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Toward nutrition education for adults: A systematic approach to the interface design of an online dietary assessment tool

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Toward nutrition education for adults: A systematic approach to the interface design of an online dietary assessment tool

Abstract

To support nutrition-related behavioural change, a dietitian can offer tailored educational programmes based on patients' specific dietary behaviours. A model has been developed to integrate learning technologies into this process. This tool allows patients to self-report their dietary intake, creating awareness, and to receive individually tailored dietary advice from their General Practitioner (GP) via a dietitian, to assist with change. This article examines how a step-wise approach to the interface design has allowed a multidisciplinary approach to automated dietary assessment to be undertaken. Concentrating on the identification of core foods and on the questionnaire format using an outline of the diet history interview, the design features of the programme used focus groups with end users and in-depth discussion between the multidisciplinary team. The development of an online self-administered dietary assessment programme must ensure outcome goals are met whilst upholding the simplicity of the interface design to allow a larger number of patients access to the programme. Original journal article available [here](#)

Keywords

nutrition education, evaluation studies, software design and development, primary health care, behaviour change, dietary assessment

Disciplines

Arts and Humanities | Life Sciences | Medicine and Health Sciences | Social and Behavioral Sciences

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Toward nutrition education for adults: A systematic approach to the interface design of an online dietary assessment tool

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- Linda Tapsell is director of the National Centre of Excellence in Functional foods and is involved in both theoretical and practical research in the area of nutrition and dietetics.
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- Marian Baré is a research assistant of the Human Nutrition Unit. She is involved in the testing of the glycaemic index of food items.

Abstract

Background. Many lifestyle diseases can be managed by diet. To support nutrition-related behaviour change, a dietitian can offer tailored educational programs based on patients' specific dietary behaviours. Patients however value their GPs advice about nutrition. Therefore increased involvement of the GP in the area of nutrition is vital. A model has been developed to integrate learning technologies into this process. For this online for self-administered dietary assessment application, the GP refers the patient to the system, a dietitian compiles a dietary prescription from the patients' electronic data and send it to the GP. This allows for a greater number of patients with lifestyle diseases to receive individualised dietary advice.

Objectives. To report on the key components of interface development, including the identification of core reference foods using statistical analyses, the assessment of face validity and the multimedia questionnaire design from comments by academic personnel and from focus group discussion sessions with potential users.

Methods. Key components of interface development for software set in the primary healthcare setting were described. Concentrating on the identification of core foods and questionnaire format using an outline of the diet history interview, the design features of the program were attended to through in-depth discussion between the multidisciplinary team.

Results. Outcomes of focus group discussion sessions saw a modification from a desktop-based to online interface. The core foods were collapsed from the 106 of the Australian Bureau of Statistics National Nutrition Survey, down to 98 groups via

statistical analysis. Food group names were changed to simplify the visual interface design, to allow identification of foods by the layperson user and to reduce the time required for completion of the dietary assessment by reducing the amount of reading involved.

Conclusion. Development of an online self-administered dietary assessment program must ensure outcome needs are met whilst upholding simplicity of the interface design. This will allow a broader number of patients access to the program as it will be suited to all levels of computer experience.

Key Words. Nutrition education, evaluation studies, software design and development, primary health care, behaviour change, dietary assessment.

Introduction

For people with type 2 diabetes, a critical issue is managing their health behaviours particularly in terms of exercise and nutrition. In terms of patient education to support nutrition-related behaviour change, a dietitian can offer tailored programs based on patients' specific dietary behaviours. However, despite the growing number of dietitians, the general public still has more confidence in the nutrition-related advice given by their general practitioner (GP).^{1, 2} Yet, doctors often feel that they cannot always provide the information and thus educational intervention that is required.^{1, 3} Factors contributing to this perspective include time restrictions for patient encounters, lack of confidence^{2, 4} and the limited nutrition-related training obtained during their medical school and continuing education programs.¹ This translates to only 15-17% of doctors reporting an interest in the area of nutrition.⁴ Attempts are being made to educate GPs about nutrition issues for their patients. However, limited time available for professional development and the vast number of topic areas means such programs cannot always address all nutrition issues or those specificity related to disease and patient profiles. GPs are also able to spend significantly less time being involved in patient education activities.⁵ The average consultation in Australian general practice is 14.6 minutes and in the United States of America it is 8 minutes.⁶ This timeframe does not allow for assessment of the dietary intake and in-depth discussion about food and nutrient interactions for disease management. Length of consultation is also the primary reason why many doctors opt for medical, rather than educational, intervention for their

patients.⁷⁻¹⁰ Therefore, incorporating nutrition education into the patient consultations appears to be a challenge.

When GPs do engage in nutrition counselling, they often provide generic dietary advice to their patients. This disregards the opportunity for patients to further learn about the implications of what they eat upon their health. Although many patients may be referred by their GP to see a dietitian, practical limitations exist when considering this step in the management of their disease. The large number of patients presenting to a GP may not always wish to pay to see a dietitian.^{11, 12} Dietitians and GPs are rarely co-located and thus time and transportation become considerations. Further, the process of undertaking a diet history is time consuming - often ranging from 45-60 minutes.

