed toward increasing nutrition advice from the GP by allowing the doctor to print off reliable nutrition advice whilst the patient is waiting. Findings by Western (2003) indicate that 86% of Australian GP practices are now

computerised (26) and therefore able to utilise this concept. It has been recognised that doctors do not have the available tools in their surgeries to correctly identify a patient's present dietary intake (25).

2.2.2 Computers in dietetics

A study by Fitzmaurice *et al.* (2002) evaluating research grants from the last 30 years found minimal use of computers in research for the area of nutrition (9). Computers have, however, been widely used in the area of health for a number of functions (8, 13, 27-31) including electronic patient medical records, patient simulations in dentistry and decision support in cancer treatment. Computers were primarily used in dietetics for nutrient analysis when interviewing patients, when developing instructions for students and for food service management (32). The following literature outlines these and other methods of computerisation over time in the area of nutrition.

During the 1970s, computer programs were being used to allow health professionals who were not specifically trained in nutrition to assess dietary intake. For example, questionnaires were designed to be completed in the dentist's waiting room, allowing dentists to recognise the link between diet and dental caries (33). The 1970s also saw a study of computers used for dietary interviews. The program provided the ability to generate a weight reducing diet and offer dietary suggestions for the nutritionist or dietitian to use with their patient (34). When comparing the order effect of computer and face-to-face interviews, the study found that patients who used the computer first had faster consultation times with the dietitian than those who saw the dietitian first (34).

Evaluations of dietary computer software were mainly identified in the literature during the 1980s and early 1990s. Loretta Hoover (1983) worked with software companies to compare the nutrient composition of the diet using different programs (35), while Pennington and Wilson (1990) chemically analysed foods and compared them with the USDA nutrient database (36). Nieman *et al.* (1992, 1995) compared the software features of databases and applications to determine the differences between programs and investigators (37, 38) and the DASH study (1995) compared four programs for their ability to calculate the composition of research diets (39). In 1999, a review paper by

McCullough *et al.* (40) assessed the usability, features and costs of four nutrient databases. It was concluded that the choice of database is dependant upon the nutrients of interest, ease of use of the program, overall accuracy, features of the software, and the cost of the program. The review also identified that the majority of automated dietary programs are based on the analysis of nutrients rather than the assessment of the dietary intake.

2.3 Automated dietary assessment

Dietary methodology has changed dramatically since its published beginnings in the 1960s. From the early use of food frequency questionnaires (FFQ) with a limited number of foods and hand calculated nutrient output, dietary assessment now incorporates automated nutrient analysis, computerised interview programs and specialised dietitians working in a number of practice domains.

Moving far from the lengthy interview and hand calculated nutrient profile, present day assessment involves a faster interview due to automation, with increased time to be spent on the provision of accurate and individualised dietary advice (41). In Australia, this automation is presently limited to the nutrient analysis component of the assessment.

Use of the computer for the assessment processes has many advantages including cost-effectiveness, time saving, reliability, standardisation, precise time registration and facilitation of statistical analysis (13, 42, 43). The dietary assessment process can be completely or partially automated to allow the health professional to focus on dietary advice and/or recommendations (41), rather than the need for coding and analysis of the food intake data.

One of the earliest forms of automated dietary assessment was in subjects with diabetes mellitus. Diet histories had been in common use since the early 1970s and this period also saw the beginnings of computer use in dietary assessment (41). The assessments were based on an interview structure and 653 pre-assumed responses. The interview was broken up into subject identification, medical history, social history, family medical

history, subject's knowledge of diabetes, prescribed treatment and food habits. The interviews were self-assisted and 50 subjects aged between 20-80 years assessed. The key downfalls of the program were that subjects felt they were unable to express themselves completely and could not explain additional information about their diets. This interview also took longer than a face-to-face interview with a dietitian (44), with an average completion time of 63.6 minutes (25-110minutes) (45). However, the interview was enjoyed by the subjects and saved time in collecting medical information about the subjects' backgrounds. The program was easily operated and composed of both statements and questions for the subjects. An assistant was available during the entire interview and food models were used as guides. The memory core of the program was, however, only 4000 words. This is approximately equivalent to one kilobyte of memory. Programs today use thousands of megabytes of memory.

2.3.1 Programs in population surveys

The most common form of interview automation at present is that of Computer-Assisted Survey Interviewing (CASI) in which an interviewer is present for operation of the program (46, 47). This method is seen in large scale dietary interventions, where a dietitian or health professional asks the questions of the subject and keys the responses into the computer. Few programs allow the subject to enter all data about their diets themselves. Such findings were identified by Kolasa and Miller (1996) who reviewed a number of programs and found the majority to be designed for health experts and dietitians (48).

When the method of assessment is based on a diet history or 24-hour recall, the studies generally involve larger population studies of America or Europe, and address diet-disease relationships. No large studies have been found to date in Australia. Variables of these studies do not differ immensely from smaller studies. Both include the key principles of individual behaviour, socio-demographic variables and psychosocial factors such as expectations, attitudes, self-efficacy, perceived treatment and readiness to change (16). Each of these factors can to affect the response of the individual when using a computer for dietary assessment. The population survey will generally include the use of a nutritionist or interviewer who asks the questions and/or enters the responses into the program being used. Programs developed for population surveys

compose the largest proportion of existing programs due to the vast number of diet-disease focal points that may be formed.

2.3.2 Nutrition education programs

Specifically developed to suit the topic area and target population, nutrition education programs are the most commonly identified dietary program available for the general population (49, 50) yet are the least frequently identified in the literature. For example, programs such as NIBBLE have been developed for patients with lower levels of literacy (51). More recently, these programs are being used for education of health professionals (17, 52-56). For example, programs such as the Health Touch database are being developed to improve patient doctor interactions in primary care (57).

Developed with a sequential module system, these programs are generally not aimed at assessing the diet, but at teaching a person about key issues relating to diet.

Recently the US Preventative Services Task Force has made recommendations to include nutrition education and care as a component of standard medical examinations (58). This provides the opportunity for the application of numerous education programs for health management. Furthermore, these education programs are usually self-assisted, and do not require the support of an interviewer or nutritionist, making them more feasible in the healthcare setting. Such recommendations have not yet been made in Australia.

A study by Shah *et al.* (1999) reviewed selected computer-assisted information and computer-assisted learning packages including the cost and range of functions available (59). These programs were designed to complement the training of dietitians. In general, most computer packages especially those for nutrition education have been inadequately evaluated (60, 61). A review by Bental (1999) indicated that a range of patient education materials are available on the computer. Of the 15 programs evaluated approximately four relate generally to the area of diet or nutrition. Of these four programs most are completed online by the patient and generate generalised advice and readings (62)

2.3.3 Nutrition programs in clinical management

Individual counselling and dietary assessment, the traditional model of the dietitian's daily practice, encouraged the development of computer software which would assist the dietitian in examining and analysing the nutrient composition of the diet. Available initially to the health professional, programs are now also targeted at the general public. Generally based on one to three day food recalls, the programs are structured to have dietary data input and to output nutrient profiles of the diet. These nutrient profiles are used to develop the dietary advice. Such assessment programs are now seen as the basis for the dietary assessment interview, with very few dietitians coding and analysing nutrient data by hand. The interview process is, however, still using the pencil and paper interview (PAPI) technique.

Many programs have been used in the dietetics setting, each with their own limitations. CBord for example has been used in hospitals in Western countries to retrieve menu information, though this information is only based on a specified energy intake and the dietitian cannot modify the diet, nor find the total nutrient profiles (63). The program DietPal was developed in Malaysia to mimic the workload of the dietitian and has the ability to automatically calculate the nutrient intake from dietary intake information. The program also generates menu plans based on anthropometric information (64) but is not used widely.

Zoellner *et al.* (2005) developed an interactive multimedia (IMM) 24-hour recall program for use in the low income Hispanic population of Colorado, USA. Utilising a self-administered multiple pass approach the IMM began with a two-and-a-half minute demographic section followed by a four minute introduction. The program used graphics and touch screen item selection to cater for the population's low literacy levels. This was followed by the selection of meal times and foods eaten, followed by portion sizes, food variety and cooking methods and the final component allowed users to add or delete food items. Validating the instrument against a face-to-face 24-hour recall, findings reported no significant differences between the assessment forms for 19 of the 20 nutrients assessed. Differences were only found for Vitamin C. The program was well accepted by its users and found to take less time in total than a complete face-to-

face recall and nutrient analysis. Limitations to the program included a list of only 167 foods, specifically selected as consumed by more than 2% of participants in the 1982-1984 Hispanic Health and Nutrition Examination and the Colorado Expanded Food and Nutrition Education Program. This list would need to be expanded before use in other population settings. The program was also based on single use and needed to be tested further to determine the impact of multiple-day recalls (65).

Table 2.1 provides an overview of existing nutrition software showing the variability of the features of each of the packages and the types of automated assessment forms available.

Table 2-1 Review of nutrition programs, adapted from Probst *et al.* (2005) (11)

<i>Program</i>	<i>Basis</i>	<i>Nutrient Assessment Y/N</i>	<i>Meals vs. Foods Entered</i>	<i>Interviewer Present Y/N</i>	<i>Other</i>
CARDIA Diet History Questionnaire (DARCC) [AMERICA] (66)	DH	Y - in main database	700 foods, food groups	Y – enters the data and asks all questions	<ul style="list-style-type: none"> • Food models used • Uses cue cards identified by a number on screen • 6 different screens – fat use, foods eaten, details about food items, preparation information, fat choice and additions • 5 frequency options • Average time 50-60mins
Computerised quantitative food frequency (QFFA) * (67)	FFQ	Y - including fatty acids, from NHLBI Food Table	860 food combinations of computer readable cards (pictures) Foods not on list are added during processing	Y – shows to subjects printed life-sized pictures of foods based on food models, which are also on the computer.	<ul style="list-style-type: none"> • Printout giving high fat, cholesterol, sugar, alcohol and sodium foods, all foods consumed, graph comparing intake and recommendations • Nutritional counselling → change in food intake → altered risk factors → desirable health outcomes → economic benefits
Computer-Assisted Learning System (CALS) * (68)	FFQ	Y - Cholesterol Saturated Fat index	11 categories	N	<ul style="list-style-type: none"> • Dietary goals and recommendations given
Computer-Assisted Self Interviewing (CASI) * (69)	DH	Not specified	Meals in context, 20 categories of foods	N -meet computerised interviewer	<ul style="list-style-type: none"> • Uses prompts and visual cues of foods

Computerised self-administered FFQ * (70)	FFQ	Y - specific to increased or decreased cancer risk	85 foods and food groupings based on food similarities	Y – nutritionist only to assist with problems	<ul style="list-style-type: none"> • Foods eaten less than once per month were omitted • Used food models and reference materials for portion size • Average 45 mins (range 20-70 mins) • Phone follow up if needed
Counselling Nutrition Data System version 2.6 [AMERICA](38)	1d FR DH	Y - 32 components	>23,000 foods, includes brand names	Y	<ul style="list-style-type: none"> • No physical activity data • Prompts for food combinations allowing 160,000 foods
Cybernetic Dietician v2.06 (71)	24-hour recall	Y – 8 components	2,400 foods, with groups/ subgroups for identification	N	<ul style="list-style-type: none"> • No frequency of consumption option • Gives comparison to recommended intakes
Desktop Diet v1.2 (72)	FR	Y – 25 components	>7,000 foods	N	<ul style="list-style-type: none"> • No food frequency option • Exercise and medication logs • Nutrition, Health and Fitness components • Graphical representations of body
Diet Balancer for Windows (38, 73, 74)	FR	Y - 26 components	5,000 foods, 42 groupings, includes brand names	N	<ul style="list-style-type: none"> • No food search options • No food frequency option • Many mouse and keystrokes required for entry

DietMax Plus for Windows (38)	FR	Y -54 components	7,100 foods, including brand names, need to be transferred from menu development sections	Y	<ul style="list-style-type: none"> • No food search options • No food frequency option • No comparison to RDIs • Increase and decrease portion size by mouse clicks on arrows till amount is reached, cannot type in amount
Diet*Calc (75)	FFQ, DH	Y – 93 components	255 foods	N/A	<ul style="list-style-type: none"> • Nutrient analysis program using specialised DH forms developed to be filled in and scanned into the program
Dietary Data Collection (DDC) * (76)	DH	Y	9,500 foods (probing questions) and 50 categories	Not specified	<ul style="list-style-type: none"> • Less time spent with computerised coding of dietary assessment • Recipe modification and cooking preparation allowed
Diet Improvement & Nutritional Evaluation (DINE) (68, 77-82)	3-d FR	Y – 10 components, output based on serving size not per 100g	10,000 foods grouped into 17 categories	N	<ul style="list-style-type: none"> • Foods listed in alphabetical and numerical order, lengthy process of identification • Recommendations provided • Only limited serving sizes • Addition of recipes completed by the user • Users are given an output score based on a comparison of their nutrient values to an “ideal” diet

Dietary Interview Software for Health Examination Studies (DISHES 98) [GERMANY] (83)	DH 4 weeks	Y	Foods	Y -keys in answers	<ul style="list-style-type: none"> • Foods not listed on main screens can be searched for – open ended • Household measures used for portion sizes • Average time 35mins • Standard recipes used only • Only one loop of frequency estimates • No difference between weekday and weekend questioning
Dutch DISHES [HOLLAND] (84)	DH cross check	Y	Foods	Y	<ul style="list-style-type: none"> • Includes maximum possible amount of food and drinks consumed • Portion size using actual foods and models
Electronic Diary (ED) * (85)	4-d FR	Y -macro only, on PC	180 foods, food categories, 18 food items per category	Y	<ul style="list-style-type: none"> • Compare to hand written FFQ • Entries at certain times of the day only
EPIC-SOFT (European Prospective Investigation into Cancer and Nutrition Study software) [EUROPE](83, 86- 88)	24 hr recall	Y – 10 different European countries with 23 centre using national food consumption databases (nonstandardised)	Foods, quick list to specific details 17-23 food groups, 1,500-2,200 foods including brand names and 150 recipes, all foods entered as prepared or eaten and converted to amount eaten by formulas	Y conducting both face-to- face and telephone interviews. Nutritionist present to answer questions and provide feedback, guided by prompts	<ul style="list-style-type: none"> • Colour photographs and household models used for portion size • Portion book adapted to suit each country, originally 146 pictures reduced to 45, for Norway 35 pages, 126 for FINDIET Finland • Open ended • Average time 31.1±13.3 mins

Food Processor Plus [AMERICA](38)	FR	Y – includes fatty acids (94 components)	>12,000 foods, including brand names	Not specified	<ul style="list-style-type: none"> • No food frequency option • Includes food exchange lists
Food/Analyst Plus (38)	FR	Y – includes fatty acids (84 components)	22,500 foods, includes brand names	Not specified	<ul style="list-style-type: none"> • No physical activity data • No food frequency option
Food Works [AUSTRALIA](89)	FR DH	Y- includes fatty acids	>4,500 foods	Y	<ul style="list-style-type: none"> • Allows inclusion of recipes and menu plans • Databases used from Australia, New Zealand, Malaysia and Pacific Islands
Health and Diet (90)	FR	Y	2,000 foods	N	<ul style="list-style-type: none"> • Dietary recommendations given
Health Habits and History Questionnaire (HHHQ) [AMERICA](91, 92)	FFQ	Y – 33 components with possibility to add more	97 food entries from 20 major food groups	Y	<ul style="list-style-type: none"> • Serving sizes for small medium and large only • Includes exchange lists for meal planning • Probing questions displayed to be asked by interviewer for invalid and questionable responses
Life in New Zealand, Electronic Dietary Data Acquisition System (LINZ LEDDAS) [NEW ZEALAND] (93)	24-hour recall	Transferred to database for analysis	Foods	Y to key in responses and read out questions	<ul style="list-style-type: none"> • Automatic prompting system • Pass 1: Quick list of foods • Pass 2: Detailed description of foods • Pass 3: Review of list of all foods eaten

Iron-FFQ [NEW ZEALAND] (94)	FFQ 4 wks	Y – using a specifically designed computer program combining all nutrients from different database sources	206 foods sorted into 17 groups, foods containing iron or one that modifies iron absorption eg. Vitamin C, meat, fish, poultry, phytate, calcium, tea, coffee	Y to explain use and supervise	<ul style="list-style-type: none"> • Food portions estimated based on proportions of common measures, provided with 3-D models for meat and cheese and cup sized portions of beans for volume estimation • Probing lists of high iron foods • Time 45-90mins
Nutri-Calc (90)	FR	Y	3,400 max foods	N	<ul style="list-style-type: none"> • Dietary recommendations given
Nutrient Analysis System 2 Plus 8 version 1.0 (38)	3-d FR	Y – includes fatty acids, (79 components)	8,000 foods, with food groups limited to 40 foods	Not specified	<ul style="list-style-type: none"> • No food frequency option, large number of keystrokes required
Nutrition Education by Computerised Training and Research (NECTAR) (17)	N/A	N/A	N/A	N	<ul style="list-style-type: none"> • Nutrition education program
Nutrition Data System (NDS) [AMERICA] (38, 95, 96)	DH 24 hr recall	Y	No inclusion of brand name food products	Y – asks questions and keys in answers	<ul style="list-style-type: none"> • 2-d food portion picture and household measures used • Pass 1: Quick list 24hr recall • Pass 2: each food from recall probing questions for type, amount, additions, prep method • Pass 3: review of food list, details of foods and amounts

Nutrition in Medicine (NIM) (97)	N/A	N/A	N/A	N	<ul style="list-style-type: none"> • Nutrition education program based on 10 modules for specific health issues & nutritional needs
Nutrition Evaluation Scale System (NESSy) (98, 99)	Weighed FR with scales attached to PC	Y - at mainframe	Foods and meals, menu driven selections	Y - assist only, training provided before to subjects	<ul style="list-style-type: none"> • Foods manually weighed by staff both before delivery and after • Foods identified by name/barcode • Subjects required to live on site to allow all foods to be recorded • Given containers to serve own food amount
OsteoCalc (91)	FFQ	Y	70 food items (good sources of calcium, vitamin D & caffeine)	Not specified	<ul style="list-style-type: none"> • 4 frequency ranges – daily, weekly, monthly, yearly • Portion sizes listed on computer
USDA Automated Multiple Pass Method [AMERICA] (100)	24hr recall	Y	Food categories	N	<ul style="list-style-type: none"> • Pass 1: recall list of all foods and drinks consumed • Pass 2: probing questions for forgotten foods from 9 categories • Pass 3: time/name of meal • Pass 4: probing questions for information about the foods and amounts • Pass 5: Additional food consumed

Abbreviations: DH – Diet History, FR – Food Record, FFQ – Food Frequency Questionnaire, Y – Yes, N – No,

* Researchers did not specify program name but only assessment methods

2.3.4 Availability of assessment programs

Information about nutrition and health is becoming widely available with the recent increase in the use of computers and the Internet. Two of these programs include NAT (www.nat.uiuc.edu/mainnat.html) and EC (www.aces.uius.edu/~food-lab/energy/ec.html) which are both readily accessible by the general public. The programs show the nutrient intakes for a daily intake and can be accessed worldwide (101).

The vast majority of nutrition programs have been developed for population studies of the United States of America. The outcomes of the population studies are often published and as a result the details of computer programs are included. Details of educational programs are not published, yet may be briefly referred to by name in a vast number of articles. Programs for clinical practice similarly do not see publication in journals, but can be found on the software companies' Internet sites.

A selection of computerised nutrition programs has been shown below (Table 2.2) to indicate the variability in availability of programs to the general public.

Table 2-2 Availability of selected nutrition programs, taken from Probst *et al.* (2005) (11)

2.3.5 Program structure

Many different degrees of computerisation have been used in dietetics with Computer-Assisted Personal Interviewing (CAPI) the most common. These programs are based on a person or interviewer typing in or clicking from a list the foods. This results in the compilation of a food recall, commonly of a 24-hour to three day time span in the one interview. Very few programs for health professionals, or for the general public use a recall of more than three days due to the increased burden associated with increased recall periods (see 3.6.6.3).

It has been identified by subjects and researchers that the increased usability of a dietary program was linked to the inclusion of user manuals and help screens. Usability has also been related to ease and speed of entry, ability to preview single nutrients while entering foods, ability to assign different weight measures to the food items, ease of editing food lists, ability to compare results to a variety of dietary standards, limit in the number of food entries and ease of averaging multiple days of input (38). Features such as the ability to use a keyboard, mouse and/or the menus of a computer system may also need to be considered when developing a program for a cohort of users who do not commonly use computers.

Computers used for dietary assessment vary in their applications and usability, generally assuming the health professional as the user. The computer programs are based on a traditional DH assessment followed by data keyed into the computer for the nutrient analysis. Few programs are available where complete automation has been considered, and those that are limited by the food portion size assessment and/or computer literacy of the user.

The speed of processing, however, is based on the size of the program and the memory and hard drive space of the computer being used (38). It is also relative to the degree of recall required by the subject. Repetition of computerised questionnaires sees an increased ability to remember previous answers for portion size and frequency (learning effect), and increasing correlations between methods (70). These findings have similarly been identified in traditional dietary assessment techniques.

In a study conducted by Noah *et al.* (2004), it was found that dietitians requested the following information to be contained within a computer program: medical diagnosis, current body height and weight, nutrient requirements, biochemical values, dietary recall, medical history, medication, allergies and supplement use (64). Inclusion of all of these features within a program will depend on the setting in which it will be used and the form of program at hand.

2.3.5.1 Prompts and probing questions

To encourage subjects to remember all areas of their usual diet, the use of probing questions (102) and/or visual or audio aids can be employed (69). Self-administered programs aim to encourage the subject's memory by placing the subject in a situation similar to one they would commonly find in the home environment. The use of visual and audio assistance, simulation of these surroundings has been shown to result in a higher degree of recall compared to programs which do not use visual or audio data. Studies that do not use audio or visual data tend to focus on the use of probing or prompt questions to encourage subjects to think of specific foods in their diet.

Grouping foods together when asking probing questions reduces the incidence of non-consumption responses and results in a higher degree of accuracy. Similarly, the use of meal based questions rather than food based questions results in a higher degree of accuracy of the food intake (69, 102). Consecutive order of foods eaten is a cognitive approach used to encourage food recall (103). The European Prospective Investigation into Nutrition and Cancer (EPIC) study identified the need for flexible categorisation systems for the classification of food items. This resulted in the development of EPIC-SOFT, a computer program that deals primarily with foods and mixed recipes, each with specific definitions for classification (104).

2.3.5.2 Portion size

The evaluation of portion size is an area in which a wide degree of variation occurs between studies. Dietary recall poses challenges with respect to portion size and accuracy of recall. However, the use of computers can assist in this process through the use of prompts, menu displays, detailed queries and images of food portions. This

allows for decreased manpower in the collection of the recall information, though it does not imply more accurate data (105). For these reasons, both frequency of intake and portion size are not often assessed in computerised questionnaires (70).

Most computerised studies use a manual method of portion size assessment similar to a traditional DH interview. The amount of food eaten is commonly assessed using food models and portion picture booklets, from which the subject selects the most appropriate size. Household measures such as measuring cups and spoons have also been incorporated. When the computer is used for portion sizing, the selection of portion sizes of mixed meals has been found to involve features such as an interactive display of a plate that allows subjects to select the amounts of particular foods eaten and 'drag' them onto the plate (50). When portion sizes are visualised through realistic images, as in Nutrichec (81), the process helps to aid recall of dietary habits (generic memory) and casual encounters (episodic memory) relating to the diet (69). Studies have linked the use of portion sizes using food models to limiting the choice and accuracy of the actual amount eaten (70), yet the use of visuals is highly important in that it allows people to focus on the time, setting and the task to be remembered (102). Older studies such as the Nutrient Analysis System (NAS), designed to analyse self-recorded food recall data using mark-sensitive cards with images of foods on them, saw food portion vary from half the indicated size to seven-and-a-half times the size (32).

Dietary assessment instruments that use self-reporting are often associated with bias and can result in overestimation of the intakes (106). The USDA therefore developed ProNESSy (Table 2.1), a program linked with the ProNutra program, to allow for a more accurate dietary assessment by weighing all food items before as well as weighing anything left on the plate. Initial prototypes were developed and tested for accuracy and whether any time would be saved by the methodology. ProNutra runs in the dietitian's office, whilst ProNESSy runs in the kitchen using touch screen technology and can be linked to a keyboard and mouse if needed (107). Foods can be entered by hand or scanned using a bar code.

2.3.5.3 Nutrient analysis

The first food composition tables were developed in late 19th and early 20th Centuries (108). Food composition databases are a key area for error within a dietary analysis (109). The link between a diet assessment and a nutrient database does not always occur in diet programs. Linked databases or manual analysis is sometimes required due to an increase in the time taken. One of the key aims of computerised assessment is its speed of processing and ability to decrease the amount of labour required for a DH or FR analysis. An area where time is increased is when it is necessary to identify missing food items that are not contained in the original program database. Missing foods in a database is a problem that has been overcome in a number of different ways, including the food data being obtained from other sources such as USDA, scientific literature, food manufacturers and foreign food composition tables (38). Other studies have used substitutions usually due to naming difficulties (38) or spelling errors. Food items may be entered manually at the time of processing (67) or written on piece of paper for later reference (85). Automating the assessment process saves time by decreasing the need to write down and check for missing items. However, efficacy of this process is still reliant on a high quality nutrient database.

The key aims of nutrient calculation software identified by Stumbo (2003) are to assess intake composition and adequacy, to determine the composition of new foods, and to evaluate and/or produce meal plans and diets. Each item of software differs in its purpose, features, users and function, as well as in its database and pricing. Most programs include features such as summaries of the composition of the diet and of individual food items, categorisation of the foods by nutrient composition, comparison of the nutrients to particular standards of reference, and the provision of recommendations (39). Incorporation of new nutrients into the database from external sources varies. Dixon *et al.* (2005) used a comparison of the key database to values obtained from external sources. If the ratio of comparison varied outside of 0.8-1.2, the match of the food data was judged as unacceptable. The key nutrients of concern were the absolute difference of energy and fat as well as the ratio of energy between the two food data. Initially 3.8% of the foods in the database did not match (110).

2.3.5.4 Dietary advice

Provision of dietary advice is not seen in all computerised diet packages. Many packages are limited to only the nutrient output (15) or involve a dietitian or trained health professional who will give dietary advice from the generated nutrient profile.

Feedback to patients by GPs and health nurses has often been provided face-to-face with the initial screening and risk identification information provided by computer. Further nutrition feedback is then provided in the form of leaflets, videos and pamphlets (15). Similarly, computers can generate advice based on the nutrient profiles of the subject or user, while others also generate shopping lists (81). Responses linked to a message archive (word processor), which are arranged into a predetermined order to form a tailored nutrition letter (15, 16), have also been used to personalise this process.

The personalisation of dietary advice has been identified as a key factor in the success of dietary programs (15, 16). For subjects with diabetes for example, the dietary advice needs to include individualised including nutrition plans for day-to-day meals, as well as include items such as energy restriction and/or carbohydrate (CHO) control. However, the patient's willingness to change their dietary habits is related to the stages of change model. This theory helps to explain why certain people are less likely to change their lifestyle (15).

Often persons using the computer for dietary information have an optimistic view of their intake. Therefore, comparing dietary intakes to other intakes in their peer group allows adequate change to occur. The information also needs to be related to personalised goals and psychosocial feedback to make it more likely to be read (15). The advice should also encompass nutrition education. This has been shown to have a better effect than group education sessions, where the impact upon self-care and change is limited to a generalised message (50). AIDA is a free computer program, accessible via the Internet, that is designed to assist persons with type 1 diabetes to monitor their insulin levels. The program utilises demonstration, teaching and self-learning principles (111-116). It has been successful in its education of subjects who require insulin for diabetes management.

2.4 Computers and the general public

The first commercial computer was introduced by Univac in 1951. This computer was mainly used for data storage and retrieval processes (117). Since then, computers have developed widely into items such as laptops, hand held palm pilots and notebooks.

2.4.1 Access to computers

The Australian Bureau of Statistics indicates that 48% of households had a computer in the home and 61% of households had access to the Internet in 2001 (118). These figures are expected to increase with time. Similarly, the United States Department of Commerce determined that in the year 2000 approximately 51% of households were found to own a computer and 41% had access to the (119).

Access to technology in the United States is limited for older people, females and those with less education (117, 120). Chalmers (2003) states, that “as technology is made more usable, it may be more accessible to a larger portion of the population” (Chalmers, 2003, p595). Seniors are the strongest group in the Australian population when it comes to computer ownership (121) and second strongest in the United States exceeded only by the 35-44 year age group (122).

2.4.2 Attitudes toward computers

Patient and/or subject attitudes toward the computer have been identified as an area of concern in research relating to computers. Generally it was found that interventions using computerised dietary software had a higher degree of subject acceptance especially, when used under supervision and when the patient was shown how to point and click food choices (94). Perceptions of ‘enjoyable’ and ‘easy to use’ were rated highly in many computerised programs (52). Positive outcomes for subjects of diabetes education and assessment were found with increased comprehension of nutrition messages and a higher degree of practicability (50). This acceptability is not associated with patient age, health status, education level or minority status (123). Although it is thought that older persons will be less likely to have positive outcomes from computerised research, it was found that a high level of acceptance was observed in seniors (119, 124, 125) and although use of computers is often limited, many are willing

to learn (69). Coordination with respect to using a mouse is often of concern for older adults (124), however, it is more commonly things such as memory impairment, visual impairment, cognitive impairment (119, 126) and confidence (127) that affect computer use. Following this are access issues such as cost, literacy and opportunity for use (121), though often having access to computers often still results in the subject's response 'I'm just not good at computers' (117).

The testing of programs is vital to their functionality. In a study by Kressig (2002) of the development of software that produces an exercise prescription, their product was tested on persons aged 60 and over (124). These subjects needed to have intact manual dexterity (able to dial a phone number) and intact near vision (able to read a newspaper). These two features have been found to affect computer use including Internet access (119). Those who took longer to complete the sessions and asked for assistance also rated the usability of the program lower (124). Similarly persons who use a system more often were more likely to report more positive experiences with programs (119). The main limitations relating to computerisation include the patient's own ability to answer questions about their health rather than their ability to use the computer (123).

2.4.3 Acceptance of computers

Acceptance of computers may be related to past experiences and one's view of the usefulness of the system. Motivation is one of the primary variables affecting a person's interaction with a computer and "one's mood will influence the level of effort expended on a computer related task" (Chalmers, 2003, p604). Mood will also affect the initial acceptance of the system (13). Venkatesh (1998) found an influence of self-efficacy and system usability to influence technological usability (128), whilst Briggs (1998) found cognitive load to influence the usefulness of the technology (129). Therefore if the technology is easy to use and does not require a large learning load on the user, the tool may be perceived as easy to use and in turn the tool is assessed as more useful. Venkatesh *et al.* (2000) also suggest that general beliefs about computers and computer usage, perceptions of external control, computer anxiety, perceived enjoyment and objective usability influence the perceived ease of use of the technology (130). These

concepts have been combined to form the Technology Acceptance Model (TAM) which is detailed in Chapter 3.

In a German study by Weber (2003) in which computerised examinations were used by patients, it was found that self-confidence was lost when the users of the system were left alone with the computer, yet acceptance of the computerised examination occurred in 80.8% of patients. Of this 75% enjoyed using the system, whilst 39% experienced difficulties. No gender differences were found. When comparing the computerised examination with the traditional examination methods, 65% of patients preferred the computer (13). An American study by Lukin *et al.* (1985) found an 85% preference for the computerised assessment (43). Similar results have been found in self report questionnaires with respect to risk taking behaviour and alcohol consumption (13, 131).

2.4.4 Ability to use a computer

The ability to use computers is frequently assessed and studies have found that approximately 12.7% of persons of an average age of 43 years had never used a computer (123). With the target population falling around this age group, these limited computer skills must be considered in this thesis. Other studies have found 90% of persons had previously typed and 50% had taken an entry level computer course in school (average age 28 ± 4 years female, 29 ± 5 years male)(98). Despite this, lack of computer experience which may be affected by gender, is a key indicator of negative enjoyment of a computerised dietary program (50).

Computer use may be related to level of education (117, 132) and years of computer experience rather than the age of the user (117). In the United States, males tend to use computers for games and competitive work whilst females use the computer for word processing and collaborative computer learning. Females also approach the computer with more anxiety and less confidence than males (117).

A study by Ogozalek (1994) found that men have a preference for multimedia interfaces whilst women preferred printed leaflets to computerised text-only interfaces (133). Technical difficulties and difficulties with comprehension were discovered for one in four users of a diabetes education program (50) and confidence when using computers

varied notably between users, with 38.1% found to be very confident, 36.5% somewhat confident, 4.2% don't know and 8.5% uncomfortable (123).

Computer anxiety can be related to disorientation (117) and disorientation may be related to the use of text on the UI. As a result, many users will print off the text and read it from paper rather than orient themselves with the screen. This may be due to the font used, the size of the font, the brightness of the screen or the inability to adapt to text on screen (117). The interface design needs to be constructed so that it is understandable to a beginner and yet maintains the attention of the expert user (117).

The following section outlines the target population within which the CAST program was implemented.

2.5 The diet-disease relationship of the metabolic syndrome

2.5.1 What is Metabolic Syndrome?

Encompassing three of Australia's leading disease states (134) – obesity, cardiovascular disease and type 2 diabetes - metabolic syndrome, otherwise known as syndrome x, is a lifestyle condition growing dramatically on a worldwide scale. In 2002, it was estimated that 47 million people in the United States, or one in four, met the criteria for metabolic syndrome (135, 136).

First identified in the literature in 1923 by Kylin, the early findings included a description of obesity, hypertension and gout clustered as disease states (137). Since then, many stipulations have been made about the syndrome. It has also been referred to by many different names including insulin resistance syndrome and the deadly quartet. In the late 1980s, Gerald Reaven re-introduced the concept of metabolic syndrome by describing the cluster of cardiovascular disease factors. These factors specifically included obesity, hypertension, high triglyceride levels and low HDL cholesterol levels (138, 139).

Although the conditions relating to this cluster of diseases were generally agreed upon, a concise definition of metabolic syndrome was yet to be defined. Table 2.3 outlines the first criteria for metabolic syndrome as defined by the World Health Organisation (WHO) (140) in 1998, which identified fasting glucose levels of the individual as the primary determinant of the syndrome. Since then, many opposing views and new definitions have arisen including that of the ATPIII National Cholesterol Education Program (NCEP) (Table 2.4), and the European Group for the Study of Insulin Resistance. Debate arose as to whether insulin resistance, fasting glucose or obesity were the primary determinants of the syndrome, with shifting opinions and research being the primary drivers for each new definition. The most recent and accepted definition of metabolic syndrome, developed by the International Diabetes Federation (IDF) in 2005 (141) (Table 2.5), shows the changing opinion of research over the preceding two decades. Obesity is identified as the underlying cause of each of the clustering diseases and therefore the primary factor in determining metabolic syndrome in an individual (135).

Though primarily seen as a lifestyle disease, components of metabolic syndrome result from interactions between genetic and behavioural factors. Central obesity for example, is strongly heritable at rates of 25 to 40%. High blood triglycerides account for 50 to 60%, hypertension for 50% and total cholesterol for 50 to 60% heritability (142). Despite these figures, physical inactivity and poor diet have a strong influence on their development (142). Poor education and high alcohol intake have also been associated with metabolic syndrome (143).

Table 2-3 1998 WHO criteria for metabolic syndrome

<i>At least one of:</i>	<i>Plus at least two of:</i>
<ul style="list-style-type: none"> • Type 2 diabetes • Impaired glucose tolerance • Insulin resistance 	<ul style="list-style-type: none"> • Hypertension (BP \geq 140/90mmHg) • Obesity (BMI \geq 30.0kg/m², or waist-hip ratio >0.90 for mean, >0.85 for women) • Hypertriglyceridemia (≥ 1.7mmol/L) or low serum HDL level (<0.9mmol/L for mean, <1.0mmol/L for women) • Microalbuminuria (albumin creatine ratio >2.5 mg/mmol for mean, >3.5 mg/mmol for women)

Table 2-4 2001 ATP NCEP definition of metabolic syndrome

<i>At least 3 of 5 risk factors</i>	<i>Defining level</i>
• Abdominal obesity	• Waist circumference: Men > 102cm, Women > 88cm
• Triglycerides	• ≥ 1.7 mmol/L
• HDL Cholesterol	• Men <1.0mmol/L, Women <1.3mmol/L
• Fasting glucose	• ≥ 6.1 mmol/L
• Blood pressure	• $\geq 130/\geq 85$ mmHg

Table 2-5 2005 IDF criteria for metabolic syndrome

Central obesity	<i>Plus any two of the following four factors:</i>
	• Raised TG level: 3 150 mg/dL (1.7 mmol/L), or specific treatment for this lipid abnormality
	• Reduced HDL cholesterol: < 40 mg/dL (1.0 mmol/L) in males and < 50 mg/dL (1.3 mmol/L) in females, or specific treatment for this lipid abnormality
	• Raised blood pressure: systolic BP ≥ 130 or diastolic BP ≥ 85 mm Hg, or Treatment of previously diagnosed hypertension
	• Raised fasting plasma glucose (FPG) ≥ 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes.
	If above 5.6 mmol/L or 100 mg/dL, OGTT is strongly recommended but is not necessary to define presence of the syndrome.

Obesity within the Australian population continues to rise. In 1980, 27% of females were overweight or obese and this has risen to 43% in 1995, with males increasing from 48% to 63% in the same time period (144). The 1997/98 NSW Health Survey found 35% of women and 51% of men report themselves as overweight (145) and figures from 2003 indicate that Australia has now peaked to a higher percentage of overweight and obese people than America. The current figures indicating that over 60% of the Australian population are currently obese and 25% of children are obese (146).

Defined by waist circumference (Table 2.6) or BMI, obesity is one of the leading diseases of the Western world. Furthermore, WHO has noted that with every unit increase in the BMI of an individual a 5% increase in the prevalence of obesity results. The world rates of obesity have been predicted to increase from 143 million in 1997 to 300 million by the year 2025 (147).

Table 2-6 Defining central obesity

Country/Ethnic group		Waist circumference
Europeans	Male	≥ 94cm
<i>In the USA, the ATP III values (102cm male; 88cm female) are likely to continue to be used for clinical purposes)</i>		Female ≥ 80cm
South Asians	Male	≥ 90cm
<i>Based on a Chinese, Malay and Asian-Indian population</i>		Female ≥ 80cm
Chinese	Male	≥ 90cm
	Female	≥ 80cm
Japanese	Male	≥ 85cm
	Female	≥ 90cm
Ethnic South and Central Americans	Use South Asian data until more specific data are available	
Sub-Saharan Africans	Use European data until more specific data are available	
Eastern Mediterranean and Middle East (Arab) populations	Use European data until more specific data are available	

Cardiovascular disease is the largest cause of premature death in Australia, accounting for 39% of deaths in 2000 (148). The NNS95 found 21% of the Australian population had long-term cardiovascular conditions (144, 149), which when compared to a 1977-78 figure of 8%, indicates that the prevalence of people living with cardiovascular disease had increased with time (144). By 1996 cardiovascular disease became a national health priority area in Australia (144). Many risk factors can affect the incidence of cardiovascular disease risk, including hypertension, high blood pressure, obesity and diet. Individuals who have metabolic syndrome have a three-fold greater increase in cardiovascular disease mortality (135).

Records show that 17% of males and 10% of females were documented with hypertension in the NNS95, seeing declining levels from 1980 and a continuing trend into the 1990s. High blood pressure was identified in 47% males and 39% females, with these levels remaining constant (148). Physical inactivity, cigarette smoking and obesity were identified as key risk factors for the disease (144).

Type 2 diabetes or non-insulin dependant diabetes mellitus (NIDDM) is also continuing to rise within the Australian population. It is a condition in which the beta-cells of the

pancreas have been blocked, usually by excess body fat limiting the secretion of insulin into the bloodstream. It is currently found within Australia at a rate of 7.8% of the total population (146). It is expected that the rate of undiagnosed diabetes, estimated at approximately 50% (140) would see a significant increase in this figure.

The San Antonio Heart Study data showed that body weight, BMI, waist circumference and waist to hip ratio were all predictors of type 2 diabetes while BMI, fasting insulin and triglyceride levels were predictors of hypertension (150). These findings again show the clustering of metabolic syndrome and the inter-relationship of its components. Further, Leonetti *et al.* (2002) established that obese individuals with zero metabolic alterations had a 43% prevalence of metabolic syndrome while two and four metabolic alterations saw 71% and 100% prevalence respectively (151).

2.5.2 Prevention and management

The single most important factor in the management of metabolic syndrome is weight management with a primary objective of weight loss. With obesity identified as the underlying cause of metabolic syndrome, a reduction in weight will lead to a reduction in insulin resistance (152) and improvements in T2DM (135). However, this reduction in weight can only occur through a combination of physical activity, dietary management and in some instances pharmacotherapy (153). Physical activity stimulates muscle uptake of blood glucose resulting in lower plasma glucose and insulin levels and, in turn, decreased body fat of the individual. Dietary management of metabolic syndrome primarily focuses on the macronutrient composition of the diet with particular importance placed upon CHO and fat intake.

The traditional low fat high CHO diets (<30% energy from fat and >60% energy from CHO) (154) which were commonly followed for weight loss have been found to have significant effects on health. Consuming a high CHO and low fat diet is linked with decreased HDL cholesterol levels and increased triglyceride levels (155). These diets have also been related to higher post-prandial glucose readings (142). Advice therefore is linked to a higher fat diet with low saturated fat content.

Although saturated fat in the diet declined from 16% to 13% between 1983 and 1995 (144), the ratio of saturated fat within the diet has risen, and has been predicted to continue to rise if current fast food eating patterns continue (148). In the 1995 National Nutrition Survey of the Australian population aged 19 years and over, total fat equated to 67.6g per day for females and 98.5g per day for males. Of this, females consumed 26.7 grams saturated fatty acids (SFA), 24.3 grams monounsaturated fatty acids (MUFA) and 10.4 grams polyunsaturated fatty acids (PUFA), while males consumed 39.0, 36.2 and 14.7 grams per day for SFA, MUFA and PUFA respectively (144). Specifically, SFA within the diet is a key risk factor to cardiovascular diseases.

To assist in lowering the saturated fat levels, replacement of saturated fat with unsaturated fat has been recommended (156). PUFA omega-3 (n-3) and omega-6 (n-6) fatty acids are of particular interest (157, 158). These fatty acids have been found to benefit those with cardiovascular disease, or those at high risk of disease (159). The n-3 fatty acids have been specifically linked with health benefits, including a slowing of the degree of atherosclerotic plaque formation and a lowered incidence of coronary heart disease (158). They have also been correlated with a decreased plasma triglyceride level, decreased platelet aggregation and an increased bleeding time, beneficial for those at risk of thrombosis (158, 160). The n-6 fatty acids have similarly been associated with decreasing cardiovascular disease risk through a reduction in plasma LDL cholesterol levels (161).

Dietary management of plasma glucose levels is primarily addressed through consideration of the amounts and types of CHO consumed in the diet. Diets that contain a number of low glycaemic index (GI) food items have been linked with improved glucose utilisation, though at the same time if considered as the only component of diet, have been shown to decrease plasma HDL cholesterol levels (153). Therefore not only should a low GI diet be considered for the management of metabolic syndrome, but this should be adopted in conjunction with a diet low in saturated fat and higher in monounsaturated and polyunsaturated fats.

Consumption of fibre has also been beneficially linked to the management of metabolic syndrome. Having beneficial effects on diabetes, weight management and

cardiovascular disease, soluble fibres in particular have been linked to improved blood lipid profiles (142). These benefits have primarily been due to the delayed gastric emptying and increased satiety of fibre rich foods.

Many large cohort studies have investigated the link between diet and varied components of metabolic syndrome. The Diabetes Prevention Study (DPS) involved 523 subjects with diabetes and tested the benefit of specific dietary prescriptions. Subjects were randomly assigned to either the intervention or control group and were followed up progressively. At the two year time point, weight loss was significantly greater in the intervention group than in the control group. The control group was given oral and written information about diet and exercise, but no specific individualised advice was provided. The intervention group were given detailed advice tailored to each subjects' needs, which included <30% energy from total fat, <10% energy from saturated fat, increase fibre to 15g/1000kcal, exercise for 30 mins per day and frequently consume whole grains, fruit, vegetables, low fat dairy and meat, margarines and monounsaturated vegetable oils (162).

Dietary recommendations from the Dietary Approaches to Stop Hypertension (DASH) study including high fruit and vegetable intake, low fat dairy, high fibre, low in refined CHO, low sodium and ~26% total fat of which ~7% saturated fat produced promising results. Following eight weeks of the diet, a significant reduction was seen for blood pressure and total and LDL cholesterol. HDL cholesterol levels were also significantly increased (163, 164).

These findings have lead to the development of guidelines for a diet to assist individuals with metabolic syndrome. This diet considers the evidence for dietary management of diabetes (165), cardiovascular disease risk factors and obesity. Consisting of approximately 15% protein primarily from fish and legumes, 45-55% CHO primarily from fruits, vegetables and low GI foods with 25% from high GI foods, 30-40% total fat of which approximately 20% is monounsaturated and approximately 10% is polyunsaturated, <30g/day alcohol and <4g/day salt (166).

