INSIGHT

Over- and underreporting of energy intake by patients with metabolic syndrome using an automated dietary assessment website

Yasmine PROBST†,2 and Linda TAPSELL2
†Smart Foods Centre, and 2National Centre of Excellence in Functional Foods, University of Wollongong, Wollongong, New South Wales, Australia

Abstract
Under- and overreporting of dietary intake in a face-to-face context is related to age, gender and body mass index. The use of computer technology in dietetic practice is restricted to analysis of nutrient data rather than assessment of the diet. DietAdvice, a website developed to allow patients with metabolic syndrome to self-report their dietary intake, has been developed in the Illawarra region of New South Wales, Australia. Patients are recruited by their general practitioner, and use the website, and the data are electronically fed to a dietitian for an individualised dietary prescription. The aim of the present study is to describe the reporting status of patients using a pilot test of the website from November 2004 to October 2005, and determine relationships to body mass index, gender and age. Reported energy intake (EI) was compared with predicted basal metabolic rate (BMR). Patients were classified as underreporting if EI : BMR <1.35 and overreporting if EI : BMR >2.4. Chi-square and ordinal regression analyses were used to determine relationships to patient characteristics. Two hundred patients were recruited, of whom 57 had missing data or did not complete the assessment. Of the remaining 143 patients, 32.3% underreported their intakes, 21.7% overreported their intakes, and 46.2% were on target with their reporting. No relationships were found for age, gender or body mass index. Findings suggest that computerised dietary assessment may encourage patients to report with less bias than in a verbal dietary assessment when compared with the literature.

Key words: bias, energy intake, Internet, metabolic syndrome X, social desirability.

INTRODUCTION
Computerised dietary assessment is an area of growing interest. Programs have been developed in the USA and Europe to assist dietitians with the assessment of a patient’s dietary intake, although such programs are yet to be developed in Australia.1 In Australia, the use of computer technology in dietetic practice is primarily restricted to analysis of nutrient intake profiles rather than patient self-reporting of dietary intake.1 This means that the dietitian is required to perform the dietary assessment in a face-to-face setting and analyse the nutrient intake data before education and counselling may be provided to the patient.

The use of computer technology in the field of dietetics creates the opportunity for dietitians to spend increased amounts of time with the patient for education and behaviour change counselling. Presently there is limited time available for this in a standard consultation without compromising the quality of the dietary assessment. Furthermore, the limited time means that dietary data obtained may be reviewed quickly using a ready reckoner system to estimate amounts of particular nutrients pertaining to the patient’s diet. Potential inaccuracies from this practice may result in less precise dietary education.

Inaccuracies of estimated nutrient intake may not only be the result of hastened analysis methods, but may also result from reporting bias from patients themselves. Underreporting is highly dependent on memory, social desirability, lack of awareness of food and portion sizing, and reluctance to disclose foods and/or amounts eaten.2 Reporting of dietary intake is also strongly influenced by the characteristics of the patient. Patients who are overweight have been found to modify their dietary intake when reporting face-to-face with a dietitian.2–4 Energy may be underreported by as much as 50% by these individuals.5 Underreporting is also influenced by gender and age,6 with older women underreporting to a higher degree than their younger counterparts and men of...
the same age. The primary nutrients affected are energy, fat, saturated fat and carbohydrate, with protein less affected. Reporting of alcohol intake is also significantly affected by underreporting.

The use of computing technology for the interview process may decrease underreporting by decreasing the social desirability bias resulting from face-to-face interviewing. Patients are not faced with the need to ‘impress’ the dietitian with their healthy eating pattern, but rather are more likely to report their true dietary intake. The use of computers, therefore, may be a means to improve the reporting of patients.

DietAdvice, a website allowing patients to self-report their dietary intake, has been developed in the Illawarra region of New South Wales, Australia. To pilot test this program in practice, patients were recruited by their general practitioner, and entered their dietary intake via a website. The data were electronically fed to a dietitian, who then developed an individualised dietary prescription using the ‘dietitians interface’ of the program. The use of Internet technology allowed patients to use the website in the privacy of their own home and at a time convenient to them.

Findings from other studies with the DietAdvice website suggest that computerised dietary assessment may encourage patients to report with less bias than in a verbal dietary assessment. The aim of the study reported here is to describe the accuracy of energy intakes reported by patients using the website from November 2004 to October 2005, and to determine whether relationships exist between reporting status and patient characteristics—age, gender and body mass index (BMI).