The study reported here sought to overcome these limitations and facilitate a clinical nutrition education partnership. The study sought to explore how learning technologies might facilitate this partnership. The intervention involves GP referral of patients to a program which includes online collection of dietary intake data via computer in the GP surgery (or another location convenient to the patient). Data are analysed by a dietitian who tailors a dietary prescription which is in turn communicated to and followed up with the patient through their GP.

While online diet assessment and advice applications are available, they have limited capacity to provide individualised dietary and nutrition behaviour prescriptions.¹³ Computer-based dietary intake data collection brings with it advantages and

disadvantages.¹⁴ Advantages include less missing data, standardisation of the interview (reduced interviewer bias), provision of a stimulating interactive environment, and speed of processing. Limitations due to computer literacy and typing skills, rigidity of the interview and initial costs are disadvantages. These issues need to be taken into account when structuring systems and designing the related interface for collecting a person's dietary information. Thus, potential users are best placed to inform the design of such systems.

Computer-based nutrition programs available to patients focus on either the dietary assessment process or nutrition education -- very few are able to combine the two adequately. A patient's awareness of their diet needs to be generated before educational interventions can be meaningful. This requires the dietitian having the full picture of the patient's dietary habits.

This is difficult with currently available programs that use closed questioning schemes¹³ and assess the actual intake of the patient. Few programs use open-ended questioning,¹⁵ an area for further exploration in the area of dietary assessment. For example, an initial attempt at using computer technology for the dietetic interview in the 1970's, where simple one word responses were required found that subjects felt they could not express themselves completely and could not explain additional aspects of their diets, even though the program took longer (25-110min, average 63.6min) than the face-to-face interview with the dietitian.¹⁶ One of the lessons from this exercise may be that the

computer program should not be required to collect all aspects of data and that staged completion of the dietary assessment may be less burdensome.

Automating the process of dietary assessment involves the identification of the type of assessment method to be utilised and then mapping the steps to be taken to obtain the required dietary information associated with the chosen method. A number of assessment methods exist:

- the **food record** involves a patient recording exactly what and how much has been eaten for a select period of days;¹⁷
- the **food frequency questionnaire** involves a dietitian asking a range of questions relating to specific foods to obtain a spectrum of the patient's intake over a select period of time;¹⁸
- in the **24-hour recall interview** the patient is asked to report on the last 24 hours of food (types and amounts) eaten; and,
- during the **diet history interview** the patient is asked to recall of their usual diet including details on foods, amounts and frequency of consumption over a period of time (e.g., one week, two weeks, or one month).¹⁹

The diet history interview allows the interviewer to capture a picture of the eating patterns of the patient. Capturing the usual intake of a person through the diet history creates awareness of the intake and allows for the development of individualised dietary advice. By tailoring advice to the specific intakes of the person, there is an increased chance of dietary change.^{20, 21} Patients may learn about the food choices that are not benefiting their health and will have the ability to change these choices accordingly. By

tailoring to the individual, chances of long-term behavioural modifications are also increased.²² Limitations for change will, however, depend upon the individual's current position in the Stages of Change Model.²³ This will primarily influence their willingness to accept and act upon the recommendations given. If a patient is currently in the contemplation stage, individualised advice may be the trigger for the patient to progress to the action stage. This relationship has been identified in many dietary studies in relation to fat,^{24, 25} fibre,²⁶ and alcohol intakes.

The aim of this article is to describe the systematic approach undertaken in the design of an online dietary intake data collection tool aimed at being an initial and key step toward implementing a nutritional education program involving general practitioners, dietitians and patients with metabolic syndrome – a condition which comprises of type 2 diabetes mellitus, impaired glucose tolerance, overweight/obesity, hypercholesterolemia and/or hypertension.²⁷ This software tool should allow patients to self-report their dietary intake, creating awareness, and receive individually tailored dietary advice from their GP via a dietitian, to assist with change.

Methods

In order to design a software tool which allows automation of a dietary assessment process, many stages must be undertaken. All design features of the program were addressed through a progressive review of the program by the multidisciplinary study team which included statisticians, dietitians, computer technicians, instructional

designers, graphic designers, web designers, general practitioners, patients and survey analysts. The reviews took the form of formal meetings and trial interactions with the potential software layouts at each stage of its design. These stages included:

- conceptualisation of the design concept;
- focus group discussion sessions with potential users;
- the identification of core reference foods using statistical analyses of the Australian Bureau of Statistics (ABS) National Nutrition Survey (NNS) data;
- the assessment of face validity of these foods; and,
- the multimedia questionnaire design for the user interface.

Figure 1 illustrates the steps within this systematic approach. Ethics approval for the study was provided by the host institution's human research ethics committee.