2.6 Discussion

Within the Australian context the development of dietary assessment software for the primary healthcare setting has many advantages. Not only does current software of this type not presently exist within Australia, but with the growing rate of metabolic syndrome, such an application would allow for dietary management of patients in remote locations and for those who do not have readily available access to a dietitian. The literature has identified the benefits of self-administered computer interviewing and utilising this concept, the CAST project will aim to replicate these benefits in the field of dietary assessment interviewing. Self-administered interviewing for dietary assessment has not only the ability to provide increased accuracy of responses, but it also has the potential to fill the current gap of GP-Patient interactions related to nutrition. The GP will have the ability to provide individualised advice to the patient through an experienced healthcare professional, the dietitian, and the patient will receive advice which is more relevant to their true eating practices.

Diet Advice

**Methods development &
research methodology**

3

CHAPTER 3

Methods development & research methodology

3.1 Introduction

This chapter addresses the theoretical framework of the thesis and outlines the reasoning behind the study design and the analytical methods applied. This chapter also describes the various research methods used in the thesis within the framework of a case study, which is set in action research within the primary healthcare setting. It presents a brief literature review of methods detailing their strengths and limitations and then finishes with the area of the thesis in which they were applied. Social theories of behaviour change and technology were applied during interpretation of the data. Qualitative and quantitative methods from social research, dietary methodology and epidemiology were used to address the hypotheses. The relationship between these sections is shown in Figure 3.1. The final part of this chapter outlines the central hypothesis of the thesis and the sub-hypotheses addressing the objectives of the thesis.



Figure 3-1 Relationship between research methodology and research methods

3.2 The CAST case study

A case study as identified by Punch is “the basic idea that one case (or perhaps a small number of cases) will be studied in detail, using whatever methods seem appropriate. While there may be a variety of specific purposes and research questions, the general objective is to develop as full an understanding of that case as possible” (1998, p150)(167). Case studies allow researchers to define the context of the study yet limit generalisations of the research to the case itself (168). An investigation into the real-life context of a contemporary phenomenon (169), each case is limited by the boundaries of the context of the research, ensuring that generalisations will only fall within this field yet inferences may be broader (170). The representativeness of the sample is known within the limits of the research, providing increased confidence of the sample and of the ability to check the sample during the research processes.

Traditionally utilising purposive sampling methods within a select population (170), the inferences made within the study may then be applied to the whole population as this group would be expected to be representative of the group as a whole (170). Purposive sampling allows the researcher to choose a case or cases that represent key features of interest (groups, individuals or locations) within the research. When applied in conjunction with qualitative research as seen in this thesis, the sampling methods may vary widely. Case studies are also known to utilise multiple methods of research to establish construct validity (171). This process allows triangulation of the research to strengthen the validity of observations and beliefs of the researchers. Different insights are inextricably provided by the different methods employed. This, rather than providing a single perspective, allows an accumulation of ideas to be developed (171) providing a broader understanding of the area.

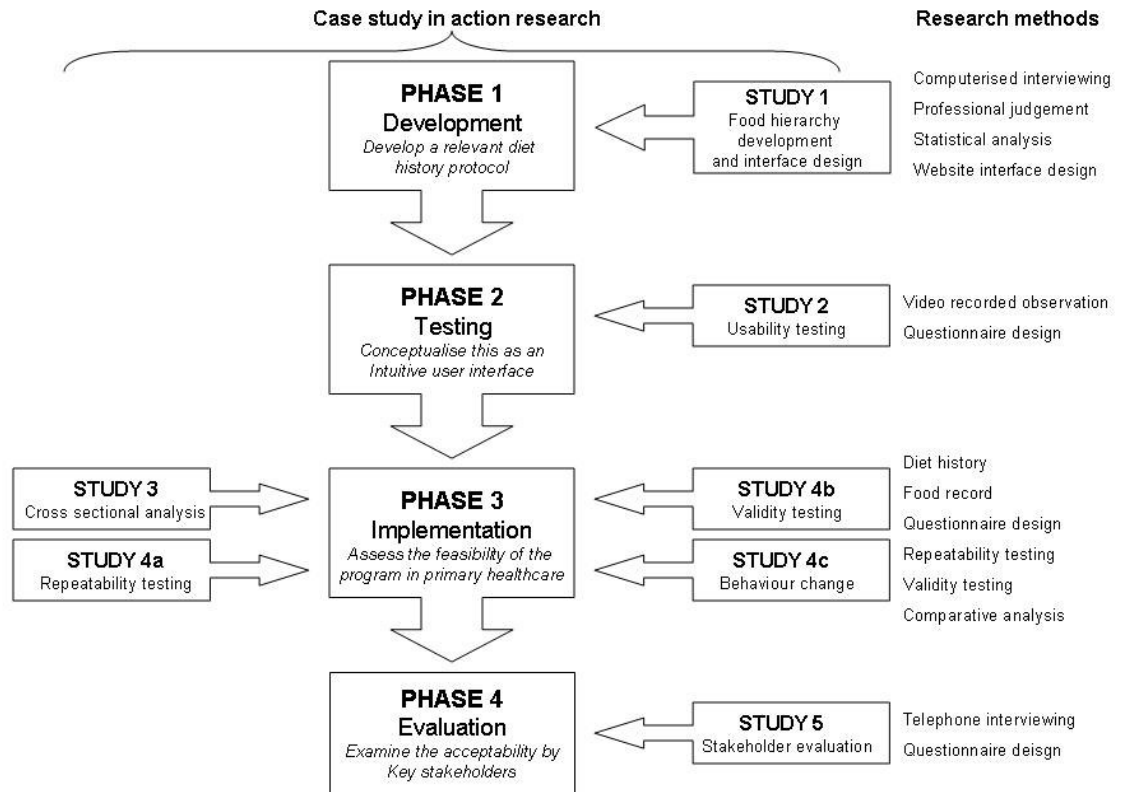


Figure 3-2 Overview of the CAST case study

The CAST project was limited to the local Illawarra area and it was expected that the complexity of GP practice would differ between regions. For this reason a case study format was selected to present the findings. Furthermore, a case study was felt to be highly relevant as multi-method research has been applied through both quantitative and qualitative measures. Figure 3.2 provides an overview of the entire project showing each stage of the case study and the five studies and research methods used to evaluate it.

Though there are many forms of case study (intrinsic, instrumental and collective) the CAST project may be considered as a collective case study within which a general phenomenon was investigated through a number of different cases (GP practices). The concept of the CAST project used as a case study for this thesis was formulated by Prof Linda Tapsell* in conjunction with the chief investigators of the

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project including Dr Marijka Batterham[†], Prof David Steel[‡], Dr Lori Lockyer[§] and Prof Barry Harper^{**}. The project concept was then further developed in consultation with Dr Andrew Dalley^{††} and Mr Chester Goodsell^{‡‡}. The project was based on the development of a computerised program designed to essentially shorten professional dietary consultation. This project was a component of an ARC linkage grant between the University of Wollongong, Illawarra Division of General Practice and Xyris Software Australia.

The CAST program was assessed in 14 different GP practices in the Illawarra region of NSW, Australia, under which it was anticipated that approximately 2,000 patients would be involved in self-administered diet entry. A dietitian would receive the electronic patient dietary data from the program, develop a dietary prescription using the program's 'dietitians interface' (DI) and send this to the patients' corresponding GP. It was anticipated that a total of 200 patients would receive detailed individualised dietary advice. The remaining 1,800 would receive less detailed individualised advice.

As outlined in Figure 3.2 the case study was broken into four key phases: development, testing, implementation and evaluation. Two studies of the development phase were conducted prior to the work of this thesis. The first evaluated the existing technology available for dietary assessment and the second involved focus group interviews of patients to identify their perceptions relating to computer use and nutrition. The outcomes of these focus groups were used to guide the development of the program (172). The first study of this thesis and the final stage of the program development involved the construction of an interview schedule based upon the DH interview.

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^{††} Chief Executive Officer, Illawarra Division of General Practice

^{‡‡} Director, Xyris Software Australia Limited

From there, the testing phase utilised video recorded observation of user interactions with a prototype of the program. Implementation in the primary healthcare setting for a period of 12 months allowed a profile of the recruitment practices of GPs to be identified and a profile of primary program users to be determined. The fourth study involved a comparison of outcome measures of repeated automated DH data and relative validity testing. It included an evaluation of patient perceptions of using an automated dietary assessment tool with that of traditional dietary assessment, and attempted to determine behaviour change as a result of the dietary advice received. The final phase of the project, the evaluation phase, addressed the perceptions of key stakeholders on the implementation of the innovation in the primary healthcare setting. Each of these phases were examined from a theoretical perspective in the construction of this thesis.

3.3 Action research in primary healthcare

Action research is frequently used in the healthcare setting. It is focussed on finding ways to assist the patients rather than conduct research on them (171). The research seeks to generate a solution to a problem or area of concern within the context under study (171). The action research methodology was selected as it provides a flexible, culturally and socially adaptable framework within which research may be conducted. It allows the researcher to explore the effects of demographic variables such as gender and socioeconomic status on health, and can be adapted to a range of different settings (173). Traditionally action research would involve regular feedback from the researcher to the participants within the study, utilising ideas and responses from this feedback to inform decisions for the next components of study (174).

Due to the feed forward and feedback mechanisms inherent to the project, the interrelationship between the four phases of the CAST case study fell within the framework of action research methodology. In this thesis the area of concern related to the need to provide individualised dietary advice to patients with metabolic syndrome the clinical condition of reference (related to overweight, cardiovascular disease, T2DM and hypertension - all of which are national health priorities) (148). While GPs are the most trusted source of nutrition advice (20) they have many

demands in daily practice and dietitians are not always available to provide support. The CAST model could be one way of addressing the problem. This process was followed throughout the CAST case study. The developmental phase of the program addressed the opinions and expressed needs of patients and GPs alike, through focus group interviews, observational studies and individual consultations. The second phase sought information from patients as the program was tested, and the third stage sought information from both the patients and GPs as the program was implemented on site. The final phase involved in-depth interviews with GPs, patients and dietitians to assess their overall acceptance of the program and intervention strategy. The theoretical aspect of the thesis attempted to explain the observed outcomes. Figure 3.3 provides an overview of the feedback and feed forward mechanisms employed throughout the CAST case study.

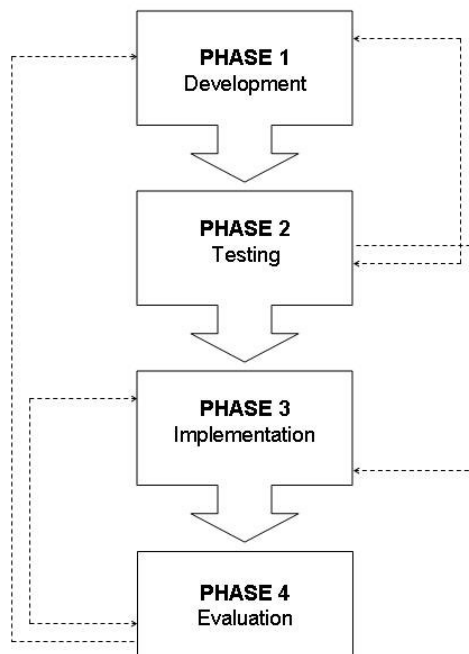


Figure 3-3 Feed forward and feedback mechanisms between phases of the CAST case study

3.4 Social research methodology

Social research aims to describe and explain how society functions. As with other disciplines it is a meticulous and purposive investigation aiming to create new knowledge. It has existed since before Christ when Thales (640-540BC) applied the concept of observation to natural events (175). Since then social research has taken

shape to a broad field. It is today encompassing both positivist (quantitative) and non positivist (qualitative) domains of research (175). Social theory has been used in this thesis to explain observations. A number of social methods were used to collect the data. The context under study involved observation and assessment of human behaviour throughout all phases of the case study. The main theoretical frameworks considered relevant to this analysis related to the uptake of technology and its influence on health behaviour. For this reason, the theoretical frameworks offered by social determinism (and more specifically its spin off, technological determinism) were considered.

In view of the use of computerised interviewing in the research reported here, theories of computer interaction (human computer interaction and technology acceptance model) and cognitive processes (social cognitive theory) could provide hypothesised explanations for some of the observations. While testing these explanations was not part of this thesis, an understanding of the underlying theory was warranted. A brief summary of these explanatory theories follows.

3.4.1 Theoretical positions

3.4.1.1 Technological vs. social determinism

A theory of social change, technological determinism addresses the progress of a productive technique that obeys a logic of its own. In this process, the technique is the principle determinant of social relationships. Though in its literal context untrue, the concept of technological determinism is related to a gradual cultural change with the introduction of a technology leading to its full social impact (176). On the contrary, social determinism sees technology as having a linear relationship with society (14). The impact of the CAST model parallels these gradual changes as technology is introduced to a wide range of applications in everyday life. Tasks previously completed manually can now be accelerated through automation, though the full impact of this will not be known while the shift is continuing.

3.4.1.2 Human computer interactions

Human computer interactions (HCI) is an area of research focussing on the design, evaluation and implementation of interactive computer programs and/or systems for

human use. It is the study of the phenomena surrounding these developmental issues (177). The key problems identified are those of organisation, development processes, competence, roles and communication. The fundamental concern needing to be defined during HCI is the mapping of the mental processes occurring whilst a person is using a computer. This will help to assist in the functionality and aesthetic appeal of the program whilst working within the boundaries of computer use of the target group (177). A wide range of research areas exist in the field of HCI. For example, usability tests have revealed a correlation between user satisfaction, effectiveness and time (178).

The key deterrents to success within the field of HCI are those of level of education, gender, socio-demographic background, level of income, disabilities and age. These combined with the varied lifestyles and attitudes of the general public create a number of challenges for the computer programmer. A website for dietary assessment cannot be assessed without considering HCI, as the relationship between the two is inseparable. This theory was primarily considered during the testing phase of the case study during which video observation of the HCI was evaluated. The level of education, gender and age of the participants were the primary issues addressed when considering the usability of the CAST program and were therefore the focus of further research that will be discussed in later chapters.

3.4.1.3 Technology acceptance model

The technology acceptance model (TAM) proposed by Davis in 1989, addresses the acceptance of information technology based on the perceived usefulness and perceived use of the technology (179-181). TAM was adapted from the theory of reasoned action and has been validated and utilised by numerous study teams (130, 182, 183). The theory is concerned with the influence of external variables on the perceived usefulness and perceived ease of use of an item of technology. These perceptions will in turn affect the attitude, intention to use and actual use of a system (Fig. 3.4).

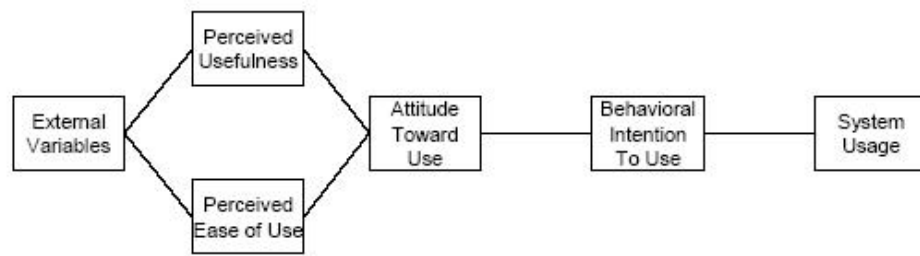


Figure 3-4 The technology acceptance model

Applied throughout the CAST model, acceptance of technology may be linked to each phase of the study. If intended users had not accepted the technology during testing, use of the system would have been minimal. Similarly, if the GPs had not understood the perceived usefulness and ease of use of the program, their attitude toward the program may have been negatively affected.

3.4.1.4 Social cognitive theory

Social cognitive theory assumes that individuals acquire their attitudes through various sources of the social network, including observation of others and observation of those displayed in the media (184). Behaviour is affected by a person's feeling of self-efficacy to successfully execute a behaviour to achieve a desired outcome (185). The influence of the social environment is the primary determinant of a person's belief that they can change their behaviour. If they lack the belief, the successes of behaviour change are less likely. Behaviour is influenced by three factors:

- Situational outcome expectancies where environmental influences do not result in personal action,
- Action-outcome expectancies where personal actions lead to the outcomes, and
- Perceived self-efficacy where the capabilities of performing the desired action can produce the desired outcome (186).

Social cognitive theory is referred to in later chapters of this thesis to postulate links between the ability of the participants to change their dietary behaviours and the medical conditions with which they are faced with. It was proposed that the media played a significant role in this relationship through television advertising and programming, as well as the growing influence on positive health practice.

The seven theoretical positions described above each provided plausible reference points for a number of observations made in this thesis. Social research methodology was also applied in the empirical (data collection and analysis) component of the thesis. This related to sampling for observational studies and the use of a number of data collection and analytical methods. Details of these components are outlined in the following sections.

3.4.2 Social research sampling methods

Depending on the outcomes required, a range of sampling methods were used in the social research components of this thesis.

3.4.2.1 Convenience sampling

The advantage of convenience sampling in this setting was that all subjects were aware of the purpose of the research yet possessed varying degrees of computer literacy. In this case, convenience sampling was appropriate as it served the purpose of developing a program with stakeholder input, but with some variation in capability. In the first phase of the research convenience sampling was used to study the link between the design elements and use of the interface. Focus group studies conducted as a component of the author's Masters research (172) determined key design issues. The same subjects were recruited for usability testing of the UI of the program reported in this thesis (**Chapter 5**).

3.4.2.2 Systematic sampling

A statistically representative sample cannot always be created in qualitative research. The form of sampling is often dependant upon the duration and depth of the research (171), and therefore a planned systematic approach to the sampling frame is required. In this thesis, this method of sampling was applied for the two professional stakeholder groups targeted for the stakeholder evaluations, the last phase of the research. The stakeholder evaluations for the GPs were based on 'recruiting' and 'non-recruiting' GPs. Due to the large variations seen in the recruitment rates of the GPs within the study, a profile of recruitment practice was the basis of selection for evaluation. This enabled a range of opinions about the project to be expressed in the

evaluation. In contrast, randomised sampling may not have captured both ends of the GP recruitment spectrum.

Similarly the dietitians selected for the stakeholder evaluation needed to span the Illawarra region and also cover a range of different fields of practice. A list of dietitians was created as detailed later in the thesis (**Chapter 8**). Each dietitian was listed against the suburb in which they worked as well as their field of practice – public hospital, private practice, community and education. The Dietitians Association of Australia (DAA) conducts annual surveys of dietitians Australia-wide. These surveys include a breakdown of dietitians in each practice area per state of Australia. Using the NSW data of 2004 (187), a percentage of each of the work areas was determined. This percentage was used to determine the proportion of dietitians from each work area to be included within the stakeholder evaluation. A list of dietitians within the Illawarra region of NSW was created by contacting area health service managers, managers of nutrition and dietetics departments within the local hospitals, the Illawarra Division of General Practice and by searching the online and printed versions of yellow pages directories. These dietitians were listed by suburb and work area. Dietitians within the education field needed to be excluded as all were from the University of Wollongong (UOW) and were already aware of the CAST model. The dietitians' locations of practice were then assessed for spread within the Illawarra region. Though this form of sampling encompassed random sampling, it was felt that random sampling alone would not ensure the same degree of representation.

3.4.2.3 Random sampling

Random sampling is the selection of n units from a population N in which each unit has equal chance ($1/N$) of selection (188, 189). This method was selected for the patient stakeholder evaluation. Randomised sampling may be easily applied to a large number of population groups, and can be analysed by sound statistical methods. The limitations to this form of sampling exist when there is a heterogeneous population. Random sampling was chosen for the sampling of patients for the stakeholder evaluation study because of the larger population size and assumed homogeneity. Random sampling was expected to allow patients from different backgrounds to be included due to the variability of the recruited GP

practices. Patients who had used the program during the early stages of implementation as well as those towards the end of the study period would also be included in this model. **(Chapter 8)**

3.4.3 Social research methods

To obtain data from participants in the research, a number of social research methods were applied.

3.4.3.1 Focus groups

Focus groups aim to gain information about experiences, beliefs, opinions, feelings and attitudes of a target group of people about a topic of interest. First published in 1926 (190), focus group research was widely used by Merton and colleagues in the 1940s to examine the impact of training on troops in World War II (191). Focus groups were then primarily used in the 1960s for product marketing purposes, to examine the opinions of potential buyers on the development of new products (190).

Utilising either purposive sampling of participants with expert knowledge in a particular area, or voluntary recruitment, focus groups are generally conducted with groups of four to 12 participants of diverse background experiences (190). These experiences are often identified from a questionnaire completed prior to the group sessions, thus allowing for a range of opinions to be present within each group. Depending on the purpose of the research, any number of focus groups may be required. Often four to eight groups will suffice (192), though some research may require only four groups whilst others require 50 separate groups (190). The concept of data saturation is commonly applied, in which no more groups are held once the information being obtained is repeated with each additional group.

A high level of planning is required on the researchers' behalf. Key areas of discussion or specific questions to be asked need to be pre-defined and all participants informed of the purpose of the focus group. Confirmation of attendance and location is also often required. The location should allow all participants to see one another in order to respond to comments throughout the session. To begin the session, the researcher or moderator should welcome the participants and thank them for their attendance. The manner of discussion within the group also needs to be

decided (190). Will questions be asked of the group as a whole or of each individual? Both methods have their advantages. Addressing the entire group will allow those who have had an experience relevant to the question to respond. This may in turn encourage others with similar experiences to respond. However, addressing the entire group may result in the dominance of some participants. Asking each participant will allow the view of each member to be heard, though the structure of this approach may not encourage group discussion. It is then important for the researcher to target particular points of interest and raise these for group discussion.

Creating a feeling of trust within the group setting will encourage shy participants to voice their opinions and draw on personal experiences, especially when they are similar to those of others within the group. Group dynamics is vital to the outcomes of the research (191). Implemented during the author's Masters research (172), the description of focus group methodology has been included in this thesis to allow for comparison to be made between this and other evaluative forms of research used in the project.

3.4.3.2 In-depth telephone interviewing

In depth interviews are less structured and may cover a more limited number of topics in greater detail. The questions are usually open-ended, neutral, sensitive and clearly worded (171). Six types of questions that may be asked have been outlined in Pope and Mays (2003) as behaviour or experience questions, opinions or beliefs, feelings, knowledge, sensory and background or demographic questions (171). Each of these six factors, as well as the time constraints of the interview, was taken into consideration when developing the stakeholder interview questions. **(Chapter 8)**

Involvement of healthcare professionals in the implementation and evaluation of action research is vital to ensure the research is suited to its stakeholders. The primary stakeholders identified for the CAST project were not only the patients and GPs, but also the dietitians, whose workload would be improved through the increased time available by automating the assessment phase of the DH interview. Involvement of two busy professional groups in the stakeholder interviews meant the evaluation phase of the project needed to be flexible and quick to complete.

For these reasons, the use of focus group interviews such as those used before the development of the program were not suited to the stakeholder groups. The influence of others within the group setting may have affected the responses to questions and it was also found difficult to assemble a number of professionals together at the one time for a focus group session. Separating the individual stakeholders by interviews allowed for the true beliefs of the individual to be expressed. Use of the telephone for the interview also decreased potential questioning bias (46, 47). Telephone interviews allowed each of the individual stakeholders to be contacted at a time convenient to them (193). Interviews could be adapted to the responses received through use of prompting questions to gain further insight relevant to the question topics.

Transcription of data

Interviews and focus group sessions are generally tape recorded with the researcher opting to take field notes throughout as required. These recordings need to be transcribed before data analysis is performed. The use of verbatim transcriptions is common practice in qualitative research (192). Ranging from two to four hours per hour of audio recording, transcription of data has various conventions which may or may not be used by the researcher such as symbols to indicate phonetics.

Thematic analysis

The categories into which responses from the focus groups and interviews may be sorted are usually determined before thematic data analysis begins. These categories are based on the hypotheses to be tested. Computer automation now enables this process to occur efficiently (192). Using analysis programs such as NVivo (194), the transcripts may be uploaded into the program and thematically analysed by categorisation.

3.4.3.3 *Video recorded participant observation*

Video recording is a method for systematically observing behaviour. Video recording is a qualitative methodology which is growing in use in the field of the social sciences (195). Allowing researchers to capture high quality data from smaller numbers of participants, video recording provides the advantage of being

able to review components of the interaction numerous times. Use of the video to capture observation data provides greater flexibility, assures a permanent record, and allows more detailed analysis and multiple viewing (196, 197). Studies using video cameras tend to vary between use of one or two cameras. Bowman (1994) used two cameras capturing a view of the face and hands and another of the screen viewed by the user (196). Kaufman *et al.* (2003) recommends that the camera capture a profile of the subject and of the subject's fingers. The capture of hand and finger movements as well as interaction with the computer can then be assessed (197).

Analysis of video data can also be time consuming unless the appropriate analysis packages are utilised. Time stamping of the transcript forms a link with video footage at the same time point (198). The common data rate of uncompressed digital video footage can be approximately 1GB per four minutes recording (197) making hard drive space the primary limitation to video observation in research. In this thesis, video observation was selected for the usability study in preference to an audio recording. It allowed the researcher to determine the interactions of the participants with the computer and the website. Providing increased depth of data, the additional visual information of participant reactions and body language allowed for deeper analysis within the field of human computer interactions as opposed to only usability testing an IT interface. **(Chapter 5)**

Non-verbal communications: Data coding and analysis

Video observation has been employed in the usability testing of software. This allows problems with particular components of the software to be identified through the behaviours expressed by the user. There is, however, very little research on non-verbal behaviour in human computer interactions and therefore coding of body language and eye movement is often exploratory (197). Software packages are available to assist in the analysis yet are often priced according to features included (199), or used for only short sections of video footage. As the use of video observation for research increases, advancements in programming have allowed researchers to create freeware to share amongst those using similar analysis techniques. The freeware may be modified to suit the outcome measures needed for the research. Transana (198) is a program created for this purpose. In this thesis,

Transana was employed during usability testing and was adapted to allow the behaviours of users to be assessed while they were accessing the website.

Usability testing

Qualitative testing on the target population would increase the likeliness of the program to be suited to the individual and useful for dietary change (15). Usability testing is commonly conducted during the development of computer software.

Usability testing refers to the process of employing people who are representative of the end users of the system and evaluating the ability of the system to satisfy its usability criteria (197, 200-202). The researcher is viewed as a participant in the research as the level of computer experience is seen as independent of the amount of assistance and involvement of the researcher. Novice users often require step-by-step directions and at times, hands-on demonstrations of the programs (197). In this thesis, usability testing of the UI ensured that the implementation of the CAST program in the primary healthcare setting would be suited to its target user.

(Chapter 5)

Think-aloud protocol

Applying a think-aloud technique to usability testing is common in the field of computing (203-205). Think-aloud protocols allow for the researcher to gain an insight into the mind of the user as thoughts are expressed at the time of occurrence (206). The cognitive processes involved when asking a user to recall their interaction with a computer interface after the event, results in lower quality data when compared with the concurrent think aloud technique (203) used in the CAST project during usability testing **(Chapter 5)**.

3.4.3.4 Questionnaire design

Questionnaires also formed an important part of data collection in a number of phases of the research.

Demographic data questionnaire

In this research, a demographic data questionnaire was developed to obtain a picture of the patients' lifestyle patterns. Utilising a multiple choice questioning scheme, this approach was chosen over the use of open ended questioning due to the

decreased time required for completion. It was also used due to the possibility that patients referred to the website would not be highly computer literate or familiar with a keyboard, meaning they would only need to point and click with the mouse to answer a question. (**Appendix A**)

Pre- and post-usability testing questionnaires

Using the theoretical approach of the technology acceptance model, the pre- and post-usability testing questionnaires aimed to assess the feelings and beliefs of the users both before and after use of the CAST program. Utilising internal validity testing prior to implementation, questionnaires were developed to allow comparisons between the pre- and post-testing component 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 to decrease subject burden. (**Appendix B**)

Automated and traditional assessment questionnaires

Throughout the first six months of the implementation phase of the website, regular visits to GP practices were made and a hotline telephone number was available to patients who had queries or problems. A collation of these responses was used to create the questionnaires for user preference between the automated and traditional assessment methods. Using categorical multiple response variables and Likert scales, the majority of questions between questionnaires were matched, allowing responses to be compared between assessment methods. Validity testing of the questionnaire began internally with the research team. The modified questionnaires were then sent externally to n=10 volunteers from the usability testing study to test for comprehension and clarity of the questioning sequence. (**Appendix C**)

3.4.3.5 Validity of social research methods

Qualitative research, though very different from quantitative research may be analysed for validity of the data. The application of validity testing is strongly based on the judgement of the researcher and again by the reader of the analysed data. Methods used to validate qualitative data include respondent validation during which the accounts of the participants are compared with the account of the investigator. This method is affected by the variability of individual responses and the need for

the researcher to apply the findings to a wider population (171). Reflexivity is related to the sensitivity of the research methods. The researcher must ensure that their experiences and assumptions are expressed to enhance the credibility of the research. This, and a clear explanation of the research methods and relevance of the work, as well as the ability not to overlook negative cases leads to increased validity of the dataset (171). The concept of triangulation mentioned earlier in this chapter, is the technique by which a comparison of different research methods is made.

Triangulation can be by method (as primarily used in this thesis), time, paradigm, investigator or sampling (175) and relies on the assumption that limitations or weaknesses in one method will be balanced out by the other, ensuring a comprehensive set of research findings (171). Silverman argues that comparing different sources of data can only be considered useful when identifying context specific accounts and behaviours (207) and that triangulation should therefore be used as a technique to make a study more comprehensive, rather than to validate the findings. Triangulation in this thesis was applied through the use of questionnaires and observation as was seen in the usability study of this thesis, or by a comparison of results from a number of different data sources such as the method utilised in the stakeholder evaluations of this thesis.

3.5 Quantitative methods

Epidemiology is about the distribution and determinants of health and disease in populations (208) and is largely based on quantitative measurement. It takes a disciplined approach to study design, sampling, validation and statistical analysis of data. Quantitative methods were used in this thesis in the implementation phase of the research. This related to a cross-sectional study of patients and validity and reliability testing of the dietary assessment method. The variables of interest and research outcomes were quantitative and concerned with health determinants. The research was pilot in nature and this enabled some discretion with sampling and other methods.

3.5.1 Sampling

Sampling is an important consideration in quantitative research. Used in this context it should be representative, providing the researcher the ability to generalise the results and should follow standard principles (175). Though different sampling types were used for the social research components, the following outlines the sampling methods used during the implementation stages of the CAST case study.

3.5.1.1 *Practice recruitment*

The purposive sampling technique allows the researcher to select participants who in their own opinions are relevant to the research. Using professional judgement, purposive sampling has often been termed judgemental sampling (175). No set criteria were provided for this form of sampling as the criteria and the selection of participants is dependant upon the knowledge and expertise of the researcher. Purposive sampling was employed within the CAST case study for the recruitment of GP practices from the Illawarra region.

To implement the CAST program in the primary healthcare setting, a sample of GP practices from the Illawarra region was needed. The sampling process was applied to ensure a broad socio-economic spread within the pilot study. Targeted practices invited to participate were identified from a complete listing of all the GPs who were members of the Illawarra Division of General Practice. Grouped by practices, 92 in 2003 (209), this list was subsequently narrowed down based on availability of space within the surgery and a current ADSL internet connection, or a plan to convert to ADSL in the near future. Demographic features of the practices and of individual GPs were considered including the total number of GPs, age and gender. Finally, the demographics of the surrounding area were taken into account, including the socio-economic status and the general age category of the patients who frequented the practice. The final list of practices was narrowed down to target GP profiles and a range of locations covering the Illawarra region. (**Appendix D**)

Twenty-two target practices were approached to determine interest. Of these practices five declined immediately due to the perceived computer illiteracy of their patients (due to age). Three further practices agreed to take part but later declined

due to space limitations within the practice. The remaining 14 practices were recruited. Location of the computer within the practice was determined based on power and network access. Where required, additional networks points were installed and internet hub sizes increased. Two of the 14 practices merged to form one larger practice approximately nine months into the implementation phase.

(Appendix E)

3.5.1.2 Within practice GP recruitment

Within the 14 GP practices individual GPs nominated themselves to recruit patients. GPs were approached individually by two members of the study team or were approached by a recruited GP within their practice. A snowball sampling method was used for this recruitment (175). Selected GPs were targeted (usually the owner of the practice) and these GPs were asked to recommend other GPs within the practice who they felt would be interested and willing to participate in the study. These GPs then further informed other GPs until ‘saturation’ was reached. Not every GP from a practice was involved in the study. Although this process primarily involved GPs who were aware of nutrition management as a principle of disease prevention and treatment, it was felt that in order to pilot test the CAST program, the variable demographic features of the individual practices as well as the patients frequenting the practices would complement the bias of the recruited GPs.

3.5.1.3 Patient recruitment

Patients recruited for the studies conducted during the implementation phase of the project were identified through purposive sampling. This is the primary sampling form used in action research as it allows the researcher to target a specific field of interest, in this case, willing patients with metabolic syndrome the clinical condition of reference. Patients of the GPs involved in the study were recruited via their GP. Each GP was provided with consent forms and an outline of the patient recruitment criteria (consent forms were later made available electronically for ease of recruitment). An eligible patient would be identified and approached for the study by the GP. The study would be explained and consent obtained from the patient, initially in writing and later electronically. Posters and pamphlets were also displayed in waiting areas and advertisements placed in the local newspaper for patient-initiated recruitment. Incentives were not provided.

The recruitment criteria for patients initially used the WHO definition of metabolic syndrome (**Section 2.5.1**). Feedback from the GPs identified this to be too strict a recruitment protocol and the recruitment criteria for patients was modified to include:

- Any patient over the age of 45 years who would benefit from dietary advice related to body weight and heart health, or
- Any patients under the age of 45 years who had any one component of metabolic syndrome (T2DM, hypertension, hypercholesterolaemia, overweight, IGT/IFG).

GPs were informed that patients recruited to the study must be over the age of 18 years, not newly diagnosed with diabetes and literate in English. A profile of the patients selected is outlined later in this thesis. (**Chapter 6**)

For the repeatability study, an electronic database within the GP practice was the primary information source for patient recruitment. Practice staff created a patient mail out based on pre-determined selection criteria. The method of recruitment involved a mail out to all patients with T2DM between the ages of 18 and 75 years. Patients then volunteered for the study by contacting either the practice within which the research was to be conducted, or the Smart Foods Centre at the UOW. This form of recruitment provided patients within the context of the study, yet did not unduly bias the selection process. It is recognised, however, that the participants volunteering for the study would be highly motivated, a factor that may not be able to be generalised to primary healthcare practice. (**Chapter 7**)

3.5.2 Anthropometric measures

Anthropometric data during implementation of the CAST program was self-reported by the patients. The repeatability study involved patients using either the website or visiting a dietitian. In this instance, the dietitian measured the patients' height using a stadiometer and weight using digital scales in the GP practice. Both measures were conducted without shoes. Body mass index (BMI) was calculated for all patients using the following equation

$$\frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

Patients were classified as normal weight if BMI<25.0kg/m², overweight if BMI 25.0-29.9kg/m² and obese if BMI>30.0kg/m².

3.5.3 Determining energy requirements

A study by De Lorenzo *et al.* (1999) compared four different equations for predicting metabolic rate with indirect calorimetry. Of the four equations only the Molnar *et al.* equation produced significantly different results to the calorimetry (210). Though the Schofield equation has been found to overestimate BMR, the differences are not significant. Schofield was used to calculate BMR in this thesis as it is the default equation used in the FoodWorks (211) program upon which the DI was modelled.

The energy requirements of patients were determined to evaluate dietary intake (automatically in the program's DI) and to derive dietary advice strategies. For calculation of the energy requirements of an individual, the Schofield equation (212) has been widely used in nutritional epidemiology (213, 214). Using the height and weight data of an individual (215) the equation uses the gender and the age of the person to determine their energy requirements.

3.5.4 Over- and under-reporting

The validity of reported energy intakes was another important consideration for the implementation phase of the CAST case study. Certain individuals are prone to under- or over-report their dietary intake (216, 217) with an under estimation by approximately 20% of energy commonly identified (218). The literature supports the claim that obese individuals are primary under-reporters (219) increasing the underreporting to approximately 50% of energy (218). Under-reporting has also been linked to age, gender, education and smoking status (217, 218, 220). Under-reporting is highly dependant on memory, social desirability, lack of awareness of food and portion sizing and reluctance to disclose foods and/or amounts eaten (219). CHOs and fat intake are generally under-reported to a larger degree than protein intakes, and snack foods considered to be healthier are under-reported less than those considered to be less healthy (218). The majority of subjects involved within the

CAST project would be overweight, as this is a primary determinant of metabolic syndrome, the clinical condition of reference in this thesis. Assessment of under-reporting was vital to the accuracy of the nutrient intake data.

When no biochemical measures are available, the reporting bias of an individual may be determined by comparing the energy intake (EI) with the basal metabolic rate (BMR) of the person. Goldberg *et al.* (221) identified that the previously used figure of 1.2xBMR would only be useful for persons who were confined to bed-rest and that a healthy individual cannot survive at an EI level below 1.35xBMR. Creating cut-off limits for minimum intake levels, the Goldberg cut-offs provide two levels of EI below which underreporting is recognised. Cut-off 1 relates to usual intake and as identified above is set at 1.35 EI:BMR. Cut-off 2 relates to actual intake and is dependant upon the reporting period of the diet, the number of subjects within the study and the method of determining BMR (measured or estimated)(221).

Black described the need for individualised cut-offs and that the physical activity level (PAL) of the individual would be highly dependant on these figures (216) (222). Later research lead to the use of 1.55xPAL and it was considered that individuals reporting dietary intakes below this figure were biased in their reporting and could be classified as under-reporters. Later, in a review of existing studies of energy expenditure (EE), Black developed the recommendations of 8.5% BMR (223), 23% EI (222) and 12.3% PAL (224) to serve as minimum cut-off levels. Though the recommendations by Black are highly significant and should be used in intervention trials where physical activity may be measured and compared to a gold standard, the physical activity data obtained from the CAST project was self-reported and highly influenced by subject bias. If the subject were identified to be an under-reporter for their nutrient intake, it would be assumed that they similarly would be an over-reporter for their activity levels. Also, although the International Physical Activity Questionnaire (225), used throughout the study, had been validated, it had not yet been validated in a computerised form, nor in a similar setting to this study. Therefore in this thesis underreporting was determined using the Goldberg cut-off limits as opposed to Black's recommended PAL measures.

Over-reporting, however, was determined using a factor of EI:BMR ≥ 2.4 outlined by Black (217, 226). (**Chapter 6**)

3.5.5 Repeatability testing

The ability of the dietary assessment method to produce consistent data was another important consideration for the research. Repeatability is determined by the closeness of results over a relatively short period of time when using the same test measurement or observer (4, 188). Separated from reliability testing within which the same instrument provides similar results under different conditions (188), the within subject and between subject data obtained from both methods provide data to assist in determining measurement error of the methods used (227, 228). Also repeated measures do not require as many subjects due to the increased statistical power obtained by repeating the assessment (227).

To determine repeatability of data from the CAST program the automated and traditional forms of assessment were compared. These types of assessments have been conducted in other fields of healthcare such as psychology. The study design includes patients using one form of assessment followed by the other. The literature shows that the time span between these types of assessments ranges from one week (229) to three weeks (230). A similar study to that reported here used a two week time span and was therefore applied in this thesis (231). During the implementation phase a selection of patients was requested to visit a GP practice for repeat assessments two weeks apart. (**Chapter 7**)

3.5.5.1 *Learning effect*

Known as the latency effect, consideration is taken for learning with time when repeating the same form of assessment within a given time period (227). Dependant on the time period between the methods, participants may modify their responses due to repeated use of the instrument or alternatively they may still remember previous responses that they provided. This learning effect was considered in the CAST project when addressing repeatability.

3.5.6 Relative validity testing

Relative validity testing of dietary assessments generally compares an assessment method with a ‘gold standard’. In the absence of a ‘gold standard’ such as doubly labelled water or biomarker analysis, the weighed FR is employed as the reference method. When compared with the DH method in its traditional form, the mean intake is generally higher than the FR due to the variations of recording and the limited period covered by a FR assessment (232). Traditional forms of dietary assessment have been validated frequently (233-236) though few reported studies exist in which computerised self-administered dietary assessments have been validated. The following provides two recent examples.

The first of these validation studies compared an automated 24-hour recall with a face-to-face 24-hour recall using a two-period cross over design. Eighty-eight subjects were recruited and assigned to two groups, each completing one form of assessment followed by the alternate form on the same day. No significant differences were found between assessment methods (65). The second validated tool, the Food Intake Recording Software System (FIRSSt), was a self-administered 24-hour recall used for fourth grade school children. Validation was conducted with 138 school aged children from two different primary schools, randomised into six groups. Assessing lunch eaten at school and meals eaten on the previous day, findings were compared with hair samples taken from the children. This method was found to be less accurate than a face-to-face 24-hour recall. The validation exercise compared food items rather than nutrients. A 46% match was found for the lunch and a 60% match of food items was found for the previous 24-hours of recall (237). The CAST program was validated against a weighed 3-day FR though the study design also allowed comparisons to be made between the automated and traditional forms of assessment. It was felt that by using the FR over a face-to-face interview, actual intake data could be obtained which is less affected by bias than performing a separate DH interview with each participant. (**Chapter 7**)

3.5.6.1 *Measurement of bias*

Plotting the difference between measures against the mean of the two measures (Bland Altman method) allows researchers to predict the bias at high and low intakes

of nutrients for differing assessment methods (228, 238). This method of assessment was employed for data from the DH and FR for both automated and traditional dietary assessments.

3.5.7 Other comparative analytical techniques

A number of analytical tests were applied to quantitative data in this thesis.

3.5.7.1 *Chi-square analysis*

To verify independence between two categorical variables (4, 188) the chi-square test is based on the assumption

$$\chi^2 = \frac{\sum (\text{Observed frequency} - \text{Expected frequency})^2}{\text{Expected frequency}}$$

Traditionally utilising a two by two cross tabulation of the frequency of responses, chi-square analysis requires a minimum expected cell frequency of five, though this assumption may not be required in practice (239). **(Chapter 6)** Comparing the distribution of a variable with the distribution of another variable, chi-square tests were used in the implementation phase of the CAST case study to determine relationships between demographic responses and reporting status, as well as user preferences between the automated and traditional form of dietary assessment.

3.5.7.2 *Ordinal regression*

Predicting the relationship of multiple characteristics on other characteristics requires the use of regression analysis (240, 241). This allows researchers to identify explanatory variables (240). Linear regression was used during the development phase to determine the foods required to predict nutrient intakes of a population. The difference between linear and ordinal regression primarily relates to the form of the raw data before analysis. Later in this thesis, categorical responses obtained from the demographic data questionnaire were assessed using ordinal regression to predict the profile of the website users. The Polytomous Universal Model (PLUM) of ordinal regression in SPSS was specifically applied. Considering the probabilities of an event through linear combinations, the model for ordinal regression may be written as follows with the section to the left of the equation known as a logit (242).

$$\frac{\ln \frac{\text{prob(event)}}{(1 - \text{prob(event)})}} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

The result of the equation will provide the odds that an event will occur (**Chapter 6**).

3.6 Dietary methodology: development of the computerised dietary assessment questionnaire

Dietary methodology was employed throughout the CAST case study. The following sections outline the context as well as the specific uses of dietary methodology in this thesis.

3.6.1 Computerised interviewing

In clinical settings, interviewing is the main form of dietary assessment. Computerised interviewing is a relative newcomer to dietary methodology. Research supporting computerised interviewing in healthcare was first reported in the early 1970s in which the computer was used in the field of psychology (243). Allowing automation to be added to a number of well-known psychological tests, the majority of interviews used self-administered questionnaires which the patient would answer on the computer.

Dignon (1996, 1997) described the use of a computer for interviewing in psychology. Using a traditional paper and pencil psychiatric assessment (present state examination), Dignon felt the interviews needed to modify the wording and structure of the interview to allow automation. The questions needed to be fully articulated and closed in nature, and the language needed to be simple. The interview would allow valid and reliable answers and would not require information that could not be provided by the respondent. This format was highly accepted, easy to use and preferred by patients (6, 7, 244). Since then, a review by Lewis (1999) was conducted to assess the use of computers in patient education. Of the 66 articles reviewed he found nine articles in which computers had been used specifically for history taking and interviewing (243). The interviews primarily used a closed questioning system.

The amount of information revealed in an interview has been associated with the degree of privacy of the interview situation. Many differing opinions exist when

comparing computer-assisted survey interviewing (CASI) with face-to-face interviewing. The concept that subjects disclose more socially undesirable answers in a CASI interview has been debated, with some studies finding computerised interviews to result in increased answering of socially undesirable questions due to increased anonymity (6, 94, 131, 245, 246). It has also been found that in face-to-face interviews, subjects often use the situation to gain sympathy about a particular situation, or to discuss issues occurring in their life with the interviewer (247). The participant will also assess the gender, race and appearance of the interviewer in deciding on how to answer the questions (131).

Further, it is recognised that there are true benefits to using a computer to automate the interviewing process. A number of these advantages of computerisation are outlined in Table 3.1.

Table 3-1 Advantages of computerised interviewing, taken from Probst *et al.* (2005) (11)

A form of CASI known as the computerised self-administered questionnaire (CSAQ) was used as the basis for the CAST program. This method does not involve an interviewer. Instead the questions to the interview are displayed on screen. Less affected by social desirability bias (46), studies have reported higher rates of self-

disclosure to socially undesirable questioning relating to smoking, illicit drug use, alcohol consumption, sexual orientation and health status. No differences in reliability and validity have been found when compared to pencil and paper interviewing in psychology. The following table compares the various forms of computer-assisted interviewing.

