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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

Yasmine Probst

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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

Peer-reviewed abstracts supporting this thesis

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- 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
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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.