[INSERT FIGURE 1]

Conceptualisation of design

Automation of the dietary assessment process has been considered,¹³ but is primarily used to address actual (daily) rather than usual (average) dietary intake of a person. The usual dietary intake has only been automated in a few cases. And, these have been limited by the complexity of the normal face-to-face interview such as the use of food models and utensils as cognitive guides²⁸ and the communication abilities of a professional interviewer.²⁹ Collection of dietary intake data is further complicated by tendencies of patients to over- or under-report their food intake,³⁰⁻³² It has been identified that the use of a self-administered technique, whether pen-and-paper or computerised, decreases the patient bias when responding to questions, especially those

of a socially-undesirable nature, when an interviewer is not present.^{14, 33} Therefore, allowing the patient to enter their own dietary data into a computer system may result in a decreased bias in responses when compared with those of the face-to-face dietary interview. Where involvement of the dietitian is vital to the process is in the advice-giving stage such that nutritional education can be tailored to each patient.

This method of individualised dietary management is vital for the increasing number of patients in the population with metabolic syndrome, a lifestyle related condition that can be managed by dietary intervention.³⁴

Focus group discussion sessions

Before design and development of the online tool began, potential users were recruited for focus group discussions. These sessions allowed the research team to identify issues of interface design and system functionality preferred by the population group and also refine the initial idea to suit the lifestyles and levels of computer experience of the target population. Focus groups were held at the host institution and details of the preferred design concepts are reported in detail elsewhere.³⁵

Potential users are persons who have been diagnosed with metabolic syndrome (and/or self-identified as being 40 years of age or older and overweight). For these focus group sessions, participants were recruited from volunteers of another dietary intervention trial involving patients with type 2 diabetes mellitus. All participants had consented to further contact. Participants were asked to take part in a multi-option telephone

questionnaire and focus group discussion session. The questionnaire was used to determine demographic information such as age, gender, level of education, computer experience and a brief medical background. The focus groups addressed the participant preferences for involving their GP in the nutrition management of their diabetes and their thoughts on putting a computer in the GP practice waiting rooms for dietary assessment. Five focus groups of 6-8 participants were formed. All focus groups were recorded using micro-cassette recorders.

The data obtained from the telephone questionnaires was numerically coded and analysed to determine the proportion of responses per question. Focus group data was transcribed verbatim and all transcripts were checked for accuracy by an external assistant before coding of the data. A framework for thematic grouping was developed prior to coding in NVivo qualitative analysis software (QSR International, v2.0.161). Data was sorted based on computer use, software features, nutrition programs and dietary analysis. This paper reports on the involvement of the GP in the area of nutrition, a topic which was coded under the dietary analysis theme.

Statistical analysis & core food group development

To provide the theoretical framework for the program, existing Australian food data was analysed. Theoretical framework, or food hierarchy, for the design of this program would include the food and nutrient database from which the assessment will be drawn. Data from the National Nutrition Survey (NNS) of 1995³⁶ is a key indicator of dietary intake within the Australian population. The dietary survey was conducted on over

13000 people within the Australian population and used a hierarchical system of categorising all of the food items reported. As the NNS is the most recent nationwide survey of dietary intake, this was used as the basis for theoretically developing the food hierarchy. This food hierarchy would become the underlying key to the program around which all food intake questions were based. The difference between the hierarchy described in this paper and that of the NNS is the stage at which the hierarchy was developed. The current hierarchy was developed before the food data has been obtained, whereas the NNS hierarchy was developed after all food data was collected.

The original NNS data was assessed for errors which may effect the reporting of dietary data. This was aimed to determine the minimum number of food groups that were needed to be able to capture a reasonable 'picture' of a person's usual dietary intake. Commonly consumed foods of the NNS population were then identified using a cut-off at 99% of the population. These foods could all be grouped into meals as NNS had coded each of the items accordingly. Food associations were then analysed for those foods which were commonly eaten together. If food A was eaten with food B more than 50% of the time it was said to be associated. For example tea was identified to be commonly consumed with milk and sugar. Cluster analysis using the Ward method, average linkage and complete linkage method³⁷ to determine the similarities in nutrient composition of the NNS food groupings were employed to re-arrange the NNS food groups based on a nutritional foundation. These cluster analyses were performed for all macronutrients (total energy, protein, carbohydrate, saturated fat, monounsaturated fat and polyunsaturated fat). Initially all 497 groups (the entire data set) were clustered

based on their macronutrient similarities. This cluster analysis saw groups of foods formed including foods such as custard and pasta due to their similar carbohydrate content. These foods are however not conceptually similar for the layperson and therefore separate subcategories of the NNS underwent cluster analysis.

User interface design

The theoretical data from the food hierarchy developed through statistical analysis needed to be applied to the practical aspects of the diet history interview for the interface design of the online tool. Using an outline of a traditional diet history interview,²⁹ the meal questions such as ‘Do you eat breakfast?’ and ‘How often do you eat breakfast?’ were mapped out based on foods consumed at breakfast, between breakfast and lunch, lunch, between lunch and dinner, dinner and after dinner. Sections of the food hierarchy could then be allocated to questions on each meal depending on regularity of intake per meal.

The final phase of the development of the food hierarchy would require face validity testing and the renaming of food groupings to suit the target population. This involved five dietitians and was undertaken prior to interface design initiation. These dietitians created an outline of foods they believed to be important within the diet history interview. Foods from this list were systematically merged with the statistically developed food hierarchy using a consensus method to ensure foods commonly reported in a diet history interview had been included. For example if spaghetti bolognese was identified by the dietitians it could be included under pasta with a meat-based sauce.