Table 3-2 Forms of automated interviewing, adapted from Probst *et al.* (2005) (11)

<i>Traditional Form</i>	<i>Computer-Assisted Form</i>	<i>Method</i>	<i>Advantages</i>	<i>Disadvantages</i>
Telephone Interviewing	CATI (Computer-Assisted Telephone Interviewing)	Most common form of survey collection using a computer program to display questions and information for the interviewer to read. The interviewer also enters the responses of the participant into the computer (46).	<ul style="list-style-type: none"> • First form of computer-assisted interviewing • Decreased interviewer bias • Standardisation of the interview • High consumer acceptance compared to paper-pen interviews 	<ul style="list-style-type: none"> • Interviewers sometimes complain about the rigidity of the interviews
Telephone Interviewing	TDE (Touchstone Data Entry)	After dialling into a computer, participants are played recorded versions of the questionnaire. Answers are indicated by pressing buttons on the telephone handset.	<ul style="list-style-type: none"> • Speed of processing • User friendly for persons unable to read and/or write 	<ul style="list-style-type: none"> • Clarity of speech required • Equipment needs
Telephone Interviewing	IVR (Interactive Voice Response) / ASR (Automatic Speech Recognition)	As above, the participant dials into the computer. Answers are given by answering aloud using voice recognition entry (VRE) (46).		<ul style="list-style-type: none"> • Questionnaire may be overheard by others reducing accuracy of responses (46)

Face-to-face interview	CAPI (Computer-Assisted Personal Interviewing)	Uses very similar technology to CATI. However, the computer is generally portable and involves face-to-face interviewing (46)	<ul style="list-style-type: none"> • Only a small percentage (5%) report negative feelings • Prevents interviewer mistakes compared to traditional paper and pen interviews (PAPI) • Diminished number of missing data such as 'don't know' or 'no answer' • Little difference in data quality when compared to PAPI 	<ul style="list-style-type: none"> • Less privacy and increased bias in answering socially undesirable questions • Not always possible to back track to make changes • Typing skills and computer literacy especially with open ended questions • Long interview with closed questions n=2,000 30% cost saving whereas shorter interview with few open ended questions n=200 save 5% costs • Approx 1,500 interviews needed to balance front end and back end costs when compared to PAPI
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Self Administered Questionnaire	CASI (Computer-Assisted Self-Interviewing) or CSAQ (Computer Self-Administered Questionnaire)	The computer is used by the participant to enter in the responses to the program. Generally the questions are displayed on screen in a textual format.	<ul style="list-style-type: none"> • Less affected by social desirability bias (46) • Increased self-disclosure (yet diminishes with time as computers increase in familiarity) • Subjects find it interesting, amusing and easy to use • >80% no problem using computer & program • Higher degree of privacy and anonymity • Lower number of errors and missing responses 	<ul style="list-style-type: none"> • Limited populations to be studied due to computer accessibility • Eye Strain (physical problems) • No difference in reliability and validity when compared to PAPI when used in psychology
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Self Administered Questionnaire	ACASI (Audio Computer-Assisted Self Interviewing)	The computer displays the questions in a textual format, as well as reading it to the participant.	<ul style="list-style-type: none"> • Increased participation and completion rates by providing a stimulating and interactive environment. • Illiterate patients can complete questionnaires (46) • Wider population target (46) • Can be recorded in any language (246, 255, 256) • Provides an electronic data record (246, 255, 256) 	<ul style="list-style-type: none"> • Reduced comprehension if long questions used (46) • Questionnaire may be overheard by others reducing accuracy of responses (46)
Self Administered Questionnaire	CASI-V (Computer-Assisted Self Interviewing – Visuals)	The computer displays both text questions and visuals on screen for the participant.	<ul style="list-style-type: none"> • Images help relieve boredom and improve motivation (253) 	<ul style="list-style-type: none"> • Respondents must be able to read, and recognise numbers to respond appropriately
Self Administered Questionnaire	CASI-IP (Computer-Assisted Self Interviewing with Interviewer Present)	Interviewer is present to assist if necessary, whilst the participant enters responses on the computer.	<ul style="list-style-type: none"> • Able to assist participant with interview where required • Interviewer helps maintain motivation (46) 	<ul style="list-style-type: none"> • Bias in answering socially undesirable questions • Interviewer may distract answering of questions (46) • Variation in probing for answers (46)
Mail Survey	DBM (Disk By Mail)	Participants are sent questionnaire on disk for use on own computer	<ul style="list-style-type: none"> • 25-70% response rate • Approx 35% response without reminders 	<ul style="list-style-type: none"> • Restricted to populations with a computer or access to one • More expensive

Mail Survey	EMS (Electronic Mail Survey)	Participants are sent questionnaire via email	<ul style="list-style-type: none"> • More open communication, participation and more ideas given (possibly due to the differences in interaction between EMS and PAPI) 	initially compared to PAPI (yet high response rate)
Mail Survey	PDE (Prepared Data Entry)	Participants receive electronic questionnaires by mail and complete them on their own computer (46)	<ul style="list-style-type: none"> • The questionnaire controls the order of questioning and checks for missed responses (46) 	
Mail Survey	Web Interviewing	Traditionally a self-administered questionnaire that is completed on the Internet.	<ul style="list-style-type: none"> • Speed of data collection improved 	
Panel Research	CAPAR (Computer-Assisted Panel Research)	A number of researchers questioning the participant.	<ul style="list-style-type: none"> • Various input from large number of persons involved 	<ul style="list-style-type: none"> • Answering bias based on questions asked

The CSAQ method was selected as it is the most feasible within the primary healthcare setting, decreasing the need for an additional person to conduct the interview while still allowing high quality personal data to be obtained from the patient.

3.6.2 Self-report data

As previously discussed, self-reporting has been identified as a factor of bias within interviewing for many years. Careful consideration should be taken when allowing for the wording of the questions and the setting of the interview (257, 258). In the context of this thesis, it was recognised that self-reporting may have a negative impact on the accuracy of data relating to the consumption of foods traditionally seen as unhealthy. However, when self-reporting is carried out in a computerised environment, it can produce a very different result. In 1969, the Massachusetts

Institute of Technology published a paper on computer based self-reporting. The Institute's researchers have used a questionnaire that included socially undesirable questions and provided participants with either the computerised version or the paper and pencil version. The study found no significant differences between the two methods of administration for questions not relating to social behaviour. There was, however, a higher response rate for the computer questionnaire for socially undesirable questioning (131). Overall, participants reported that compared to the paper and pencil interviews, using the computerised version was quicker, more professional, more accurate and more understandable. They also reported that they had enjoyed the experience and had felt less tense and more comfortable with the process (131). Self-reporting is the underlying methodology of the CAST project and due to its computerised format, and thus limited face-to-face contact, the nutrient intake data obtained is expected to be less biased than that of a traditional assessment.

3.6.3 Professional judgement

Professional judgement is often used in questionnaire development and was an important component in the CAST website. Professional judgement, that is the application of knowledge, skills, values and the experiences of qualified professionals to the interpretation of data, has not been widely reported in the literature. A search strategy of Medline (New York, N.Y.: Ovid Technologies, Columbia URL: <http://www.columbia.edu/cgi-bin/cul/resolve?clio4066287>) from 1996 to 2005 and using the search terms “professional judg(e)ment” and “professional interpretation”, found that studies utilising professional judgement as a methodology either did not define the details, or had been reported more than ten years ago (259-264). The few recent studies describing such processes (265-268) did not commonly relate to the field of nutrition, and none related to database development. However, there appeared to be a theme in the comparison of professional judgement with that of quantitative applications or for the assessment of work practices within the healthcare system. For example, Greaves and Grant (2000) conducted a comparison of the professional judgement used by experienced anaesthetists on the assessment of their trainee's capabilities. They found a high degree of complexity involved in such processes when attempting to document the assessments (265).

The only nutrition paper found described a comparison of professional judgement used by dietitians and dietetic technicians with an algorithm used for assessment of malnutrition in hospital patients. Finding differences between the level of experience and the reliability of the professional judgement, the inter-rater reliability of the algorithm was preferred (269). The use of professional judgement is outlined in relation to the development of the CAST program discussed in the next chapter. Professional judgement was chosen to complement statistical analyses due to the form of computerised interviewing selected for the project. The level of food literacy of the end-user would not be as high as that of the Australian Bureau of Statistics (ABS) researchers who created the NNS95 food database that was used as the basis for statistical analysis. Furthermore, the application was intended to complement the advice provided by qualified dietitians, and without their input the development of dietary advice from the program could become increasingly time consuming.

(Chapter 4)

3.6.4 Data reduction

The numbers of food items listed in the questionnaire was delimited using statistical techniques. The statistical techniques employed during the development of the UI need to be understood to ensure that the professional judgement applied to the output followed the same assumptions as the statistical model itself. The statistical analysis for development of the program was conducted by the Centre for Statistical and Survey Methodology at UOW. Details of the statistical process may be found in **Appendix F**.

3.6.4.1 National Nutrition Survey 1995 (NNS95)

Conducted by the ABS as a subset of the National Health Survey, the NNS95 consisted of a population of approximately 13,000 people across Australia. Dietary intake data was obtained by 24-hour recall and data was hierarchically categorised into food groups. Creation of a food database for the CAST website required the use of existing food consumption data. The NNS95 survey allowed this project to gain an insight into the consumption patterns of Australians and thereby the food items likely to be consumed. Limited by the changing food supply over the past ten years, the analysis used generic food items as opposed to branded food products.

3.6.4.2 Association rules

Knowledge about the patterns of food consumption was needed to structure the food database. Due to the extensive size of the NNS95 survey (149), associations between certain foods could be identified. Using the raw food data, food associations were developed using equation 1.

$$\begin{aligned} \text{Support} &= \frac{|X|}{|T|} \\ \text{Confidence} &= \frac{|X \cup Y|}{|X|} \end{aligned} \quad (1)$$

This was based on a 50% level of association between food A and food B i.e. of the people who consumed food A, 50% of people also needed to have consumed food B for it to be associated. These associations were used to rank order the food groups, which had previously been alphabetically ranked by the ABS.

3.6.4.3 Cluster analysis

Clustering techniques include average linkage, complete linkage and the Ward method. Multiple methods are commonly used and combined to determine the most suited output. The average linkage technique (270) treats the distance between two clusters as the average distance between all pairs of items where one member of the pair belongs to each cluster. Note that initially, each observation is assigned to a unique cluster and distances between all objects are calculated using the Euclidean distance measure. Then, for any two clusters A and B, the distance between the clusters is calculated using equation 2 where d_{ij} is the distance between object i in cluster A and object j in cluster B, and N_A and N_B are the number of items in clusters A and B respectively.

$$D_{AB} = \frac{\sum_{i \in A} \sum_{j \in B} d_{ij}}{N_A N_B} \quad (2)$$

The complete linkage (furthest neighbour) technique (270) does not consider the distances between all objects in two clusters. It only considers the distance between the two most distant objects in each of the clusters. That is, the observations are still initially assigned to individual clusters and the closest clusters are agglomerated. However, when two clusters each contain more than one item, the distance between those clusters is specified as the distance between the furthestmost items in the

clusters. Therefore, equation 3 gives the distance between two clusters A and B. The method tends to form compact spherical clusters and is therefore not appropriate where elongated clusters are expected.

$$D_{AB} = \max_{i \in A, j \in B} (d_{ij}) \quad (3)$$

Ward's hierarchical clustering method (271) is based on minimising the loss of information from joining two groups. It uses an analysis of variance approach with the loss of information taken to be an increase in the error sum of squares criterion (ESS). For a given cluster k, let ESS_k be the sum of squares deviation of every item from the cluster mean (as shown in Equation 4 where \bar{x} is the mean of all N items in cluster k). If there are currently k clusters, then the total ESS is given by $ESS = ESS_1 + ESS_2 + \dots + ESS_k$. At each step, the joining of all possible combinations of clusters is considered and the two clusters whose combination results in the smallest increase in ESS are joined. The method assumes that the clusters to be formed are roughly elliptically shaped.

$$ESS_k = \sum_{j=1}^N (x_{jk} - \bar{x}_k)^2 \quad (4)$$

Nutritionally consistent food groups were needed in order for nutrient analysis to be useful. Cluster analysis was performed primarily through the use of dendrogram plots within which foods could be clustered together based on their similarity of nutrient values. An example dendrogram plot is shown in the next chapter (**Fig. 4.2**). The nutrients included within this process were energy (kJ), protein, CHO, saturated fat, monounsaturated fat and polyunsaturated fat. Total fat was not included as it has a linear relationship with the saturated, monounsaturated and polyunsaturated fats.

3.6.4.4 Stepwise regression analysis

Regression analysis allowed the researchers to determine the minimum number of food groups per nutrient that would be required for a certain level of accuracy. The nutrients assessed were again energy (kJ), protein, CHO, saturated fat, monounsaturated fat and polyunsaturated fat. The output of the stepwise regression allowed for the inclusion of food-based predictors within the food groupings vital to the reporting of each nutrient.

3.6.5 Web site interface design

The human-computer interface otherwise known as the UI can be defined as “the point of contact between the application and the end user” (Chalmers, 2003, p594) (117). A quote in 1998 from Reed Gardner “ [i]n my opinion, the success of a project is perhaps 80 percent dependant on the development of the social and political interaction skills of the developer and 20 percent or less on the implementation of the hardware and software technology!” (Lorenzi *et al*, 2000, p117) (272) signifies the importance of interface design during the planning and development stages of software items.

There are a number of ways to design human computer interfaces. Generally, the top-down model in which a specific interface is designed for a particular task is applied to cognitive research. Alternatively, the bottom-up technique involves analysis of the structure of the task, systematically addressing the features. Testing and design will then determine the outcome of the interface (273). This method is the primary form employed throughout the development of the CAST program.

The design of the computer screen layout has a strong influence upon the completion of lessons or questionnaires on the computer. Researchers found, for example, that when a good screen design had been used, there was a higher degree of lesson completion in shortened periods of time. A well designed screen also holds the users attention and allows ease of interaction between the computer and user (117).

Use of red and green should be avoided in interface design due to the large number of colour blind people in the population. The organisation of text is also vital to the understanding of results (117). Rules for interface design as described by Chalmers (2003) are outlined in Figure 3.5.

Applying the cognitive structure of the event to a process often means that the interface will be compatible with the user in terms of the mental representations and comprehension of the program. The instructions for the event should appear segmented and hierarchical, and should not break the sequence around which the event occurs (273).

- | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ol style="list-style-type: none">1. Consistency2. Enabling shortcuts to be used by frequent users3. Informative feedback is provided4. Closure of dialogues5. Error handling and prevention6. Easy reversal of procedures7. Supporting internal locus of control8. Reduce the need for short term memory use. |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Figure 3-5 Rules for interface design

Pictures for cognitive programs are superior to verbal depictions. Representing both at the same time has even greater effect for the user. Limitations can lie within the presentation of inappropriate or misunderstood images, or the use of text and graphics when there is a likelihood of split attention spans. This is often noted in studies when animation is used with text (273). The cognitive structure of the CAST UI mimics the DH interview for which cognitive processes have previously been well documented. The use of graphics throughout and the use of recognisable ‘Australian’ food items also assists to decrease the cognitive burden for the user.

3.6.6 Dietary assessment methods

3.6.6.1 Diet history interview

For assessment of the diet, the DH (DH) technique was developed in 1947 by Burke (4, 274). This method of analysis is often combined with a FR or FFQ to maintain internal validity of the data of an individual or group of people (5, 161). There are many existing techniques existing for the DH, ranging from open-ended questions or narrative interviews (2, 275), to self-administered questionnaires. Utilising the concept of usual dietary intake, the period covered in a DH interview may range from 24-hours to more than one year, but there is no specified length. Shortened spans have been found to result in increased precision and validity of the data (161). Providing information about meal patterns, food consumption and nutrient intakes, DH interviews do not require numeracy or literacy skills of the subject. The interview may be focussed toward specific nutrients and has the ability to assess

seasonal variations of intake (5). The limitations of this technique are in the recall ability of the subject, the skill of the interviewer, the props and utensils available, and the time and cost constraints of the study. DH interviews are time consuming. Often taking up to an hour to complete, the accuracy of responses can be affected as the interview progresses. Subjects may also have a tendency to exaggerate or minimise their intakes due to psychological factors (5, 276).

Performed during a face-to-face dietary consultation, the DH interview is still used in the clinical, community and research setting, allowing the dietitian to discuss with the patient foods eaten over the past day, week or month (276, 277). DH interviews allow the health professional to obtain a broader picture of the person's usual dietary intake, allowing for more specific dietary advice strategies.

Often followed up with a checklist of commonly omitted food items, the DH interview employs components of the FFQ to cross-check foods known to be biased in their reporting by certain groups of subjects. This form of assessment is the basis for the development of the CAST program. Selected due to the limited software currently utilising this methodology, automation of the DH interview would allow dietary advice to be based on the usual dietary intake as opposed to the highly variable actual intake of other assessment forms. Utilising a shortened form of the interview (7-days) the automated assessment was predicted to produce increased precision of dietary data. This form of assessment is compared with the traditional structured DH interview in later chapters of this thesis. **(Chapter 6) (Appendix G)**

3.6.6.2 Food frequency questionnaire

Using a list of food items of variable length, subjects are asked to indicate whether they have eaten each of the food items during a given period of time (278). FFQs (FFQ) may also employ a frequency of consumption option usually based on categories of daily, weekly, monthly or occasional (279). Furthermore, FFQs may ask participants to estimate the amount that is consumed by giving options against which the participant marks the amount they eat. Generally employed as a self-administered questionnaire, the FFQ does not capture the scope of foods that would be identified in the DH interview. Due to the use of closed questioning in the CAST program, components of questionings may be related to the FFQ. The need for a

limited list of food items (280) being the primary feature that included was within the automated DH interview.

3.6.6.3 Food record

FRs are used to determine the nutrient intakes of an individual or population group. Based upon the recording of all food items consumed over a specified period of time, generally ranging from one to seven days, an increased length of recording results in lessened co-operation due to the higher levels of burden (2, 161, 277, 281). Subjects are asked to document all brand names, amounts, additions to and types of foods eaten, which may either involve the subject weighing or estimating the amounts consumed. Limited by the subjects' ability to accurately record, assess and/or measure consumed amounts, subjects participating in this method must be literate (277). Because of its nature, this method can also result in subjects altering their diet due to subconscious influences (276, 277).

Used to determine actual food intakes (2), FRs are frequently used in case-control and cohort studies (1, 281, 282) with the FR employed as the standard of reference. Accuracy of the measures is highly important to the analysis (283). FRs are variable in the amount of detail recorded and can be modified according to the requirements of the study. In this project a 3-day FR was employed, because it suited the study (recording actual intakes provided a useful comparative reference) and was easy to complete. It required subjects to weigh and record two weekdays and one weekend day, allowing comparisons to be made between actual intake (FR) and usual intake (DH). **(Chapter 6) (Appendix H)**

3.7 Ethical considerations

Ethical approval for a study should be sought before any procedures or components of the study design have taken place. Researchers need to ensure the rights of the participants are upheld and honoured. They also need to practice beneficence, ensuring that no harm or wrong doing is intended toward the participant. Equally as important is the concept of justice and fairness for the participants (283).

3.7.1 Participant consent

Ethical considerations need to be observed when gaining access to research participants, in the disclosure of information, when gaining ongoing participant consent throughout the study period. The design of the study, especially in the qualitative research setting, and in the analysis and reporting of data, is an area in which ethics may be forgotten. The study design should ensure that the range of information collected within the study is known to the participants, and that when this information is reported on in the context of the study, the identity of the participants is not revealed. When interviewing participants, the researcher needs to be alert to sensitive issues that may be discussed (172). These areas require continued consent from the subject even though they may originally have given written consent for participation within the study. The CAST case study used paper-based consent forms for all studies. The consent form for the implementation phase was later automated to decrease the burden on the GP. Stakeholder interviews were conducted with verbal consent from the participants. Ethics approval was obtained from the UOW Human Research Ethics Committee for all components of the CAST case study.

3.7.2 Privacy and anonymity

When reporting study data, analysing transcriptions, or even analysing visual observation data, the researcher must ensure the anonymity of all participants is maintained and that no identifying information is revealed. In order to achieve this, coding may be used throughout the study as the only identifier of a subject. Similarly, coding may be used in the transcription of qualitative data in place of names or data that may reveal the subjects identity. In the case of observational data, especially with the use of video recordings, researchers must ensure that identifiable visual features of the subject are masked before reporting or presenting the data to external persons.

3.8 Discussion

The CAST case study was used to determine the feasibility of applying automated dietary assessment in the primary healthcare setting. As the case study is focussed

within the field of action research, the multiple research methods applied throughout this thesis are used to determine the viability of the program. Three-way triangulation (use of multiple methods) of research methods creates a relationship between the qualitative and quantitative methods used and produces not only a validated result but also multiple means of understanding the analysis. Through the use of multiple methods the feedback mechanisms applied in an action research setting can be adapted in a more effective manner than if single methods of analysis had been applied.

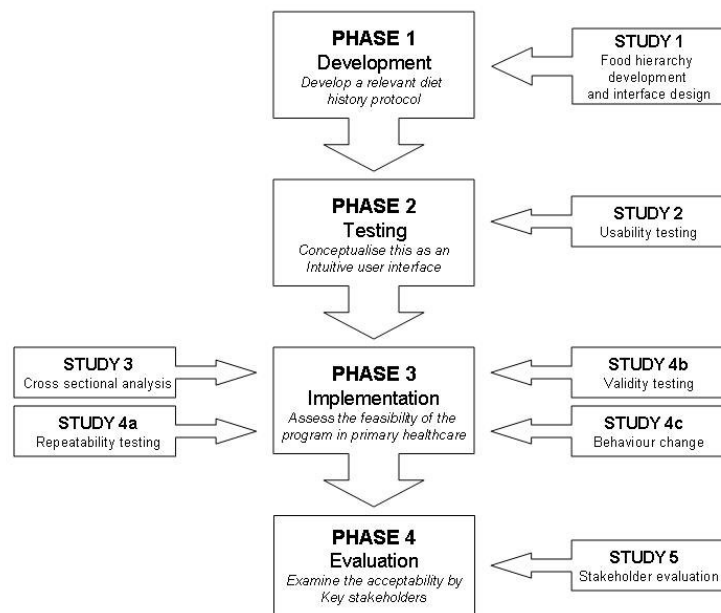


Figure 3-6 Study design of the CAST project showing phases and studies within each phase

3.8.1 Hypotheses

The central hypothesis of this thesis is that: *“CAST will be a feasible option for use in dietary management of metabolic syndrome, the clinical condition of reference, in the primary healthcare setting and will improve clinical services and be accepted by both patients and providers of the services.”*

To confirm this central hypothesis the following sub-hypotheses were tested.

Study 1:

1. The food database (food hierarchy) will be limited to closed questioning yet will capture a broad range of food items reported in the most recent Australian NNS95.

Study 2:

2. The degree of assistance will be affected by the level of computer literacy of the user i.e. users with a higher degree of computer literacy will have a reduced need for assistance.

Study 3:

3. The program will be accessible by a broad range of patients from differing demographic backgrounds.
4. The computer in the GP surgery will be the least preferred location of access to the program due to the levels of computer ownership in the region.

Study 4a

5. The CAST program will be repeatable, and due to the limited face-to-face contact and the convenience of use the computerised assessment will be preferred by users.

Study 4b

6. The degree of bias in reporting nutrient intakes will be different to the traditional dietary assessment, due to the limited face-to-face contact. The use of computer technology will result in equal, if not more accurate responses due to limited personal contact.

Study 4c

7. Dietary change will result from use of the CAST program.

Study 5

8. Stakeholders will accept the technology, seeing it as an advancement in nutrition practice rather than a burden on practice.

Overcoming limitations to current dietary methods by the implementation of a computerised program is expected to see a similar or decreased measure of error due to the ability to incorporate large amounts of information into a computer package. The limitations of memory, food literacy and computer literacy will be the main obstacles to this project and will be addressed accordingly.

The next chapter will address the first of these sub-hypotheses as the development phase of the CAST project is described through the use of statistical analysis, professional judgement and interface design.



DEVELOPMENT PHASE

Diet Advice 

**Development of the food hierarchy
and user interface**

4

CHAPTER 4

Development of a food hierarchy & user interface * † ‡ §

4.1 Introduction

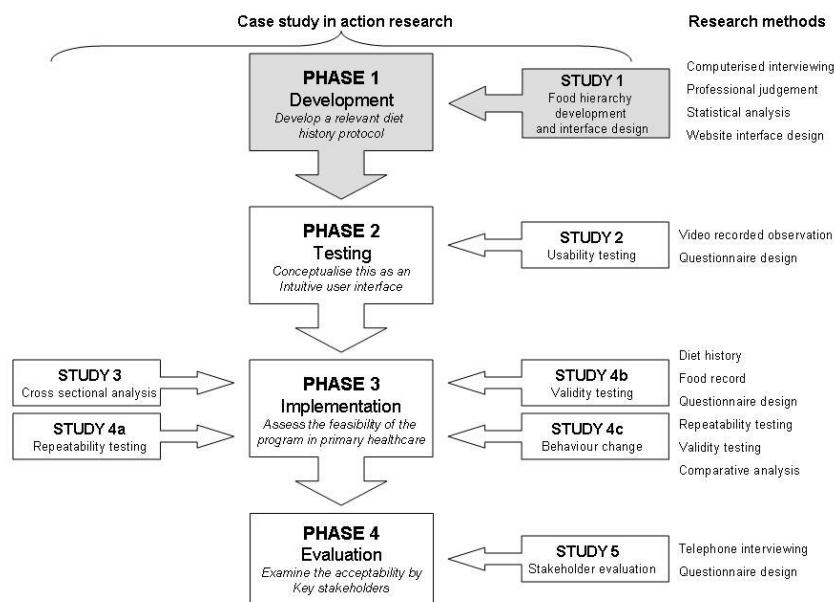


Figure 4-1 Overview of the CAST case study showing development phase

* An overview of the processes described in this chapter has been accepted for publication in a peer reviewed journal: Probst Y., Lockyer L., Tapsell L., Steel D., McKerrow O., Baré M. Toward nutrition education for adults: A systematic approach to the interface design of an online dietary assessment tool, *International Journal of Learning Technology*, Accepted Dec 2005.

† A significant proportion of the statistical analysis methodology has been submitted to the Journal of the American Dietetic Association and may be found in **Appendix F**. Statistical analysis for development of the food hierarchy was performed by Ms Sandy Burden. This chapter outlines the work of the author only, including the application of professional dietetic judgment, face-validity testing and components of interface design.

‡ Data from section 4.4 has been published in a peer reviewed journal: Probst Y., Krnavek C., Lockyer L., Tapsell L. Developing a computer-assisted dietary assessment tool for use in primary healthcare practice: Perceptions of nutrition and computers in older adults with Type 2 Diabetes Mellitus, *Australian Journal of Primary Health*, 2005; 11(3):54-62.

§ Data from this chapter has been presented at the: 2005 6th International Food Data Conference, Pretoria South Africa; 2004 Nutrition Society of Australia Conference, Brisbane Australia; and has been published in the Asia Pacific Journal of Clinical Nutrition 13(Suppl):S40, S136; 2004 General Practice and Primary Healthcare Conference, Brisbane Australia; and 2004 Medical Research Week Symposium, Wollongong, NSW Australia.

The development of the self-administered dietary assessment program is addressed in this chapter as a component of the development phase of the case study. The literature identified a need for computerised dietary assessment packages that could support the dietitian and in turn provide accurate and useful dietary data. As previously discussed, the use of the DH method in the automation of dietary assessment is not commonly seen and was therefore the focus of the CAST program. Beginning with the initial statistical analysis in July 2003, through to the interface design completion in November 2004, this chapter addresses each of the dietetic processes that were involved in developing the program and how they related to the final product. The program aims to incorporate the GP into the nutrition management of patients with metabolic syndrome, the clinical condition of reference, and by so doing, to facilitate greater accessibility of dietary care to a number of patients.

4.2 Aims

1. To develop a program suited to a self-administered dietary assessment which contains a database catering for a broad range of food intake patterns
2. To develop a food classification hierarchy based on levels of grouped nodes. This hierarchy is the underpinning component for the development of a self-administered dietary assessment program that will allow a free-living person to adequately assess their diet.
3. To create food groups clustered on a nutritional basis, that will allow easy identification of a broad range of food items
4. To ensure that naming criteria and the reasons for grouping of foods are suited to the general population
5. To arrange the website UI in such a way that food selection is simple and understandable for the end-user.

4.3 Process overview

Development of the questioning (food hierarchy) and UI of the CAST program occurred in four distinct stages. Focus group discussion sessions were held with potential users of the program to determine preferred interface components such as navigation, help options, colour and included functions. Secondly, statistical analysis was performed using the ABS NNS95 Confidential Unit Record File (CURF) data. Several statistical tests were performed using these data files to provide an outline of foods to be included in the food hierarchy (**Section 3.6.4**). Thirdly, face-validity testing ensured inclusion of all key components of the DH interview and commonly reported food types, and finally interface development used the resultant food hierarchy and focus group outcomes to develop screen layouts which were easy to understand and clear to view. These phases were not separate entities but rather, involved numerous multidisciplinary discussions during the project development to ensure compatibility of functions.

4.4 Focus groups

As a component of the author's Masters research (172), focus group discussion sessions shaped the direction of the research plans of the CAST project. Originally the project had planned to develop a desktop PC software package that could only be used in the waiting rooms of GP practices in the NSW, Illawarra region. The results of the focus group discussion sessions saw modification of this plan to utilise web capabilities for the UI of the program, thus allowing access to the dietary assessment from areas other than the GP practice. The focus groups also identified that there was a large number of older people in the Illawarra region with computer experience and a keen interest in Internet applications. Findings from the focus group discussion sessions have been formally reported elsewhere (284, 285) (**Appendix I**)

4.5 Program structure

Outlining the structure of the program allowed further analysis to be shaped to the needs of the food hierarchy. Knowing the format of the questioning sequence as well as the meals of concern allowed statistical analyses and UI development to begin simultaneously.

4.5.1 Multiple pass approach

The arrangement of the program needed to be designed in order to capture not only the foods eaten by a range of people following the DH interview sequence, but also to ensure that the structure of questioning was logical when moving through the screens of the computer program/website. A multiple pass system used effectively in other automated assessment programs (95, 286) was therefore agreed on by the team and two key arrangements were identified.

1. Horizontal approach: Each meal would be asked about in sequence and all information about the meal obtained through a multiple layer questioning sequence. For example, for breakfast the user would be asked whether they eat, bread, cereal, eggs etc. They would then be questioned about the type of bread (such as grain bread), followed by the exact bread eaten (such as soy and linseed bread). The user would then be asked how much and how often each item was eaten. This process would be followed through for every food item eaten for breakfast until the next meal was reached.
2. Vertical approach: Each meal would be asked about in sequence, yet information would be obtained about the entire day, building on detail as the next layer of questioning was reached. For example, a user would be asked whether they eat bread, cereal, eggs etc for breakfast. They would then be asked similar food group questions for lunch and the remaining meals for the day. Once all meals had been broadly defined, more detail for each meal would be requested beginning with breakfast. Once the detail about the foods had been obtained, the amounts and frequency would then be examined.

From a dietetic perspective, it was felt that the cognitive benefits of approach number one were outweighed by the need for the food data to be user-friendly and to

potentially be entered in a number of sittings. Previous programs had utilised approach number one. However, these were interviewer administered and used a 24-hour recall assessment. Approach number two was selected, as the layers of questioning allowed the user to progressively complete the DH interview in more than one sitting if needed. It is known that the DH is time consuming when administered face-to-face, therefore this factor was the basis for the decision. Further, the interface design of approach number one did not allow for all components to be clearly displayed on screen.

4.5.2 Meal mapping

A traditional DH interview is composed of distinct segments of questioning which are sequentially followed by a dietitian. These segments begin at the start of the day with the first meal consumed and progress through to the end of the day to the last meal consumed. Following this pattern the dietitian can again begin with the first meal of the day and ask questions relating to the exact food type(s) eaten, the amount and how often the food was consumed over a 28-day period (287).

The focus meals in a traditional DH interview were mapped out based on those most commonly consumed within society - breakfast, between breakfast and lunch, lunch, between lunch and dinner, dinner and after dinner. These were later renamed breakfast, morning tea, lunch, afternoon tea, dinner and supper. Although some variations of meal names exist in the population, these names were selected as the most commonly identified meal names and therefore applicable and recognisable by the majority of the population. Food data from ABS NNS95 survey was listed by meal and time of consumption. Snacks were grouped together and needed to be separated based on when they were consumed. By sorting the consumption times into segments of 6am-12pm, 12pm-6pm and 6pm-6am all food items could be placed into one of six meals. A category of brunch was also identified from the ABS data but was later excluded from further analyses due to its limited regular consumption.

4.5.3 Open vs. closed questioning sequence

The wide variety of foods available in the Australian context raised issues of question type for the food items. Should the end-user be allowed to type further

information about the food items or should the foods be limited to point and click only? Although computer literacy did not appear to represent a significant concern within the target population, typing abilities within this age group have been shown in the literature to be limited and a source of negative enjoyment when interacting with computer interfaces. It was therefore decided that food items would be selected from a list, rather than being typed in by the user. This decision shaped the need for food group development from interpretation of the statistical analyses.

4.6 Statistical analyses

The ABS NNS95 food data is the most recent survey of Australian food intakes (Section 3.6.4.1). Each of the foods in the total NNS95 food list was given a unique numerical identification corresponding to an 8-digit code. The NNS95 food data was also arranged into a hierarchical structure with three nested levels of grouping, each level containing more detail than the previous. The highest-level grouping (first node) contained 2-digit codes known as food categories. This was followed by sub categories (second node) with 3-digit food codes and 4-digit codes for the lowest level of grouping (third node). Table 4.1 provides an outline of the hierarchical structure and the number of groups at each level. The level of a food item (fourth node) is identified by the 8-digit code.

Output data from the statistical analysis of food intake data reported in the NNS95 (149) was interpreted upon completion of each phase of analysis. The interpretation of the data was based on recognition of food groups by a dietitian as being food commonly reported during a DH interview, readily available to the general public, or as suitable for the selected study population. Foods were included if they were identifiable in documentation from DH interviews conducted during previous intervention studies using a similar target population. Foods were excluded if they were unavailable to the general public, or if they were aimed at population groups outside of the target group, children or infants for example. Further, new food groups were added to the list if the dietitian considered them to be consumed in greater quantities today than ten years ago. Foods eaten together and the composition of food groups based on nutrient and conceptual similarities were then considered.

Finally, the devised food group list was assessed by five dietitians for face validity and modified by consensus.

Table 4-1 ABS NNS95 Food grouping structure (149)

4.6.1 Minimum number of food questions

Analysis of bias for the differing levels of food groups per macronutrient (energy, protein, CHO and total fat), were used to decide on the lowest level of reporting needed within the program. These calculations were performed by the statistics team of the CAST project. It was determined that the reporting of foods at a 4-digit food group level still allowed a person to capture an outline of their diet with a 20% rate of systematic error when compared with reporting of the individual food items (8 digit level). It was therefore decided that 4-digit reporting should be the lowest level of detail required.

4.6.2 Commonly consumed food items

The food groups to be contained within the food hierarchy needed to be determined. Statistical analysis of NNS95 CURF data ranked the most commonly eaten foods for both frequency of consumption and contribution of total energy (kJ) intake. This list was based on the foods consumed by greater than 1% of the total NNS95 population. The calculations were performed for the 4-digit level of grouping of the ABS data. Such calculations also provided the inclusion of the number of times each food item was recorded on the survey as a whole. Output from the ABS NNS95 data gave a listing of commonly consumed food items of the Australian population. In total, 390 foods listed for the frequency of consumption data and 945 food items listed for the weighted energy data required interpretation.

The item codes of the NNS95 food groups were used in the statistical analysis (288). Names of the food groups were not included in the analysis, therefore interpretation of the results began with naming each of the item codes that emerged from the analysis of each meal (breakfast, lunch, dinner). Each common food was then related back to the original upper level food grouping from NNS95. This analysis resulted in the identification of a number of individual foods that were not commonly eaten. This list was reviewed to determine the impact of their inclusion or exclusion within the food hierarchy for the study population (i.e. adults with metabolic syndrome, the clinical condition of reference).

The names and item codes also needed to be compatible with the Australian nutrient database (AUSNUT) to allow nutrient analysis at future stages of the hierarchy development. It was identified that the item codes for food items were compatible and that the first 2, 3 or 4 digits of the code could be used to identify which ABS food group the food item would fall into. An example of this is shown in Table 4.2. For example 11 identifies the juice below as part of the non-alcoholic beverages group, 113 identifies it as a fruit juice and 1131 as an apple juice. Data from the commonly consumed foods listing from ABS could then be summarised based on meals and checked for relevance to current-day food consumption patterns. Each of the food items were found to be compatible with those commonly eaten at mealtimes today.

Table 4-2 Example of a comparison of ABS and AUSNUT listing

<i>ABS NNS95 Food Code and Listing</i>	<i>AUSNUT Food Code and Listing</i>
11310101	11310101
Juice, Apple, No Added Vitamin C	Berri Apple [Juice]
	Berri pure'n'fresh apple [Juice]
	Daily juice co. apple [Juice]
	Dean's apple [Juice]
	Glen Park apple [Juice]
	Mr Juicy apple [Juice]

Of the 4,551 individual foods of NNS95 only 3,519 were reported during the survey (288). From these foods, milk was found as the most commonly reported food item by frequency of reporting and also by contribution to total energy (Table 4.3).

Table 4-3 Foods commonly reported in NNS95 showing percentage of all food items reported

<i>Meal</i>	<i>Frequency of consumption</i>	<i>%</i>	<i>Contribution to total energy</i>	<i>%</i>
Breakfast	Milk	11.1	Milk	13.0
Lunch	Tomatoes	3.8	White bread	6.7
Dinner	Carrots	3.1	Rice	3.2
Snacks	Milk	8.4	Milk	5.7

Infant formulas and infant foods were excluded from the database as they were not suited to the study population, thus decreasing the total number of individual food items to 3,500.

Due to changes in the food supply over the past decade, the option of ‘other’ was included for each ABS food group. This would allow newly developed foods to be categorised accordingly with time. Also, due to differences in the food consumption patterns of today compared with 1995, dietary supplement food was included as a food group at each meal even though it had not been included in the NNS95 commonly consumed data.

4.6.3 Foods eaten together

Due to the extensive size of the NNS95 survey, associations between certain foods that were commonly eaten together were also identified by the statistics team. The dietitian used these associations to rank the order of the food groups, which had previously been alphabetised by the ABS. Due to the number of foods that were associated with more than one food item, the process of ordering the food database based on associated foods was eliminated. Each meal was given a standardised order of foods which could later be modified on screen, depending on commonality of reporting from previous DH interviews.

The associated food names were to be used as probing questions in the web-based questionnaire. The associated food lists required review by the dietitian to determine their inclusion or exclusion within the question schedule for the automated dietary assessment. Food combinations were included if they were reported together in DH interviews, for example, coffee with milk. Foods which did not appear in the output for associated foods analysis but appeared regularly in the DH documents were also added to the food list, for example, salad dressing. Foods that were not commonly

reported together were excluded from the associated foods listing, yet were still included in the common foods listing if they met the inclusion criteria for that category for example, bacon.

The associated food list identified foods that were still eaten together today. Milk with breakfast cereal appeared 24% of the time for all milk associations (n=111), tea with sugar appeared 23% of the time for all tea associations (n=53) and bread with margarine appeared 24% of the time for all bread associations (n=54). Due to the overlap between the numbers of associated foods, a list of foods that were eaten with another food compiled (Table 4.4). This list was used as prompting questions in the corresponding location of the website.

Table 4-4 List of foods eaten with other foods (associated foods) used in prompting questions in the CAST website

Bread	Margarine	Salad filling
Butter	Mayonnaise	Sauces & gravies
Cheese	Meat filling	Savoury spread e.g. Vegemite
Cream	Milk	Sour cream
Dip	Oil	Sugar & sweetener
Egg filling	Pasta	Sweet sauce & topping
Fish filling	Potatoes	Sweet spread e.g. Jam
Fruit	Rice	Syrup
Malt extract e.g. Milo	Salad dressing	Yoghurt

4.6.4 Re-grouping foods

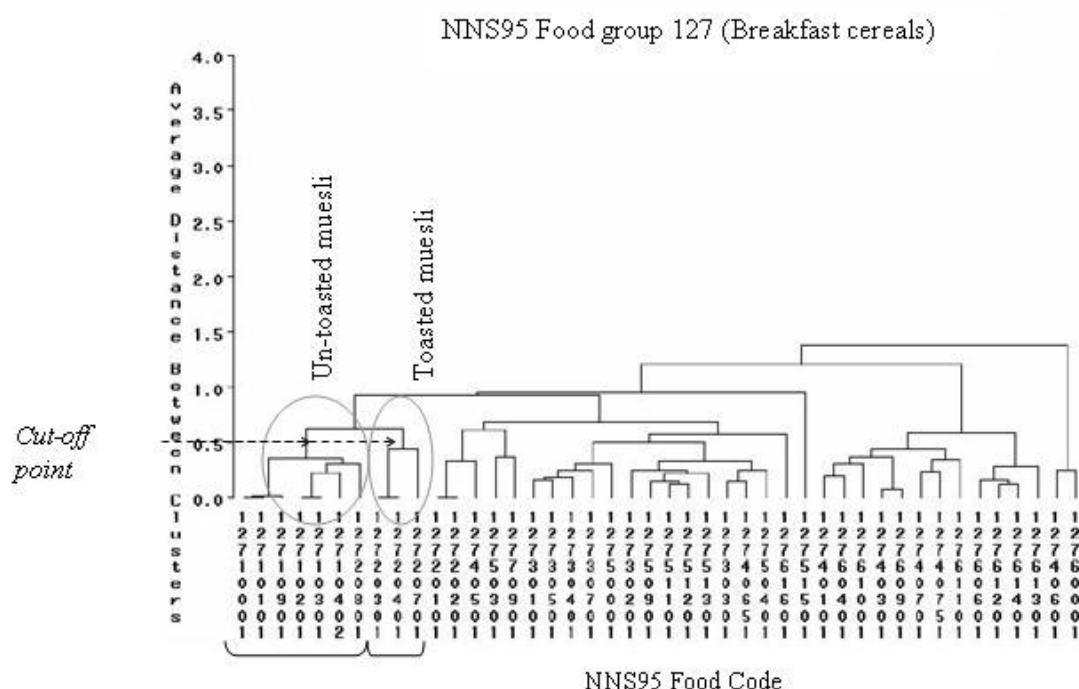
Cluster analysis was performed by the statistics team to establish the similarity of nutrient composition of the food groupings used in the NNS95. The nutrients included within this process were total energy (kJ), protein, CHO, saturated fat, monounsaturated fat and polyunsaturated fat. Total fat was not included as it has a linear relationship with saturated, monounsaturated and polyunsaturated fats. The clustering techniques employed for each set of food groupings were average linkage, complete linkage and the Ward method (**Section 3.6.4.3**).

Cluster analysis data was originally provided for the entire list of more than 4,500 foods (288). Interpretation of this data revealed unrelated foods grouped together and clustering needed to be selective with certain groups in the NNS95 database. These groups were determined by assessment of the original NNS95 groups for nutrient similarities and everyday recognition of similarity (conceptually similar). Foods which were judged as not recognisable by a layperson were re-clustered individually.

Output from the cluster analysis took the form of dendrogram plots displaying the stepwise progression of groups from the least similar as a whole to those most similar as a whole. Dependant on group size, tables were also provided using Microsoft Excel (version 2000, Microsoft Corporation, USA). These tables indicated the split of food groups that was not distinguishable in the dendrogram (288).

A cut-off point for the number of groups to be formed needed to be created for each dendrogram produced. This point was set to ensure that a 'picture' of the entire food group could be seen and the majority of foods which were similar were all within the cluster. The cut-off was determined by listing each of the leaf nodes (individual food items) of the dendrogram in order of their appearance and assessing similarities in nutrient composition for CHO, protein and fat (saturated fat, monounsaturated fat and polyunsaturated fat). Foods that appeared both nutritionally and conceptually similar at the lowest level of the dendrogram were grouped based on the grouping node to which it related. For example Figure 4.1 shows the dendrogram output for group 127 (breakfast cereals). The food code numbers (leaf nodes) were each related back to their corresponding food name as shown in the table. The grouping arms for the foods were then followed up on the dendrogram arms until the grouping of foods was considered recognisable to the general public. Figure 4.1 shows the formation of two of the food groups for cereals based on the average linkage clustering technique. These foods were then linked back to the original groupings used by NNS95. If these groups already existed, they were added to the food list. If a group of these food items did not already exist, a new group was created using a generic name for all foods within the group. A similar process was followed for the tables of clustered groups for which the dendrogram output was unclear. Each statistical output,

whether dendrogram or tabular, gave the three different forms of clustering. Interpretation required each method to be assessed separately. The clustering method which produced a grouping of foods that were not only similar in nutrient composition, but also conceptually similar and relevant to the layperson, was selected. Often this required combinations of more than one technique to be used and resulted in a subjective grouping of foods based on their positioning in the cluster.



