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

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requirements for the award for the degree

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by

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SMART FOODS CENTRE
SCHOOL OF HEALTH SCIENCES
2006
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.
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

*Peer-reviewed abstracts supporting this thesis*


**Non peer-reviewed abstracts supporting this thesis**


**Peer-reviewed papers supporting this thesis**


**Other peer-reviewed papers**


**Prizes and awards**

- Best Oral Presentation: 2005 Dietitians Association of Australia Conference
- 1st place poster presentation for H&BS: 2005 University of Wollongong Higher Degree Student Research Conference
- Best research student for 2005: Smart Foods Centre, University of Wollongong
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<th>Description</th>
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<tr>
<td>ABS</td>
<td>Australian Bureau of Statistics</td>
</tr>
<tr>
<td>ADSL</td>
<td>Asymmetric Digital Subscriber Line</td>
</tr>
<tr>
<td>AIHW</td>
<td>Australian Institute of Health and Welfare</td>
</tr>
<tr>
<td>APA(I)</td>
<td>Australian Postgraduate Award – Industry scholarship</td>
</tr>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>BMR</td>
<td>Basal Metabolic Rate</td>
</tr>
<tr>
<td>CAPI</td>
<td>Computer-Assisted Personal Interviewing</td>
</tr>
<tr>
<td>CASI</td>
<td>Computer-Assisted Self Interviewing</td>
</tr>
<tr>
<td>CAST</td>
<td>Computer-Assisted Survey Technology</td>
</tr>
<tr>
<td>CATI</td>
<td>Computer-Assisted Telephone Interviewing</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disk</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
</tr>
<tr>
<td>CHO</td>
<td>Carbohydrate</td>
</tr>
<tr>
<td>CURF</td>
<td>Confidential Unit Record Files</td>
</tr>
<tr>
<td>DAA</td>
<td>Dietitians Association of Australia</td>
</tr>
<tr>
<td>DASH</td>
<td>Dietary Approaches to Stop Hypertension</td>
</tr>
<tr>
<td>DH</td>
<td>Diet History</td>
</tr>
<tr>
<td>DI</td>
<td>Dietitians Interface</td>
</tr>
<tr>
<td>DVD</td>
<td>Digital Video Disk</td>
</tr>
<tr>
<td>EE</td>
<td>Energy Expenditure</td>
</tr>
<tr>
<td>EI</td>
<td>Energy Intake</td>
</tr>
<tr>
<td>FFQ</td>
<td>Food Frequency Questionnaire</td>
</tr>
<tr>
<td>FR</td>
<td>Food Record</td>
</tr>
<tr>
<td>FSANZ</td>
<td>Food Standards Australia and New Zealand</td>
</tr>
<tr>
<td>g</td>
<td>Gram</td>
</tr>
<tr>
<td>GB</td>
<td>Gigabyte</td>
</tr>
<tr>
<td>GI</td>
<td>Glycaemic Index</td>
</tr>
<tr>
<td>GP</td>
<td>General Practitioner</td>
</tr>
<tr>
<td>HREC</td>
<td>University of Wollongong Human Research Ethics Committee</td>
</tr>
<tr>
<td>IDF</td>
<td>International Diabetes Federation</td>
</tr>
<tr>
<td>IFG</td>
<td>Impaired Fasting Glucose</td>
</tr>
<tr>
<td>IGT</td>
<td>Impaired Glucose Tolerance</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS codes</td>
<td>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</td>
</tr>
<tr>
<td>Associated food type</td>
<td>A more detailed but still broad grouping of food items that are eaten with the food type items selected</td>
</tr>
<tr>
<td>Associated subcategory</td>
<td>A less coarse grouping of foods that are eaten with the subcategory food items selected</td>
</tr>
<tr>
<td>Associated food</td>
<td>A food item eaten with or on another food item</td>
</tr>
<tr>
<td>AUSNUT</td>
<td>Database of food and nutrient data of 4500 foods consumed in Australia updated regularly by FSANZ.</td>
</tr>
<tr>
<td>Automated assessment</td>
<td>Dietary assessment utilising computer technology</td>
</tr>
<tr>
<td>CAST codes</td>
<td>Unique codes given to food items and food groups for the CAST project to aid with identification</td>
</tr>
<tr>
<td>Category</td>
<td>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</td>
</tr>
<tr>
<td>Computer literacy</td>
<td>The ability to use and/or understand basic concepts relating to computer use and function</td>
</tr>
<tr>
<td>CURF</td>
<td>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).</td>
</tr>
<tr>
<td>Demographic data</td>
<td>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</td>
</tr>
<tr>
<td>Diet</td>
<td>Intake of foods rather than the restriction of particular food items</td>
</tr>
<tr>
<td>Dietary prescription</td>
<td>Dietary advice prepared by a dietitian sent to the GP of the patient</td>
</tr>
<tr>
<td>Dietitian interface</td>
<td>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.</td>
</tr>
<tr>
<td>Eating pattern questions</td>
<td>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.</td>
</tr>
</tbody>
</table>
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.