Renaming of food categories was necessary as the NNS groups were created for data analysts to sort foods rather than for the layperson to find a food. To ensure persons with minimal nutrition knowledge would be able to identify the group into which a reported food might fall, the dietitians again used a consensus method to form new group names. For example 'Coffee, made with milk, from ground, decaffeinated, NS as to strength' in the NNS could become 'Coffee' with the option to add milk in the food hierarchy. This is important as the program would be used by patients and not dietitians or GPs.

Results

Conceptualisation of design

In this study, design and development of an online application for patient self-reporting of usual dietary intake (diet history) in the primary healthcare setting was chosen.

Access to the automated dietary assessment self-reporting tool was to be facilitated by General Practitioners. Patient data would then be accessible by a dietitian for formulation of dietary advice, which in turn would be sent to the GP for discussion with the patient, figure 2. [INSERT FIGURE 2]

In this model, the importance of the dietitian has not been de-emphasised. Rather, by patients entering their dietary information into the online system, the data is transferred electronically to the dietitian who can focus on analysis of the food intake data and development of dietary advice. This advice can then be sent to the relevant GP allowing

the GP to also have a greater involvement in the nutritional education and health of their patients. This advice is detailed enough to allow the GP to understand key concepts and is planned to be the primary focus of a repeat visit of the patient. No other studies have been identified to date addressing these concepts.

The overall design of the program is based upon a multiple pass system* using a 'drill-down' approach to obtaining more specific detail in the dietary data on a desktop computer. Outlined below, this approach allows the system to capture varying amounts of dietary information depending on the amount of time the patient is willing to or able to spend in front of the computer.

- Pass 1 – Meal frequency – which meals and how often they are eaten
- Pass 2 – Food categories - broader groupings of foods eaten at each meal
- Pass 3 – Food types – detail about the groups of foods selected in pass 2
- Pass 4 – frequency of consumption and food portion size identification

The vertical multiple-pass approach, increasing the amount of detail about the whole day with each new pass; was selected over a horizontal multiple pass approach in which each meal was asked about in detail before progressing to the next. This option was selected by the study team due to the variability of each individual patient's dietary intake. This variability is assumed to be the key predictor of the length of time spent using the program. Therefore collecting less detail about the whole day will provide the dietitian with more useful data than detailed data about only part of the day.

* Multiple pass system: Areas of questioning are asked about in increasingly more detail as the user progresses through the program

Focus group discussion sessions

Thirty-seven participants agreed to take part in the study. Of this 36 (97%), completed the telephone questionnaire and 33 (89%) completed the focus group discussion sessions. Twenty-four males and 12 females with an average age of 60 years (41-77years) and a BMI of 29.6kg/m² (23.4-35.7 kg/m²) took part in the focus group discussion. The level of computer experience was variable.³⁵ The few non-computer users from the focus groups had features representative of that reported in the literature and allowed for standard interface development to be followed.³⁸

The use of an online system accessible in both the office of a health professional and in the participants' home was preferred over the desktop program that could only be accessible in the GP's office. One participant's comment was illustrative of this preference, "... doesn't matter whether it's in my doctor's surgery or here, everyone connected to the Internet can log into that".

For those who did not have a computer at home or did not have Internet access at home, suggested places to use the tool included the local library, diabetes centres, pharmacies or universities. Participants did not like the idea of having to go to their doctors or other health professional's office more often than the few visits per year required for their diabetes management. Participants reported that the GP surgery as a location for the program was not ideal due to the number of persons with illnesses that would be around them. Privacy of the location was

also identified as a potential factor to hinder accuracy of data entry in the GP surgery. One participant commented, "You're sitting in a waiting room you've got 20 other people sitting there watching you type your information into a computer."

Time constraints affecting the daily routines of the person also would deter the want to complete the program in the doctors' office. A participant explained, "particularly if people are going to be doing it at the doctors' surgery and they don't have all the time I mean you've got people with children and they've got other commitments"

Many participants were concerned that their GP's know as little as they do about nutrition. It was felt that the doctors were not interested or could not find time to talk about diet. One participant thought, "... some doctors, they put it [nutrition] in the too hard basket." The current process of dietary assessment or dietary advice provided by their doctor was seen as suboptimal and involvement of the specialist is the most trusted form of nutritional advice. One participant explained, "[Y]our dietitians will have more influences on your diet, more than your doctor." Another participant suggested,

"[A]s you mention that your blood sugar is out or they get the results, they send you to a dietitian. We're just going around in a circle like the doctor sends me to a specialist, the specialist sends me to a dietitian"

The method of dietary advice utilised by other doctors was found to be the use of generic nutrition handouts or pamphlets as has been identified in the literature. In terms

of usefulness, one participant commented, “[T]he pamphlets that they just give you, they just proliferate and, there’s nothing really specific in them.”