<i>NNS95 Food Code</i>	<i>NNS95 Food Group name</i>	<i>'New' food group</i>
12710001	Muesli, untoasted, < 20% total sugars, unfortified	Untoasted muesli
12710101	Muesli, untoasted, < 20% total sugars, fortified	Untoasted muesli
12710201	Muesli, untoasted, > 20% total sugars, unfortified	Untoasted muesli
12710301	Muesli, untoasted, > 20% total sugars, fortified	Untoasted muesli
12710402	Muesli, untoasted, homemade with dried fruit	Untoasted muesli
12710901	Muesli, untoasted, commercial, NFS	Untoasted muesli
12720101	Muesli, toasted, fat < 12%, fortified	Toasted muesli *
12720201	Muesli, toasted, fat < 12%, unfortified	Toasted muesli *
12720301	Muesli, toasted, fat > 12%, fortified	Toasted muesli
12720401	Muesli, toasted, fat > 12%, unfortified	Toasted muesli
12720701	Muesli, toasted, NFS	Toasted muesli

* Professional judgment required. Abbreviations: NNS95 – National Nutrition Survey, NFS – No form specified.

Figure 4-2 Cluster analysis for NNS95 group 127 (Breakfast cereals)

Using average linkage clustering technique showing cut-off points for grouping of food items and areas in which professional judgement was required for food group creation

For example, the original cluster analysis of the entire 4,500 plus foods resulted in noodles and custard being grouped together due to their CHO similarities (288). These were not believed to be conceptually similar. Of the 21 upper level groups of NNS95 ten groups were re-clustered. Within each of these upper level groups, groups from the second level of NNS95 were used for the clustering. For example, within the milk products and dishes category of NNS95, cheeses were re-clustered separately from milks and yoghurts due to conceptual similarities. Table 4.5 shows the results from the cluster analysis and the final interpretation for the food database. The sample shown in the table signifies the importance of using more than one clustering technique. The groups provided by a single cluster analysis method were not suitable to a database for use by the layperson. Using a combination of each analysis resulted in groups which were not only nutritionally, but also conceptually similar.

Applying professional judgement to the food database resulted in an increase from the original 370 third level NNS95 food groups to 453 food groups. This change in numbers was primarily the result of separating groups into their fatty acid constituents, the clustering output separating foods such as toasted bread or bread rolls from the untoasted forms, and the addition of 'other' categories.

Table 4-5 Sample of cluster analysis for NNS95 group 194 (Cheese) showing macronutrients, results for each separate cluster technique, and areas of professional judgement.*Numbers bolded indicate the group of foods used for the formation of final food group*

<i>NNS95 Food item</i>	<i>Macronutrient Composition (g)</i>				<i>^a Clustering technique</i>			<i>Final food group</i>
	<i>Energy (kJ)</i>	<i>Carb</i>	<i>Pro</i>	<i>Fat</i>	<i>^b Ward</i>	<i>^c Avg</i>	<i>^d Comp</i>	
Cheese, cream, reduced fat	803	3.1	8.4	16.5	3	2	2	Cream cheese, cream cheese based-dips, fruit cheeses
Dip, cream cheese-based, reduced fat, commercial	682	12.9	4.6	10.8	3	2	2	Cream cheese, cream cheese based-dips, fruit cheeses
Cheese, bocconcini	856	0.1	17.2	15.2	4	2	1	Other soft cheeses
Cheese, goat	823	1.0	13.1	15.8	4	2	1	Other soft cheeses
Cheese, haloumi	1020	1.8	21.3	17.1	4	2	1	Other soft cheeses
Cheese, processed, cheddar type, reduced fat (fat > 12%)	1066	7.0	17.7	17.6	4	2	1	Other soft cheeses
Cheese spread, cheddar-based, reduced fat	995	6.5	16.5	16.5	4	2	1	Other soft cheeses
Cheese, mozzarella	1260	0.1	26.0	22.0	4	1 *	2	Full fat cheese eg. Cheddar, parmesan, mozzarella
Cheese, pizza	1300	0.1	28.8	21.9	4	1 *	2	Full fat cheese eg. Cheddar, parmesan, mozzarella
Cheese, cheddar, reduced fat (25% reduction)	1370	0.0	28.7	23.8	4	1	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, edam, reduced fat	1290	0.1	33.0	19.8	4	1	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, gouda, reduced fat	1354	0.1	30.8	22.4	4	1	2	Reduced fat cheese eg. Light cheese, 25% reduced fat

Cheese, mozzarella, reduced fat	1200	0.1	31.7	17.9	4	1	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, Swiss, reduced fat	1390	0.1	34.7	21.6	4	1	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, reduced fat, NFS	1346	0.0	29.0	23.1	4	1	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, cheddar, reduced fat (50% reduction)	1107	0.0	31.3	15.5	4	2	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, cheddar, low fat	844	0.1	33.9	7.2	4	2	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, feta, reduced fat	974	0.1	25.7	14.5	4	2	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, processed, cheddar type, reduced fat (fat < 12%)	829	3.7	24.0	9.8	4	2	2	Reduced fat cheese eg. Light cheese, 25% reduced fat
Cheese, fat-modified, reduced cholesterol	1394	0.1	34.0	22.0	4	3	3	Soy cheese, Lo Chol, Mini Chol

* Professional judgement required

^a Numbers shown correspond with the group number formed i.e. all foods under one clustering technique with the same number were determined as similar by the clustering technique to which it corresponds

^b The Ward method uses sum of square to minimise the distance between any two clusters to create exclusive subsets which are internally similar with respect to the specified criteria. (Ward 1963)

^c Average distance clustering technique calculates the distance between clusters are determined by the average distance between any two subsets (Stockburger 2001)

^d Complete linkage clustering technique calculates the distances between clusters are determined by the furthest distance between any two subsets (Stockburger 2001)

Abbreviations: NNS95 – National Nutrition Survey, Carb – Carbohydrate, Pro – Protein, NFS – No form specified, Ward – Ward method, Avg – Average Linkage method, Comp – Complete Linkage method.

4.7 *Face-validity testing*

As the data from the NNS95 survey was prepared for researchers and statisticians, the naming criteria of the food groups did not necessarily reflect those used by laypersons to describe foods. Similarly the generic names created from the cluster analysis were not considered to be suited to the layperson.

A total of five experienced dietitians from three states of Australia (New South Wales, Victoria and Queensland) reviewed the final food list to ensure that food names were those referred to by the layperson, and that all commonly reported foods, from their experience of the DH interview, were included using the food hierarchy developed from the statistical analysis. The two dietitians from Victoria renamed food items and expanded/condensed food groups to facilitate ease of finding the foods by the end-user. The two dietitians from Queensland collaborated to create their own list of food items grouping them according to their own professional judgement. Upon completion of the two separate food lists, all dietitians met and critically analysed the resultant lists. Many food groups were combined to minimise the large number of food groups. Group consensus also resulted in foods that were not usually eaten alone being removed from the food hierarchy. These foods were either moved to the associated foods list or eliminated from the database. For example, herbs, spices, flours, custard, baking powder and gelatine were eliminated as they were not eaten alone. This decreased the list of individual food items to 3,437 foods that needed to be grouped.

The final two food lists were combined by the New South Wales dietitian (the author of this thesis). Foods from the list created by the Queensland dietitians, were assessed for their inclusion in the food hierarchy. The primary decision process related to the level of grouping of a food item. Many of the foods from the Queensland list were individual food items and needed to be grouped based on nutrient or conceptual similarities, or they were able to be inserted under one of the existing groups in the food hierarchy. Once all items from the Queensland list had been considered, the resulting food groups in the database again needed to be renamed for recognition by the layperson. This

renaming involved the addition of example food items that were recognisable by the general public.

Following a standardised format, food groups in the database needed to be expanded further to include forms currently available in the marketplace and not seen in the NNS95 data. The breads and bread rolls group, for example, contained subcategories for white, wholemeal, mixed grain and rye breads, whereas after clustering the English muffins group did not. This group was therefore modified to include the newly available wholemeal and mixed grain varieties. This further increase in food groups resulted in 501 groups in total.

Ninety-two percent of foods from the NNS95 database were renamed. For example, 'Breakfast cereal, biscuit, regular, whole wheat, low sugars' became 'Wheat based biscuits eg Weet bix, Vita Brits'. Foods were primarily renamed to simplify the description and to add an example food to allow recognition of the group by the layperson.

Table 4.6 shows the change of the food groups from the original NNS95 food groups, to those used in this study. It can be seen that these upper level groupings resulted in less groups due to the reallocation of some groups to the associated foods list, while others were excluded altogether. The final food group numbers were different from those of NNS95 (Table 4.7), primarily due to the different time periods in which the databases were created, and also to the primary function of the CAST database compared with that of NNS95.

Table 4-6 First level food groups showing the original NNS95 food groups from which they were formed

<i>1st level NNS95 food groups</i>	<i>'New' 1st level food groups</i>
Non alcoholic beverages	Non-alcoholic drinks
Cereals and cereal products	Rice & pasta dishes Bread Cereal
Cereal-Based Products and Dishes	Biscuits and crackers Convenience and takeaway foods Bakery products
Fats and Oils	*
Fish and Seafood Products and Dishes	Dishes with meat, chicken or fish
Fruit Products and Dishes	Fruit & fruit dishes
Egg Products and Dishes	Eggs & egg dishes
Meat, Poultry & Game Products and Dishes	Dishes with meat, chicken or fish Meat, chicken & fish (not in a dish)
Milk Products and Dishes	Dairy
Soup	Soups
Seed and Nut Products and Dishes	Savoury snack foods
Savoury Sauces and Condiments	
Vegetable Products and Dishes	Vegetables and vegetable dishes Salad
Legume and Pulse Products and Dishes	Vegetables and vegetable dishes
Snack Foods	Savoury snack foods
Sugar Products and Dishes	Sweet snack foods
Confectionary and Health Bars	Savoury snack foods
Alcoholic Beverages	Alcoholic drinks
Special Dietary Foods	Meal replacements & supplements
Miscellaneous	*
Infant Formulae and Foods	**
* Moved to associated food groups, ** Excluded Abbreviations: NNS95 – National Nutrition Survey	

Table 4-7 Number of food groups in each level of the new food database

<i>1st level food groups</i>		<i>2nd level food groups</i>	<i>3rd level food groups</i>
Alcoholic drinks	1	4	15
Bakery products	2	9	27
Biscuits & crackers	3	2	12
Bread	4	5	25
Cereal	5	2	15
Convenience & takeaway foods	6	11	33
Dairy	7	6	31
Dishes with meat, chicken or fish	8	7	49
Eggs & egg dishes	9	1	6
Fruit & fruit dishes	10	3	13
Meal replacements & supplements	11	3	4
Meat, chicken & fish (not in a dish)	12	16	41
Non-alcoholic drinks	13	9	34
Rice & pasta dishes	14	2	21
Salad	15	1	14
Savoury snack foods	16	8	13
Soups	17	3	15
Sweet snack foods	18	4	12
Vegetables and vegetable dishes	19	7	42
Total number of food groups	19^a	103^b	422^c
National Nutrition Survey (NNS95) hierarchy contained ^a 21 ^b 106 ^c 370 food groups			

4.8 Interface development

A description of the development of the UI and its link to the websites design has been formally reported elsewhere (285).

4.8.1 Meal selection

As not all meals would be eaten by each person, a dynamic website was created so that it could change based on the selections of the user. A meal selection screen (Fig. 4.3) asking about each meal and how often it was eaten on a weekly basis would not only save the user time, but would also allow the dietitian to cross check responses from later sections of the website.

Figure 4-3 Screen shot of 'Meals you eat' section

4.8.2 Eating pattern questions

To save time and to give the dietitian a picture of the person's eating patterns, an eating patterns section was created (Fig. 4.4). This section asked questions about commonly consumed food items to determine the type of each food eaten, for example milk, bread, margarine. These questions would allow the website to preselect responses for the user

and again save them time. This section of the website was removed prior to usability testing as internal tests confirmed that its time saving ability may not be practical. Internal testing revealed that many people were consuming more than one type of food item for different occasions. As this section only allowed one answer to each question, it was found that preselected responses later in the website would still need to be changed creating potential confusion for the user.

Figure 4-4 Screen shot of 'Your eating pattern ' section

4.8.3 Demographic data questions

As the dietary assessment would need to be interpreted by a dietitian for the purpose of developing of a dietary prescription, the inclusion of demographic data questions was required (Fig. 4.5). These questions incorporated additional questions designed to help the study profile the types of users of the website after it had been implemented in the practices (**Appendix A**). Questions began with general medical information required by the dietitian, including self-reported age, height and weight, medical conditions and physical activity. The physical activity questions were those used in the short 7-day validated International Physical Activity Questionnaire (225)..Questions relating to shopping practices, food allergies and dietary restrictions were also included. Questions relevant to profiling the types of website users included questions regarding education,

employment, computer use and comfort, and marital status. All questions were tested within the research team and were based on demographic questions used in Australian census data. Further refinement of the questions would occur as a result of user testing.

Figure 4-5 Screen shot of 'Information about you' section

4.8.4 Food item selection

The food hierarchy that resulted from the interpretation of statistical data was used as the basis for the development and design of the computerised dietary assessment program. The food hierarchy, however, still needed to be presented on screen in a visually appealing manner on screen for self-selection of food items. Based on the vertical multiple pass approach, the team mapped out the layers of each pass through the website questioning sequence. This involved naming the 1st, 2nd and 3rd level food groups so that they would be understood by the layperson. The layers of the website eventually decided upon were therefore:

- Demographic data (Information about you)
- Pass 1 – 2 digit food level (Categories/1st level)
- Pass 2 – 3 digit food level (Subcategories/2nd level)
- Pass 3 – 4 digit food level (Food types/3rd level)
- Pass 4 – Frequency of consumption and food portion size identification

Interface design began with breakfast as a ‘test’ meal. Breakfast was selected as this appeared to be a standard meal for most people and could therefore be used to model the remaining meals of the day. As one standard set of food groups had now been created for all meals, the food hierarchy now needed to indicate which food groups were to be included in which meals. Due to the variability of beverages throughout the day, it was decided that all beverages would be considered together as a ‘meal’ of their own. Working in Microsoft Excel, databases were created to indicate each level of food grouping the meals that applied to these groups. This database was uploaded to an administration area on the website. Each meal was individually interpreted using the common foods analyses to display only the ‘most common’ food items. This ensured that foods such as pasta or meat dishes did not need to be scrolled through during breakfast, for example. The food groups per meal were then placed in order of consumption so that the initial screen for the meal would display the most common foods first. Interface design of each meal could then begin. This process revealed a further need for the sorting of food items. Pass one and two were therefore combined, with only categories appearing on screen displays, while subcategories were selected by the user. The concept of ‘pass’ was also renamed ‘stage’ for ease of recognition (Fig. 4.6).



Figure 4-6 Screen shot showing categories and subcategories from food hierarchy

4.8.5 Foods eaten together

The associated foods list, created as a result of the statistical analysis, was used to speed-up progress through the website and allow foods eaten together to be selected in tandem rather than as separate entities (Fig. 4.7). Each of the individual items from the associated foods list had to be assigned to the subcategory level of each individual food group. This process needed to be completed for each meal and checked for standardisation throughout the website.

The screenshot shows the 'Diet Advice' website interface. At the top, it says 'stage 1 breakfast'. Below this, the main heading is 'Stage 1 - Types of foods you eat and drink'. On the left, there is a vertical sidebar with icons and labels for 'breakfast', 'morning tea', 'dinner', 'beverages', 'main menu', and 'save and log out'. The main content area has sections for 'Cereal' and 'Bread'. Under 'Cereal', there is a checked box for 'Breakfast cereal' and a list of options to tick: 'Milk', 'Sugar & sweetener', 'Yoghurt', and 'Fruit'. Under 'Bread', there is a checked box for 'Bread & toast' and a list of options to tick: 'Butter' and 'Margarine'. There are also unchecked checkboxes for 'Breakfast bars & drinks', 'Bread rolls', 'English muffins', 'Specialty breads', 'Crumpets', and 'Sandwiches'.

Figure 4-7 Screen shot showing associated foods as probing questions

4.8.6 Food portion size and frequency selection

At the final stage of the website, as with a DH interview, it was necessary to identify the amount of food consumed and the frequency of consumption. Commonly used food portion sizes were listed against each food item. Due to the variability of the food groups and the need to standardise the website, two methods of food portion size identification were created. Method one allowed the user to type the amount and select the measure for the portion e.g. Grams, cups, tablespoons. Method two gave a selection of commonly used servings allowing the user to click against the size that they consume (Fig. 4.8). This prompted the need for food portion images to allow ease of identification and to assist users who were not familiar with food portion sizes. The images used on the website were used with permission from DietClub

(www.dietclub.com.au) and from the EPIC-SOFT research team in France. The DietClub images were primarily brand-name Australian items which would be readily identifiable by the user. The EPIC-SOFT images included approximately 280 foods with four to six portion images for each food. The food items selected from this set were those which applied to the Australian setting. Gram measures from these images were converted to cup measures and descriptive names e.g. large slice. Each portion image was then assigned to the corresponding portion size measure and linked to the food groups.

breakfast
dinner
beverages
site instructions
main menu
save & log out

Stage 3 - Amount of food you eat

How much and how often do you eat the foods and drink the drinks you have selected?

Please select the number of **times per week** you eat the food and also the amount you eat. **Images are available** for certain foods by moving the mouse over the eye

Breakfast

How often would you have **Breakfast cereal - Untoasted muesli** at Breakfast ?

☐ Incorrect food ☐ < 1 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 times a week

How much would you have at any one time?

☐ 1/4 cup ☐ 1/2 cup ☐ 1 cup

Please type in the amount you eat

1 cup

prev next

Figure 4-8 Screen shot of food portion size and frequency section

4.9 Discussion

The application described in this chapter was that of the UI development. The development of the DI for analysis of the dietary data occurred through a link of the food hierarchy to an existing dietary assessment package, FoodWorks (89). The package was modified to suit the needs of this project. This package would allow dietary data to be directly downloaded from the website. The website also had an administrative component through which patient logins and GP recruitment could be tracked.

4.9.1 Overview

The development of a food hierarchy containing a broad range of nutritionally grouped food items that would be understood by the layperson was a challenging task.

Combining the applications of statistics, dietetics and web-design, a nutritional theme was needed to hold the study in place. Thus, each of the results could not have been used without interpretation from a dietetic standpoint and the multidisciplinary approach that was utilised throughout the study. The decision to group food items based on the degree of bias when compared with a traditional face-to-face DH interview, saw the inclusion of characteristics of the FFQ methodology. The grouping of food items also allowed for questions relating to food intake to be closed in nature, thus decreasing the respondent burden. Using closed questions would also decrease typographical errors and missing items. Users of the website would be given a finite list of foods from which they could choose those relevant to their eating patterns.

Due to the application and interpretation of the statistical analyses, the size of the database also changed throughout the development of the food hierarchy. The original ABS NNS95 database could not cater for the needs of a self-administered application. The NNS95 food hierarchy was developed to assist researchers to group food items after they had been reported. The CAST food hierarchy needed to allow food item selection from the grouped food items, whilst being able to be understood by the layperson. Foods are referred to differently by different groups of people, such as by the general public when compared with health professionals. Therefore, re-naming of the food items was critical to the success of the website. If food items were not recognisable by the user they would not be selected even if they were actually a large component of the user's diet. The degree to which users understood the final food hierarchy of the CAST website is addressed in the following chapter.

Grouping foods together and asking probing questions reduces the incidence of non-consumption responses and results in a higher degree of accuracy (69, 102). Similarly, the use of meal based questions rather than food based questions results in a higher degree of accuracy regarding food intake (289). It is assumed that although patients may not have a high degree of food literacy, recognition of the food group pasta with a meat

based sauce as opposed to the food item spaghetti bolognaise would result in similar output from the website. By using simplified grouping descriptors, it was thought that accuracy of responses would be encouraged. Combining this with a meal-based sequence of questioning would further assist with obtaining this degree of accuracy by placing the food group within a context i.e. the meal. Interpretation of the statistical data required knowledge of the processes involved in cognition and information processing.

The technological challenge of developing a website, that allows a person to cognitively process and understand the information, was observed in this study. A person can only understand items to their level of comprehension. This level of comprehension is strongly influenced by the environment, and will influence the beliefs, attitudes and behaviours that a person will exhibit. In the CAST project for example, if a person using the website does not understand the UI and selects only the items that they recognise, then, when they receive advice, they will be less inclined to make changes to their dietary intake as they know the diet they reported was incomplete. If this same user did not select food items because they were unable to interact with the UI, their behaviour and attitude toward the dietary advice may again be affected. This negative interaction could foster a decreased acceptance of the technology and a limited perception of the website's usefulness. Development of the UI was a technological challenge due not only to the information processing and cognitive burden of the end user, but also because of the need to create a system suited to a range of computer experience levels.

4.9.2 Limitations and areas for further research

The primary limitation of this study was the need to use Australian dietary survey data which was eight years old at the time of analysis. Although the majority of food items within the marketplace remain the same, many new items have been added to the supermarket shelves. It can only be assumed that these food items are being consumed in the present day, though would not have greatly altered the outcomes or format of the food hierarchy. The age of this survey data highlights the need for further nutrition surveys of the Australian population.

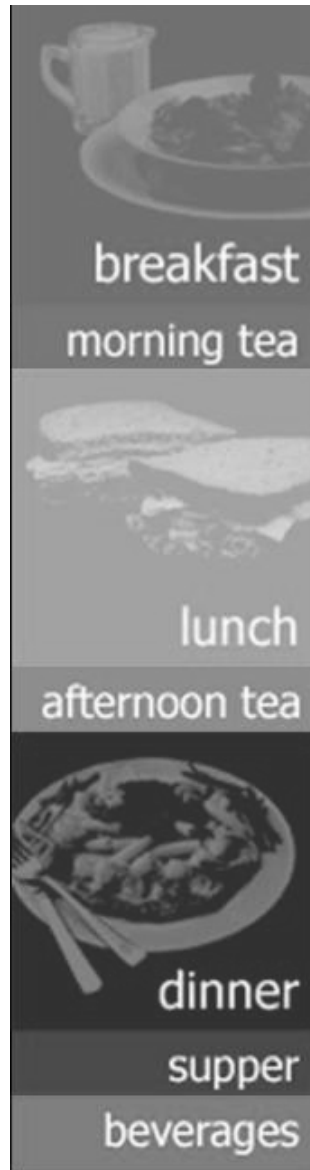
Further, the subjective nature of the professional judgement used in creating the food groups could also be seen as a limitation. This could not be overcome, as the need for

recognisable food names required not only a knowledge of conceptual similarities of food products, but also a broad knowledge of consumer terminology and food availability within the market.

Though the website was tested many times internally by the research team, the ability of the end user to understand and use the website is not known. A study is needed to determine the success of the development process and to allow further modifications to be made.

4.9.3 Relevance to the thesis and implications for practice

It would seem from the product developed during this study, that it is possible to automate the DH interview. The majority of software packages available for dietary assessment (outlined in **Section 2.3**), were developed for the researcher or for use by the dietitian. The development of a self-administered website for dietary assessment meant that patients living in remote locations would have access to a dietitian via technology and without the need to travel. Completion of the development of the CAST program, now referred to as the DietAdvice website, confirms that innovation is possible within the field of dietetics and traditional face-to-face interviews with patients are not the only method of assessment.



TESTING PHASE

Diet Advice

Video recorded usability testing

5

CHAPTER 5

Video recorded usability testing ^{*†}

5.1 Introduction

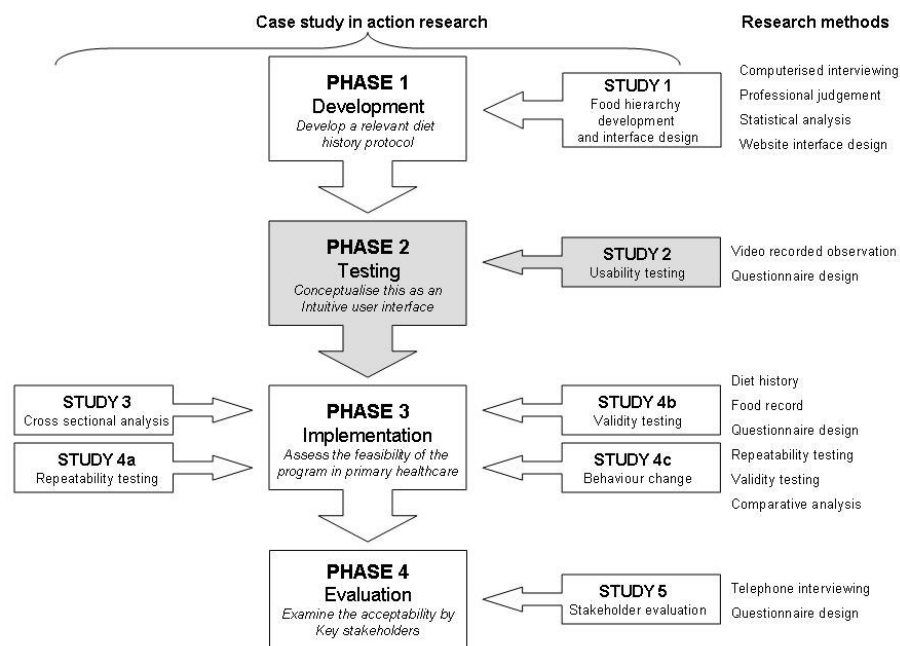


Figure 5-1 Overview of the CAST case study showing the testing phase

This chapter addresses the usability testing of the Diet Advice website prior to implementation in the Illawarra region GP practices. It is the primary study within the testing phase of the case study, assessing the behavioural interactions

* A significant proportion of this chapter has been submitted for publication: Probst YC, Tapsell L. A self-administered dietary assessment website for use in primary health care: Usability testing and evaluation. *Primary Health Care Research and Development*.

† Data from this chapter has been presented at the: 2005 National Dietitians Association of Australia Conference, Perth Australia. The best oral presentation prize for the conference was awarded for this presentation

of the potential users of the program with the computer. It examines the areas of the website causing difficulty or being misunderstood. The second sub-hypothesis regarding a user's level of computer literacy and the effect that it will have on the degree of assistance they require, is addressed here. If the website was found to be user-friendly, the implementation of the CAST model in the primary healthcare setting could be applied as planned. Usability testing was conducted during August and September 2004.

5.2 Aims

1. To assess the end-users' ability to use a prototype version of the DietAdvice website
2. To determine the approximate time spent using the program
3. To collect information about the cognitive processes involved in reading and understanding questions, and in providing responses
4. To determine the interaction between non-verbal communications and sections of the website

5.3 Methods

The usability testing of the prototype website was divided into two phases (Fig. 5.2). The first phase involved participants using the website under video and researcher observation in order to determine any problem areas of the website. The second phase, after modification of the website, did not involve any direct observation and was aimed at replicating the setting in the GP practice where the website would be implemented.

Recruitment of patients with diabetes for the usability testing was administered within a convenience sampling framework. Participants from the focus groups conducted prior to development of the website were contacted. Recruitment emails were also sent to UOW to staff and students. Inclusion criteria required at least one component of metabolic syndrome, the clinical condition of reference,

Both phase one and phase two testing were conducted at UOW. Phase one testing occurred under laboratory settings in a room containing a desk, chair, computer and video camera setup only. Phase two testing occurred in a computer laboratory, allowing multiple participants to test the website at once as would occur in the clinical setting.