Therefore, it was evident that the program design would need to cater for the online preference to ensure patients did not need to spend more time than needed in the GP practice. Beyond, the specifics of the interface, the intervention as a whole would also need to consider how the doctor would ultimately be involved in providing the dietary prescriptions provided to the patient.

Statistical analysis & core food group development

Each of the foods in the total NNS food list was given a unique identification code allowing it to be placed within one of the ABS food groups shown in table 1. The highest-level grouping (least detail) contained 2 digit codes followed by a sub category with 3 digit food codes and finally a 4-digit code for the lowest level of grouping. The level of a food item corresponds to an 8-digit code. A total of 497 food groupings existed. The foods eaten and recalled in the NNS were all coded through the use of meal categories from which commonly consumed food items could be drawn. [INSERT TABLE 1]

Bias calculations determined the minimum number of food groups needed and the level of error associated. When compared with the level of error of a traditional diet history interview with a dietitian, the computer would only need to ask about groups of foods rather than individual food items to achieve a similar result. The most commonly

consumed food item was milk followed by bread and potatoes. Associated foods saw milk and sugar in tea and coffee as commonly linked food items. Cluster analysis resulted in a separation of many of the NNS food groups based on fat content resulting overall in a larger number of groups in total.

User interface design

Focus group results saw a change in the initial design of the program from a desktop application to that of a web-based tool due to the ease of accessibility by a larger number of patients. The design need to cater for considerations that the potential users would likely be over forty years, at varying degrees of health, and each with varied levels of computer experience. The navigation needed to be intuitive and a large amount of information fitted into single screens. Therefore organisation and clarity of the screen display was vital as was identified in the focus group sessions.³⁵ Initial prototypes determined that the number of food groups again needed to be re-evaluated such that large groups of foods need to be divided into smaller numbers to allow for optimal screen displays. Table 2 gives an outline of the changes to the core food group numbers throughout the program development. The large variations seen between the original ABS food groupings and those of the current study were due to the need to differentiate between foods delivering different types of fatty acids (determined by the statistical analysis) and the need for names of group foods to be based on the food knowledge of the layperson rather than the trained professional (changed during face-validity testing and interface design) in the NNS. [INSERT TABLE 2]

The user interface needed to include the theoretically developed food hierarchy and yet also be understandable and user-friendly. Due to the age of the end-user the literature identifies a need to maintain user interest³⁹. A cognitive cue illustrates for the user their level of completion of the dietary intake tool, figure 3. Changes in colours corresponding with those of the navigation bar were included in the menus. Upon completion of a section the colours would change to maintain interest. For example breakfast – orange, morning tea - blue, lunch – yellow, afternoon tea – aqua, dinner – red, supper – dark blue and beverages – green. The challenge of using an open vs. closed questioning scheme was overcome by allowing free text entry in areas of the website where further detail may be required. Primarily however the food related questions were closed. [INSERT FIGURE 3]

Challenges in the design and functionality of menu and the layout, due to the dynamic nature of the survey, were also encountered. All users would have different diets therefore the system would need to be designed in such a way that it would adapt to each user. Designing the system so that a user could select only the meals they eat would save the patients needing to read through potentially unnecessary questions. The menu and navigation system could then change to reflect the choices of the patient. The interface needed to be designed so that a broad overview of a one week's food intake would be captured and as the user progressed further through the questionnaire, the level of detail about the foods eaten increased. One week was selected as it would provide a snapshot of a person's intake without making a patient recall all foods eaten and potentially spend hours sitting in front of a computer screen. This technique was also

thought to be useful if a user logged out part way through the questionnaire. An example of one possible layout of the user interface is given in figure 4. [INSERT FIGURE 4]

Rather than using a separate help manual, instructions are given to the user at the beginning of the program including sample questions, figure 5, and visual displays of the navigation tools as requested by the focus group participants. If a user logged out and returned the following day, their data would be saved and upon returning to the website they would be taken back to the place at which they left the survey. The design allows segments of the interface to be ‘switched off’ at any time and therefore be excluded from questioning. This can be possible due to the inclusion of two different applications, one for the user survey and one for administrative management of data. Advantages of such an approach allow modification of the administrative application without disturbing the users of the patient application. Similarly the data is not static, it will be constantly changing and be refined allowing the team to quickly and easily modify the food hierarchy. These modifications will be instantly seen by anyone using the website. [INSERT FIGURE 5]

Discussion

A step-wise approach to the interface design has allowed a multidisciplinary approach to automated dietary assessment to be undertaken. The entire team was involved in the review process of each stage, followed by groups of team members from similar areas working in their specialist field to develop key components of the design.

The original conceptual model for the assessment of having a desktop program located on a computer in the GPs waiting area was not found to be the preferred method of delivery for the automated diet history. This design was decided as it has been common practice for health assessment programs. An online tool allows for a broader range of patients to have access to the automated diet history. The outcomes of this study will allow for the development of an online self-assessment nutrition program and allow for greater participation of the GP in the area of nutrition. Employment of the internet as the medium for the program allows an increased number of patients access to the assessment tool. This will not only shorten the burdensome process of face-to-face diet history assessment for the dietitian, allowing more time to be spent on dietary advice, but it will also allow for the doctors to focus on the patients who are in need of dietary intervention and do not traditionally receive any due to time restrictions.

The use of a computer-assisted interview for the assessment of dietary intake will not only aid in the time efficiency of the dietitian, it will also allow for the initial assessment process to be standardized allowing for greater depth of individualised advice for the

patients. The development of such technology utilising the process of self-reporting will assist a number of health professionals, including the GP, as patients can have access to the program and to the dietitian without the need for additional clinic visits. This concept will be particularly useful in remote locations where access to the dietitian is limited or in lower socio-economic communities where the cost of visiting a dietitian may hinder their significance to the patients' health.

Although it was found that no studies presently exist identifying the number of GPs who refer patients to the dietitian, this study has found the process does exist and is being utilised by some doctors for management of lifestyle diseases such as diabetes. This study has identified that the patients are not entirely happy with the current practices of GPs with respect to nutrition. Therefore by developing the automated diet history website, this study will enable GPs to learn more about nutrition through their need to interact not only with the dietitian who will be giving them the dietary prescription for the patient, but also with the patient through involvement in the education process related to basic nutritional concepts.

Development of a self-report dietary assessment program must ensure the outcome needs of the program are met whilst upholding simplicity of the interface design for the user as identified in the focus groups. The complexity of the diet history interview when performed face-to-face with a dietitian formed many challenges for design. Beginning with statistical analyses of existing survey data and focus groups, an interface that will be useful and understandable by those assessing their diets can be developed.

The website is currently undergoing laboratory testing with potential users to evaluate the interaction of the user with the computer interface and questioning sequence.

Questions and food groups will then be modified as needed (construct validity).

Following testing, an interface for the dietitians will be designed to analyse the output data from this patient user interface. Dietary advice protocols will also be developed to standardise the process through which the dietary advice is generated. Upon completion of the two key interfaces the program can then be implemented in the GP practices to examine the model involving the GP, patient and dietitian. This final phase will allow the program to be validated against a traditional form of dietary assessment (criterion-related validity).

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Conflict of Interest

There is no conflict of interest to declare for this study.

Abbreviations

GP – General Practitioner

NNS – National Nutrition Survey

ABS – Australian Bureau of Statistics

References

1. Maiburg HJ, Hiddink GJ, vant Hof MA, Rethans JJ, van Ree JW. The NECTAR-study: development of nutrition modules for general practice vocational training; determinants of nutrition guidance practices of GP-trainees. *Nutrition Education by Computerized Training And Research. European Journal of Clinical Nutrition* 1999;53(Suppl 2):S83-8.
2. Truswell AS. Family physicians and patients: is effective nutrition interaction possible? *American Journal of Clinical Nutrition* 2000;71(1):6-12.
3. Brug J. Dutch research into the development and impact of computer-tailored nutrition education. *European Journal of Clinical Nutrition* 1999;53 Suppl 2:S78-82.
4. Helman A. Nutrition and general practice: an Australian perspective. *American Journal of Clinical Nutrition* 1997;65(6):1939S-1942.
5. Truswell AS, Hiddink GJ, Blom J. Nutrition guidance by family doctors in a changing world: problems, opportunities, and future possibilities. *American Journal of Clinical Nutrition* 2003;77(4):1089S-1092.

6. Nicholas LG, Pond CD, Roberts DC. Dietitian-general practitioner interface: a pilot study on what influences the provision of effective nutrition management. *American Journal of Clinical Nutrition* 2003;77(4 Suppl):1039S-1042S.
7. Crossen K, Scott RS, McGeoch GR, George PM. Implementation of evidence based cardiovascular risk treatments by general practitioners. *New Zealand Medical Journal* 2001;114(1133):260-2.
8. von Ferber L, Koster I, Pruss U. Patient variables associated with expectations for prescriptions and general practitioners' prescribing behaviour: an observational study. *Pharmacoepidemiology & Drug Safety* 2002;11(4):291-9.
9. Mant D. Effectiveness of dietary intervention in general practice. *American Journal of Clinical Nutrition* 1997;65(6):1933S-1938.
10. van Binsbergen JJ, Delaney BC, van Weel C. Nutrition in primary care: scope and relevance of output from the Cochrane Collaboration. *American Journal of Clinical Nutrition* 2003;77(4 Suppl):1083S-1088S.
11. Brug J, Campbell M, van Assema P. The application and impact of computer-generated personalized nutrition education: A review of the literature. *Patient Education and Counseling* 1999;36(2):145-156.
12. Nicholas L, Roberts DC, Pond D. The role of the general practitioner and the dietitian in patient nutrition management. *Asia Pacific Journal of Clinical Nutrition* 2003;12(1):3-8.
13. Probst YC, Tapsell LC. An Overview of Computerized Dietary Programs for Research and Practice in Nutrition. *Journal of Nutrition Education and Behavior* 2005;37(1):20-26.