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graph TD; Root[Timed & Videorecorded Prototype Testing] --> GroupA[Group A]; Root --> GroupB[Group B]; GroupA --> Subject1[Subject 1]; GroupB --> Subject2[Subject 2]; Subject1 --> TaskA[1. Perceptions prior to use<br/>2. Problem Solving Exercise]; Subject2 --> TaskB[1. Perceptions prior to use<br/>2. Problem Solving Exercise]; TaskA --> ObserverA[Observer - Prompting]; TaskB --> ObserverB[Observer - No prompts]; ObserverA --> CompA[Computer Use]; ObserverB --> CompB[Computer Use]; CompA -.-> NoteA[Note taking]; CompB -.-> NoteB[Note taking]; NoteA -.-> EvalA[Evaluation]; NoteB -.-> EvalB[Evaluation];
```

The flowchart illustrates the experimental design for two groups, Group A and Group B, under the heading "Timed & Videorecorded Prototype Testing".

Group A Path:

- Group A leads to Subject 1.
- Subject 1 performs tasks: 1. Perceptions prior to use, 2. Problem Solving Exercise.
- An Observer - Prompting is present during the task.
- The subject then uses the Computer.
- Note taking follows computer use.
- The process concludes with Evaluation.

Group B Path:

- Group B leads to Subject 2.
- Subject 2 performs tasks: 1. Perceptions prior to use, 2. Problem Solving Exercise.
- An Observer - No prompts is present during the task.
- The subject then uses the Computer.
- Note taking follows computer use.
- The process concludes with Evaluation.

Central Element:

Between the two paths, a central box states: "Talk aloud" as progress through program. This indicates that the "Talk aloud" protocol is applied to both groups during the computer use phase.

Figure 5-2 Observational study design for phase 1 testing

All participants were mailed written information about the study prior to attendance at UOW. Written consent was obtained from all participants. Demographic data questions were included at the beginning of the website questioning as outlined in **Section 4.8.3**.

5.3.1.1 Phase 1 Testing

Participants for phase one testing were divided randomly into groups A and B for observation as they used a prototype version of the website (Fig. 5.2).

Both groups had a researcher available to them during the testing period. The researcher also recorded observations not visible to the camera (e.g. foot movements). Group A participants had the researcher available for questioning and assistance. The researcher also prompted these participants to comment upon the appearance and functions of the website and upon any perceived problems. Group B participants were not allowed to ask questions of the researcher, nor did the researcher ask questions of them. Assistance was provided, and recorded only if a participant was unable to progress further.

Prior to testing the website, participants wrote down their perceived barriers to the program, their feelings about testing and computer use, and their level of computer experience.

Whilst using the interface, participants were asked to think aloud. Prior to testing, participants were given a practice “thinking aloud” exercise in an unrelated topic area. This exercise lasted for five minutes.

Non-verbal and verbal responses to the program were video-recorded. Digital video cameras were set up to observe the participants from the front (facial expressions) and from the side (body language) (Fig. 5.3).

Time was recorded automatically as an answer was selected (ticked) on screen. This was not visible to the participant, but was included in the participants log file in the administration component of the website.

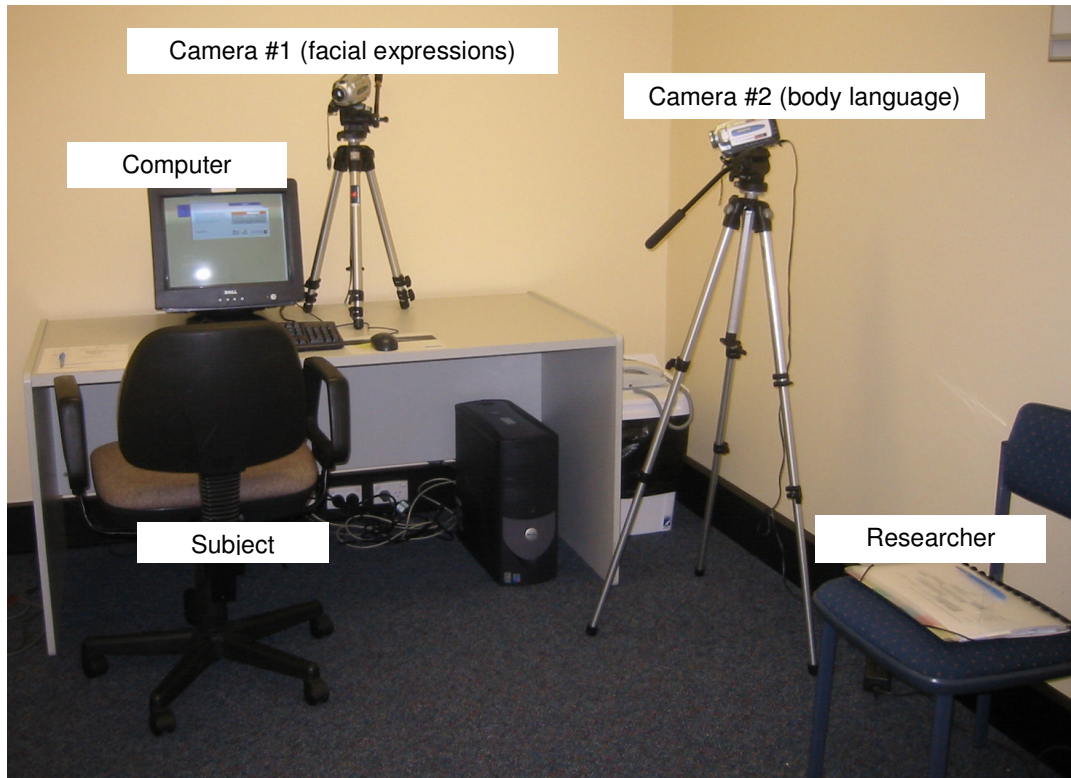


Figure 5-3 Laboratory room set up

After testing the website, participants completed an evaluation questionnaire (**Section 3.4.3.4**). Responses from the evaluation questionnaire and researcher field notes were used to modify the website prior to phase two testing.

5.3.1.2 Phase 2 Testing

Participants involved in phase two testing used the website individually, but had a researcher available for assistance if needed. This mimicked the situation found in a GP practice, where the reception staff and/or practice managers were available to patients to assist. Participant observations were not recorded. Participants were given the pre-testing questionnaire and evaluation questionnaire to complete. Participants were also given paper to note down any problems with the website. Time was again recorded automatically by the website.

5.3.2 Data analysis

Field notes from the researcher were transcribed and used to identify areas of the website where problems or difficulties occurred. Field notes also recorded the number of times assistance was requested or required by each participant, which was tallied for phase one groups A and B.

The questionnaires for both phase one and phase two were analysed using NVivo Qualitative Analysis Software (version 2.0.161, 2003: QSR International, NSW, Australia). Thematic categories and relationships between responses were formed.

A file with audio data from each video was created to allow data to be transcribed separately for anonymity. Files were created in MPG3 format (as described below) and were each approximately 35MB in size. Audio data was transcribed by an external researcher and checked for accuracy by a second external researcher to avoid bias.

Each phase one participant had two miniDV tapes of approximately 60 minutes each. One camera angle captured the face of the participant (camera one), the other captured the side profile of the participant (camera two). The data from the individual mini-DV tapes were captured in real time into MPG2 format in 720X576, 6000kb/s resolution using Pinnacle Studio (version 9, 2004: Pinnacle Systems International, California, USA). The file size was approximately 8GB for each 60 minute video tape. As one perspective on all the tapes was recorded in widescreen format, and the other recorded in normal format, the 16:9 widescreen files were then converted into 4:3 display in MPG2 format. This was achieved using TMPEnc Plus software (version 2.524, 2005: Pegasys Incorporated, Japan). The video size was then consistent from both the camera angles.

The MPG2 files were edited using Pinnacle Studio. The footage from camera one was reduced in size (approximately 60%) and laid over the camera two footage to

produce a picture in picture effect (Fig. 5.4). The two views were synchronised to begin at the same time point, and at any points at which either camera was stopped during recording. Once complete, the edited footage was then rendered to a Windows Media format (.WMV) file, video -720x576 (VBR), audio - 44.1khz (CBR). Creative Wave Studio (version 42.107, Creative) was used to create an MPG3 – 44.1kHz, 128kBit/s file from the audio output for transcribing. The windows media file and MPG3 file were then burnt to CD.



Figure 5-4 Example of edited video footage

Video files were further converted to MPG1 360X240 format using TMPEnc Plus, resulting in approximately 2GB per 60min video footage. Files were then burnt to DVD for analysis.

Analysis of the video data and transcripts from the audio was conducted using Transana analysis software (version 2.05, 2005: Wisconsin Centre for Educational Research, Wisconsin, USA). Episodes were created for each participant, video files were attached to these episodes and transcripts were then uploaded individually in .RTF format. Episodes are a collection of single digital video files held within the Transana database. This created a section per participant within the database. Time stamps were added to the transcript to link the transcript with the video footage. Keywords were created to describe non-

verbal aspects of communication, for example frowning, leaning forward in chair, tapping desk. These keywords were updated as new descriptors were required.

Clips from the video were selected and assigned a name based on the section of the website described by the participant. Keywords were assigned to the clips to classify the non-verbal communication of the participant from the video. Finally, the clips were grouped based on the general computer interaction of the participant e.g. Movement in the chair. Reports were created for each participant showing the length of the clips and corresponding section of transcript (collection summary report) and the number of times keywords were assigned to each collection (keyword usage report).

Key behaviours relating to unspoken emotion and to uncertainty were selected. There were six individual behaviours for unspoken emotion: leans forward in chair, leans backward in chair, leans to side, shifts in chair, sits up straight and slides forward in chair; and six individual behaviours for uncertainty: frowns, self touching, head tilt to side, shrugs, shakes head and pursing lips.

The behaviour of self touching was created by combining the observations of hand fidgeting, hand on stomach, hands behind head, holds back of head, holds chin, holds wrist, places hand on chest, places both hands on lap, rests hand on chest, rests hand on forehead, rubs eyes, rubs hands together, rubs nose, scratches arm, scratches back, scratches chin, scratches ear, scratches eye, scratches eyelid, scratches face, scratches forehead, scratches hand, scratches head, scratches leg, scratches neck, scratches nose, scratches shoulder, scratches side, touches arm, touches chin, touches face, touches forehead, touches hair, touches hand and touches neck.

As each participant interacted differently with the computer, components of the laboratory testing were grouped into sections. The frequency of each behaviour, per section of the website, and the mean of all participant frequencies were

calculated. Due to the range of individual behaviours fitting within unspoken emotion and uncertainty (e.g. shifts in chair, tilting head etc), behaviours were grouped under the aforementioned headings and compared for each website section.

Total time spent using the website was 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. This was used to determine the sections of the website where the most time was spent. Total time data for each action class and the proportion of total time spent using the website per participant were calculated and transferred into SPSS for Windows (version 12.0.1, 2003: Lead Technologies, Chicago, USA). Descriptive statistics were generated for phase one and two. Data was tested for normality using the Shapiro-Wilks test. Two-tailed t-tests and Wilcoxon signed ranks tests were performed. Outliers were assessed using box plots for each action class.

5.4 Results

Forty-two volunteers agreed to participate. Of these 26 were involved in phase one (P1) and 16 were involved in phase two (P2). Of the 26 participants who volunteered to participate in phase one testing, a total of nine participants withdrew (two for work commitments, one for illness, four for family issues and two were unknown withdrawals). This resulted in eight group A and nine group B participants. Seventeen participants completed phase one testing. Of the 16 participants who volunteered to participate in phase two testing, two 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 ten participants completed phase two testing. A total of 27 (64%) participants completed usability testing.

Participants randomised into groups A and B were similarly matched, though comfort using a computer varied (Table 5.1). The majority of users were of a

university level education (P1 n=9, 52.9%; P2 n=8, 80.0%) and in full time employment (P1 N=10, 58.8%; P2 N=9, 90.0%) (Table 5.1). More males volunteered for phase 1 (N=15; 88.2%) and more females volunteered for phase 2 (n=6; 60.0%) testing. Participants were primarily born in Australia (P1 n=12, 70.6%; P2 n=6, 60.0%) and owned a computer (P1 n=15, 88.2%; P2 n=9, 90.0%). They were also very comfortable using a computer (P1 n=9, 52.9%; P2 n=8, 80.0%) with advanced computer skills (P1 n=9, 52.9%; P2 n=6, 60.0%).

Table 5-1: Profile of lab testing participants

<i>Demographic variable</i>	<i>Phase 1 (n=17)</i>				<i>Phase 2 (n=10)</i>
	<i>Total (n=17)</i>	<i>Group A (n=8)</i>	<i>Group B (n=9)</i>		
Age (years \pm SD)	56.0 \pm 9.7	57.1 \pm 10.7	55.0 \pm 9.1		41.5 \pm 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%)

5.4.1 Phase 1 Testing

Of the eight participants in group A, four required assistance an average of five times. Of the nine participants in group B, seven participants required assistance an average of four times. This figure was skewed by the results of one subject who required assistance 20 times. Participants who self-reported themselves as beginner computer users were more likely to ask for assistance (Fig. 5.5). The

assistance provided primarily related to participants not reading the screen instructions correctly, and the need to restart the computer due to server difficulties during the testing sessions.

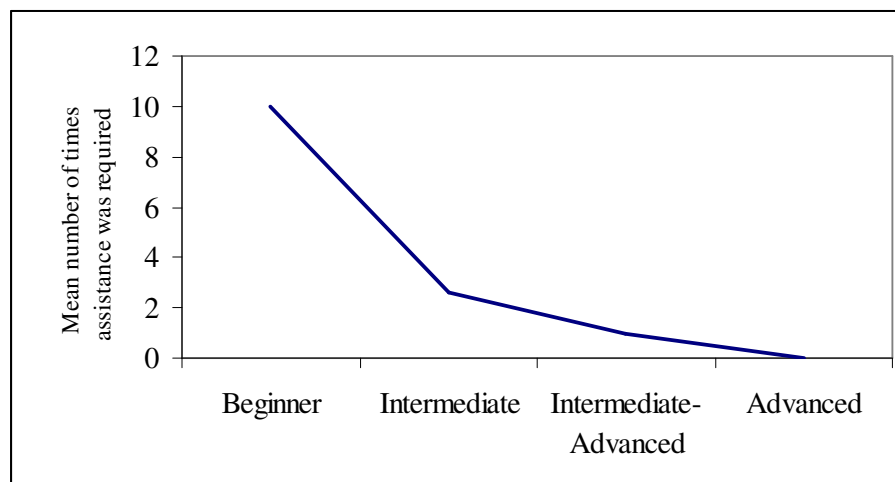


Figure 5-5 Assistance level by level of computer experience

Responses to the evaluation questionnaires did not differ widely between phase one and phase two participants, therefore thematic analysis was combined. The primary themes created for analysis were website appearance, website changes, website difficulties, overcoming difficulties, feelings throughout use of the website and feelings after testing. A more detailed table may be found in **Appendix J**. All participants were positive prior to using the website.

A relationship between positive or negative experiences with the website and the description of emotions was found. Negative experiences as a result of using the website produced a negative response, whilst positive experiences as a result of using the website produced positive responses (Table 5.2, Appendix J). Those who had little computer experience and less comfort using a computer were found to have a more positive response to the website than those who were more familiar with the computer.

Table 5-2 Sample of positive and negative experiences related to feelings

<i>Website experience</i>	<i>Computer comfort/experience</i>	<i>Feelings before website use</i>	<i>Feelings after website use</i>
Negative	Comfortable/ Intermediate	I am relaxed and interested in any faculties that can help me with nutrition admin	Terrible
Positive	Slightly uncomfortable/ Beginner	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

When participants were asked to indicate to whom they felt the website would be of use, n=20 (74.1%) felt it would be useful for themselves as patients, n=26 (96.3%) to dietitians and GPs, and n=10 (37.0%) felt other people such as researchers, endocrinologists and the food industry would benefit.

Due to technical difficulties (computer unable to read the DVD) eleven of the seventeen video recordings were analysed for non-verbal communications. The behaviours related to 13 sections of the website. One section was excluded from analysis due to overlap between sections. Figure 5.5 identifies the remaining twelve sections and the mean number of times non-verbal communication was identified at each section. The most behaviours were observed during food item selection.

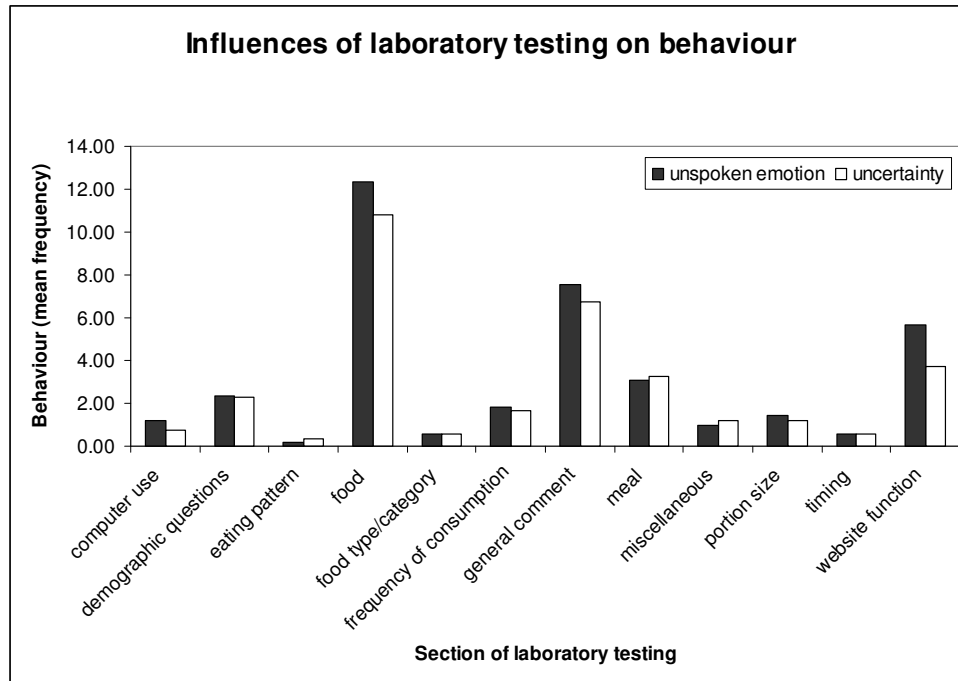


Figure 5-6 Interaction of non-verbal communication with website usability testing

When food item selection was addressed on its own it could be seen that shifting in the chair (Fig. 5.7) and self-touching (Fig. 5.8) were the primary behaviours of participants in this study for unspoken emotion and uncertainty respectively.

There also appeared to be an interaction between these two behaviours, with ten of the eleven subjects exhibiting both behaviours in parallel.

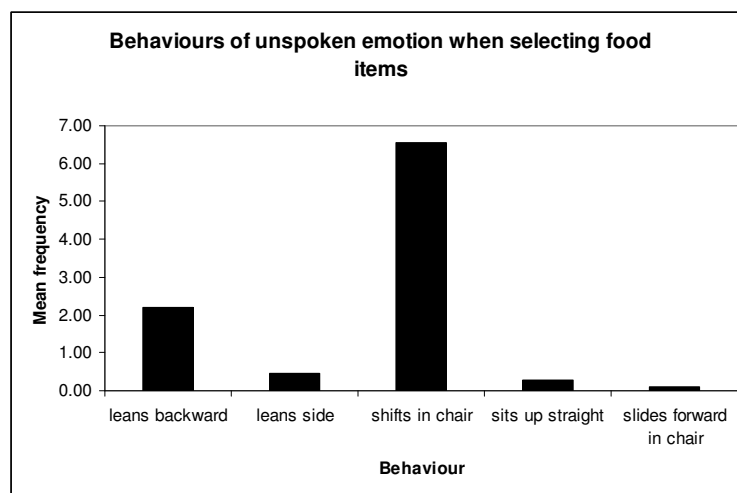


Figure 5-7 Behaviours of unspoken emotion when selecting food items

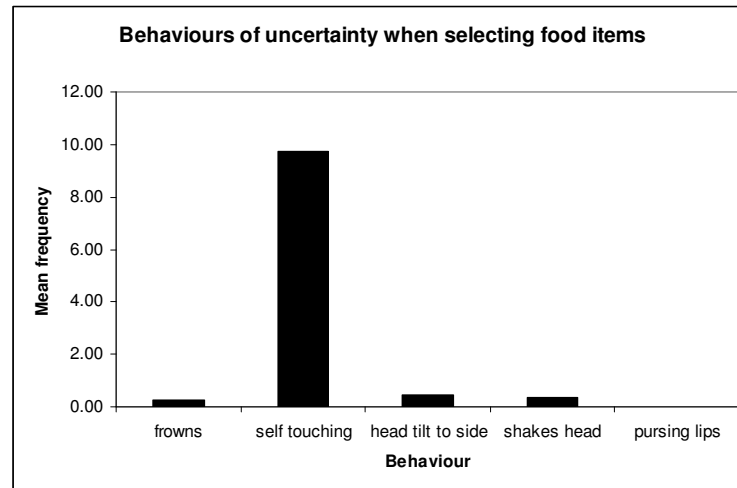


Figure 5-8 Behaviours of uncertainty when selecting food items

The website actions performed during use of the website primarily changed in the details of the action rather than the 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 (Table 5.3).

Table 5-3: Action classes created to analyse time data from participant interaction with the website

1	Login/Logout	16	Click previous meal
2	Demographic Information	17	Click next stage
3	Convert function	18	Click previous stage
4	Stage 1 food selected	19	Meal unselected
5	Stage 2 food selected	20	Incorrect Entry
6	Stage 3 navigation	21	Stage 1 Associated food selected
7	Meal selection	22	Stage 2 Associated food selected
8	Help function viewing	23	Introduction
9	Website Navigation	24	Stage 1 associated food unselected
10	Stage 1 food unselected	25	Stage 2 associated food unselected
11	Stage 2 food unselected	26	Eating pattern questions
12	View main menu	27	Reactivated stage 1 food selection
13	Click next batch	28	Reactivated stage 2 food selection
14	Click previous batch	29	Reactivated stage 1 associated food
15	Click next meal	30	Reactivated stage 2 associated food

Phase one took an average \pm SD of 1:04:37 hour's \pm 0:13:47 (Table 5.4). During this time six of the 17 participants completed the entire questionnaire with a wide range of finishing times. One participant was an outlier in the dataset for total time taken, taking 1:33:18 hours to use the website (Fig. 5.9).

Table 5-4: Summary of total time data for each action class.

<i>Action Class</i>	<i>Phase</i>	<i>n</i>	<i>Minimum (hh:mm:ss)</i>	<i>Maximum (hh:mm:ss)</i>	<i>Range (hh:mm:ss)</i>	<i>Mean (hh:mm:ss)</i>	<i>SD (hh:mm:ss)</i>
Total time taken	1	17	0:39:37	1:33:18	0:53:41	1:04:37	(±0:13:46)
	2	10	0:47:04	2:01:01	1:13:57	1:08:55	(±0:23:26)
Click next batch	1	17	0:01:53	0:33:33	0:31:40	0:10:24	(±0:08:04)
	2	10	0:07:39	0:49:22	0:41:43	0:17:22	(±0:12:22)
Click prev batch	1	8	0:00:09	0:01:19	0:01:10	0:00:34	(±0:00:21)
	2	6	0:00:14	0:02:08	0:01:54	0:00:45	(±0:00:42)
Click next meal	1	17	0:00:51	0:03:33	0:02:42	0:01:49	(±0:00:45)
	2	9	0:00:57	0:04:01	0:03:04	0:02:11	(±0:00:51)
Click prev meal	1	6	0:00:04	0:00:34	0:00:30	0:00:14	(±0:00:11)
	2	3	0:00:00	0:00:20	0:00:20	0:00:12	(±0:00:11)
Click prev Stage	1	2	0:00:00	0:00:04	0:00:04	0:00:02	(±0:00:02)
	2	1	0:00:11	0:03:38	0:03:27	-	-
Demographic information	1	17	0:03:03	0:18:34	0:15:31	0:06:42	(±0:03:30)
	2	10	0:00:00	0:16:06	0:16:06	0:06:07	(±0:04:49)
Introduction	1	17	0:00:00	0:06:37	0:06:37	0:02:12	(±0:01:47)
	2	9	0:00:00	0:04:10	0:04:10	0:01:48	(±0:01:55)
Login/Logout	1	17	0:00:17	0:10:57	0:10:40	0:03:13	(±0:03:53)
	2	10	0:00:03	0:16:29	0:16:26	0:03:42	(±0:05:29)
Meal selection	1	17	0:00:21	0:02:03	0:01:42	0:00:59	(±0:00:27)
	2	9	0:00:18	0:01:30	0:01:12	0:00:57	(±0:00:23)
Stage 1 associated food selected	1	17	0:01:09	0:19:56	0:18:47	0:05:11*	(±0:04:21)

	2	10	0:00:00	0:03:50	0:03:50	0:01:42	(±0:01:28)
Stage 2 associated food selected	1	16	0:00:00	0:07:54	0:07:54	0:03:42	(±0:02:16)
	2	10	0:00:00	0:08:34	0:08:34	0:02:33	(±0:02:36)
Stage 1 food selected	1	17	0:02:44	0:13:17	0:10:33	0:07:57	(±0:02:55)
	2	10	0:01:07	0:29:46	0:28:39	0:03:42	(±0:07:45)
Stage 2 food selected	1	17	0:03:13	0:22:42	0:19:29	0:11:54	(±0:04:50)
	2	10	0:02:16	0:17:52	0:15:36	0:09:55	(±0:05:12)
Stage 3 navigation	1	14	0:00:23	0:11:59	0:11:36	0:04:36	(±0:03:28)
	2	10	0:00:17	0:06:58	0:06:41	0:03:09	(±0:02:18)
Website navigation	1	17	0:00:55	0:14:49	0:13:54	0:04:38	(±0:03:36)
	2	10	0:03:12	0:22:06	0:18:54	0:08:16	(±0:05:59)

* Significant difference at $p=0.05$

Figures not included for convert function, eating pattern questions, 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, as data was not available for both phases of testing.

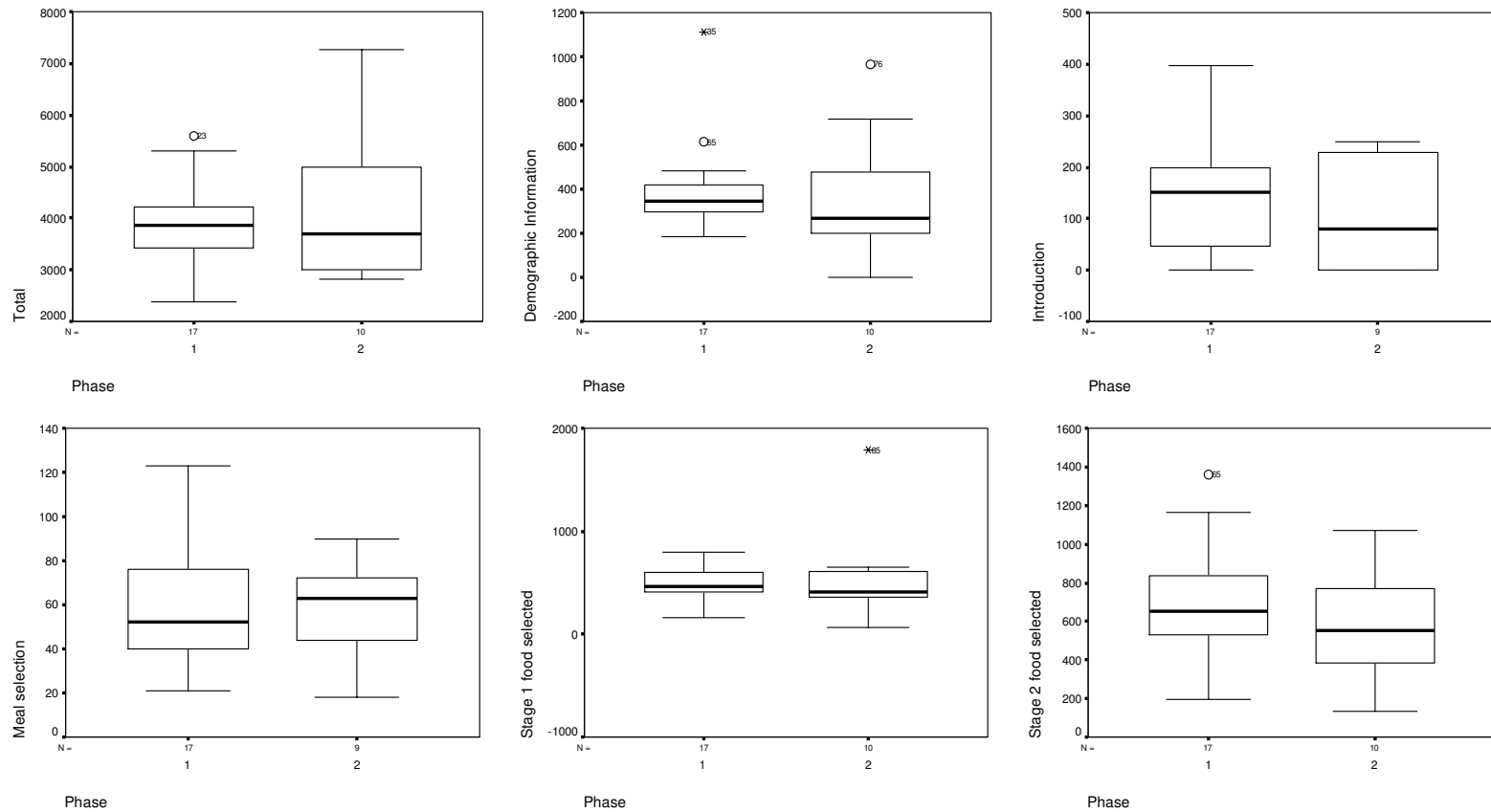


Figure 5-9 Box plots for key stages of the website for both phase 1 and phase 2.
Time axes (y) shown in seconds, outliers indicated by subject number.

5.4.2 Website modifications

The primary area identified by the participants as needing change was the selection of sandwiches as a food item. As a sandwich can generally be classified as a recipe (i.e. a food item composed of more than one food) and is highly variable in its composition, the initial version of the website used during phase one 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 the one sitting. Participants for phase two testing saw a modification to this food item. Sandwiches for phase two testing were grouped by generic fillings e.g. salad filling with the type of bread and margarine/butter was 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 the font and changing its colour for the next phase of testing.

5.4.3 Phase 2 Testing

Phase two took an average of 1:08:55 hours \pm 0:23:26 (Table 5.4). During this time six of the ten participants completed the entire questionnaire with a wider range of time taken than in phase one. A large difference between the time taken to select stage two food items was observed (P1 0:03:42 \pm 0:07:45; P2 0:11:54 \pm 0:04:50). Similarly, larger differences were observed for click next batch (P1 0:10:24 \pm 0:08:04; P2 0:17:22 \pm 0:12:22), stage 1 food item selection (P1 0:07:57 \pm 0:02:55; P2 0:03:42 \pm 0:07:45) and website navigation (P1 0:04:38 \pm 0:03:36; P2 0:08:16 \pm 0:05:59). Only stage 1 associated food item selection was found to be significantly different ($p=0.02$).

5.5 Discussion

5.5.1 Overview

The participants volunteering for the study were generally university educated, in full time employment, owned a computer and rated themselves as advanced computer users. This may be related to the study being within a personal interest area (290).

Although the sample size was small, assistance was requested more often by the beginner and less confident computer users (Fig. 5.5). Therefore the hypothesis “the degree of assistance will be affected by the level of computer literacy of the user i.e. users with a higher degree of computer literacy will have a lower need for assistance” was confirmed, as assistance was related to computer literacy in this study.

The evaluation questionnaires identified a link between interaction with the website and feelings expressed after use. Participants who were more familiar with the computer were more likely to express a negative response to the website after use than those with little or no computer experience. This may be related to the user’s expectations of the system, with those who have more advanced skills expecting more from the website.

The participants identified the website as being of use to themselves and for dietitians in practice. This coincides with the target group of the website, though participants may have been biased by the researcher’s explanation of the website.

Although a speak-aloud exercise was used, video observation of the participants revealed that there may be non-verbal forms of communication displayed by a person when testing a computer program and during dietary assessment. Behaviours suggesting unspoken emotion and uncertainty were identified. The majority of these behaviours were seen during the selection of food items. This may suggest that participants were modifying their responses subconsciously. Future research could examine whether selection of particular food items are related to non-verbal behaviours.

The time taken to use the website was comparable with a DH interview conducted face-to-face with a dietitian. Interviews take approximately one hour to complete, followed by additional time spent by the dietitian to enter 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 automated dietary assessment was taking longer than required. This timing may also be inversely related to the speed of the internet connection which was very slow at the time of testing.

Participants from both phase one and two were allowed approximately one hour to complete the website. Only n=6 (35%) of phase 1 participants completed the questionnaire compared with n=6 (60%) from phase two. This indicates that the modifications made between testing phases may have helped to improve user interaction with the website. Phase one participants may also have progressed more slowly due to the need to speak aloud.

The items that took the longest to complete in the website i.e. the selection of stage two food items (detailed food items), were also comparative to those found in a traditional dietary interview. The numerous types of food available for selection means that increased time is spent thinking about the items when compared with the amount of time spent thinking about which meals are eaten on a daily basis. The time data for the 'next batch' action class similarly took a large proportion of the total time. This could be traced back to the speed of the server while conducting the usability testing.

Despite changes being made to the website between testing phases, statistically significant differences were only found for one action class. This action class was the group within which the sandwich food selections had fallen during phase one testing.

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. Therefore it could be assumed that the food hierarchy developed catered for the majority of food selections by the user.

Computer experience or computer literacy may be paralleled with food literacy. Literacy is defined as knowledge or competence in a given context (291). Computer literacy would therefore imply the understanding of the operating systems and applications of a computer, whilst food literacy would imply knowledge about the range and composition of food produce. Studies have found computer literacy to be linked to increased usability and timing when using a program (178) and it could therefore be predicted that patients who are computer literate and food literate would use the website at a faster pace than those who are not computer or food literate. Although computer

literacy in this case study was self-reported and food literacy was not assessed, future research may be useful to determine if this relationship holds true.

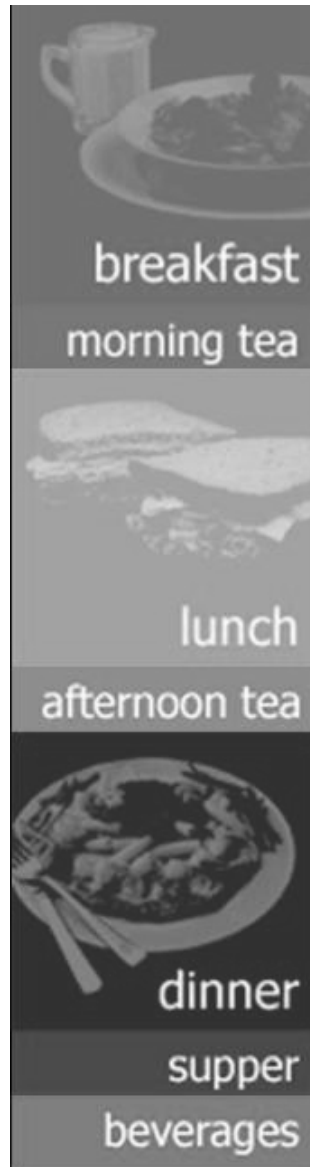
However, lack of computer experience in this study was related to an increased need for assistance and increased time using the website, a factor taken into consideration for the planning of the implementation stage of the project. Findings by Levine and Donitsa-Schmidt (1998) paralleled computer experience with attitude and the confidence to use a computer. They found beliefs about computers lead to corresponding attitudes about the computer which in turn led to behaviours such as use of the computer (124).

5.5.2 Limitations and areas for further research

A range of participants were recruited for the study. Despite this a high proportion of participants with advanced computer skills compared with beginners were identified. As recruitment was on a voluntary basis these results were anticipated, as an interest in computers has been correlated with increased experience in the use of computers (18).

5.5.3 Relevance to the thesis and implications for practice

A picture of the user's ability to use the DietAdvice website allows the implementation phase of the study to be adequately planned. Knowledge of the time spent using the website allowed for the development of protocols for the GP practices. Practice managers would be made aware of the potential time required for website use and be instructed that patients should have the option of logging out regularly or even using the website from their own home. Because assistance was required during the testing phase, the option was made available for patients to have a relative with them for assistance when using the computer.



IMPLEMENTATION PHASE

Diet Advice 

**Cross-sectional study of automated
dietary assessment in the primary
healthcare setting**

6

CHAPTER 6

Cross-sectional study of automated dietary assessment in the primary healthcare setting ^{*†}

6.1 Introduction

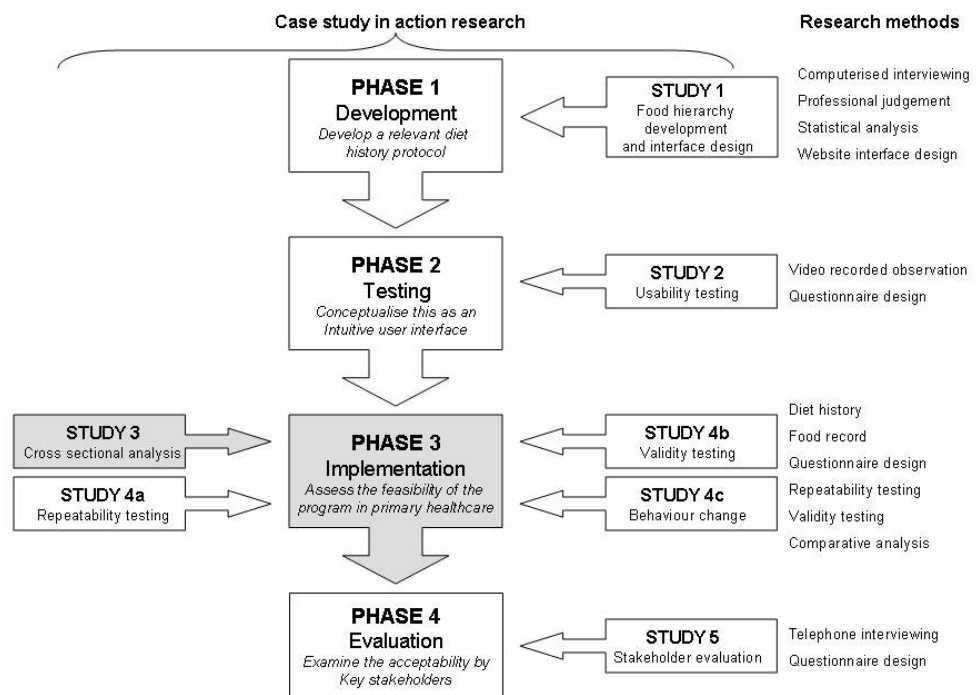


Figure 6-1 Overview of the CAST case study showing study 3 of the implementation phase

^{*} A significant proportion of this chapter has been published in a peer reviewed journal:

Probst Y. Patients with metabolic syndrome: a study using automated dietary assessment in primary care', *Rhizome*, 2005; 1:175-183; and has been submitted for publication Probst Y., Tapsell L. Over- and under-reporting of energy intake by patients with metabolic syndrome using an automated dietary assessment website, *Nutrition and Dietetics*.

[†] Data from this chapter has been presented at the:

2005 Nutrition Society of Australia Conference, Melbourne Australia and is published in the *Asia Pacific Journal of Clinical Nutrition* 14 (Suppl):S88; 2005 International Congress of Nutrition, Durban South Africa and is published in *Annals of Nutrition & Metabolism* 49(Suppl):277; 2005 Wollongong University Higher Degree Research Conference for which 1st place was won for the Best H&BS Poster Presentation; 2006 Dietitians Association of Australia Conference, Sydney Australia and is published in *Nutrition and Dietetics* 63 (Suppl 1): A3, A47; 2006 National Nutrient Databank Conference, Honolulu, Hawaii

This chapter describes the recruitment procedures of GPs and the profiles of patients using the website during the period from November 2004 to October 2005. Reported dietary intakes formed part of the profile. This information would highlight the feasibility of the program in the primary healthcare setting. The study addressed the hypotheses that a broad range of patients from differing demographic backgrounds would access the program, and that the GP surgery would be the least preferred option for completing the assessment.

6.2 Aims

1. To provide an overview of the GP recruitment procedures and compare these with the predicted figures.
2. To describe the characteristics of patients using the website and link certain variables with ability to accurately report energy intakes.

6.3 Methods

6.3.1 Data collection

GP recruitment practices were predicted to be at the rate of three patients per week with a 60% final participation. The actual recruitment rate was tracked through the administration component of the website and a recruitment database set up. Fortnightly bulletins were faxed to GP practices showing recruitment trends. Following GP feedback in the first six months, a carbon copy recruitment tracking booklet indicating patient names and date of recruitment was implemented. One copy went on the patient file, another was for GP study records, and the third copy (with patient names blocked out) enabled study managers to track of unused ID codes (**Appendix K**) and thus determine recruitment percentages.

Patients were given two weeks from their last login to complete the questionnaire, and researchers were able to remind them to do this by using the website's administration component. Within one day of expiry, patients could be given the opportunity to reset their ID code and access the website for a further two weeks, after which their access

would expire. Data on login date, responses to demographic questions and reported dietary intake was downloaded onto a separate patient database. This database enabled researchers to track patient progress through the website and ensure that the dietary advice package was sent to the GP within two weeks.

6.3.2 Data analysis

Cumulative totals of numbers of patients recruited were used to determine trends and were compared with predicted recruitment rates. When patient recruitment reached 200, the patient database was coded and transferred to SPSS for Windows (version 12.0.1, 2003: Lead Technologies, Chicago, USA). The frequency of completion of the website and categorical responses to demographic questions were determined. Mean values for age and BMI were determined. Age was categorised into seven categories to determine spread.

To determine relationships between demographic variables and computer usage, age categories were condensed to <35years, 35-55years and >56years. BMI was grouped as not overweight (<25.0kg/m²), overweight (25.0-29.9kg/m²), and obese (>30.0kg/m²).

Over and under-reporting of energy intake was determined using the cut-off limits described previously (**Section 3.5.4**). Ordinal regression and chi-square analyses were used to determine links between demographic variables, use of the website and ability to report energy intakes accurately. A model was developed to test the relationship between computer experience, age and location of use.

6.4 Results

6.4.1 GP recruitment

By November 2005, 224 patients had been recruited by the GPs. Of these, ten did not progress to giving consent on the website. A total of 200 patients was reached by October 2005. Of these 12 did not start or developed account errors, leaving full demographic information on 188 patients. Of these, 45 did not complete the website, leaving 143 to provide full dietary intake data (Fig. 6.2).

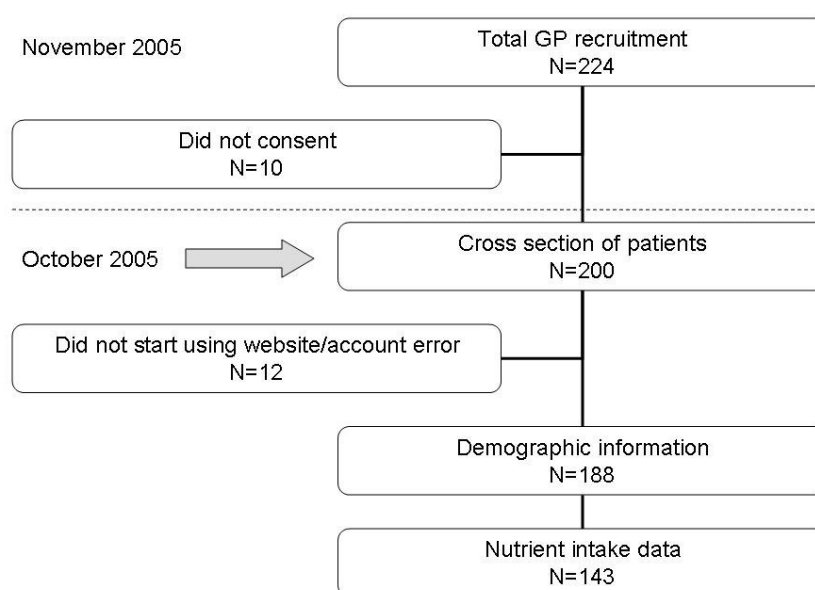


Figure 6-2 Number of patients for which data was available

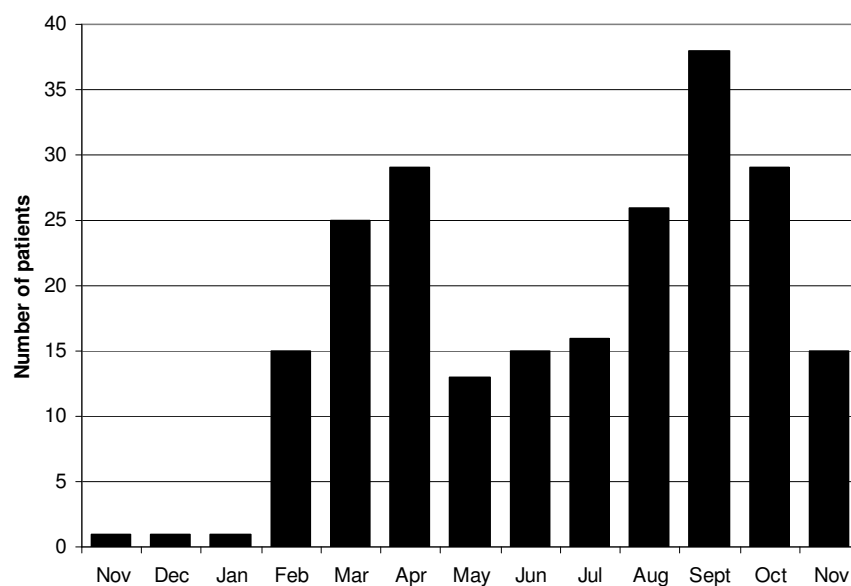
Large differences were found between predicted and actual GP recruitment rates each month (Fig. 6.3), but the cumulative trends in recruitment were similar (Fig. 6.4). The rate of acceptance into the study was higher than predicted (70% actual, 60% predicted).

Approximately one in three patients allowed their accounts to expire part way through answering the questions (Table 6.1). The stage of completion of the program varied for the 57 patients in that category.

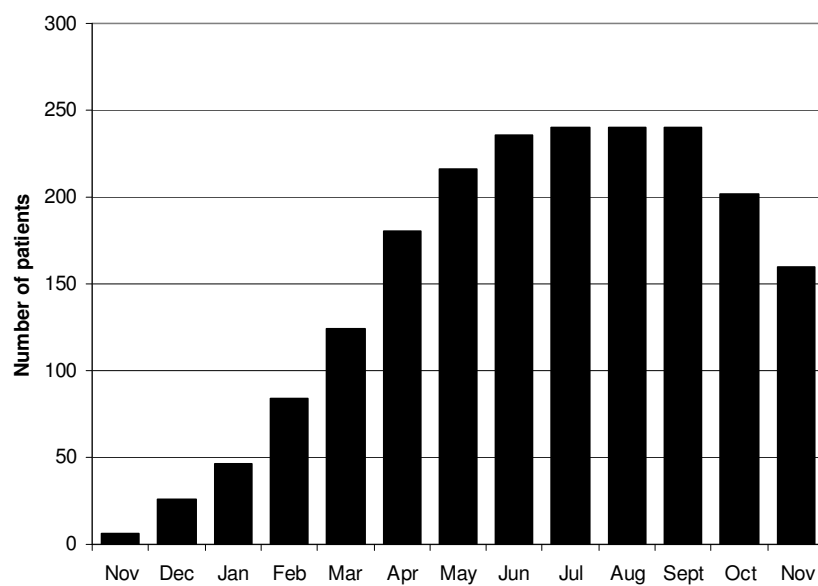
Table 6-1 Stage of completion of the dietary assessment questionnaire (n=200)

<i>Stage of completion</i>	<i>Frequency</i>	<i>%</i>
Complete	143	71.5
Account expired/void	57	28.5
- Not started	10	5.0
- Food type questions	21	10.5
- Meal questions	14	7.0
- Portion size and frequency	2	1.0
- Sub-category questions	5	2.5
- Eating pattern questions	3	1.5
- Other	2	1.0

Of the 200 consenting patients, ten did not commence the questionnaire, and of the remaining 190, most preferred to use the website at home (n=110; 58.5%), rather than at the GP practice (n=24; 12.8%), and a further 54 (28.7%) used other locations such as work or relatives' homes. The remaining two patients had difficulty accessing the website.

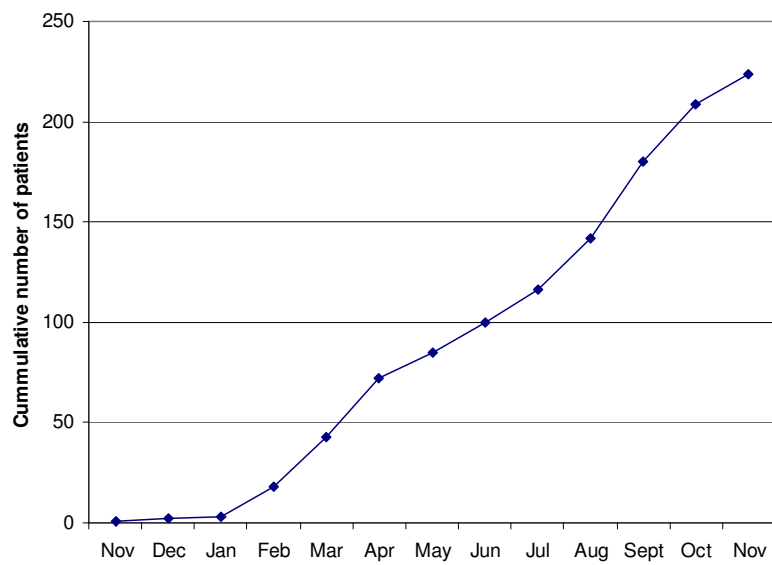


A. Actual recruitment

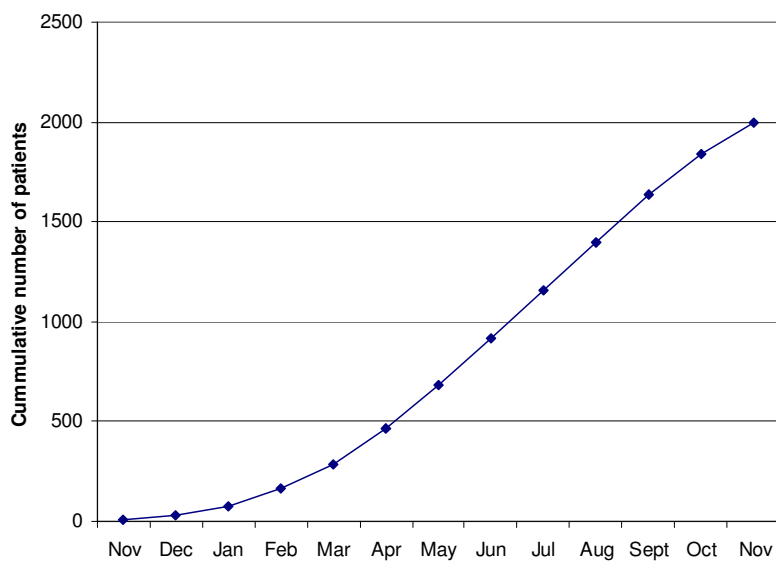


B. Predicted recruitment

Figure 6-3 Actual (n=224) & predicted (n=200) patient recruitment rates per month



A. Actual rate of recruitment



B. Predicted rate of recruitment

Figure 6-4 Actual (n=224) & predicted (n=2000) recruitment trends per month

6.4.2 Patient characteristics

Patients using the website varied in demographic profile, ranging from 19-79 years, with the majority aged between 36 and 65 years (Fig. 6.5). They reported being overweight ($n=137$, 72.6%) ($\text{BMI}>25.0\text{kg/m}^2$), but reported values that translated to obese ($\text{BMI}>30.0\text{kg/m}^2$). They also reported more than one medical condition, and from this 117 (62.2%) would fit the defined condition of metabolic syndrome, the clinical condition of reference (**Section 2.5.1**).

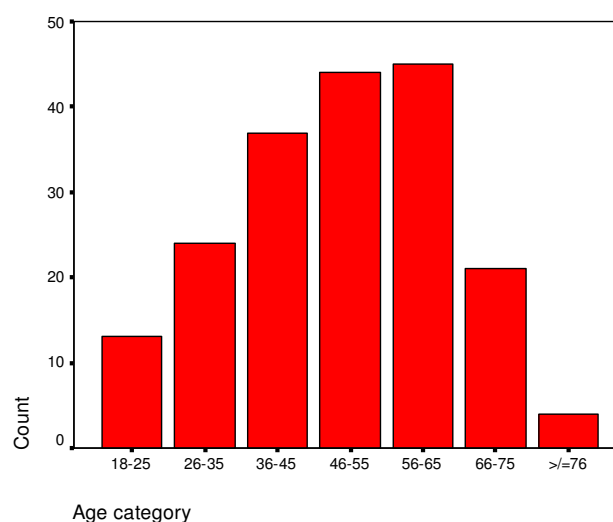


Figure 6-5 Age groups of website users (years)

, From a dietary perspective, patients were not vegetarian ($n=180$, 95.7%), did not have food allergies ($n=172$, 91.5%) or food restrictions ($n=164$; 87.2%), and did not regularly take supplements (users $n=60$; 31.9%). Lifestyle factors were mixed, with most describing themselves as sufficiently or heavily active, yet they smoked (Table 6.2). From a social perspective, they tended to be single/divorced or separated (Table 6.2), did not have children under 18 years ($n=130$; 69.1%), and were spread across the categories of employment status, with most in fulltime ($n=61$; 32.4%) (Table 6.2) or unpaid work ($n=73$; 38.8%), with an income of \$20,000-\$60,000 per year ($n=126$; 67.0%). The highest level of education was mainly high school and most patients were computer literate (Table 6.2). A more detailed patient profile is provided in **Appendix L Table A**

Table 6-2 Demographic profile of patients using the website

<i>Variable</i>	<i>Value (n=188)</i>
Age (mean + SD) *	49.1 +14.6 yrs
Height (mean + SD)*	166.7 +9.6cm
Weight (mean + SD)*	91.8 +18.9kg
BMI (mean + SD)*	32.6 +6.5 kg/m ²
Male (number, %)	63 (33.5%)
Female (number, %)	125 (66.5%)
English speaking (number, %)	184 (97.8%)
Active (number, %)	104 (55.6%)
Smoker (number, %)	166 (88.3%)
Single/divorced separated (number, %)	130 (69.1%)
Main shopper (number, %)	110 (58.5%)
Fulltime paid employment (number, %)	61 (32.4%)
High school level education (number, %)	95 (50.5%)
Own a computer (number, %)	151 (80.3%)

* n=186 (data lost for n=2)

Patients who completed the website described themselves as advanced (n=20), intermediate (n=73), beginners (n=40) and ‘never used’ a computer (n=10). Not surprisingly, patients with the most computer experience were significantly more likely to report being the most comfortable using a computer (p=0.00), while those who had never used a computer reported being the least comfortable (Table 6.3). Likewise, patients owning a computer were more likely to be an advanced or intermediate computer users than patients who were beginners, or who had never used a computer (p=0.00) (Table 6.4).

Table 6-3 Computer experience and comfort of DietAdvice website users (n=188)

<i>Comfort using a computer</i>	<i>Computer Experience</i>				<i>p-value (χ^2)</i>
	<i>Advanced</i>	<i>Intermediate</i>	<i>Beginner</i>	<i>Never used a computer</i>	
Very comfortable	25	41	0	0	0.00 ($\chi^2=197.9$)
Comfortable	2	49	16	0	
Slightly uncomfortable	0	5	25	1	
Uncomfortable	1	0	10	13	
Total	28	95	51	14	

Table 6-4 Odds between demographic variables (n=188)

<i>Dependant</i>	<i>Reference</i>	<i>Factor</i>	<i>Odds</i>	<i>p-value</i>
Comfort of computer use	>56 years	35-55 years	1.9	0.03
Comfort using a computer	>56 years	<35 years	6.0	0.00
BMI	Use computer in GP practice	Use computer at home/other location	1.9	0.04
Own a computer	Beginner/Never used a computer	Advanced/ Intermediate computer user	17.1	0.00

Reference factor compared to variables of comfort using a computer in order of 1 – Very comfortable, 2 – Comfortable, 3 – Slightly uncomfortable, 4 – Uncomfortable; BMI: 1- <25.0kg/m², 2- 25.0-29.9 kg/m², 3- >30.0 kg/m²; Own a computer: 1 - Yes, 2 - No

Patients with a higher BMI were significantly more likely to use the computer outside the GP practice, either at home or elsewhere (p=0.04) (Table 6.4), but so were advanced computer users, who were 2.8 times more likely to do so, and were 4.5 times more likely to be <35yrs than >56yrs age (p=0.00). There was a significant relationship between computer experience, age and location of use, with a strong interaction effect. Patients aged below 35yrs and using the computer at home were 16.8 times more likely to be advanced computer users than patients aged over 56yrs using the computer in the GP practice (Table 6.5). Only data for patients aged over 56yrs and using the computer in locations other than home or the GP practice did not exhibit a significant relationship.

Table 6-5 Association between computer experience, age and location of computer use (n=188)

<i>Dependant</i>	<i>Reference</i>	<i>Factor</i>	<i>Odds</i>	<i>p-value</i>
Computer experience	>56 years, GP practice	>56 years, Other location	1.6	0.47
		>56 years, Home	7.1	0.00
		35-55 years, GP practice	5.6	0.01
		35-55 years, Other location	6.3	0.02
		35-55 years, Home	8.1	0.00
		<35 years, GP practice	9.2	0.00
		<35 years, Other location	11.2	0.02
		<35 years, Home	16.8	0.00

Reference factor compared to variables of computer experience in order of 1 – Advanced, 2 – Intermediate, 3 – Beginner, 4 – Never used a computer

Under reporting of energy intake was observed in 46 patients (32.2%), over-reporting in 31 (21.7%), and 66 patients (46.2%) reported their intakes on target. No relationships were found for reporting status of the patients and age ($p=0.58$), BMI ($p=0.19$) or gender ($p=0.77$) (Table 6.6). The macronutrient intake profiles reported were similar to that found in previous studies (166) and close to that recommended by authorities (292).

Table 6-6 Cross tabulation of reporting status with age, BMI and gender (n=143)

<i>Age category</i>	<i>Under-reporting</i>		<i>On target</i>		<i>Over-reporting</i>		<i>p-value (χ^2)</i>
		%		%		%	
<35 years	9	33	14	52	4	15	0.58
36-55 years	17	27	28	45	17	27	$(\chi^2=2.86)$
>56 years	20	37	24	44	10	19	
<i>Total</i>	46	32	66	46	31	22	
<i>BMI category</i>		%		%		%	
Normal BMI	3	50	2	33	1	17	0.19
Overweight BMI	13	27	29	59	7	14	$(\chi^2=6.08)$
Obese BMI	30	34	35	40	23	26	
<i>Total</i>	46	32	66	46	31	22	
<i>Gender</i>		%		%		%	
Male	17	35	23	47	9	18	0.77
Female	29	31	43	46	22	23	$(\chi^2=0.54)$
<i>Total</i>	46	32	66	46	31	22	

6.5 Discussion

6.5.1 Overview

While it is argued that GPs generally do not have time to discuss peripheral issues with the patient during a consultation (293), the overall recruitment of patients by GPs was favourable, with the predicted cumulative trend similar to the actual, and the rate of acceptance by patients higher than expected (Fig. 6.3, 6.4). In the first instance then, the use of a computer based dietary assessment program in GP practices appeared feasible.

The GP-patient interaction is well described in the literature (293, 294), and most likely supported the observed rate of patient participation. Patients see their GPs as persons of authority (293, 295), and on confirmation of illness show trust in the expertise of the GP

(293). It is likely then, that poorer uptake of the program occurred after the patient left the GP practice and had to manage on their own and without direct support. An alternative view is that the suggestion to undertake the task may have been passively rejected at a later stage. This resistance to authority would be an attempt by the patient to regain power over their own circumstances (293). The latter is more commonly seen in those who are medically trained rather than those simply paying for health services (293).

The patients using the website most notably varied in age and experience with computers. The study profile of English speaking, overweight and physically active adults, who completed high school and tended to be single and without children at home, and who were not necessarily employed (Table 6.2), gives some indication of the type of patient that might not have access to a dietitian, a problem identified in the literature (296). The fact that on average they were obese, indicates the program might help to address one of the nation's priority areas for healthcare (297). However, it should be borne in mind that English language and computer literacy played a part. In this case, the study confirmed previous research that studies of broadly defined populations (such as patients attending GP practices) often do not include methods for identifying minority groups (298) such as those from a non-English speaking background. As the research was unable to record the number of patients requested by GPs to participate but who declined the offer, it was not able to demonstrate a cultural bias from this perspective. In fact, the recruitment may have reflected the cultural interaction seen between persons of similar backgrounds (299). This limitation needs to be addressed, given the increased risk of lifestyle related diseases in non-English speaking populations such as Asians (300-302). The problem is recognised in other programs targeting nutrition intervention (295).

The strong relationships found between computer ownership, computer experience, comfort using the computer, and the location of website use (Tables 6.3 - 6.5), confirmed that found in other research (303). It was also predicted that the older age groups would be more likely to use the computer in GP practices and be less computer literate than younger age groups. The literature suggests that the older population is increasingly keen to use computer technology, but that the level of acceptance among

this group may not be as strong as with the younger groups, who may need to use computers on a daily basis.

While BMI was a significant factor in using the computer at home, the ability to report energy intakes accurately appeared to be random and was not related to age or gender. Further, the reported macronutrient profile of the sample indicated they were very similar to the population from which they were drawn. Given that under-reporting has been shown to be associated with higher BMI (304), it may be tempting to suggest that people with a higher BMI might prefer the anonymity of reporting at home. From the data here, however, it is likely that other attributes relative to computer ownership and experience had the greatest effect on location of use.

This study found that a website based dietary assessment program utilising GPs to recruit patients was feasible in GP practices, and was accessible to a patient population that might not otherwise have access to a dietitian. It also found that patients were more comfortable using the website at home limiting the need for computers in GP practices. While the study essentially addressed a question of feasibility, the cross-sectional nature of the data exposed limitations based on the profile of patients likely to gain benefit from the service. Additional work would be required to meet the needs of other groups identified at risk for lifestyle related disease. The inclusion of GPs in the recruitment process proved effective, as has been shown in other research (305). However, there is room for improvement in records management of a type that will facilitate access to data on the rate of decline of participation in the study.

6.5.2 Limitations and areas for further research

The primary limitation to recruitment was the need to change the criteria as the study progressed. Though typical of action research, the recruitment of patients underwent the most changes with time. Beginning with paper-based consent forms and strict recruitment criteria (WHO definition **Section 2.5.1**), that parameters were broadened to allow GPs increased ease of recruitment (305). The primary focus was the utility of the computer program rather than health outcomes.

Consent forms were made available electronically to further save time and finally GPs were provided with recruitment tracking booklets. This saved the most time and increased recruitment rates. If these strategies had been employed from the outset, it is anticipated that a larger number of patients would have been recruited. Conversely the use of electronic consent forms may also be an area that discouraged participation in the study. Patients may have been interested whilst speaking with their GP and when unable to speak with a researcher face-to-face decided not to participate further. This is an area to be considered in future studies. In the field of computing, however, patients consent to the study simply by clicking the final button of the program or website.

GPs also needed to have computers installed in their practices, which resulted in the practices beginning their patient recruitment at staggered time points due to the installation timetable. Some practices required new ADSL hubs and/or conversions from dial-up to ADSL Internet access. Prior to the availability of adequate Internet access in their practices, these GPs were recruiting patients who already had Internet access, which caused the location of use figures to be skewed. The main limitation to this process was the added manpower required for the installations. Support for the computer system was also limited to only two IT professionals. These factors need to be considered when implementing a computerised system in an 8524km² (211) area.

6.5.3 Relevance to the thesis and implications for practice

Knowledge of GP recruitment practices allowed for segmentation of the GPs for stakeholder evaluation. This evaluation was required in order to provide the information necessary for refinement of recruitment criteria in future intervention trials.

The reported nutrient data is also an area for further research. Although it may be assumed that the majority of patients reported on target, this was only determined through comparison of their nutrient data and predicted energy requirements. Further investigation would also determine accuracy of this reported data and discover whether repetition of the assessment provides similar findings. These two factors are evaluated in the next chapter.

Diet Advice

Traditional versus automated assessment

7

CHAPTER 7

Traditional verses automated assessment ^{*†}

7.1 Introduction

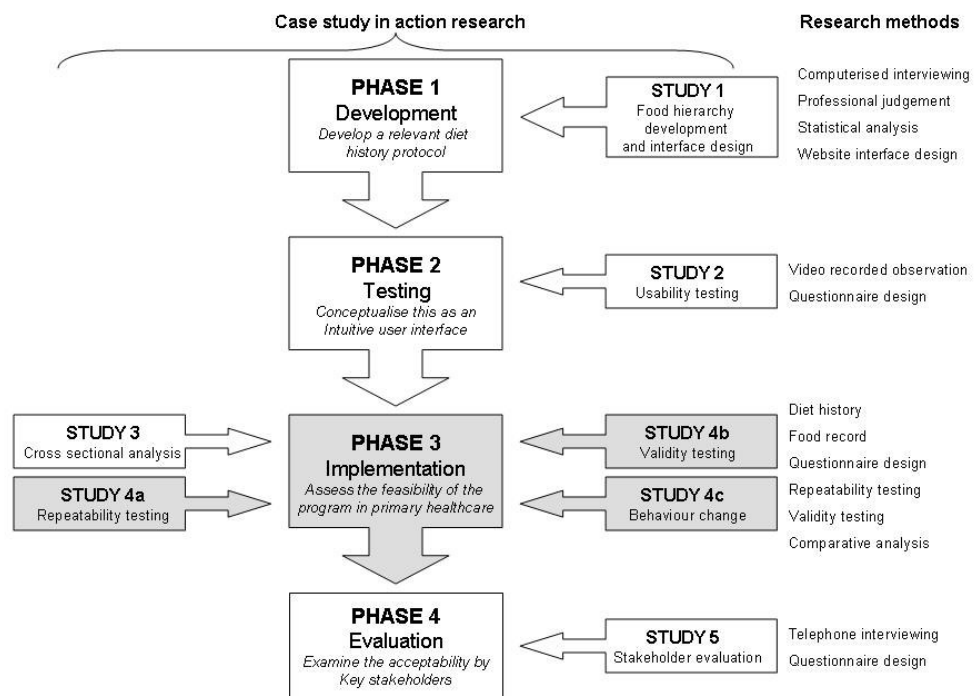


Figure 7-1 Overview of the CAST case study showing study 4 of the implementation phase

This chapter describes the ability of the website to produce reliable and valid data on dietary intake, and to assess dietary change in the context of primary healthcare. Since the whole purpose of the project was to evaluate the use of this technology as part of

^{*} An invitation was received to present data from this chapter at the 2006 National Dietitian's Association of Australia Conference and is published in Nutrition and Dietetics 63(Suppl 1):A3

[†] A second abstract was presented at the: 2006 National Dietitian's Association of Australia Conference and is published in Nutrition and Dietetics 63(Suppl 1):A47

healthcare practice, a crossover design was applied to enable a comparison between traditional and automated dietary assessment. Analysis focused primarily on reported energy intakes, with some attention to reported intakes of total fat and fat type as these would be a focus of dietary advice based on the evidence of their deleterious effects (163, 164). In addition, patient evaluations of the experience were obtained. The integral study was conducted from June to December 2005 in one of the GP practices.

7.2 Aims

1. To assess the repeatability of reporting energy intakes at intervals two weeks apart without dietary advice
2. To assess the relative validity of reported energy and fatty acid intakes
3. To assess reported dietary change following dietary advice, based on identified goals
4. To report on patient evaluations of the computer assisted dietary assessment experience.

7.3 Methods

7.3.1 Data collection

A crossover design was applied to test the performance of the website (referred to as ‘automated’) relative to 3-day FRs and face-to-face interviews with a dietitian (referred to as ‘traditional’). Demographic and anthropometric data were collected by questionnaire. Likewise, the relative comfort with computer use over time was assessed in both groups.

Recruitment of patients for the study began in June 2005 through one of the fourteen GP practices. Bulli Medical Practice had adopted an electronic patient files system using Medical Director patient management software (version 3, 2005: Health Communications Software, NSW, Australia). A search was performed for patients aged 18 to 75 years with T2DM. Letters were sent to eligible patients. Interested patients

were randomly allocated to one of four study arms (Fig. 7.2) and were asked to book visits to Bulli Medical Practice. Reminder phone calls were made one to two days prior to the appointment. The patients visited Bulli Medical Practice on three separate occasions.

A computer in Bulli Medical Practice was used for the automated dietary assessment and a spare room provided for traditional dietary assessments with a dietitian. The dietitian had had no previous contact with the DietAdvice website. The dietitian conducted a demographic questionnaire (**Section 3.4.3.4**), structured DH interview (**Section 3.6.6.1**) and anthropometric measures of height and weight. Food portions were identified using conventional household measures. Patients using the computer had a researcher available for computer related problems.

The first two visits ($t=0$ and $t=2$) were separated by two weeks for a repeat dietary assessment (Fig. 7.2). After each visit, patients were given a 3-day FR booklet (**Appendix H**). At $t=2$, patients were also given an evaluation questionnaire (**Section 3.4.3.4**) corresponding to the form of assessment i.e. traditional or automated, and received their first set of individualised dietary advice. The dietary advice contained dietary goals for the patients to achieve during the following six weeks. The goals were based on guidelines published in the Australian Guide to Healthy Eating (306) and were written as practical suggestions to assist the patients in achieving their nutrient targets. For example, patients received goals such as switching from butter to margarine to reduce their saturated fat intake. Each set of advice came with nutrition education sheets.

At the third visit ($t=8$), a final dietary assessment was performed. A second evaluation questionnaire was completed, and a second set of dietary advice provided. Patients received a National Heart Foundation recipe book and DietAdvice computer mouse as a token of appreciation for their involvement.

Repeatability was assessed from repeated dietary assessment measures conducted two weeks apart and before any dietary advice was provided. The primary analysis was based on the proportion of patients reporting accurate energy intakes at both times

compared to those achieved from a traditional interview. Differences in reported total fat and fatty acids were compared as of secondary interest. Further, differences between repeated measures from automated diet histories and FRs at both time points were compared.

Relative validity was assessed by comparing automated and FR data at all time points for reported intakes of energy, total fat and type of fat. A similar validity assessment was conducted on data from the traditional interviews to enable comparisons.

Dietary change was assessed as a percentage of dietary goals achieved, based on reported changes made relative to the dietary advice sheet sent to GPs. Patient evaluations were based on results of a questionnaire administered to patients at t=2 and t=8.

The study groups are referred to throughout this chapter by codes corresponding to the assessment forms at t=0-2-8.

- Group A: Automated-Automated-Automated
- Group B: Traditional-Traditional-Traditional
- Group C: Automated-Automated-Traditional
- Group D: Traditional- Traditional-Automated (Fig. 7.2)

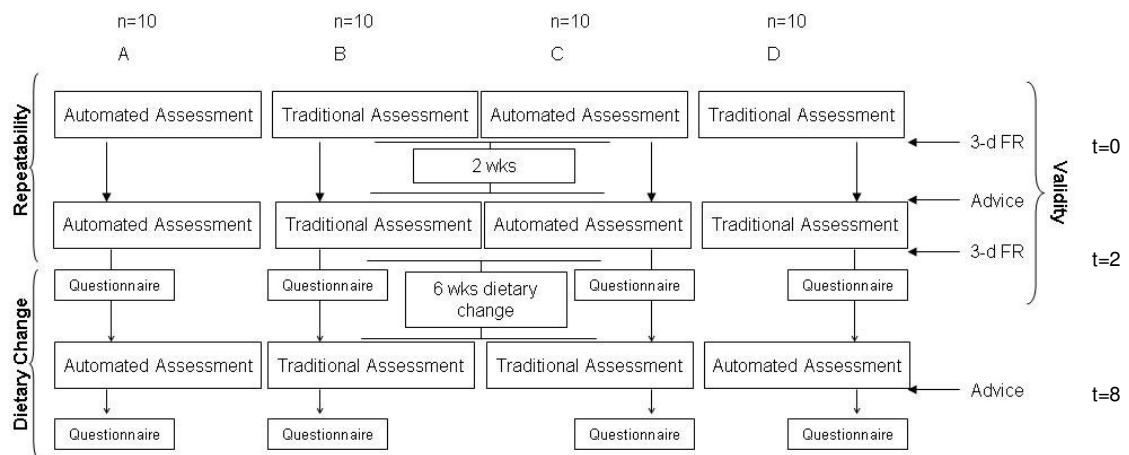


Figure 7-2: Study design indicating repeatability, validity testing and dietary change

7.3.2 Data analysis

Anthropometric variables from the automated and traditional assessments were compared using repeated measures ANOVA in SPSS for Windows (version 12.0.1, 2003: SPSS Incorporated, Chicago, USA). Variables for computer experience, comfort and ownership were compared using chi-square tests.

Traditional assessments were analysed in FoodWorks (version 4.0.158, 2005: Xyris Software Pty Ltd, Queensland, Australia) by the dietitian, and automated assessments were downloaded into the DI. Data from FoodWorks was transformed into data from the CAST database by assigning each food item into its corresponding CAST group using look-up tables in MS Excel (2003 version: Microsoft Corporation, USA). The 3-day FRs were also converted into CAST data using the look-up table method. Total energy, total fat, SFA, PUFA and MUFA was calculated for each patient. BMR was automatically calculated in FoodWorks (v4.0 2005: Xyris Software Australia, QLD, Australia) or the DI using the Schofield equation (212) (**Section 3.5.3**).

Over- and under-reporting of energy intake was determined using the cut-off limits described previously (**Section 3.5.4**). A McNemar's test for correlated proportions was conducted for under- and over-reporting between t=0 and t=2 for the traditional and automated dietary assessment forms. Repeated measures ANOVA were conducted for energy, total fat, SFA, PUFA and MUFA for t=0 and t=2, and separately for t=2 and t=8 for the assessment forms and groups. Post hoc Bonferroni analyses were also conducted for within subject differences for the groups.

Mean FR and DH data for t=0 and t=2 were calculated and compared using paired samples t-tests and Pearson's correlation. Limits of agreement according to the method of Bland and Altman (238) were used to determine reporting bias between assessment forms.

Dietary change was assessed by comparison of the dietary goals of t=2 with the reported intake data at t=8. The proportion of goals achieved by each of the patients was determined.

Groups A and B received the same evaluation questionnaire for both visits, whilst groups C and D received separate questionnaires corresponding to the type of assessment. Average responses were calculated for each questionnaire to determine the most common response by the patients. Paired t-tests and repeated measures ANOVA were performed in SPSS to determine differences between reporting for t=2 and t=8 for each group.

7.4 Results

Tables of significant data of primary interest are provided here, with supplementary data provided in the Appendices as indicated.

A total of 105 patients recruited by GPs were eligible for the study. On being contacted by the researchers, 13 indicated that they were not interested. Of the remaining 92 patients who received details of the study in the mail, 43 returned signed consent forms (Fig. 7.3). Two withdrew before randomization and a further three withdrew before the study began. Thus, 38 patients began the study at t=0.

A further two withdrew (one for psychosocial reasons, the other relocated) leaving n=36 (97.4%) patients completing the t=2 DH. Another five patients withdrew prior to t=8 (two illness, two other commitments, one reason not given) leaving n= 31 (86.1%) completing the t=8 DH. The FR booklet was returned by n=33 at t=0 and n=30 patients at t=2. Thirty patients returned both evaluation questionnaires at t=2 and t=8.

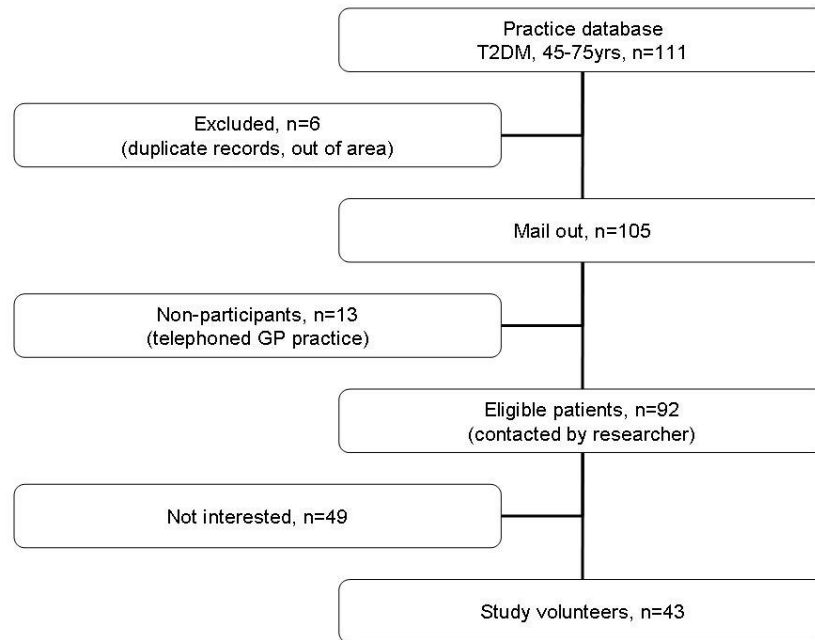


Figure 7-3 Patient recruitment process

7.4.1 Profile of patients

Although the patients recruited from the database in the surgery were defined as having only T2DM, other conditions of the metabolic syndrome, the clinical condition of reference, were also identified. For example 15 patients (39.5%) also reported being overweight. Similarities in the characteristics of the patients were seen with $n=33$ (86.8%) born in Australia, $n=37$ (97.8%) spoke English at home and $n=27$ (71.1%) were retired. More than half of the patients ($n=21$) were female (Table 7.1). A detailed profile of the patients is provided in **Appendix L Table B**.

A significant difference was seen between $t=0$ and $t=2$ for weight ($p=0.03$) and BMI ($p=0.03$), though no other differences within the groups were found (Table 7.2). No significant differences were identified for $t=2$ and $t=8$.

Table 7-1 Demographic profile of all patients at t=0

<i>Variable</i>	<i>Value (n=38)</i>
Male (number, %)	17 (44.7%)
Female (number, %)	21 (55.3%)
English speaking (number, %)	37 (97.4%)
Active (number, %)	24 (63.2%)
Smoker (number, %)	18 (47.4%)
Single/divorced/separated (number, %)	34 (89.5%)
Main shopper (number, %)	20 (52.6%)
Retired (number, %)	27 (71.1%)
High school level education (number, %)	14 (36.8%)

Table 7-2 Anthropometric data for t=0, 2 and 8

<i>t=0 (n=38)</i>	<i>Automated</i>		<i>Traditional</i>	
Group	A (n=10)	C (n=10)	B (n=9)	D (n=9)
Age (mean \pm SD)	58.3 \pm 10.8 yrs	66.3 \pm 6.7 yrs	62.0 \pm 8.8 yrs	60.7 \pm 9.8 yrs
Height (mean \pm SD)	171.4 \pm 11.0 cm	165.4 \pm 6.9 cm	168.4 \pm 11.5 cm	167.8 \pm 5.8 cm
Weight (mean \pm SD)	85.0 \pm 13.6 kg	89.2 \pm 20.2 kg	79.2 \pm 13.5 kg	96.1 \pm 22.0 kg
BMI (mean \pm SD)	28.9 \pm 3.7 kg/m ²	32.6 \pm 7.1 kg/m ²	27.8 \pm 2.2 kg/m ²	34.3 \pm 7.1 kg/m ²
<i>t=2 (n=36)</i>	<i>Automated</i>		<i>Traditional</i>	
Group	A (n=10)	C (n=9)	B (n=9)	D (n=8)
Weight (mean \pm SD) *	82.4 \pm 16.0 kg	85.9 \pm 19.4 kg	78.8 \pm 13.1 kg	88.4 \pm 9.9 kg
BMI (mean \pm SD) *	27.8 \pm 4.2 kg/m ²	31.4 \pm 6.8 kg/m ²	27.7 \pm 2.2 kg/m ²	31.8 \pm 3.2 kg/m ²
<i>t=8 (n=31)</i>	<i>Automated</i>		<i>Traditional</i>	
Group	A (n=9)	D (n=7)	B (n=9)	C (n=6)
Weight (mean \pm SD)	83.1 \pm 16.0 kg	85.1 \pm 7.1 kg	78.8 \pm 13.0 kg	84.3 \pm 17.1 kg
BMI (mean \pm SD)	28.3 \pm 4.6 kg/m ²	31.3 \pm 2.6 kg/m ²	28.2 \pm 2.0 kg/m ²	30.2 \pm 6.5 kg/m ²

*BMI – body mass index, Automated – Computerised diet history assessment, Traditional – face-to-face dietitian diet history assessment, * Significant difference between t=2 and t=8, p=0.03.*

Shifts in responses between the reported computer comfort and experience during t=0, t=2 and t=8 were observed (Table 7.3-7.4). The proportion of patients feeling very comfortable using a computer decreased while feeling comfortable increased. Similarly, the number of patients reporting slightly uncomfortable decreased between t=0 and t=2 while uncomfortable increased. Similar patterns were identified for self-reported computer experience though no significant differences were found. Computer

ownership in t=0 differed ($p=0.05$) though the majority of the patients owning a computer were in the traditional assessment group (Table 7.5).

Table 7-3 Computer experience for t=0, 2 and 8

<i>t=0 (n=38)</i>	<i>Advanced</i>	<i>Intermediate</i>	<i>Beginner</i>	<i>Never used a computer</i>	<i>p-value</i>
Automated	2	4	6	7	0.66
Traditional	4	5	6	4	
<i>t=2 (n=36)</i>					
Automated	3	2	10	4	0.10
Traditional	1	7	4	5	
<i>t=8 (n=31)</i>					
Automated	2	3	11	2	0.31
Traditional	1	5	4	3	

Table 7-4 Computer comfort for t= 0, 2 and 8

<i>t=0 (n=38)</i>	<i>Very comfortable</i>	<i>Comfortable</i>	<i>Slightly uncomfortable</i>	<i>Uncomfortable</i>	<i>p-value</i>
Automated	4	4	9	2	0.43
Traditional	3	7	5	4	
<i>t=2 (n=36)</i>					
Automated	2	5	8	4	0.09
Traditional	2	7	1	7	
<i>t=8 (n=31)</i>					
Automated	2	4	9	3	0.49
Traditional	2	4	3	4	

Table 7-5 Computer ownership for t=0, 2 and 8

<i>t</i> =0 (<i>n</i> =38)	Yes	No	<i>p</i> -value
Automated	8	11	0.05
Traditional	14	5	
<i>t</i> =2 (<i>n</i> =36)			
Automated	8	11	0.09
Traditional	12	5	
<i>t</i> =8 (<i>n</i> =30)			
Automated	12	4	0.09
Traditional	4	10	

7.4.2 Repeatability

All patients in the traditional group except one (*n*=16; 94.1%) under-reported their energy intakes during *t*=0 (Table 7.6). No significant differences were found between *t*=0 and *t*=2 for people under-reporting and over-reporting (*p*=0.85). The majority of patients still under-reported at *t*=2 (*n*=13; 76.4%). Patients from the automated assessment group who under-reported during *t*=0 (*n*=6; 31.6%) reported on target (*n*=8; 42.1%) or over-reported (*n*=4; 21.1%) during *t*=2 (*p*=0.04).

Table 7-6 Under- and over-reporting behaviour for t=0 and t=2

	<i>t</i> =2	<i>Under-reporting</i>	<i>On target</i>	<i>Over-reporting</i>	<i>Total</i>	<i>p</i> -value
	<i>t</i> =0					
<i>Automated</i>	Under-reporting	6	0	0	6	0.04 *
	On target	0	5	2	7	
	Over-reporting	1	3	2	6	
	Total	7	8	4	19	
<i>Traditional</i>	Under-reporting	12	3	1	16	0.85
	On target	1	0	0	1	
	Over-reporting	0	0	0	0	
	Total	13	3	1	17	

*Conducted using chi-square analysis. *Significant difference at $p < 0.05$.*

The McNemar's test did not reveal any significant differences between automated and traditional groups in the proportions reporting (*p*=0.39) under-over and on target.

Reported total fat intake was highly variable for the automated assessment group and was higher in the automated group than in the traditional assessment group, but no significant interaction effect was found for repeated measures between t=0 and t=2 (**Appendix M**). A significant time effect was found for reported SFA intakes ($p=0.03$) between t=0 and t=2, and there were significant group effects between t=0 and t=2 for all nutrients except for data on saturated fat intakes.

7.4.3 Relative validity

Reported energy intake for the automated assessment group was significantly different between the automated DH and FR for both t=0 and t=2 (Table 7.7). For fat, however, the automated DH produced the strongest correlation between the DH and FR data at t=2. The traditional assessment group saw weak correlations between the reported energy for both t=0 and t= 2 and for PUFA during t=0 (Table 7.7).

Bland Altman plots for energy and SFA for the automated assessment show sufficient clustering around zero at t=0 indicating little difference between the DH and FR dietary data (Fig. 7.4). This clustering improved at t=2 when compared with t=0, see plots A and B for example. Overall reporting of energy intake and SFA intake varied largely between assessment forms. The reporting for the traditional assessment form was scattered for both nutrients. Reporting of smaller intakes was more accurate whilst larger intakes were more commonly underreported for traditional assessments (Fig. 7.4). Energy at t=2 shifted towards larger differences between the DH and FR at larger energy intakes.

Table 7-7 T-tests and Pearson's correlation coefficients for food record and diet history for t=0 and t=2

<i>Macronutrient</i>	<i>Dietary Assessment</i>				<i>Pearson's Correlations</i>	
	<i>FR1</i> (<i>t=0</i>)	<i>DH1</i> (<i>t=0</i>)	<i>FR2</i> (<i>t=2</i>)	<i>DH2</i> (<i>t=2</i>)	<i>FR1/DH1</i>	<i>FR2/DH2</i>
Automated dietary assessment						
Energy (Mean ± SD)	8313±2632kJ*	22691±39929kJ	7361±2277kJ*	10817±5950kJ	0.26	0.31
Total fat (Mean ± SD)	79±39g	217±438g	69±33g	84±62g	0.25	0.52
SFA (Mean ± SD)	25±9g	78±177g	22±11g	27±19g	0.16	0.42
MUFA (Mean ± SD)	31±20g	84±167g	27±14g	31±23g	0.22	0.51
PUFA (Mean ± SD)	15±9g	36±61g	14±8g	18±15g	0.30	0.47
Traditional dietary assessment						
Energy (Mean ± SD)	8284±2521kJ	7338±1719kJ	7309±2011kJ	7643±3052kJ	0.30	0.47
Total fat (Mean ± SD)	76±39g	62±17g	65±26g	60±21g	0.12	0.02
SFA (Mean ± SD)	26±11g	23±8g	26±12g	21±8g	0.16	0.21
MUFA (Mean ± SD)	30±18g	22±7g	23±9g	23±8g	0.02	0.01
PUFA (Mean ± SD)	13±11g	10±4g	10±5g	10±4g	0.51	-0.02
<i>FR – Food record, DH – Diet history, SFA – Saturated fatty acids, MUFA – Monounsaturated fatty acids, PUFA – Polyunsaturated fatty acid. *Significant difference between DH and FR, p<0.05</i>						

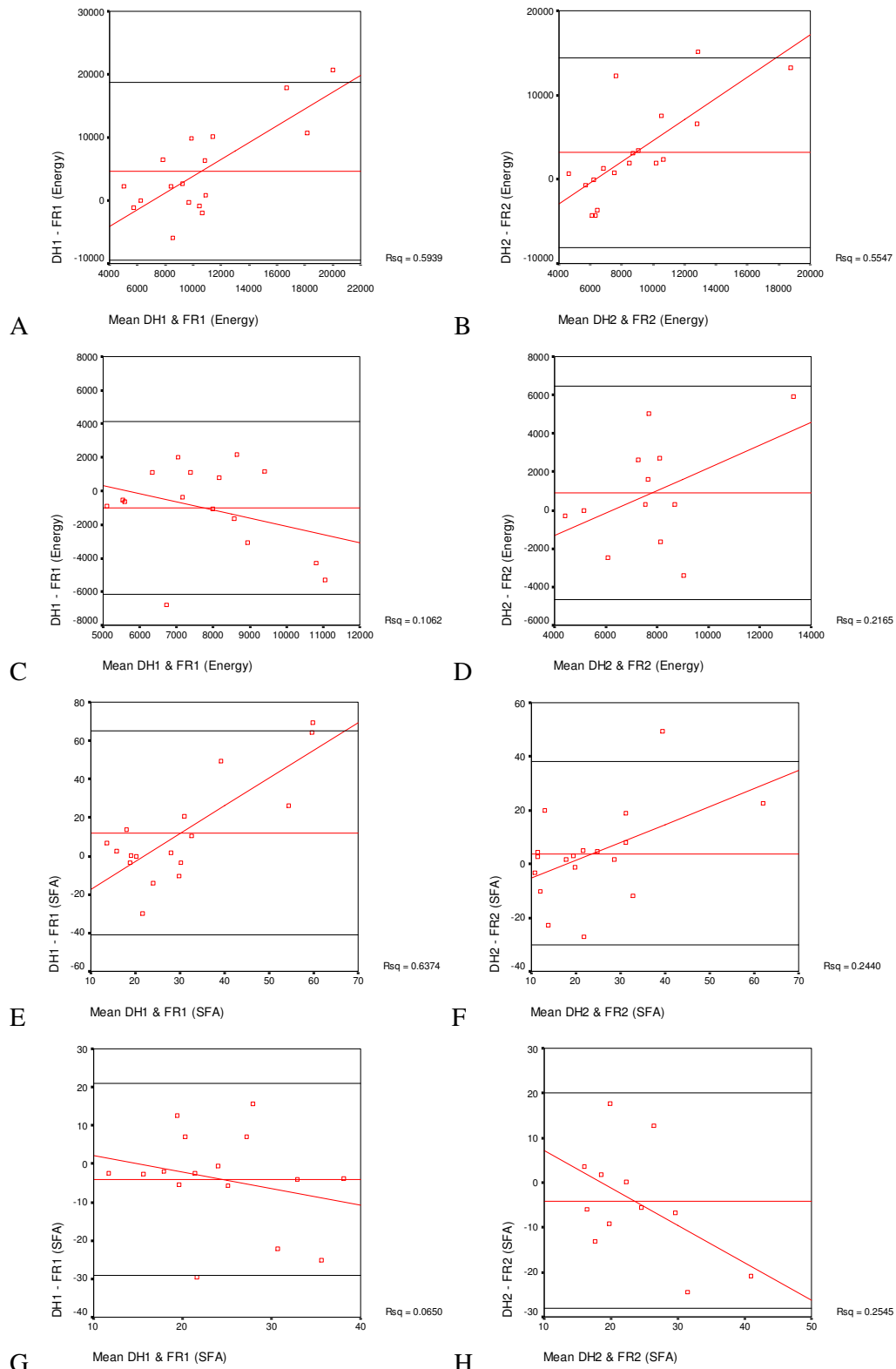


Figure 7-4 Bland Altman plots showing mean and 1.96SD for automated assessment

A - Energy Week 0, B - Energy t=2, E - SFA t=0, F - SFA t=2; and traditional assessment, C - Energy t=0, D - Energy t=2, G - SFA t=0, H - SFA t=2

7.4.4 Dietary change

Although statistical analyses of reported energy and nutrient intakes did not show significant differences, (**Appendix M**), patients reported changes in the number of dietary goals achieved. 5 ± 1 goals were set and 4 ± 1 goals remained by $t=8$. The greatest changes were observed for the two groups that crossed over (Table 7.8), though no significant differences were observed between the groups. Overall approximately 30% of goals were achieved by the study group.

Table 7-8 Percentage dietary change per group between $t=2$ and $t=8$

	<i>Group</i>			
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
% change of dietary goals	25.19	28.77	40.15	29.17
<i>A – automated assessment only, B – traditional assessment only, C – automated to traditional assessment, D – traditional to automated assessment</i>				

7.4.5 Patient preferences

For the traditional assessment evaluation questionnaire, the majority of patients indicated that they had seen a dietitian approximately two weeks previously. Interviews took approximately 45 minutes and covered one fortnight's food intake (Table 7.9). The most difficult part of the interview was thinking about how often the foods were eaten yet felt the interview required no changes. Patients partially agreed that the interview had captured a reasonable overview of their food intake and slightly disagreed about the interview being too restrictive. Patients felt comfortable, understood all questions, understood the structure of the interview, reported accurately and were in a comfortable setting. Face-to-face interviews were preferred over computerised interviews and paper-based interviews were the least preferred (Table 7.9).

The automated assessment evaluation questionnaire revealed no patients had previously used a computerised dietary program. Computers had been used by most patients and neutral feelings were expressed for both computer use and website use (Table 7.9). The interview took one hour to complete and covered one fortnight's food intake. No

changes were required for the website and the website was not overly restrictive. Patients slightly agreed that the website provided a reasonable overview of their food intake and slightly agreed that they had reported accurately. The appearance of the website and setting of the computer were moderately comfortable and slight agreement was found about the need for an assistant during computer use. A slight agreement for face-to-face interview was also expressed, though a paper based interview was preferred (Table 7.9).

The two groups who changed assessment forms (C and D) saw significant differences in reporting for time spent conducting the dietary assessment ($p=0.00$; $p=0.01$) and for the preference of a paper-based questionnaire over the current assessment form ($p=0.02$; $p=0.04$). The group that changed from automated to traditional assessment also reported a difference in the reporting period of their dietary intake ($p=0.02$). Time spent doing the dietary assessment differed by time ($p=0.00$) and between groups ($p=0.03$) (Table 7.7). Significant differences were also found for the setting of the interview between groups ($p=0.03$).

Table 7-9 Repeated measures ANOVA for evaluation questionnaires (n=30)

<i>Topic</i>	<i>Grp</i>	<i>t=2</i>	<i>t=8</i>	<i>P (grp)</i>	<i>P (time)</i>	<i>P (int)</i>
Time spent at interview	A	60 mins	60 mins	0.03	0.00	0.13
	B	45 mins	45 mins			
	C	>60 mins	30 mins			
	D	45 mins	60 mins			
Period of dietary intake reported	A	2 wks	1 wk	0.55	0.23	0.51
	B	2 wks	2 wks			
	C	2 wks	2 wks			
	D	1 wk	1 wk			
Provided reasonable overview	A	Partially agree	Partially agree	0.59	0.73	0.62
	B	Totally agree	Partially agree			
	C	Partially agree	Partially agree			
	D	Partially agree	Partially agree			
Setting of interview	A	Somewhat comfortable	Somewhat comfortable	0.03	0.78	0.13
	B	Comfortable	Comfortable			
	C	Somewhat comfortable	Comfortable			
	D	Comfortable	Somewhat comfortable			
Reported accurately	A	Partially agree	Partially agree	0.31	0.37	0.13
	B	Totally agree	Totally agree			
	C	Partially agree	Partially agree			
	D	Partially agree	Partially agree			
Prefer paper-based interview	A	Neutral	Neutral	0.08	0.54	0.11
	B	Partially disagree	Partially disagree			
	C	Neutral	Totally disagree			
	D	Partially disagree	Neutral			
Prefer computerised interview	A	Partially disagree	Partially disagree	0.84	0.45	0.33
	B	Partially disagree	Partially disagree			
	C	Totally disagree	Totally disagree			
	D	Partially disagree	Partially disagree			

Grp – Group effect, Int – interaction effect, Grp A - Automated (computerised) diet history assessment, Grp B - Traditional (dietitian) diet history assessment, Grp C – Automated to traditional diet history assessment, Grp D – Traditional to automated diet history assessment.

7.5 Discussion

7.5.1 Overview

This study assessed the repeatability and relative validity of automated dietary assessment in the GP context. As this was not hypothesis driven experimental research power calculations were not performed. The sample size was determined from previous developmental studies reported in the literature, from both psychology and nutrition. Comparisons of automated and traditional assessment forms have been conducted with approximately 30 subjects. Greater than 30 subjects is considered a large sample size in clinical practice studies (228) and is commonly found in both repeatability and validity studies similar to the research in this thesis. For this study therefore it was decided that 40 subjects would be recruited. The cross over design somewhat strengthen the power in the design

Recruitment practices and methods of recruitment are vital to a study and should be considered according to the numbers required in the study (307). Of the 110 patients contacted, less than 40% were recruited to the study. The low initial participation rates were anticipated due to the context of the study. Patients from a patient database in a GP practice may not be motivated to participate in a study. As reported in the literature on similar studies (308, 309), once committed to the study, withdrawal rates were relatively low with 78% of all patients completing the entire study. It is assumed that as the burden of a study increases, the completion rate of a study decreases (307, 310) due to the participants' personal circumstances and level of motivation.

7.5.1.1 Profile of patients

The patients in this study were primarily aged between 50 and 60 years, retired, and of minimal or beginner computer experience. In the 2001 census, 13% of the population in the Illawarra region were aged 45-54 years, and 24% were retired/not in labour force, and 42% were using computers at home (311). While not representative of the general population, the patients in this study did represent a group likely to benefit from this service.

The significant difference in BMI between $t=0$ and $t=2$ was anticipated due to the large differences in the self-reported weight for group A (Table 7.2). Group A self-reported their weight at each visit, whilst groups B-D had at least one visit with the dietitian to measure their weight. The large differences may therefore reflect weight change and/or self-reporting error.

Changes in the computer experience and comfort between weeks may have been influenced by the patients' interactions with the assessment method. Those who used the computer during $t=0$ and had a positive experience may have moved to a more positive response, whereas those who had a negative experience may have moved to a negative response at their next visit (291).

7.5.1.2 Repeatability

As this was a context based evaluation, the focus of the repeatability assessment was on accuracy of reporting energy intake. More people under-reported with the traditional DH compared to the automated DH (Table 7.6). This was possibly due to the limited face-to-face contact during the automated assessment encouraging more accurate reporting of data (47). While the difference in proportions of under/over/on target reporting were not significantly different between groups at $t=0$, and $t=2$; reporting status appeared random in the automated group. This result suggests a learning effect (227, 312) of the automated assessment with repeated use, albeit producing individual variability in results.

It may be assumed that patients were reading the screen and becoming more aware of the expectations of the website during their subsequent visits. It was observed that during their first visit, patients were reporting all foods they had eaten regardless of the time frame, whereas by their second and/or third visits they were reporting with respect to the one week period of food intake requested. SFA data may therefore have been affected by the analysis for time, as the foods higher in SFA appear to be foods consumed occasionally and therefore were not reported as patients became more aware of the one week reporting period.

Although significant differences were observed between $t=0$ and $t=2$ for fat intake data, food data revealed similarities at both time points. Furthermore, the differences were primarily seen between groups rather than with time (**Appendix M**). The only nutrient variable that displayed differences with time was SFA intake. All other nutrient data were repeatable with time. No significant interactions effects were observed for any of the reported nutrient intakes assessed. Repeatability results may have been affected by the small size of the groups within this study rather than by the two week period between assessment methods.

The time and group effects for the reported nutrient data for $t=0$ and $t=2$ also indicated that the factors influencing the patients were not independent of one another (**Appendix M**). It is proposed that as found in the literature (313), the repeatability component of the study may have been influenced by the previous assessment and the context in which the assessment was conducted. Patients may have changed their eating patterns between week 0 and week 2 as a result of participation in the nutrition research. Data for groups A and C using the automated assessment were consistently higher for all nutrients than the traditional assessment visits both at $t=0$ and $t=2$. This suggests that more foods are captured by the computer than the dietitian, and on face value, in a repeatable fashion.

7.5.1.3 Relative validity

Significant differences observed between the food record and DH for the automated assessment group suggests that the website was capturing a greater amount of dietary information than a food record (Table 7.7). In some ways over-reporting may be a problem, but there may also be some advantages as it may provide increased information for the dietitian when providing dietary advice. Data reported by the patients using the website also correlated better with the 3-day FRs, suggesting a possible consistent bias toward under-eating with the FR (314, 315). Correlations for the automated assessment were less varied (a maximum at $r=0.52$ for total fat and were lowest at $r=0.16$ for SFA data) than for the traditional assessment (highest correlation was for energy at $r=0.47$ and lowest at $r=0.01$ for MUFA intake). Better correlations between self-administered assessment and FR have been reported in the literature (316) though computerised 24-hour recalls saw similar correlations similar to that found in

our study (65). The traditional assessment results were lower than those reported on other face-to-face DH and 3-day food records validity studies (287, 317) related to clinical trials with volunteers. This may be due to the primary healthcare setting of the interview in the study.

The significant clustering around zero in the Bland Altman plots further emphasises the smaller differences between the automated DH and food record (Fig. 7.4). The degree of bias in reporting fat intakes was different to the traditional dietary assessment, and was assumed to be due to limited face-to-face contact, with the use of computer technology resulting in equally accurate if not more accurate responses. Improved clustering around zero for the Bland Altman plots between $t=0$ and $t=2$ for the automated assessment also supported the assumption of a learning effect reported above.

The Bland Altman plots also demonstrated bias in the reporting of large intakes with the traditional DH. This confirms the observation of a larger proportion of patients under-reporting energy in this group. The lack of significant differences between data for $t=0$ and $t=2$ for the traditional assessment reflected the consistent majority of patients who under-reported for both visits.

When groups C and D crossed over, the lower reporting of fat in the $t=8$ data paralleled with the patients visiting the dietitian, while the higher reporting paralleled with the patients using the computer. This suggests that the automated DH may be capturing a fuller picture of dietary intake.

7.5.1.4 Dietary change

Although no significant differences were identified for the reported fat intake between $t=2$ and $t=8$ using repeated measures ANOVA (**Appendix M**), changes in the food patterns indicated dietary changes were made by the patients. These findings may be due to the small sample size, which was not powered to show nutrient intake change but could pick up qualitative changes. Although this is self-reported dietary data, and biochemical measures would be required to confirm these changes, it may be seen that even without face-to-face dietary counselling, motivated patients can make changes (312, 318) even in a reasonably short time period.

Similar findings were identified by Beresford *et al.* (1992) who found small but significant changes in a primary health care study with $n=242$ patients. This suggests that with increased sample size, significant differences may have been observed in fat intakes, though the support of a dietitian may still be required for these changes to continue in the long-term (319).

7.5.1.5 Patient preferences

The patients from this study reported having previously seen a dietitian. This may have affected the responses given in the questionnaires. For example, the traditional assessment group reported that thinking about how often foods were eaten was most difficult part of the interview. This suggests that although someone is available to clarify and assist during the interview, cognitive challenges are still faced whether the interview is conducted with the computer or by a dietitian.

Patient preferences revealed that the reporting of dietary intake was not in line with the reporting period suggested by the assessment form. The automated assessment referred to an average one week reference period, which was identified by group A by $t=8$. The traditional assessment covered a reference period of approximately 28 days which patients perceived to be covering only one to two weeks. Despite patients reporting that they understood all the questions asked and felt that they had given a reasonable overview of their food intake, this misunderstanding may be strongly related to the nutrient intake findings of this study. Patients completing the traditional assessment form may have felt they were limited to only one or two weeks and therefore only reported a limited number of foods. This may be a reason for the high degree of underreporting identified in the study. Conversely, the automated assessment groups may have felt they could report more than was expected by the program, which may have led to the positive reporting from the patients.

Patients also preferred a face-to-face assessment over a computerised one. The opinions provided by the participants in this study about the traditional and automated dietary assessment forms may be influenced by their computer experience and comfort of skewing the preferences toward the traditional assessment form.

Due to the demographic profile of the patients (approximately 60 years) in this study it was also identified that an assistant was preferred during the use of the automated assessment. Studies have shown that the type of user and context may influence their need for assistance(178). Although feasible in a small study such as this, an assistant would not be feasible in GP practices across the Illawarra region. Group C who used the computer at t=2 and saw the dietitian at t=8, reported an improvement in their comfort using a computer, whilst group D who saw the dietitian at t=2 and used the computer at t=8, reported a decrease in their comfort using a computer. Similar findings were also seen in these two groups for their preference toward a paper-based questionnaire and a computerised interview. This suggests that the setting of the assessment may influence the reporting of the patients' opinions and beliefs.

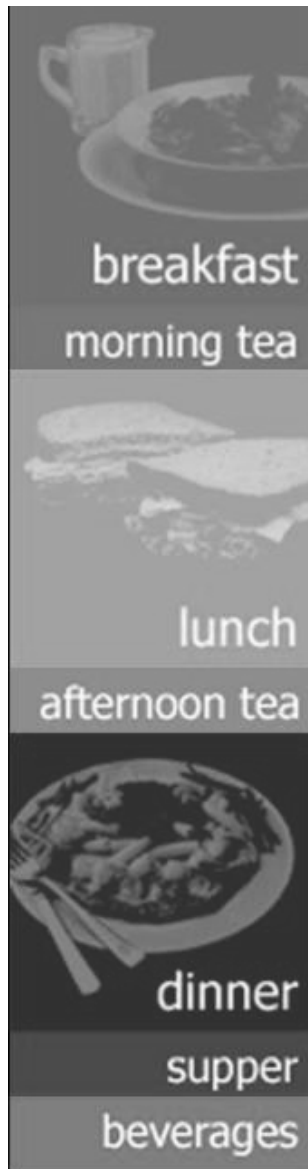
In general the DietAdvice website appears to be associated with random variation in reported energy intakes as patients learn to use the website. The types of food reported, however, are reasonably consistent. The website might also produce more valid results, but this needs to be tested empirically under more controlled experimental conditions. There is also some evidence that under controlled conditions, the inclusion of this technology in practice may support dietary change.

7.5.2 Limitations and areas for further research

From an empirical perspective, the primary limitation to the study was the small sample size and the limited power of the study. Nevertheless, for the purpose of practice based research, clinically relevant changes, such as the reported weight loss of the patients after receiving dietary advice, were identified. The high degree of underreporting found in the traditional group compared with the automated group also suggests the need for further research to confirm the accuracy of reporting. A further study using doubly labelled water would determine whether the nutrient intake data found for the automated assessment group are linked to the actual intake of individuals with metabolic syndrome, the clinical condition of reference. Dietary change could also be further investigated through biochemical measures of plasma lipid concentrations and blood glucose to determine the impact of dietary changes on the health of a larger sample of patients. The learning effect identified in this study should also be pursued.

7.5.3 Relevance to the thesis and implications for practice

The differences between the automated and traditional assessment forms were noticeable. The interview conducted by the dietitian was structured, though the dietitian was unaware of the types of questions asked by the automated assessment program. The structured interview conducted by the dietitian contained a checklist of commonly forgotten food items, yet the nutrient intake data reported by the patients was still lower than those reported by the automated assessment groups. This may indicate that the use of a list of food groups as seen in the automated assessment program may act as a prompt for the patients, who were required to read through each of the food items and relate them individually to their own food intakes. Furthermore this study identified that when assessing dietary change, individual differences between patients need to be viewed at the food intake level rather than by nutrient intakes. The majority of patients had made dietary changes after eight weeks of the study yet statistical analyses were unable to pick up these changes in nutrient terms. The literature supports the need for individualised dietary advice and therefore the model of the CAST case study may be beneficial for patients who are already self-motivated yet do not have access to a qualified dietitian. User preference in this study was still skewed towards the traditional assessment form. The findings of this study informed the discussion on stakeholder evaluation in the next chapter, in terms of whether the influence of this study setting affected patient responses.



EVALUATION PHASE

Diet Advice

Perspectives of key stakeholders

8

CHAPTER 8

Perspectives of key stakeholders

8.1 Introduction

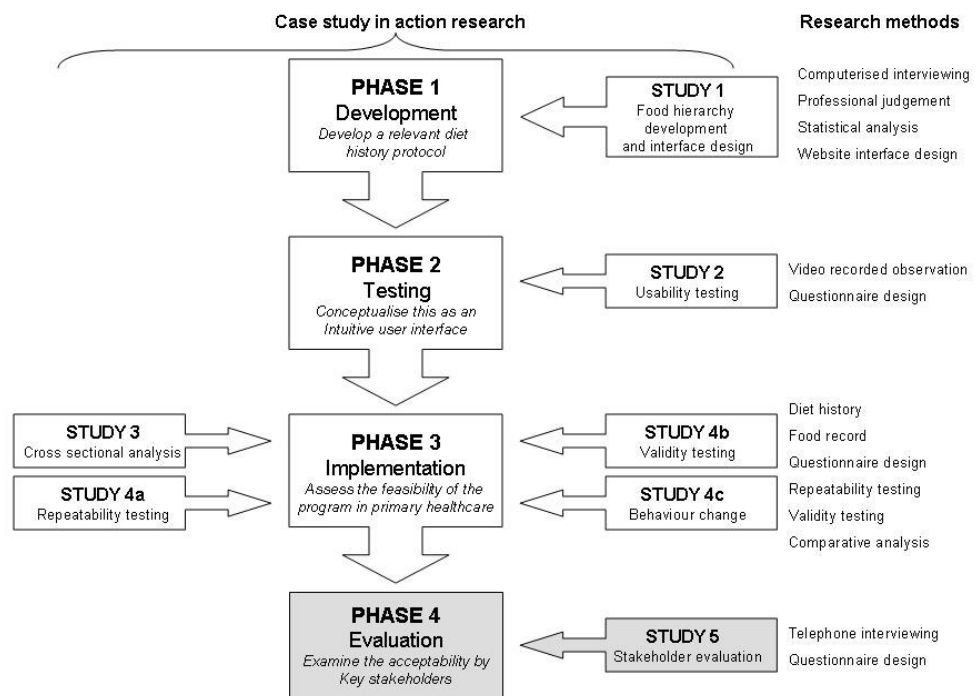


Figure 8-1 Overview of the CAST case study showing the evaluation phase

Though the website was found to be user friendly and a valid form of dietary assessment, it was still not known whether the concept was accepted by the key stakeholders. Dietitians, GPs, and their patients were the three stakeholder groups targeted in this study to determine acceptance of the technology. The stakeholder study was conducted from November to December 2005. The hypothesis under considerations was that stakeholders would accept the technology, seeing it as an advancement in

nutrition practice rather than as a burden. This chapter outlines the stakeholder interviews conducted as the final phase of the CAST case study allowing for future applications of the technology to be determined.

8.2 Aim

To gain an understanding of the acceptance of the automated interview by its users and healthcare providers.

8.3 Methods

8.3.1 Data collection

The CAST model primarily related to three key stakeholder groups – the patients who used the DietAdvice website, the dietitians who would be providing the dietary advice for the patients, and the GPs who recruited the patients.

For the selection of patients for the stakeholder evaluations, all patients who had logged on to the DietAdvice website by October 2005 were considered. It was assumed that the GP practice to which the recruiting GP belonged would be the practice closest to the patient's home. The patients were therefore listed by GP practice, and a random selection of ten patients was taken using random digits from the www.randomisation.com website.

As only two dietitians were involved in the pilot of the CAST model, dietitians recruited for the stakeholder evaluation had not been involved with the DietAdvice website. Selection of the dietitians by field of work and location is detailed in **Section 3.4.2.2**. The dietitians selected for interview were determined by random sampling within these two groupings ensuring the percentage of work areas equated to that of the state level and that an even spread within the region was achieved. Random sampling was also conducted using random digits created by the www.randomisation.com website.

Due to the variations in recruitment by the GPs (**Section 6.4.1**), systematic sampling was selected for the GP stakeholders to ensure that a mix of opinions was achieved. ‘Recruiting’ and ‘non-recruiting’ GPs were the two groups selected to interview. The selection process is as follows: of the 41 GPs involved in the study the total number of patients recruited by October 2005 was taken. This figure was divided by the total number of months the GP had been involved in the project, and further divided by the total number of patients recruited for the study. This gave a weighted percentage of total patient recruitment allowing all GPs to be rank ordered. The ten highest recruiting GPs were selected for the ‘recruiting’ GP stakeholder group and the ten lowest recruiting GPs were selected for the ‘non-recruiting’ stakeholder group.

Stakeholders selected from each of the three groupings were contacted by email or by telephone to determine interest in the study. Interviews were conducted over the telephone unless otherwise requested. All participants were informed prior to the interview that their responses would be audio recorded and further coded for anonymity during analysis.

Development of the interview schedule was based on key areas of the CAST model (recruitment, website use, dietary advice etc) and included additional questions about the stakeholder beliefs on health, nutrition and technology (**Appendix N**). The questioning scheme was designed to ensure that enough information could be obtained without taking up too much of the interviewee’s time. The questions formulated for each stakeholder group followed a similar sequence of questioning to allow for analysis of the data to be combined for the three stakeholder groups, and to ensure that interviews would take approximately only ten minutes to complete. As the dietitians had not been involved in the study, an information sheet was sent to participating dietitians prior to the interview.

8.3.2 Data analysis

Interviews of participants who consented to audio recording were transcribed verbatim. Face-to-face and self-administered interviews were also transcribed. Data for all interviews was uploaded into NVivo qualitative analysis software (version 2.0.161, 2003: QSR International, NSW, Australia). Content analysis was conducted. Categories

were developed from the sections of questioning. Further sub-categories were developed as required to capture emerging ideas and opinions (320). To illustrate the ideas that developed, the data is presented as examples of each of the categories developed.

8.4 Results

Of the ten patients selected, two were not interested and one patient withdrew due to time restrictions. All were telephone interviews. Only one dietitian was unable to participate as she was on holidays overseas. Of the remaining dietitians, eight completed telephone interviews and one completed a face-to-face interview. All ten GPs in the 'recruiting' GP group participated. Two needed to be interviewed face-to-face due to policies within the medical practice, and one did not consent to audio-recording the interview. Of the 'non-recruiting' GPs, three were not interested. Six of the remaining seven GPs completed the interview by telephone and one preferred to complete the interview in a self-administered form on paper due to time restraints. In total, 33 stakeholder interviews were conducted with 83% participation. A profile of these stakeholders is shown in Table 8.1. Overall similar numbers of male and female stakeholders were interviewed and an even spread of locations within the Illawarra region was covered (**Appendix D**).

Table 8-1 Profile of stakeholder interview participants

<i>Stakeholder group</i>	<i>Quota</i>	<i>Location</i>	<i>Gender</i>
Patients	1	Warilla	Female
	1	Wollongong	Female
	1	Thirroul	Male
	1	Shellharbour	Male
	1	Kiama	Male
Dietitians	2	Berkeley	Female
	2	Shoalhaven	Female
	5	Wollongong	Female
	1	Shellharbour	Female
Recruiting General Practitioners	1	Port Kembla	Female
	2	Coniston	1 Female, 1 Male
	2	Berkeley	1 Female, 1 Male
	3	Wollongong	2 Female, 1 Male
	1	Warilla	Male
Non-recruiting General Practitioners	1	Dapto	Male
	1	Kiama	Male
	3	Helensburgh	1 Female, 2 Male
	1	Warrawong	Male
	1	Wollongong	Female
	1	Dapto	Male
	1	Thirroul	Male
Total	33	12 Locations	13 Female, 14 Male

The categories and subcategories developed from the data analysis were:

- | | |
|-------------------------|------------------------------------------|
| General health/practice | - Obtaining/providing dietary advice |
| | - Health (patients only) |
| | - Health and technology |
| | - Dietary consultation (dietitians only) |
| | - Referring to a dietitian (GPs only) |
| The CAST model | - Advantages |
| | - Disadvantages |
| | - Dietary advice |
| | - Recruitment |
| | - Future use |

8.4.1 Patient perspectives

The patients all felt that nutrition was important as it helped them manage their health. The majority obtained their nutrition information from magazines, books and the Internet, and although expressing concerns about the privacy of their information, felt that technology is beneficial (Table 8.2).

The general finding from the patients was that the website made them more aware of their eating patterns (Table 8.2). One patient who had a very simple eating pattern suggested that the website was too complicated and that she would prefer face-to-face interviews instead.

“Well you know, um it’s just you see, I eat very simply, and that was a bit, a bit over the top...I mean a lot of people eat differently I suppose and some are answering it from another perspective might be alright with it, but I find it a bit difficult sort of, you know, answer. Face-to-face would be better.” (28110501P)

This patient’s comment was not related to her computer skills which she self-reported as eight out of ten. Similar findings were suggested by another two patients, of which one preferred face-to-face contact as she was of a non-English speaking background. The patients all reported feeling that the website was repetitive. When asked what changes should be considered, a suggestion was made to include instructions outlining the period of food intake to be reported (Table 8.2). Two patients who had used the computer in GP practices also reported difficulty, because the Internet disconnected thus interfering with their ability to use the website.

Of the seven patients interviewed it was identified that three had not received their dietary advice from their GP. All had returned to their GP since and two had forgotten about the advice. One patient had returned specifically to pick up the advice and was told by the GP that it had been lost. The four patients who had received their advice reported finding the advice very useful (Table 8.2), although not all had had the opportunity to discuss it with their GP. On average, the patients reported their computer skills at six out of ten, with one patient never having used a computer before.

Table 8-2 Key categories within patient stakeholder interviews

<i>Category</i>	<i>Sub-category</i>	<i>Illustrative quote</i>
General Health	Obtaining dietary advice	Um, obviously the doctor and what you guys gave me, and low GI book I bought. (24110503P)
	Health	I think nutrition is important because, you know, for you to have a healthy long life. (24110501P)
	Health and technology	[W]ell using technology for your health would give you access to it, but I also find I have got a little bit of resistance about doing things say on the computer and things like that. (15120501P)
The CAST Model	Advantages	I mean it was, it was very good in that it did give you a better look at, um you know, at your diet and so forth, I mean we always thought we had a fairly good diet but I was able to pick up things that I could improve on, um, it was good in that regard. (28110501P)
	Disadvantage	I found the website to be a little bit complicated and by the time I finished answering all the questions I found that I was getting quite frustrated with it, because I found that a number of the things when I was picking out what I ate especially for dinner I found it difficult to keep it within seven meals a week because of the way it was laid out. (15120501P)
	Dietary advice	It was, it was in detail and it was easy to follow, and it as pretty, as far as, saying about your health and what you should do and um, how you should go about it. It was like step by step, and I thought it was pretty good actually. (28110502P)
	Recruitment	[M]y doctor told me about it. (28110502P)

8.4.2 Dietitian perspectives

The dietitians felt that the education component of the dietary interview was the most important to the patient. They also felt that technology is beneficial, although at present is very generic and generalised (Table 8.3)

Though the dietitians had not used or been involved with the DietAdvice website, it was seen as a positive addition to current dietetic practice. Many identified it as a time saving mechanism which could be used before patients came to see them, allowing additional time to be spent educating and counselling the patients (Table 8.3). They were primarily supportive of the inclusion of technology into dietetic practice, indicating that the number of patients requiring dietary advice outweighs the number of

dietary services which can be provided. They felt that the DietAdvice website is a means of addressing this problem.

Table 8-3 Key categories within dietitian stakeholder interviews

<i>Category</i>	<i>Sub-category</i>	<i>Illustrative quote</i>