14. de Leeuw E, Nicholls W. Technological Innovations in Data Collection: Acceptance, Data Quality and Costs. *Sociology Research*. 1(4). In: *Sociology Research* [serial online]. Vol 1 (4) ed; 1996.
15. Medlin C, Skinner J. Individual dietary intake methodology: A 50-year review of progress. *Journal of the American Dietetic Association* 1998;88(10):1250-1257.
16. Hsu N, Gormican A. The computer in retrieving dietary history data. II. Retrieving information by summary generation. *Journal of the American Dietetic Association* 1973;63(4):402-7.
17. Rebro SM, Patterson RE, Kristal AR, Cheney CL. The effect of keeping food records on eating patterns. *J Am Diet Assoc* 1998;98(10):1163-1165.
18. Caan BJ, Lanza E, Schatzkin A, Coates AO, Brewer BK, Slattery ML, et al. Does nutritionist review of a self-administered food frequency questionnaire improve data quality? *Public Health Nutrition* 1999(2):4.
19. Sasaki S, Yanagibori R, Amano K. Self-administered diet history questionnaire developed for health education: a relative validation of the test-version by comparison with 3-day diet record in women. *Journal of Epidemiology* 1998;8(4):203-15.
20. Campbell L, Barth, R, Gosper, JK, Judd, JJ, Simons, LA, Chisholm, DJ. Impact of Intensive Educational Approach to Dietary Change in NIDDM. *Diabetes Care* 1990;13(8):841--847.
21. Campbell MK, DeVellis BM, Strecher VJ, Ammerman AS, al e. Improving dietary behavior: The effectiveness of tailored messages in primary care settings. *American Journal of Public Health* 1994;84(5):783.

22. De Looy A, Auty, PL, Coates, CA. Is our dietary advice effective? Proceedings of the Nutrition Society 1992;51:63-69.
23. Greene GW, Rossi SR, Rossi JS, Velicer WF, Fava JL, Prochaska JO. Dietary applications of the stages of change model. Journal of the American Dietetic Association 1999;99(6):673-678.
24. Hargreaves MK, Schlundt DG, Buchowski MS, Hardy RE, Rossi SR, Rossi JS. Stages of change and the intake of dietary fat in African-American women: improving stage assignment using the Eating Styles Questionnaire. Journal of the American Dietetic Association 1999;99(11):1392-1399.
25. Greene GW, Rossi SR, Reed GR, Willey C, Prochaska JO. Stages of change for reducing dietary fat to 30% of energy or less. J Am Diet Assoc 1994;94(10):1105-10; quiz 1111-2.
26. Glanz K, Patterson RE, Kristal AR, DiClemente CC, Heimendinger J, Linnan L, et al. Stages of change in adopting healthy diets: fat, fiber, and correlates of nutrient intake [published erratum appears in Health Educ Q 1995 May;22(2):261]. Health Educ Q 1994;21(4):499-519.
27. Shaw JE, Chisholm DJ. MJA Practice Essentials 1: Epidemiology and prevention of type 2 diabetes and the metabolic syndrome. Medical Journal of Australia 2003;179(7):379-383.
28. Elmstahl S, Gullberg B, Riboli E, Saracci R, Lindgarde F. The Malmo Food Study: the reproducibility of a novel diet history method and an extensive food frequency questionnaire. European Journal of Clinical Nutrition 1996;50(3):134-142.

29. Tapsell L, Pettengell K, Denmeade S. Assessment of a narrative approach to the diet history. *Public Health Nutrition* 1999;2(1):61-7.
30. Bathalon GP, Tucker KL, Hays NP, Vinken AG, Greenberg AS, McCrory MA, et al. Psychological measures of eating behavior and the accuracy of three common dietary assessment methods in healthy postmenopausal women. *Am J Clin Nutr* 2000;71:739-745.
31. Black AE, Cole TJ. Biased over- or under-reporting is characteristic of individuals whether over time or by different assessment methods. *Journal of the American Dietetic Association* 2001;101(1):70-80.
32. Johansson L, Solvoll K, Bjorneboe GE, Drevon CA. Under- and overreporting of energy intake related to weight status and lifestyle in a nationwide sample. *American Journal of Clinical Nutrition* 1998;68:266-274.
33. Tourangeau R, Rips L, Rasinski KA. *The psychology of survey response*. Cambridge: Cambridge University Press; 2000.
34. Roth JL, Mobarhan S, Clohisy M. The Metabolic Syndrome: where are we and where do we go? *Nutrition Reviews*. 2002;60(10 Pt 1):335-7.
35. 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* Accepted.
36. McLennan W, Podger A. *National Nutrition Survey. Nutrient intakes and physical measurements*. ABS Cat No 4805.0. Canberra: Australian Bureau of Statistics; 1998.

37. Johnson RA, Wichern DW. Applied multivariate statistical analysis. 5th ed. Upper Saddle River, New Jersey: Prentice Hall; 2002.
38. Kressig RW, Echt KV. Exercise prescribing: Computer application in older adults. *The Gerontologist* 2002;42(2):273-277.
39. Kushniruk AW, Patel VL, Cimino JJ. Usability testing in medical informatics: cognitive approaches to evaluation of information systems and user interfaces. *Proceedings of the American Medical Informatics Association Annual Fall Symposium* 1997:218-22.