General practice	Health and technology	I think they're beneficial. I think they're generalised, but obviously they'd have to be, um, and as long as they weren't confusing I think they're going to be fine. (06120501D)
	Dietary consultation	All parts are relevant as in order to give education, collection and assessment is needed. Education is the most important overall as it is what they patient gets out of it. (30110501D)
The CAST model	Advantage	[T]hey shouldn't use the Internet as their sole access for education in that respect using the Internet and seeing a dietitian or a practitioner then I don't think it's compromised I think it's only advancing it the more patient knowledge you have of patient the better with certain complications I guess metabolic syndrome. (14110501D)
	Disadvantage	I would hate not to be able to book in to see my doctor when I have a chest infection for instance, and they don't see me, because they're spending time supporting or motivating someone to make dietary changes. (16110501D)
	Dietary advice	[T]he only other thing was that the general practitioner was the one who was responsible for discussing this dietary prescription with the patients, and the only problem I have with that is that they first of all got to understand it and also got to have time to be able to educate people, and like I said I think education is one of the most important things, identification is one thing, but getting people to implement changes I think the most important thing, I think that's where in my opinion it will fall down, because the dietary prescription would be better coming from somebody that is trained dietetically more so than medically. (08120501D)
	Future use	[S]omeone in private practice could have this, and then someone could book in for an appointment and I can say if you're on the Internet why don't you log on as this and then send me this, and I will get this information prior to them coming along to consultation...way of me being about to provide a service, a cost effective way as well as a time-efficient way of being able to provide this service. (16110501D)

Computer literacy was still felt to be a concern and identified as a possible reason for potentially limited use of the website. Another concern was the provision of the dietary advice to the patient by the GP, and the fact that the GP may not be available to more serious medical cases whilst discussing diet with these patients (Table 8.3). It was felt that a person who had been trained in dietetics should be the person discussing the advice with the patient. The relationship of the GP, patient and dietitian was seen as beneficial. The majority of the dietitians saw the CAST model as complementary to current dietetic practice, while three felt it would compromise a dietitian's role (Table 8.3). On average the dietitians reported their computer skills at eight out of ten.

8.4.3 GP perspectives

Information available on the Internet was identified by both the 'recruiting' and 'non-recruiting' GPs as one of the advantages of technology in healthcare. The 'recruiting' GPs were more likely to routinely refer to a dietitian, whilst the 'non-recruiting' GPs had only referred for specific conditions. Similarly the 'recruiting' GPs felt that they did not have the expertise to give dietary advice (Table 8.4), whilst the 'non-recruiting' GPs turned to other resources such as pamphlets and books for nutrition advice for their patients (Table 8.5).

Both the 'recruiting' and 'non-recruiting' GPs identified the DietAdvice website as beneficial due to its accessibility from a number of locations, and because patients could obtain information about their personal eating patterns (Table 8.4). Computer literacy was identified as the limiting factor for patient recruitment by both groups of GPs. Time was also raised by the 'non-recruiting' GPs as a reason for limited recruitment (Table 8.5). The need for a face-to-face component in the CAST model was also suggested. Some GPs suggested that face-to-face assessment could be used to complement the use of the website and others suggested it could be used to provide advice to the patients (Table 8.5). Although this was already a component of the CAST model, the GPs felt that the dietitian should be the one providing advice to patients, as the GPs did not feel confident discussing the advice with their patients due to limited training and access to resources. Only two of the 'non-recruiting' GPs could recall receiving dietary advice for their patients. On average the 'recruiting' GP group reported their computer skills at six

out of ten whilst the ‘non-recruiting’ GPs reported their computer skills at seven out of ten.

Table 8-4 Key categories within ‘recruiting’ GP stakeholder interviews

<i>Category</i>	<i>Sub-category</i>	<i>Illustrative quote</i>
General practice The CAST Model	Providing dietary advice	We are not very familiar with discussing nutrition on a good basis. We’re sort of good on a general, we look at the pyramid and discuss that and discuss carbohydrates and fruit and vegetables and things like that. A good working analysis of what things you need, we have no education. (30110501R)
	Health and technology	[E]ligibility of the records, reliability of records, you don’t need to set your mind on memories or looking up books, they’re already accessible at your fingertips the knowledge that you want. (14110501R)
	Referring to a dietitian	I think a dietitian is more... they’re more expert, and they have an hour, half an hour to explain what we do in only 2 minutes. (22110501R)
	Advantage	Oh yeah, provides access to, to, to, access to information about nutrition for my patients and when it was free it was great. But also the access to very professional advice through the CAST program. And also the cost, it’s the hassle, cause they gotta get out and they actually have to go and see a dietitian somewhere, and on CAST program they could go online putting down a half-hour, put the information in and getting something back from it. (30110501R)
	Disadvantage	[S]ome patients are not computer, have no computer skills, so it makes it difficult for them to join in, sort of thing...to, um, participate in the program. (30110502R)
	Dietary advice	And the written data that we got back had been fantastic, they could take it away, study and analyse it and use it as an ongoing resource. (30110501R)
	Recruitment	I’m surprised. I think it’s that the doctors are so busy, and that you only have to start recruiting, and get a couple and then you’re in the swing of it, but it’s getting started that’s the difficulty. (14110501R)
	Future use	Um, we’re now in a bigger centre and so I would think that if um, if the study going to be ongoing I’d be happy to do it as a nurse initiative thing, or do a mail-out. (09110502R)

Table 8-5 Key categories within ‘non-recruiting’ GP stakeholder interviews

<i>Category</i>	<i>Sub-category</i>	<i>Illustrative quote</i>
General practice	Providing dietary advice	I have a little bit of confidence, not a great deal...might refer to a pamphlet that I have like for the low fat sort of thing, there's lots of the cholesterol lowering medications that I have pamphlets. Or yeah, if I get some information that way or I might check a little bit in a like a low fat book or a low GI sort of counter that might be what I might use. (14110501N)
	Health and technology	Um, as long as it's I guess a credential source and it's important easier to go through, I think it's good idea, Internet is one of the fastest growing means of media out there, I think need to take advantage of the Internet. (11110501N)
	Referring to a dietitian	[W]ith the new, um, what's it called, the GP referral system...Allied Health Initiative, I've been using that more in recent times, to refer patients with metabolic syndrome to dietitians. (28110501N)
The CAST Model	Advantages	Well, I mean with the CAST program it also um, what I've read, things like discussion with the practitioner such as a dietitian or general practitioner, it's not just patient only, I think that's a good idea... it's good that they can access information and questionnaires over the Internet, so they can have an idea of nutrition assessment. (11110501N)
	Disadvantages	[A] lot of my patients here, the older population I, um, asked to be part of the program didn't have a computer access or computer confidence. (10110501N)
	Recruitment	I think it was just hard to remember, because as I said at the start problems the person has, and you're looking at your watch, you know, 15 minutes or whatever time and you're running late, so it's one of those things you just go well, that's an extra, it might only be just 30 seconds but it's an extra thing and you know go into another conversation about it, so that might be the problem and maybe if they, maybe if we did it through the front desk and they just got given something and then they could be recruited through the front desk. For me, I just find it hard to remember to recruit people like that, the same with other projects that have been through too, whereas I think some of the other doctors remember better than I do. (14110501N)
	Future use	I think the format's good, I'm not sure whether you're proposing to replace dietitian assessment, or whether you're trying to complement it, um, but I think in an initial diabetes or metabolic syndrome assessment probably a face-to-face assessment is probably better for reinforcing patient compliance...be great for um, for follow up. (10110501N)

8.5 Discussion

8.5.1 Overview

Conducting stakeholder interviews with the three very different stakeholder groups identified an overall acceptance of the program by all groups. The level of participation of the stakeholders was an observation which was of importance. The GPs who had successfully recruited a number of patients to the website were all willing and able to participate in the stakeholder interviews, whilst the GPs who had not recruited or only minimally recruited, were not as willing to participate in the stakeholder evaluation. A study by Wilson *et al.* (2000) compared recruiting and non-recruiting GPs who were involved in a study for the Royal Australian College of General Practice (RACGP). It was found that a strong patient relationship, as well as a topic area of interest encouraged GPs to participate in the research (321). This is assumed to be the reason for the varied participation rates of the GPs in this study.

Similarly, the dietitians who were available at the time of the study all agreed to participate in the stakeholder evaluation. It is possible that this was related to their interest in the innovation and its relevance to their daily practice (290). The patients appeared to be willing to participate, even if they had had negative experiences with the program, such as not receiving their dietary advice. This may be related to altruism, which has been associated with participation in clinical trials independent of other socio-demographic, psychosocial and clinical features (295). Though it is not known what the experiences of the non-participating patients was like, it may be assumed that those who did participate were more motivated (123), or had become increasingly motivated as a result of using the program. Other studies, such as one conducted by Sciamanna (2002), also found acceptance of the use of computers in healthcare practice (123) to relate to the level of participation.

An interesting result from the patient stakeholder interviews was their suggestion for instructions to avoid repetition of reported foods. The website indicates on numerous occasions the need to report only a one week period of food intake. This would suggest that patients are not reading the instructions. Rettig (1991) suggests that adult learners are more likely to get started quickly through self-initiated exploration and learn from

their mistakes, rather than read manuals or instructions. This was found to be the case at all levels of computer experience (322). The patients captured in the stakeholder evaluation also had varying levels of computer experience and were from different socio-economic backgrounds (by location only). Despite these differences the key findings were:

- Repetition of the foods,
- Internet difficulties in the GP practices,
- Not receiving their dietary advice from their GP, and
- A preference for a face-to-face interview.

The dietitian stakeholder interviews revealed that although the dietitians had not been involved in use of the program, they were very willing to provide suggestions for use.

The primary issues identified by the dietitians were:

- The GP providing the dietary advice,
- The computer literacy of the patients,
- The ability to save time through implementation of the DietAdvice website prior to dietary education and counselling, and
- The importance of including a dietitian with face-to-face contact in the CAST model.

The GPs who did not recruit many patients, self-reported their computer skills to be higher than the GPs who recruited many patients. It may be assumed that with the increasing numbers of clinical resources now available online (20) this additional computer literacy allows those GPs to find their own resources for patients, rather than use the DietAdvice website. Other than this, time limitations were found to be the primary reason for lower recruitment rates. The main issues identified by ‘recruiting’ GPs were:

- Patient satisfaction with the dietary advice,
- Increased availability of dietary services created by the DietAdvice website,
- A potential limitation of patient computer literacy, and
- The importance of nutrition in health.

The ‘non-recruiting’ GPs identified:

- A lack of time available to recruit patients,
- A potential limitation of patient computer literacy,
- The importance of technology in healthcare, and
- The need for face-to-face contact in the CAST model.

Interestingly the ‘recruiting’ GPs had established referral systems in place for patients, whilst the ‘non-recruiting’ GPs were more likely to use the resources to which they had access. This may relate to the willingness of GPs to refer their patients to a dietitian. A study by Nicholas (2003) found GPs were more willing to refer patients with complex nutrition needs to a dietitian, although they felt that cost would be the main limitation for the patient (323). The GPs in this study also identified time and lack of knowledge as limitations to providing nutrition advice.

The patients’ demographic had the strongest influence on their perceptions of the usefulness and ease of use of the website. The patients in this study had all used the DietAdvice website, which indicated that they had perceived the website as useful and easy to use. This perception impacted upon their attitude regarding the website, as well as upon their intention to use it, and resulted in use of the system. In turn, a positive or negative experience with the system as well as the perceived benefit of the dietary advice provided potentially influenced the reported beliefs of each of the patients. The influences of the external environment have the ability to determine a person’s beliefs and in turn their behaviour (324). The influences in this study may be the environment of the GP practice, the GP, or family and friends. If a positive experience resulted from using the DietAdvice website, then positive beliefs may be formed about the program which would be further supported by positive results brought about by behaviour change.

The dietitians and GPs are similarly affected. Rather than the model leading to use of the system, it appears to run in reverse for health professionals. Use of the system by their patients influences their behavioural intention to recruit additional patients, as well as their attitude toward the system. Repeated many times, this process will lead to a changed perception of usefulness and ease of use of the system (325). This ease of use encouraged GPs to recruit patients, though they were also influenced by the external

variable of time. The perceived usefulness for the dietitian, however, could be related to their ability to identify the system as beneficial to their daily practice, and easier to use than a traditional face-to-face interview. The external variable likely to persuade the dietitian would be the field within which they work. These findings suggest that the perspectives of patients and counsellors (dietitians and GPs) show some variation based on their experience with the automated system, their focus on nutrition and the roles they play in the healthcare system.

8.5.2 Limitations and areas for further research

The main limitation to this research was the need to provide the dietitians with information sheets about the website. Time restrictions prevented them from being able to use the system and evaluate it as a component of the stakeholder evaluation. Further research would include a range of dietitians from different practice areas utilising the system with their patients for a given period of time. This would allow opinions and beliefs to be established from actual use of the website, rather than from the assumptions made after reading an information sheet.

8.5.3 Relevance to the thesis and implications for practice

This study was of primary importance to this thesis, as it allowed stakeholders to express their opinions about the CAST model and the DietAdvice website. Researchers were unable to be present in each GP practice for the duration of the study, and were therefore not aware of the practical challenges faced by the GPs and the patients who had been recruited. Evaluation of this study will allow for future use of the website to incorporate the suggested changes, and for the model to be adapted to suit the setting within which it is to be used.

Diet Advice

Conclusions & recommendations

9

CHAPTER 9

Conclusions & recommendations

9.1 Introduction

The preceding chapters have reported on the five studies used to support the CAST model of automated dietary assessment in the primary healthcare setting. The thesis, based on a case study in the field of action research, found that the CAST model was effective and this was likely to be due to the processes followed in the research, to drawing on a range of theoretical positions to support the integrity of the questionnaire design, the usability of the instrument, and to an effective use within the primary healthcare setting. This chapter brings together the dimensions of the case study and provides suggestions for future applications. The chapter begins by summarising the key findings from each research activity within the limitations of a case study. It then continues by suggesting a way forward in this field of research, discussing how the program could be applied to other fields of healthcare practice and research.

9.2 General conclusions

The CAST program was feasible in the primary healthcare setting and improved clinical services by increasing access to dietary services for patients who would not otherwise have had access to a dietitian. CAST was also generally accepted by each of its stakeholders. The program was found to work in the Illawarra region, providing benefit to both the patient and the GP.

The first study utilised closed questioning in the development of the UI. This allowed for a low respondent burden yet the design needed to consider human information processing and cognition. The interface design was based on simplicity and ease of use for the user, allowing it to cater for a range of levels of computer experience. By using

representative data from the NNS95, concepts of dietary methodology of both the DH interview and the FFQ could be automated. The database listed foods based on what people actually eat. Therefore study one was successful because not only did it ask the right questions, but they were presented in a format that users could identify with and were based on previously reported food intakes.

The second study was focussed upon the computer literacy of the patient-user. By trialling a prototype of the website, human computer interactions were observed allowing changes to be made as required. Usability testing showed that the website works because of the observed patient interactions when they used the website.

Although the third study found that the website was primarily used by a limited range of cultures, it brought an understanding of the cultural acceptance of the website. The website was found to work though primarily for certain cultural groups primarily due to the accessibility of the resources. The website was also, by preference, used in the patient's home. The social desirability of the home environment may have been the reason for the higher reported intakes. The website was found to work at home because this is where the patients preferred to manage nutrition issues i.e. self-care.

The fourth study identified a learning effect with repeated use of the website. Tested in the primary healthcare setting, users became more familiar with the website's functions with repeated use. Similar findings have been identified in traditional dietary methodology. Therefore the website was successful in that awareness of learning effects in dietary assessment had already been documented in the literature.

The fifth and final study with the stakeholders revealed an acceptance of the website. This may be related to the ability of both the healthcare professionals and the patients to accept technology in healthcare practice. The website was again found to work as each of its stakeholders were able to use the computer and to accept computers as a technology of the future.

Setting the CAST program within a case study model meant that though the findings were limited to the context of the case study, assumptions could be made that relate to

the broader population (168). As a case study is an investigation into the real-life context, it is bound by its size and the setting within which it is being tested (170). Therefore traditionally the CAST case study is bound by the 14 practices and 224 patients who used the system in the Illawarra region's primary healthcare setting. Silverman argues that although the ability to generalise from a case study means that conclusions about professionals and their clients cannot be drawn, the practise itself has the possibility to work in other settings (207, 326). We therefore cannot assume that the GP-patient interactions in different regions of Australia would be similar, though it may be assumed that the implementation of the CAST program into the GP practices throughout Australia would still be feasible and accepted, though modifications to the model may be needed to suit those other areas.

9.3 Summary of key findings

The following section describes the outcomes of each of the five studies as related to each of the eight sub-hypotheses of this thesis. Each sub-hypothesis is referred to as a finding of the research.

9.3.1 Appropriate questionnaire design

Finding 1 - The food database (food hierarchy) was necessarily limited to closed questioning and was able to capture a broad range of food items reported in the most recent Australian National Nutrition Survey.

Development of the program was based on a closed questioning structure and the food items captured from the reported intakes of the Australian NNS95. Applying statistics, dietetics and web-design, a nutritional focus drove the development of the food hierarchy. The two challenges addressed in the development phase were: To produce an interface that addressed knowledge of human information processing in reporting dietary intake, and to delimit the technical problems arising from use of the program (e.g. spelling errors).

The Australian NNS95 data provided a picture of the eating patterns and types of foods eaten within the Australian population. Though limited by the age of the survey, the

broad range of food items were assumed to cover a range of eating patterns to be addressed in the website. Although the range and number of food items in the supermarket has changed, it was assumed that due to the use of generic food items in the NNS95, food patterns could still be determined. The overall structure of the questionnaire was able to follow that of a DH interview by including the identification of food items as well as portion size and frequency of consumption over a one week period of reference. The inclusion of closed food groupings combined some of the dietary methodology of the FFQ dietary assessment, such as the ability to capture information about food intake with a limited number of food items (177).

Technological challenges were addressed through an understanding of human computer interactions (177) and the concept of cognitive information processing (204). Reference to social cognitive theory (289), meant the research was sensitive to factors that might influence the accuracy of reporting (4, 276, 327), such as cognitive burden and limited computer literacy. Meeting the technological challenge of automating a process normally performed face-to-face was the first step. Meal based questions rather than food based questions were used because of research indicating a higher degree of accuracy of reported food intake (328). Similarly, the use of grouped food items rather than individual food items has been reported to encourage increased accuracy of responses (277). It is believed that grouping of food items in the DietAdvice website decreased the overall number of questions, yet still allowed for a broad number of eating patterns to be reported.

The use of food groupings also addressed the importance of decreasing the cognitive burden on the respondent during a self-administered dietary assessment (329). Self-administered dietary assessments usually require a patient to read each of the individual food items or groupings item by item, and interpret their meaning in relation to their own eating pattern. By selecting a dynamic website design, cognitive burden was addressed. A multiple pass format was selected for the questioning scheme to allow users to login and log out at their convenience without losing vital information required by the dietitian (**Chapter 4**). Although the lists of food items were extensive, the patient was only required to complete information about those foods selected as being relevant to their own dietary intake. Items not required were not shown to the patient in

subsequent sections. Viewing the food groups on screen assisted the patients' answering process by providing cognitive prompts. The number of food items for which increased respondent burden was observed was not determined in the study, though would be beneficial for future applications.

A closed questioning sequence limited the number of technological problems associated with the typographical errors and spelling errors which may have occurred with the use of open ended questioning. Although open ended questions were included in the questionnaire to collect demographic data, the majority of the questions were closed in nature (**Chapter 4**). Closed questions also decrease the burden on the patient as they are only required to point and click as opposed to typing names of the foods.

Although technology provides the advantage of speed and automatic nutrient processing (38), the computer is unable to provide professional judgement for the interpretation of the data. Due to the variability of individual dietary intakes, food items or portion sizes that were incorrectly reported could not be detected by the computer. Therefore the question is raised, is the interaction of a traditional face-to-face interview vital to the reporting of dietary intake or does the structure alone represent the key to accurate dietary information? If the interaction of the dietitian and patient are considered not to be required, then it may be said that the DietAdvice website is truly an automated DH interview. If, however, the dietitian-patient interaction is vital to the process and accuracy cannot be achieved by the structure alone, then the DietAdvice website may be said to be an adjunct to the DH interview.

9.3.2 Understanding the patient-user

Finding 2 - The degree of assistance was affected by the level of computer literacy of the user i.e. users with a higher degree of computer literacy had a reduced need for assistance.

Computer literacy and computer experience were related to the assistance required and time taken using the website. Usability testing aimed to modify the website to improve time efficiency and patient understanding, though a learning effect was still identified with later use.

Users of the website generally did not require a large degree of assistance while using the website (**Chapter 5**). However, the participants for the study were volunteers recruited to a dietary computer program. It may be thought that these volunteers were interested in the topic and were potentially more computer literate than the general population, resulting in an overall decreased need for assistance. Research shows that an increased need to ask for assistance is related to a decreased rating of usability (178). This is also inversely related to the amount of time required by a person to test a program

The time taken to use the website was found to be comparable to the time required by the dietitian to conduct a dietary assessment, as well as to analyse the nutrient intakes of the client (**Chapter 5**). If the time taken had been assessed with repeat uses, it may have been seen that repeated use also resulted in faster rates of completion. Decreasing the amount of time spent using the website was the aim of the changes made after usability testing.

The main changes made to the website were to improve the users' understanding of food item selections and to emphasise the need to report foods over a one week reference period. This may relate to the learning effect identified during the repeatability testing (**Chapter 7**). The initial use of the website appears to be less understood by the user than during repeat uses. Learning effects have been found to occur with repeated use of other computerised healthcare programs (330-332). In neurology for example, repetition of a neuropsychological test also resulted in a learning effect with repeated use. The recommendation given was to repeat the study using double baseline testing to minimise the effect (330). The learning effect of the DietAdvice website may have been related to the patient's understanding and interpretation of the food groups. Upon using the website for the first time, patients may have been unsure of what was meant by 'normal' dietary intake. They may have selected as many food items as they felt were relevant and then when reaching stage three (portion size and frequency) they were unsure how to assign frequency of consumption to the items. For example, nominating the foods eaten less often as a frequency of one time per week for breakfast, resulted in multiple food items eaten per

week for breakfast. By the time they used the website for a second time, they were aware of stage three and opted to select the most commonly consumed items only. This resulted in fewer foods reported as well as less time taken to use the website. The CAST model also found that patients who owned a computer were more likely to participate in the study (**Chapter 6**). Therefore, generalising the study may be limited to those with computer access rather than to the general population.

9.3.3 Accessible technology

Finding 3 - The program was accessible by a broad range of patients from differing demographic backgrounds.

Patients recruited to the website were from a range of demographic backgrounds, though they appeared to be limited in their ethnic spread. It is believed recruitment of patients may have been affected by culture, patient-GP interactions and acceptance of technology.

The age groups, gender, levels of education and locations of the patients who used the website over a 12 month period varied widely (**Chapter 6**). Thus, the main limitation to the demographics was a limited ethnic spread. In the Wollongong region, however, approximately 17% of the population are from a non-English speaking background with the most common languages being Macedonian, Greek, Italian, Spanish and Germans (310). These groups may speak English at home and therefore may not be easily identified on the website. The website was primarily used by patients from an Australian English speaking background with the inclusion of a few patients (2.6%) speaking languages other than English at home. This finding was again identified in the repeatability study, in which the majority of patients were Australian born and English speaking (**Chapter 7**). This apparently limited ethnic spread may be due to both culture (295, 333) and GP-patient interactions (293, 321), which have been reported as barriers to patient participation in other research programs. Resistance to the medical advice of the GP may also be seen after a patient has left the GP practice. Regaining power or resistance to authority is identified in patients who are medically trained, although this can span across a number of demographic areas. This may be an explanation for those patients who did not participate in the study. They may have previously visited a

dietitian and upon the GP suggesting they participate in a study, they may have felt that their knowledge of nutrition was sufficient.

Finally, acceptance of the program by the patients who participated in the study could also have been related to their ability to accept technology as a form of healthcare practice (181). The acceptance of technology and the patients' ability to recognise the usefulness and ease of use of the website may have meant that the social characteristics of the surrounding environment that were creating negative influences could, in many cases, have been overcome. These benefits would have needed to outweigh the negatives. In the stakeholder interviews, some GPs reported that their patients were not taking an interest in technology as they did not have access to computers in the home (**Chapter 8**). This limited access could have led to a decreased interest, and in turn a decreased acceptance of the program within the region. Therefore it may be thought that the introduction of a technological innovation has the ability to transcend social barriers, yet is still limited by the context of the practice.

The introduction of a new piece of technology requires cultural changes before it can be seen as useful to most within society. In other words, as technology is introduced into a setting, there needs to be change (176, 334). In the research reported here, the introduction of the website, required change in the GP practice. The GPs became more aware of their patients' needs relating to nutrition, and the patients were provided with a new and convenient method of dietary consultation. The staff in some GP practices were introduced to the concept of computerised healthcare.

The extent of the cultural change is assumed to be strongly related to the amount of influence from the GP themselves, as well as the external influences from the environment (294). The GP, though interested in the study, may only have limited computer experience or limited computer equipment within the practice. This in turn may affect their attitude towards the website. External influences from the environment could have included the computing experiences of the practice staff, socio-economic status of the surrounding area and average age of the patients visiting the practice. If the staff have had negative experiences with computers (335) they may not encourage the GP to refer patients to the website. Similarly, if the socio-economic status of the area is

lower, less patients from the area may have access to a computer (336) and potentially have a lower level of computer literacy (337). If the patients are unable to accept computerised healthcare, the culture within the practice will not change widely. However, if the demographics of the population are younger, they may have more exposure to computers, be more accepting of computers and also have higher computer literacy (179, 181, 325). This, combined with a positive attitude from the GP and practice staff, may encourage a culture change toward increased use of the healthcare technology.

Finding 4 - The computer in the GP surgery was the least preferred location of access to the program due to the levels of computer ownership in the region.

A preference towards use of the computer at home rather than in the GP practice may have related to the ownership of computers, computer experience and patient anonymity. Use of the computer at home may also have been related to nutrition and self-care for health management.

Although there was a computer available in the GP practices, the comfort of the patient's home was the preferred location for use of the website in this study. This relationship has been found in research to relate to computer ownership and time allocations of a person's daily living activities (118, 338). The computer is only being used when spare time is available in between many other day-to-day tasks. As people become more and more busy, the convenience of the home computer is vital (118, 338). Therefore, the ability to access the website from home at the patients' convenience, but also the ability to log out of the website and finish using it at a more suitable time, were two features used to address these time allocation constraints in the CAST project.

In this research, ownership of computers was found to be high with only one in ten patients not owning a computer (**Chapter 6**). When compared with the 2001 Australian Bureau of Statistics data (48% computer ownership) (118), this may be an indication of increased computer ownership within households. This high level of computer ownership amongst study participants may also have indicated a high overall acceptance of technology and a progression towards technological determinism. As society

changes, technology is increasingly being implemented. This influence within society has the ability to affect the behaviour of the public and their acceptance of computers. This finding may, however, have been limited to patients who did participate in the CAST project. Patients who did not participate may not have owned a computer, or may not have been accepting of technology in the healthcare setting.

A statistical model was developed in this study to test the relationship between location of use, age and computer experience, three factors which strongly influence human computer interactions. The study found younger, more experienced computer users preferred to use the website at home than compared with the older less experienced computer users who were using the system in the GP practice. This relationship may be related to self confidence when using a computer. Younger patients may have been familiarised with computers through work and school and felt more confident using the computer alone in the home. Older patients may not have been as familiar with computers and preferred to use the website in a location where assistance was readily available i.e. the GP practice.

Patients with a higher BMI were also found to have an increased tendency to use the website in the home. It is assumed that the home environment is less threatening, provides more convenient computer access and provides greater anonymity than using a computer in the GP practice. Face-to-face contact is reduced allowing the patient to address their health problems in a private setting. Use of computers in the home setting is also the social norm (339). The use of technology could be related to the setting within which the computer is found. As age increases the need for social contact while using a computer may also increase, while as BMI increases the need for anonymity increases leading to a preference of use in the home environment. Therefore it may be thought that younger patients with a high BMI would use the computer at home while older patients with a low BMI would use the computer in the GP practice. The DietAdvice website may therefore be a means of capturing dietary information from the obese population, and as younger people age and technology continues to have its impact on society, then dietary assessment technology may be a technique for obesity management in dietetics. Though this was not tested specifically, it raises the question

of whether older patients with a high BMI were as willing to participate in the CAST project.

Using the website at home may be paralleled with self-care. The willingness of patients to look after their own health or self-care may relate to their opinions about the need for a GP for medical intervention. Although research has shown this self-care to be accepted and used by patients, it has not been shown to reduce the number of consultations with a GP (340). The spectrum of self-care vs. GP care would vary depending on the type of medical condition experienced. It is thought that conditions requiring specifically prescribed medications or surgical procedures would be skewed towards the GP care end of the spectrum, whilst headaches, for example, which may be treated with paracetamol from the supermarket, would be skewed toward the self-care end of the spectrum. Nutrition, however, would be seen as a form of medical intervention which may be initiated without the need for a GP. Therefore nutrition would be skewed toward the self-care end of the spectrum, though the level of nutrition intervention would depend upon the need for assistance by the GP and the level of knowledge and motivation of the patient.

9.3.4 Measurable dietary change

Finding 5 - The CAST program was partly repeatable though the automated assessment was not preferred by users due to the limited face-to-face contact and the convenience of use.

Repeatability testing of the website found a potential learning effect with repeat uses of the website. Patients also reported a preference for the traditional dietary assessment as opposed to the automated format.

The nutrient data from the website resulted in significant differences between the first two uses of the website, while repeatability was seen between the second and third uses (**Chapter 7**). This suggests that a learning effect (70, 227) was identified for the automated assessment group. Repeat uses of the website potentially lead to an increased understanding of the features and in turn an increased similarity of results with time. This learning effect was assumed to be a result of the patients becoming more familiar with the website rather than remembering their previous responses from 6 weeks prior. Research has found repeated use of computer applications to also be linked with a more positive experience with software (119), which is an area for future exploration with the DietAdvice website. Familiarisation with the website interfaces and functionality may be leading to increased accuracy of responses as patients become more aware of the expectations of the website. However, as the data from the traditional assessment was also not repeatable, this may suggest that the settling within which the dietary assessment was being conducted may have influenced the reporting.

The learning effect may have also been a reason for the patients preferring the face-to-face traditional dietary assessment over the automated dietary assessment, as it required less work on their behalf. As the patients were learning with each interaction with the website, this may have decreased the added convenience that computerisation of the interview was expected to bring. This finding was different to that reported by Weber (2003) and Lukin (1985) who both found a preference for use of the computer over the traditional assessment form (13). Weber developed a computerised psychology questionnaire and compared this with its traditional form – pencil and paper. The

questionnaire was tested with psychiatric patients who used both forms of assessment. The study found acceptance amongst users, though there was difficulty experienced with the computer (43). Lukin also applied computers to a psychological personality test and also compared this with a pencil and paper format. Results obtained from both forms were comparable and 85% of users preferred the computerised format.

These studies are comparable with the CAST project as the website may be considered as the computerised format while the face-to-face interview could be considered the pencil and paper format. The difference between these studies and the findings of the CAST project may again relate to the setting within which the users are found. The psychology studies were primarily performed with hospitalised patients in a laboratory style setting, whereas patients of the CAST project were free-living with the study set in a real-life setting. This may indicate that under laboratory settings, the CAST project findings may have been different and not directly applicable to the clinical setting.

Though the patients in the GP setting preferred to use the computer at home (**Chapter 6**) in a setting of privacy and anonymity, a preference for face-to-face dietary assessment (**Chapter 7**), within which the anonymity and privacy of the environment is reduced, was also identified. These findings present ambiguity amongst the research findings. Ambiguity of norms is a concept often seen in social research. Differing opinions and beliefs observed in different contexts within a study may be referred to as uncertainty in situations with unknown probability (341). Conventional probabilities cannot be used to refer to a person's beliefs and opinions. The opposing findings within the studies of this thesis may, therefore, relate to the environmental influences at play within each of the differing GP practices.

The stakeholder evaluations also revealed a preference for face-to-face interviews from the patients (**Chapter 8**). This coincided with the GP and dietitian suggestions that the DietAdvice website should be included as a component of a dietary interview with a dietitian, rather than used on its own. A similar suggestion was made by Slack (1976) who stated that use of a computer prior to visiting a dietitian would result in faster overall visits (34). The suggested need for face-to-face contact emphasises the fact that a dietitian cannot be completely removed from the equation when attempting to

automate dietary assessment. The computer may be used to obtain information from the patient regarding their eating patterns, though the interpretation of nutrient data and education of the patient cannot be automated due to the strong need for professional judgement and human interaction throughout both processes.

Finding 6 - The degree of bias in reporting nutrient intakes was different to the traditional dietary assessment, due to the limited face-to-face contact. The use of computer technology resulted in equally if not more accurate responses due to this limited personal contact.

Dietary over-reporting was primarily observed for the DietAdvice website while underreporting was observed for the face-to-face assessment. These differences are assumed to be due to the decreased social desirability bias when using a computerised interview.

Underreporting of nutrients was observed for patients visiting the dietitian while over-reporting was observed for patients using the computer. This increased or over-reporting has been linked to self-administered dietary assessment forms such as the FFQ (342, 343). Within this study it was assumed to be due to the limited face-to-face contact of the automated assessment, resulting in decreased bias and increased accuracy of reporting. This assumption, however, would need to be tested in future studies with biochemical measures and controlled environmental conditions to confirm whether increased accuracy is actually observed. In this study, the assumption was supported by validity testing the website against a 3-day food record in which the automated assessments correlated better than the traditional assessments. The elimination of the social desirability bias that can occur during face-to-face interviewing (47) may have resulted from the use of the computer. In the setting with a dietitian the patient may feel that they are being judged by the dietitian and may be judging the gender, age and ethnicity of the dietitian themselves. The interpretation of this judgement by the patient may result in modifications to the reported dietary intake (344) and a desire to seek praise from the dietitian (343, 345, 346). Patients have been observed in other studies to report 'healthier' food choices as a result of this interaction (185). When using the DietAdvice website the face-to-face contact is removed. Patients do not feel they are

being judged and therefore may report more of the foods actually consumed rather than only those considered 'healthy'. If this phenomenon has truly been observed, then automated dietary assessment may be a useful method for population groups who are known to under-report their intakes.

Although the primary aim of new dietary assessment methods is to increase the number of patients reporting their food intake 'accurately', the finding of this study (over-reporting) still allowed for the eating patterns of the patients to be observed. The real value of the innovation may be an improvement in dietary intervention for the obese population by facilitating recognition and acknowledgement of the 'problem' areas of dietary intake. This acknowledgement may not only be by the dietitian but may also be observed by the patient viewing their food intake on the computer screen (as found in the stakeholder evaluation). Given the growing obesity epidemic, such a tool would be beneficial to a number of health professionals.

The use of technology in the healthcare system now sees pathology results sent electronically to the GP, and many patient files in GP practices are in a computerised format. These existing forms of technology could be used concurrently used with automated dietary programs to allow another form of healthcare practice to be computerised. The question remains, can the healthcare system deal with this move in a realistic manner? Will patients benefit from the increased automation through standardisation of the processes, or will this detract from the patient-doctor negotiations currently occurring in daily practice?

<i>Finding 7 - Dietary change resulted from use of the CAST program</i>

Although no significant differences in the macronutrient intakes were observed, patients were able to achieve some of the dietary goals included in their dietary prescriptions.

Although no significant differences were identified for the reported nutrients before and after the implementation of dietary advice, changes in the food patterns of the patients were observed indicating dietary changes had been made. This study showed that goal setting was important for patients who were willing and interested in making dietary

changes to benefit their health. The patient's interpretation of their own results may have paralleled the dietary advice that was provided by the dietitian, working as an initiator to change. The intent to change a behaviour can be strongly related to the behaviour itself in terms of action, context, time and target (347) and may further be influenced by attitude, perceived behavioural control and subjective norms. As patients' viewed their eating pattern on the computer screen they may, at their level of food literacy, have been evaluating the dietary changes needed. This evaluation could also include a subconscious evaluation of the barriers to change existing within their personal life. If the patient felt that the barriers could be overcome, they may have been able to begin modifying their dietary behaviours. Furthermore, patients who had previously intended to change their dietary behaviours may only have needed the display of their food items on screen to initiate behaviour change. This shows that the 'technological face' of the computer may have the power to work at a higher cognitive level. The attitude of the patient and the subjective norms within society still have a strong influence over behaviour change and must first be addressed before positive long-term change can be seen.

The primary limitation of the implementation phase was the number of patients, identified by the stakeholder evaluations, that did not receive their dietary advice, **(Chapter 8)**. This indicated that the planned communication strategy, though working in some GP practices was not suited to others. Research in 'real life' situations may require constant modifications to the study design as would be observed in many action research studies. Community research or 'real life' research often requires increased flexibility and a multidisciplinary approach. It needs to consider the political, social, cultural and economic influences and may often see ambiguity in the results (341).

9.3.5 Stakeholder acceptance

<i>Finding 8 - Stakeholders accepted the technology, seeing it as an advancement in nutrition rather than a burden on practice.</i>

The patients, dietitians and GPs all generally accepted the CAST model, though they had notable recommendations for the program. The patients felt that the program was repetitive and many did not receive their dietary advice from their GP. The dietitians

felt that the model would be useful for inclusion before the patient went to see a dietitian, and the GPs identified a possible limitation due to lack of computer literacy. Each of these reported findings may be linked to other areas of the CAST case study.

Firstly, the feeling of repetition within the website confirms the assumption that repeated use of the website may result in increased understanding by the user. As patients in the implementation phase only used the website once, it may be assumed, based on the findings from the repeatability study, that with further use of the website they would understand the reason for the repetition. Secondly, the suggestion to have the website used prior to visiting a dietitian may also be linked with the patients' preferences in the evaluation questionnaires. Patients preferred to have face-to-face dietary assessments, though this was not unanimous. Inclusion of both face-to-face and automated dietary assessments may be a means to achieving a balance between the two. Finally, lack of computer literacy can be a limitation within given groups of the population. However, as society continues to include more technology in day-to-day practices, the acceptance of computers may increase.

Although some GPs felt that the recruitment of patients was challenging, the program was not seen as a burden upon practice but rather as a useful component that allowed more patients to access a dietitian. The GP recruitment rates identified could be related to the opinions that the GPs had about the CAST model. Many GPs felt their patients were not able to use the program due to their age. GPs who did not recruit as many patients may not have been aware of patient perspectives about the program. These GPs would have reported on their assumptions about computerisation in society, as well as upon the responses from the few patients they had recruited. GPs who recruited multiple patients may have been more aware of both the positive and negative responses made by their patients, which may have helped to shape their ideas about the study overall. This gap between 'recruiting' and 'non-recruiting' GPs has been identified in the literature. A study by Pearl *et al.* (2003) found that the GPs who agree to participate in a study were not always those who recruited patients for a study (305). Although the study by Pearl *et al.* provided financial reimbursement for the GPs, similar findings were identified throughout the CAST project. Upon recruitment, all GPs appeared interested in the idea of the DietAdvice website, yet only a few followed through and recruited

patients to the website. It is assumed that this finding was related to the GPs' social acceptance of technology in which the external variables of their practice influenced their perceptions of usefulness and ease of use (181) of the DietAdvice website. It would be expected that GPs who accept technology as a component of their practice and use it on a regular basis may be more likely to accept technology for other forms of healthcare practice. Correspondingly, it would be expected that GPs who were not regular users of technology and prefer to use paper-based systems within their practice, would be more likely to hesitate or be more restrained in recruiting their patients.

It would also be assumed that increased computer use would result in higher self-reported computer literacy, which in the context of the CAST project was found for the 'non-recruiting' GPs. These 'non-recruiting' GPs were also less likely to refer their patients to a dietitian than the GPs who recruited patients. Therefore, the GPs who used technology to a greater extent within their practices may have been using their electronic patient management systems to print off nutrition information for their patients. These information sheets are generic in nature and not individualised for the patient. Is it therefore the convenience of the computer that is driving the 'non-recruiting' GPs and, if so, is there a way to make CAST more convenient for them? The difference for the 'recruiting' GPs may then be that they were more interested in the topic, were interested in establishing a relationship with the research team, and perceived the research as worthwhile and beneficial to the patients (321).

9.4 Limitations and areas for further research

The three main limitations of the research were:

1. At the time of analysis, the Australian NNS95 dietary data was eight years old. This problem could not be overcome, as the survey was the most recently available dietary data for the Australia population. This suggests a strong need for technology such as the DietAdvice website, which may in the future allow for another population survey of Australian intakes to be conducted.
2. The need to change the patient recruitment criteria for the GPs as the study progressed: Though falling into the field of action research, an area within which

feedback from the participants results in modifications to the study design, the recruitment of patients for the study was the area that underwent the most changes over time. The final criteria was found to work well within the boundaries of this case study, though this would need to be tested further in other regional areas.

3. Limited ethnic groups using the website may indicate the existence of a language barrier. Translation of the website into the key languages used throughout Australia may broaden the usability of the website in its current context.

The website was implemented in the primary healthcare setting under the framework of a case study to pilot test the CAST model. Future studies would need to address use of the website outside of the Illawarra region of New South Wales to determine whether the findings of the case study are applicable to a wider population. Such studies would also allow for the repeatability and dietary change to be addressed through a larger group of patients, and would need to consider the recommendations made by the stakeholders of this case study to encourage the website's continued acceptance. Biochemical measures should be included to track patient progress and dietary change, and repeat uses can be included as a component of the model thus allowing the dietitian to perform follow-up rather than leaving the provision of advice to the GP alone.

9.5 Implications for clinical practice

The CAST model has been found to be useful in the primary healthcare setting. The readily available website meant GPs were able to refer their patients to the website as needed, without the concern of their patients being placed on a dietitian's waiting list.

The patients were also able to use the website at their own convenience. This means that appointments were not necessary and the patient could assess their diet at a time suited to them. Following are three ways in which the website could be used in the future:

1. If used in line with the new Australian shared care initiative (Enhanced Primary Care) (348), it will allow for GPs to utilise a multidisciplinary approach to healthcare, thus providing increased benefit to their patients. The dietitian service would be readily

available to a broader number of patients in the convenience of their own homes. A new model could be developed for the healthcare system in which the GP works in isolation surrounded by a 'total healthcare team' (349, 350). Total healthcare teams consist of a multidisciplinary mix of healthcare professionals whose aim it is to achieve the best outcome for the patient. Teams may include dietitians, exercise physiologists, psychologists, pharmacists and the like. This approach to healthcare would ensure that a patient's total health is looked after by experts from each of the relevant fields. Similarly, other allied health professionals would also be able to utilise the services of a dietitian through implementation of a similar model in their practices. Furthermore, the individuals within the 'total healthcare team' could aim towards development of a similar website within their field of practice, thus allowing increased access to a number of healthcare services in remote locations.

2. The introduction of an automated dietary assessment to the daily practice of dietitians would allow for additional time to be spent educating and counselling patients for change. Use of technology in the field of dietetics is primarily focussed on use of nutrient analysis software or modular education series for patient and/or doctor learning (17, 54-56). Education and counselling was identified as the most important part of the dietary interview and may be highly useful given the growing number of people worldwide with metabolic syndrome, the clinical condition of reference. Increased time spent educating patients will encourage increased numbers of patients to understand and use their experience to benefit their health (351).

3. The use of handheld computing devices is increasing rapidly, especially in medical care. Workers are now able to access their patient data whilst on the ward. The website could be further developed into a PDA format (352) so that it may be used by dietitians working in the hospital setting. The dietitian would be able to visit the patient's bedside, determine their eating pattern by using the portable version of the DietAdvice website and then upload the data into the DI in their office. The analysis of the data would thus be more accurate than the ready-reckoner systems currently used in many hospital systems.

The above ideas are only a few of the ways in which the DietAdvice website could be used in the healthcare practice for dietitians. The website would also be of particular relevance to researchers. The primary focus is that despite the context in which the website is implemented, the dietitian would still be the prime contact for interpretation of the data. The dietitian provides a unique contribution to the program through the use of professional judgement and professional practice. Their expertise is required for the translation of the data and its interpretation into a format that the patient understands.

Utilising the dietary assessment and education processes, each of these methods include the primary focus of medical nutrition therapy for the patient. Patient benefits are at the heart of each method with the aim of improved understanding and the ability to educate patients toward change. Automation of the dietary advice process would result in a decrease in the personalised format of the advice, and it is expected that certain areas of judgement would also be overlooked by the computer. Computers can be used to automate standardised processes of dietetics, but should not compromise the interaction required for effective patient counselling and education.

Technology has the ability to speed up the daily practice of dietitians and allow GPs to learn more about the dietary needs of their patients. Development, testing, implementation and evaluation of the CAST project has shown that this is already possible within society, and as computers and technology become increasingly important for healthcare practice, automated assessments may well become common practice rather than just a way of the future.

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A. Demographic data questionnaire

Diet Advice 

www.dietadvice.net

Traditional interview
Demographic Data Questionnaire

PERSONAL INFORMATION

Subject Code: _____

Phone Number: _____

Email: _____

Gender:

- ☐ Male
☐ Female

Age: _____

Weight: _____

Height: _____

BMI: _____

DIETARY INFORMATION

1. Are you a vegetarian?

- ☐ I'm not a vegetarian
☐ Vegan (no animal products at all)
☐ Lacto-ovo Vegetarian (no meat but eat eggs and dairy)
☐ Ovo-Vegetarian (no meat or eggs but dairy)
☐ Other

2. Do you have any special dietary restrictions?

- ☐ Yes (please complete next section)
☐ No (move to question 3)

Diet Advice

www.dietadvice.net

Religious restrictions: _____

Food allergies: _____

Other restrictions: _____

3. Do you take Vitamin or Mineral Supplements?

- ☐ Yes
☐ No

Type(s): _____

4. Has your doctor indicated that you have any of the following medical conditions?

- ☐ Type 2 Diabetes
☐ High Cholesterol
☐ High Blood Glucose Levels (IGT/IFG)
☐ High Blood Pressure
☐ Overweight
☐ Other, please specify: _____

Diet Advice

www.dietadvice.net

PHYSICAL ACTIVITY QUESTIONS

Think about all the physical activities that you did in the last 7 days and answer the following questions.

- i. On how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ Days per week

How much time did you usually spend doing **vigorous** physical activities per day?

_____ Hours per day

_____ Minutes per day

- ii. On how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____ Days per week

How much time did you usually spend doing **moderate** physical activities per day?

_____ Hours per day

_____ Minutes per day

- iii. On how many days did you **walk** for at least 10 minutes at a time?

_____ Days per week

How much time did you usually spend walking on one of those days?

_____ Hours per day

_____ Minutes per day

- iv. During the last 7 days, how much time did you spend **sitting** on a week day?

_____ Hours per day

_____ Minutes per day

Diet Advice

www.dietadvice.net

LIFESTYLE RELATED QUESTIONS

1. Do you smoke, if so, how many cigarettes per day?

- ☐ No
- ☐ Yes

_____ Cigarettes per day

2. Please indicate your marital status

- ☐ Single/divorced/separated
- ☐ Married/de facto

3. Do you have children under the age of 18 years old living with you?

- ☐ Yes
- ☐ No

4. What country were you born in? Country of birth

- ☐ Australia
- ☐ New Zealand

Other _____

5. What language do you speak most often at home?

- ☐ English

Other _____

6. Which best describes the food shopping practices for your household

- ☐ I am the main shopper
- ☐ I do not shop for food
- ☐ I share the shopping with my partner

Diet Advice

www.dietadvice.net

7. What is your employment status?

- ☐ In paid work – full time
- ☐ In paid work – part time/casual
- ☐ Un-paid work
- ☐ Retired/Other _____

8. Please indicate the income range of your household

- ☐ Less than \$20,000 per year
- ☐ \$20,000-\$40,000 per year
- ☐ \$41,000-\$60,000 per year
- ☐ \$61,000-\$80,000 per year
- ☐ \$81,000-\$100,000
- ☐ Greater than \$101,000 per year
- ☐ I do not wish to disclose

9. Please indicate your highest level of education

- ☐ Primary School
- ☐ High School
- ☐ TAFE
- ☐ University
- ☐ Other, please specify _____

10. Do you currently own a computer?

- ☐ No
- ☐ Yes

11. Please indicate your level of comfort with using a computer

- ☐ Very comfortable
- ☐ Comfortable
- ☐ Slightly uncomfortable
- ☐ Uncomfortable

5

Diet Advice

www.dietadvice.net

12. Please indicate your level of computer experience

- ☐ Advanced – able to install and use programs with minimal assistance required
- ☐ Intermediate – has used word processing and spreadsheet programs, can access the internet
- ☐ Beginner – basic word processing/typing and plays games, frequent assistance required
- ☐ Never used a computer before

13. If you have used a computer before, what kinds of activities do you use a computer for (indicate all that apply)?

- ☐ Typing letters or documents with a word processing package
- ☐ Sending and receiving email
- ☐ Accessing web sites
- ☐ Internet shopping or banking
- ☐ Games
- ☐ Programming
- ☐ Play or edit music
- ☐ View or edit photos
- ☐ Other, please specify _____

B. Pre- and post-usability testing questionnaires

University of Wollongong



Evaluation Questionnaire

BEFORE TESTING:

1. Have you used a computer before?

☐ Yes

☐ No

2. Please circle your level of computer experience

Beginner

Intermediate

Advanced

3. What are your feelings about testing the nutrition software?

4. Do you believe the development of nutrition software to automate the diet history interview will be useful (please tick all that apply)

☐ For yourself

☐ For dietitians

☐ For GP's

☐ Not useful at all

☐ Other _____

University of Wollongong



4. What did you think of the way the website looked (e.g., colours, pictures, typeface)?

5. What would make the website better?

6. What are your feelings about testing the nutrition software?

Thank You!

C. Automated & traditional assessment questionnaires



Northfields Avenue, Wollongong NSW 2522. Australia
Phone: +61 2 4221 5302, Fax: +61 2 4221 4844

Automated Interview Questionnaire

Subject Code: _____

Site: _____

Date: __ / __ / ____

**Thank you for taking part in this dietary assessment study.
Please complete the following questionnaire and hand it back to
the research team before you leave today.**

INSTRUCTIONS:

1. Please read all questions carefully
2. Tick ☒ one (1) answer that you feel best suits your response
3. Do not tick more than one answer per question

1. Have you used a computer before?

Yes ☐

No ☐

2. How comfortable do you feel using a computer?

Comfortable

Somewhat
comfortable

Neutral

Somewhat
uncomfortable

Uncomfortable

☐

☐

☐

☐

☐

3. How comfortable did you feel using the website

Comfortable

Somewhat
comfortable

Neutral

Somewhat
uncomfortable

Uncomfortable

☐

☐

☐

☐

☐

4. Have you used an Internet-based dietary assessment program before?

Yes ☐ (continue to question 5)

No ☐ (please skip to question 6)

5. If yes, did the program do the following? (tick the most appropriate option)

Keep a food diary for you on the Internet ☐

Require you to keep a food diary on paper ☐

Ask you to report the foods eaten over the past day ☐

Ask you to report the foods eaten over the past week ☐

Ask you to report the foods eaten over the month or more ☐

6. For how long do you feel you were filling in the questionnaire at the computer today?

- About 15 minutes ☐
- About 30 minutes ☐
- About 45 minutes ☐
- About 1 hour ☐
- More than 1 hour ☐

7. What period of your food intake do you feel the website is covering?

- One day ☐
- A few days ☐
- One week ☐
- A fortnight ☐
- One month ☐
- More than one month ☐

8. The website should have included

- Less food options to select ☐
- More food options to select ☐
- No change needed ☐

9. The website allowed me to give a reasonable overview of all the foods I usually eat

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Totally Agree | Partially Agree | Neutral | Partially Disagree | Totally Disagree |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

10. The website was overly restrictive in the foods I was able to select.

Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

11. The appearance of the website was

Visually appealing	Somewhat appealing	Neutral	Somewhat unappealing	Visually unappealing
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

12. The location of the computer was

Comfortable	Somewhat comfortable	Neutral	Somewhat uncomfortable	Uncomfortable
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

13. I feel I reported rather accurately on the foods I eat.

Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

14. An assistant should be available to help people while they use the website

Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

15. I would have preferred the questions on diet to be asked by an interviewer

Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

16. I would have preferred the questions in the website to be written down on paper for me to answer

Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

17. Overall I prefer computerised interviews over face-to-face interviews for these kinds of interviews (describing dietary intake)

Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Thank you for completing this questionnaire.
Please hand this questionnaire back to the research team to receive your
3-day food diary.



Northfields Avenue, Wollongong NSW 2522. Australia
Phone: +61 2 4221 5302, Fax: +61 2 4221 4844

Traditional Interview Questionnaire

Subject Code: _____

Site: _____

Date: __/__/____

**Thank you for taking part in this dietary assessment study.
Please complete the following questionnaire and hand it back to
the research team before you leave today.**

INSTRUCTIONS:

1. Please read all questions carefully
2. Tick ☒ one (1) answer that you feel best suits your response
3. Do not tick more than one answer per question

1. Have you had a dietary assessment from a dietitian before taking part in this study?

Yes ☐ (continue to question 2)

No ☐ (please skip to question 3)

2. If yes, how long ago was your assessment with the dietitian?

Less than one week ☐

1-2 weeks ☐

One month ☐

Six months ☐

One year ☐

Greater than one year ☐

3. How long was today's interview with the dietitian?

About 15 minutes ☐

About 30 minutes ☐

About 45 minutes ☐

About 1 hour ☐

More than 1 hour ☐

4. In today's interview with the dietitian, over what period of time were you recalling your food intake?

One day ☐

A few days ☐

One week ☐

A fortnight ☐

One month ☐

More than one month ☐

5. The most difficult part of the interview was thinking about

- | | |
|-------------------------|--------------------------|
| All the foods I eat | <input type="checkbox"/> |
| Often I eat these foods | <input type="checkbox"/> |
| How much I eat | <input type="checkbox"/> |

6. The interview should have included

- | | |
|------------------|--------------------------|
| Fewer questions | <input type="checkbox"/> |
| More questions | <input type="checkbox"/> |
| No change needed | <input type="checkbox"/> |

7. The interview allowed me to give a reasonable overview of all the foods I usually eat.

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Totally Agree | Partially Agree | Neutral | Partially Disagree | Totally Disagree |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

8. The interview was too restrictive in the foods I was able to discuss.

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Totally Agree | Partially Agree | Neutral | Partially Disagree | Totally Disagree |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

9. During the interview with the dietitian, I felt

- | | | | | |
|-------------|-------------------------|---------|---------------------------|---------------|
| Comfortable | Somewhat
comfortable | Neutral | Somewhat
uncomfortable | Uncomfortable |
|-------------|-------------------------|---------|---------------------------|---------------|

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. I understood all the questions that the dietitian asked me				
Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. The structure of the interview was clear				
Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. The setting of the interview was				
Comfortable	Somewhat comfortable	Neutral	Somewhat uncomfortable	Uncomfortable
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. I feel I reported fairly accurately on the foods I eat.				
Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. I would have preferred to answer the interview questions on the computer				
Totally Agree	Partially Agree	Neutral	Partially Disagree	Totally Disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
© CAST Traditional Interview Questionnaire				

15. I would have preferred the questions in the interview to be written down on paper for me to answer

Totally Agree
☐

Partially Agree
☐

Neutral
☐

Partially Disagree
☐

Totally Disagree
☐

16. Overall I prefer face-to-face interviews over computerised questionnaires

Totally Agree
☐

Partially Agree
☐

Neutral
☐

Partially Disagree
☐

Totally Disagree
☐

Thank you for completing this questionnaire.

**Please hand this questionnaire back to the research team to receive your
3-day food diary.**

D. General Practice locations



E. General practice computer set-up

G. Structured diet history booklet



Northfields Avenue, Wollongong NSW 2522, Australia
Phone: +61 2 4221 5302, Fax: +61 2 42214844

Diet History Interview

Subject Code: _____

Site: _____

Date: _____

Interviewer: _____

Age: _____

Ht: _____ cm Weight: _____ kg

BMI: _____ kg/m²

Medications: _____

History of health conditions: _____

Supplements: _____

Physical activity level: _____

Core Food Choices: Please indicate the **type** of foods you select in these categories

Food group	Type	Food group	Type
Milk (full fat, skim)		Spread (margarine etc)	
		Oils (olive, canola)	
Bread (white, grain)			
		Drinks (sweetening)	

Part 1: Breakfast

How often do you eat this meal? _____ Home _____ Away _____

Breakfast Cereals/Porridge

Type	Amount	Frequency
Milk with cereal		
Sugar with cereal		

Toast/Bread/Muffins etc (including toppings)

Type	Amount	Frequency
Spread with toast		
Topping on toast		

Eggs and other cooked dishes

Type	Amount	Frequency
Oil/fat		

Other Foods (including drinks, fruit, yoghurt)

Type	Amount	Frequency

A - 329

Part 5: Food Frequency Checklist

Food category	Amount	Frequency
Bread/crumpet		
Biscuits		
Crispbreads/crackers		
Cakes/scones/muffins/pastries		
Pancakes		
Beans/legumes		
Fruit		
Fruit juice		
Soft drinks/cordials		
Chocolate/lollies		
Chips		
Alcohol		
Milk		
Yoghurt		
Ice cream		
Cheese		
Dip/cream cheese/cheese spread		
Soy milk		
Soy yoghurt		
Eggs/omega eggs		
Salmon/tuna (fresh/canned)		
Sardines/Mackerel		
White fish varieties		
Oysters		
Walnuts		
Pecans		
Other nuts		
Seeds		

Part 6: Food Preparation Practices**6.1 Butter/Margarine**What type do you usually use?

Butter

Dairy blend

Margarine - polyunsaturated, regular

Margarine - polyunsaturated, reduced fat

Margarine - monounsaturated, regular

Other _____

6.2 Oil/Fat in cooking

What type of oil/fat do you use in cooking?

Butter

Dairy blend

Margarine - polyunsaturated, regular

Margarine - polyunsaturated, reduced fat

Margarine - monounsaturated, regular

Olive oil

Canola oil

Soybean oil

Gold'n Canola

Other _____

6.3 Fat on Meats/Chicken

How much fat is trimmed from meat before cooking/eating?

a) None

b) 25%

c) 50%

d) 75%

e) All

How much of the skin on chicken do you remove before cooking/eating?

a) None

b) 25%

c) 50%

d) 75%

e) All

Other, please specify: _____

H. 3-day food record booklet

RETURN TO:
Smart Foods Centre,
University of Wollongong
Northfields Ave, Wollongong
NSW 2522. Australia
Phone: +61 2 4221 5302
Fax: +61 2 4221 4844



3-day Food Record

Subject Code: _____

Site: _____

Date: __/__/____

INSTRUCTIONS:

1. Please select 2 weekdays and 1 weekend day to record your food intake
2. Weigh and record all foods eaten over those 3 days
3. Bring this booklet with you to your doctor's surgery or mail to Smart Foods Centre

© CAST Food record booklet

- 1 -

Date: _____

Date: _____

© CAST Food record booklet

Date: _____

Date: _____

© CAST Food record booklet

A - 337

Date: _____

Date: _____

© CAST Food record booklet

Date: _____

© CAST Food record booklet

Date: _____

I. Focus group results

J. Feelings before and after usability testing

<i>ID</i>	<i>Computer comfort/ Computer experience</i>	<i>Feelings before website use</i>	<i>Feelings after website use</i>
2	Very comfortable/ Advanced	Glad of an opportunity to contribute	Glad to contribute
5	Very comfortable/ Advanced	I have no feeling about it	Exhaustive and exhausting
8	Very comfortable/ Advanced	Undecided at this time	Good. Will do it again if needed
13	Comfortable/ Beginner	Comfortable with it	I felt that there should be a choice of weekly or fortnightly
18	Very comfortable/ Advanced	I am looking forward to it. I think it is particularly valuable, although what I have found particularly useful in interviews with dieticians is the 'informal' feedback and advice that I have received.	
23	Very comfortable/ Advanced	Nothing ventured - Nothing gained	No problem - but would prefer to do so online at home
31	Slightly uncomfortable/ Intermediate	I am ok with the testing	I have no problem with testing the software and it will be a valuable tool when finished.
35	Slightly uncomfortable/ Beginner	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

Appendix J – Feelings before and after usability testing




37	Slightly uncomfortable/ Intermediate	Willing to have a go	With enough time to place a specific menu into the program to issue a dietary plan for myself
39	Very comfortable/ Intermediate	Great idea if it helps to monitor and control on discipline my diet regime	Needs to be more stable, Needs to be larger scope in food selection, Speed needs to be quicker especially in ticking the box, the language and questions need to be adjusted to a more multicultural patient population
44	Comfortable/ Advanced	Willing to help	It should go towards a better understanding of the problems
55	Very comfortable/ Advanced	Interested in effectiveness of software	Generally positive - could be difficult for an older/technically challenged person, difficult to maintain conciseness of time
57	Comfortable/ Beginner	Good, contribution, self, interest benchmarking, statistics	Want to be more involved get back more long-term attachment
65	Comfortable/ Intermediate	Good, contribution, self, interest benchmarking, statistics	I am quite happy to have done the test and if it will help in anyway I think it is good and would be happy to do anything to help
69	Comfortable/ Intermediate	I am relaxed and interested in any faculties that can help me with nutrition admin	Terrible
70	Very comfortable/ Advanced	No problem, anything to help with diabetes education and management	Very capable package which will advantage remote/distant patients

Appendix J – Feelings before and after usability testing




71	Very comfortable/ Advanced	Enthusiastic, curious	It's a good start, but I'm not sure its ready to be released to a GP office yet.
73	Comfortable/ Advanced	might be interesting	I'd be happy to come back and have another trial if it is further modified.
76	Very comfortable/ Advanced	Never been involved in this type of thing before	Need to come back once changes/enhancements are made to software. Took 50 minutes but didn't fill all the questionnaire in.
77	Very comfortable/ Intermediate	Neutral	Glad to be of help
78	Very comfortable/ Advanced	Excitement, happy to help and be involved	Feel bad/sad about how I eat and need to improve. Very involved process on what and when you eat - hard to actively recall this when asked. Prep might be a food diary for week etc.
79	Very comfortable/ Intermediate	I am pleased to be helping in a way that could be an improvement to medical evaluation of certain conditions.	<i>No response given</i>
80	Very comfortable/ Advanced	Ok	A bit negative - too long

81	Very comfortable/ Advanced	I feel enthusiastic about testing the software. I am all for using technology to conduct research. Technology makes the job of collecting data easier as well as giving access to a wider sample. I am looking forward to participating and contributing to nutrition research.	I had a better idea of my eating habits after using the software. I think the process would be very laborious if someone was asking me questions to complete the survey.
82	Very comfortable/ Intermediate	Happy to assist in what seems to be a worthwhile project.	I was happy to test the nutrition software and support work done at the University. In general I think the software could be a valuable tool for doctors and dieticians, but needs to be easier for people to use, bearing in mind that many people are not familiar with computers, and may either be confused or get frustrated with such a long questionnaire.
84	Very comfortable/ Intermediate	Good, contribution, self, interest benchmarking, statistics	Good and hope it can really be help the people who have problem how to get healthy food.
85	Comfortable/ Advanced	Good, curious	Tired





K. GP recruitment tracking booklets

	Diet Advice 
	CAST Study Patient Recruitment
	Patients Name: _____
	Date Recruited: ____/____/20____
	 www.dietadvice.net
	Patient ID: _____
	Patient File Copy (White) 0000 0001

Page 1

	Diet Advice 
	CAST Study Patient Recruitment
	Patients Name: _____
	Date Recruited: ____/____/20____
	 www.dietadvice.net
	Patient ID: _____
	Doctor Copy (Yellow) 0000 0001

Page 2

	Diet Advice 
	CAST Study Patient Recruitment
	Patients Name: 
	Date Recruited: ____/____/20____
	 www.dietadvice.net
	Patient ID: _____
	CAST Copy (Pink) 0000 0001

Page 3

L. Demographic profile of website users

Table A: Demographic profile of users from November 2005 – November 2006

<i>Variable</i>	<i>Response (n=188)</i>	<i>Frequency</i>	<i>%</i>
Medical condition	Type 2 diabetes mellitus	42	22.3
	Hypercholesterolaemia	82	43.6
	IGT/IFG	21	11.2
	Insulin resistance	9	4.8
	Hypertension	83	44.1
	Overweight	137	72.9
	Other medical condition	19	10.1
Vegetarianism	Not a vegetarian	180	95.7
	Lacto-ovo Vegetarian	1	0.5
	Ovo-Vegetarian	2	1.1
	Other	5	2.7
Vitamin or mineral supplements	No	128	68.1
	Yes	60	31.9
Country of birth	Australia	144	76.6
	Other	44	23.4
Language spoken at home	English	184	97.9
	Other	4	2.1
Religious food restrictions	No	181	96.3
	Yes	7	3.7
Food allergies	No	172	91.5
	Yes	16	8.5
Other food restriction	No	164	87.2
	Yes	24	12.8
Physical activity	Insufficiently active	83	44.4
	Sufficiently active	46	24.6
	Heavily active	58	31.0
Smoker	No	22	11.7
	Yes	166	88.3
Marital status	Single/divorced/separated	130	69.1
	Married/de facto	58	30.9

Appendix L – Demographic profile of website users

Children under 18 years	No	130	69.1
	Yes	58	30.9
Food shopping practices	They are the main shopper	110	58.5
	They do not shop for food	27	14.4
	They share the shopping with a partner	51	27.1
Employment status	In paid work - full time	61	32.4
	In paid work - part time/casual	35	18.6
	Un-paid work	73	38.8
	Retired/Other	19	10.1
Household income	Less than \$20,000 per year	54	28.7
	\$20,000-\$40,000 per year	35	18.6
	\$41,000-\$60,000 per year	37	19.7
	\$61,000-\$80,000 per year	31	16.5
	\$81,000-\$100,000	13	6.9
	Greater than \$101,000 per year	18	9.6
Highest level of education	Primary school	8	4.3
	High school	95	50.5
	TAFE	43	22.9
	University	37	19.7
	Other	5	2.7
Own a computer	No	37	19.7
	Yes	151	80.3
Comfort using a computer	Very comfortable	65	34.6
	Comfortable	67	35.6
	Slightly uncomfortable	31	16.5
	Uncomfortable	25	13.3
Computer experience	Advanced	28	14.9
	Intermediate	94	50.0
	Beginner	51	27.1
	Never used a computer	15	8.0
Typing letters or documents	No	142	75.5
	Yes	46	24.5
Send/receive emails	No	138	73.4
	Yes	50	26.6
Accessing websites	No	137	72.9
	Yes	51	27.1

Appendix L – Demographic profile of website users

Internet shopping or banking	No	80	42.6
	Yes	108	57.4
Play games	No	86	45.7
	Yes	102	54.3
Play or edit music	No	46	24.5
	Yes	142	75.5
View or edit photos	No	86	45.7
	Yes	102	54.3

Table B: Demographic profile of patients from repeatability and testing

<i>Demographic question</i>	<i>Demographic response</i>	<i>Frequency</i>	<i>%</i>
Gender	Male	17	44.7
	Female	21	55.3
Medical condition	Type 2 diabetes mellitus	38	100.0
	Hypercholesterolaemia	8	21.1
	IGT/IFG	15	39.5
	Insulin resistance	33	86.8
	Hypertension	38	100.0
	Overweight	15	39.5
	Other medical condition	14	36.8
Vegetarianism	Not a vegetarian	38	100.0
Vitamin or mineral supplements	No	23	60.5
	Yes	15	39.5
Country of birth	Australia	33	86.8
	Other	5	13.2
Language spoken at home	English	37	97.4
	Other	1	2.6
Religious food restrictions	No	36	94.7
	Yes	2	5.3
Food allergies	No	32	84.2
	Yes	6	15.8
Other food restriction	No	32	84.2
	Yes	6	15.8
Physical activity	Insufficiently active	14	36.8
	Heavily active	24	63.2
Smoker	No	20	52.6
	Yes	18	47.4

Appendix L – Demographic profile of website users

Marital status	Single/divorced/separated	34	89.5
	Married/de facto	4	10.5
Children under 18 years	No	32	84.2
	Yes	6	15.8
Food shopping practices	They are the main shopper	20	52.6
	They do not shop for food	2	5.3
	They share the shopping with a partner	16	42.1
Employment status	In paid work - full time	7	18.4
	In paid work - part time/casual	4	10.5
	Retired/Other	27	71.1
Highest level of education	Primary school	3	7.9
	High school	14	36.8
	TAFE	10	26.3
	University	8	21.1
	Other	3	7.9
Own a computer	No	16	42.1
	Yes	22	57.9
Typing letters or documents	No	17	44.7
	Yes	21	55.3
Send/receive emails	No	15	39.5
	Yes	23	60.5
Accessing websites	No	16	42.1
	Yes	22	57.9
Internet shopping or banking	No	18	47.4
	Yes	20	52.6
Play games	No	13	34.2
	Yes	25	65.8
Play or edit music	No	19	50.0
	Yes	19	50.0
View or edit photos	No	17	44.7
	Yes	21	55.3

M. Repeatability of macronutrient data

Repeated measures ANOVA for t=0 and t=2

<i>Nutrient</i>	<i>Grp</i>	<i>t=0</i>	<i>t=2</i>	<i>P (grp)</i>	<i>P (time)</i>	<i>P (int)</i>
Energy (kJ)	A	15607±8217	11244±5966	0.02	0.14	0.17
	B	7308±1959	7128±2374			
	C	11310±7070	9425±6005			
	D	7245±1659	8223±3758			
Total fat (g)	A	142±111	92±67	0.05	0.06	0.20
	B	59±19	55±21			
	C	88±54	65±52			
	D	63±13	66±21			
SFA (g)	A	43±31	28±19	0.16	0.03	0.35
	B	21±9	19±8			
	C	31±20	22±19			
	D	25±7	23±8			
PUFA (g)	A	27±21	19±18	0.05	0.16	0.25
	B	11±4	11±5			
	C	16±10	14±11			
	D	9±3	10±4			
MUFA (g)	A	59±53	36±26	0.04	0.10	0.16
	B	21±8	22±19			
	C	32±20	22±19			
	D	22±4	26±9			

Grp – Group effect, Int – interaction effect, SFA – Saturated fatty acids, MUFA – Monounsaturated fatty acids, PUFA – Polyunsaturated fatty acids. Grp A and C - Automated (computerised) diet history assessment, Grp B and D - Traditional (dietitian) diet history assessment, ± Standard deviation n=1 data excluded, not physiologically plausible (>100,000kJ)

Repeated measures ANOVA for t=2 and t=8

<i>Nutrient</i>	<i>Grp</i>	<i>t=2</i>	<i>t=8</i>	<i>P (grp)</i>	<i>P (time)</i>	<i>P (int)</i>
Energy (kJ)	A	11244±5966	9790±4121	0.67	0.76	0.20
	B	7128±2374	7863±2478			
	C	9425±6005	8230±2881			

Appendix M – Repeatability of macronutrient data

	D	8223±3758	9606±2963			
Total fat (g)	A	92±67	69±32	0.88	0.90	0.69
	B	55±21	71±21			
	C	65±52	72±25			
	D	66±21	72±31			
SFA (g)	A	28±19	21±12	0.97	0.90	0.60
	B	19±8	24±12			
	C	22±19	22±10			
	D	23±8	25±13			
PUFA (g)	A	19±18	14±6	0.27	0.50	0.48
	B	11±5	14±6			
	C	14±11	15±6			
	D	10±4	12±6			
MUFA (g)	A	36±26	26±11	0.97	0.51	0.35
	B	20±8	30±6			
	C	22±19	26±10			
	D	26±9	27±11			

Grp – Group effect, Int – interaction effect, SFA – Saturated fatty acids, MUFA – Monounsaturated fatty acids, PUFA – Polyunsaturated fatty acids. Grp A – automated assessment only, Grp B – traditional assessment only, Grp C – automated to traditional assessment, GrpD – traditional to automated assessment, ± Standard deviation n=1 data excluded, not physiologically plausible (>100,000kJ)

N. Stakeholder evaluation questions

Stakeholder Evaluation - GPs

Do you consent to this interview being audio-recorded to allow for the data to be analysed upon completion of the study?

Profile

1. Do you work full time or part time in this surgery?
☐ Full time ☐ Part time
2. How would you describe your patient demographic?
 - Age? Gender? Socioeconomic status?
 - What percentage have metabolic syndrome?
3. Do they have ready access to dietitians?

Technology

4. Out of ten how would you rate your computer skills?

1 2 3 4 5 6 7 8 9 10
5. How do you think technology is likely to impact on health care practice in general?
 - What do you see as advantages and disadvantages to patients?

General health

6. What steps do you normally follow in a standard consultation with a patient?
 - What about nutrition?
 - For which disease states?

General nutrition

7. How confident do you feel about providing your patients with dietary advice?
 - Are you happy to refer them to a dietitian?

CAST Specific

8. What are your thoughts about the CAST program?
 - What are the advantages or disadvantages?
 - What do your patients say?
9. Do you think about the dietary advice for the patients?
10. We've had some problems with recruitment. Would you like to comment?
11. Where would you like to see CAST go from here?

Stakeholder Evaluation – Patients

Do you consent to this interview being audio-recorded to allow for the data to be analysed upon completion of the study?

General health

1. What do you believe is needed to support your health?
 - How do you find information to help you?

General nutrition

2. How important is nutrition to you and your family?
 - How important a role do you feel nutrition has in management of your health?
3. Where do you get most of your nutrition information from?

Technology

4. Out of ten how would you rate your computer skills?

1 2 3 4 5 6 7 8 9 10
5. How do you feel about using technology to assist you with your health?

CAST Specific

6. How did you learn about the DietAdvice website?
7. Describe your experience with using the website?
8. What changes would you suggest to make the website better?
9. What are your feelings about the dietary advice that you received?

Stakeholder Evaluation – Dietitians

Do you consent to this interview being audio-recorded to allow for the data to be analysed upon completion of the study?

General health

1. What are your feelings on the current management of chronic disease in primary health care?

General nutrition

2. Do you receive many referrals from GPs for patients with metabolic syndrome?
3. Do you feel people with metabolic syndrome have readily available access to dietitians?
4. In a consultation with a patient which parts do you think are of most benefit to the patient?
 - o The information collection, diet history, assessment or education?
5. What are your thoughts on making lifestyle management programs more accessible to the public?
 - o Through the internet?

Technology

6. Out of ten how would you rate your computer skills?
1 2 3 4 5 6 7 8 9 10
7. How do you feel about internet technology being used to increase patient awareness of a healthy diet?
8. How effective do you feel a health focused questionnaire on the internet would be?
 - o Benefits for your patients?

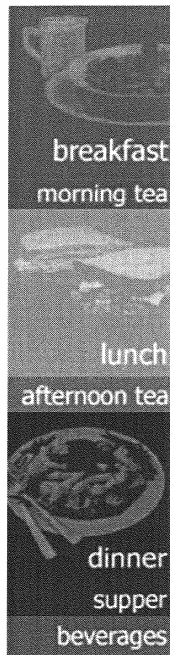
CAST Specific

Description of program ('What is the CAST program') – sent prior to interview

9. How do you feel about the concept of CAST?
 - o What are the advantages and disadvantages?
10. How effective do you think such program would be for the treatment of metabolic syndrome?
11. Do you think this program is a means of expanding a dietitians skills, or do you think it compromises a dietitians role?

Diet Advice

Smart Foods Centre
University of Wollongong
Wollongong 2522
Ph: +612 4221 5302
Fax: +612 4221 4844



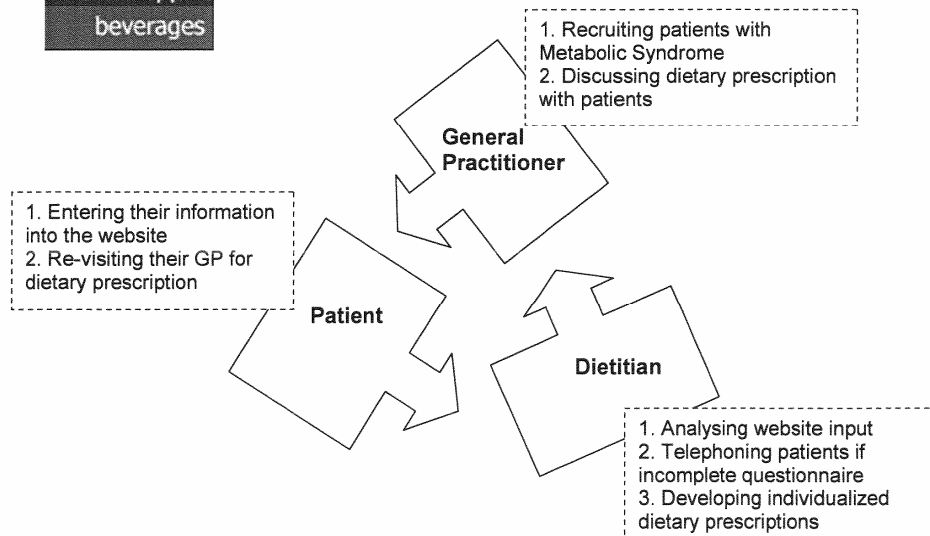
What is the CAST program?

The CAST project is a linkage study between the University of Wollongong, Illawarra Division of General Practice and Xyris Software. The project aims to automate the diet history interview traditionally performed by a dietitian.

The aim of the project is to test the effectiveness of Computer Assisted Survey Technology (CAST) as an adjunct to the professional dietary consultation. The project is being piloted in doctor's surgeries in the Illawarra area and will target patients with metabolic syndrome.

The project involves the use of specifically developed interactive website to collect a patient's diet history. The system will see the patient entering in his or her usual dietary intake. The system is web-based allowing access not only in the local Illawarra doctors' surgeries, but also in the home of the patient.

Recruitment of the patients occurs via the GP who provides the patient with a unique login access code. The patient may then login to the website at their convenience and complete the self-administered dietary assessment. Upon completion of the dietary assessment, data will be transferred to the University of Wollongong's Smart Foods centre where qualified dietitians will analyse the nutrient content and develop nutritional recommendations for the specific patient.

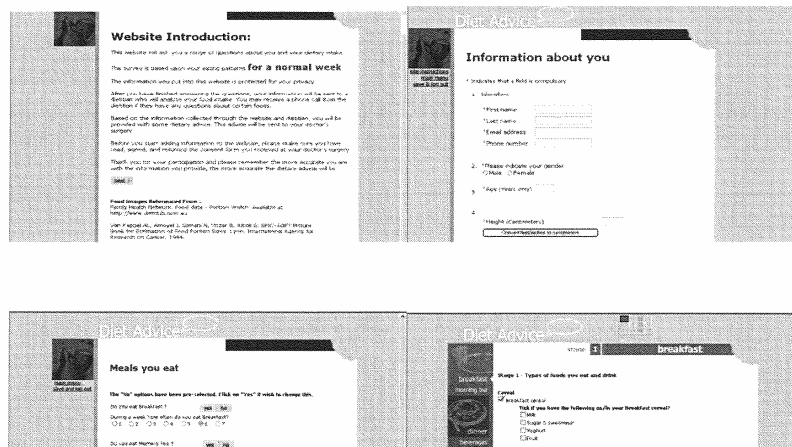


Diet Advice

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The website is broken into 3 key stages of dietary assessment – stage 1 asks about general food groups, stage 2 asks specific detail about the foods and stage 3 identifies the portion size and frequency of consumption of each of the food items. The meal questions are only based on the meals eaten by the patient (selected at the beginning of stage 1). Prior to the dietary assessment section patients are provided with instructions for use of the website and are also asked to answer a demographic data questionnaire to assist with dietary advice development. The completed assessment is downloaded electronically by the dietitian into a modified version of FoodWorks, providing nutrient data for the patient and allowing the dietitian to develop the individualised advice.

A selection of screen shots are provided below showing the layout of the website.



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