Figure 1: Relationship between methods and design

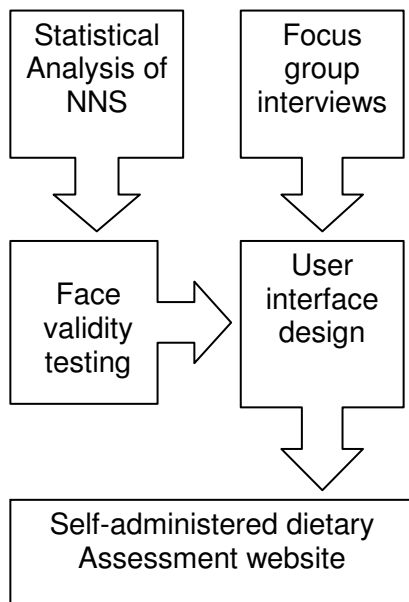


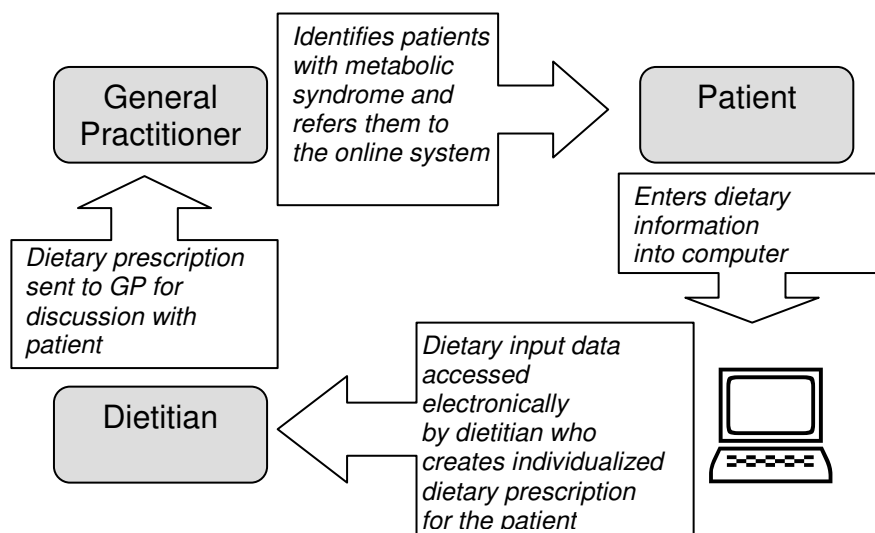
Figure 2: Automated dietary assessment model

Figure 3 Example navigation bar for the user interface



Figure 4 Sample user interface for breakfast

stage 1 breakfast

breakfast
morning tea
lunch
afternoon tea
dinner
supper
beverages
[site instructions](#)
[main menu](#)
[save & log out](#)

Stage 1 - Types of foods you eat and drink you have

Broad General Food Categories

For each meal we ask about general food categories. e.g. Do you eat Breads at a given meal ?

Please click on the foods you eat and drinks you have **in a normal week** for each meal.
Don't forget we will be asking more detail about the foods and drinks later in the questionnaire.

Bread

- Bread & toast
- Bread rolls
- English muffins
- Specialty breads e.g. focaccia, turkish bread
- Crumpets

Bakery products

- Muffins
- Crepes, waffles & pancakes

Cereal

- Breakfast cereal

Tick if you have the following on/in your Breakfast cereal?

- Milk
- Sugar & sweetener
- Yoghurt
- Fruit

Figure 5 Sample question layout included in instructions

Do you eat Breakfast ?

During a week how often do you eat Breakfast?

1 2 3 4 5 6 7

Table 1: National Nutrition Survey (NNS) food grouping structure

Names Categories	# Subcategories	# Food types
1. Non Alcoholic Beverages	6	30
2. Cereals and Cereal Products	8	32
3. Cereal-Based Products and Dishes	6	34
4. Fats and Oils	5	22
5. Fish and Seafood Products and Dishes	6	18
6. Fruit Products and Dishes	9	16
7. Egg Products and Dishes	3	7
8. Meat, Poultry & Game Products and Dishes	9	40
9. Milk Products and Dishes	8	47
10. Soup	3	11
11. Seed and Nut Products and Dishes	2	4
12. Savoury Sauces and Condiments	4	17
13. Vegetable Products and Dishes	9	19
14. Legume and Pulse Products and Dishes	2	5
15. Snack Foods	4	6
16. Sugar Products and Dishes	3	9
17. Confectionary and Health Bars	3	9
18. Alcoholic Beverages	4	13
19. Special Dietary Foods	2	6
20. Miscellaneous	6	12
21. Infant Formulae and Foods	4	13
SUBTOTAL: 21	106	370
TOTAL: 497 Groups		

Table 2: Comparison of food groupings with progression of program development

	# Categories	# Subcategories	# Food Types
ABS food groupings	21	106	370
Dietary assessment program food groupings			
- after statistical analysis	20	120	453
- after face validity testing	20	98	432
- after user interface development	19	99	437