METHODS

The computers with the DietAdvice website were set up in 14 general practices in the Illawarra region of New South Wales, Australia. For the pilot study, patients with, or at risk of, metabolic syndrome were targeted, as metabolic syndrome encompasses a number of Australia’s leading disease states that may be modified by dietary change. (The website could, however, be applicable to most diet-related conditions.) Doctors within each of the practices were requested to recruit patients to the website who were either

- Over the age of 45 years who would benefit from dietary advice related to bodyweight and heart health; or
- Under the age of 45 years and having at least one factor of metabolic syndrome as defined by the International Diabetes Federation (type 2 diabetes, overweight, hypercholesterolaemia or hypertension).

Consenting patients used the website either in the general practice or in a location convenient to them.

The DietAdvice website is based on a multiple-pass approach, in which patients are first asked questions about their demographic information. Next, the meals eaten by the patient are identified, and then food-based questions are asked to determine broad areas of food intake for each identified meal. Following this, further details about the food items are requested and, finally, the portion size and frequency of consumption is determined. The website is based on automation of the diet history interview. Patient information is uploaded into the ‘dietitians interface’, in which the patient’s basal metabolic rate (BMR) is determined using the Schofield equation, BMI is calculated, and food intake data are analysed for nutrient composition using a modified version of the AUSNUT database (S. Burden, unpublished, 2007).

Self-reported demographic data from each of the patients were uploaded from the website into SPSS for Windows (v12.0.1, 2003: Lead Technologies, Chicago, IL, USA). Age was categorised into: <35, 36–55 and >56 years. BMI was calculated and categorised into: normal (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²) and obese (>30.0 kg/m²). Dietary information from the website was uploaded using the ‘dietitians interface’. This ‘dietitians interface’ converted the reported food intake into nutrient data. Nutrient data were also imported into SPSS for Windows. Reported energy intake (EI) was compared with predicted BMR for all patients. Patients were classified as underreporting if EI : BMR <1.35, overreporting if EI : BMR >2.4, and on target if EI : BMR ranging between 1.35 and 2.4. Chi-square analyses and ordinal regression were conducted to determine relationships between BMI, gender and age with reporting status.

Ethics approval was granted by the Human Research Ethics Committee of the University of Wollongong. The research conducted conforms to the provisions of the Declaration of Helsinki. Informed consent was obtained from all participants verbally upon recruitment and then electronically through the website, and anonymity has been ensured by coding of all identifiable information.

RESULTS

Two hundred patients were recruited by October 2005 (approximately 70% participation rate), of whom 12 had not started using the website or had account errors (Figure 1). Of the remaining 188 patients, the website was used in the general practice by 24 (12.8%), with 110 (58.5%) preferring to use the website at home, and a further 54 (28.7%) using the website in other locations, such as at work or at a relative’s house. Patients with a higher BMI were significantly more likely to use the computer at home or elsewhere than at the general practice (P = 0.04).

Demographic data for the remaining 188 patients were available. Sixty-three (33.5%) male and 125 (66.5%) female patients used the website. The majority of patients using the website were overweight (Table 1). Two patients’ demographic data for age, height, weight and BMI were excluded owing to typographical errors. A broad range of patients used the website, ranging from 19 to 79 years of age (mean 49 years). They reported being overweight (n = 137, 72.6%), with self-reported values translating to a mean BMI within the obese range (BMI >30.0 kg/m²). They also reported more than one medical condition (Table 1), and from this, 117 (62.2%) would fit the defined condition of metabolic syndrome.
Overweight, n (%) 137 (72.9)
Insulin resistance, n (%) 9 (4.8)
Impaired glucose tolerance/Hypertension, n (%) 83 (44.1)

Height (cm), mean
Weight (kg), mean
BMI (kg/m²), mean

Did not start using website/account error
N = 12

Demographic information
N = 188

Did not finish questionnaire
N = 45

Nutrient intake data
N = 143

Figure 1 Number of patients for whom demographic and nutrient information was available.

Table 1 Self-reported medical conditions from website users (n = 188)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean ± SD (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years), mean ± SD (range)</td>
<td>49.1 ± 14.6 (19–79)</td>
</tr>
<tr>
<td>Weight (kg), mean ± SD (range)</td>
<td>91.8 ± 8.9 (46–158)</td>
</tr>
<tr>
<td>Height (cm), mean ± SD</td>
<td>166.7 ± 9.6</td>
</tr>
<tr>
<td>BMI (kg/m²), mean ± SD</td>
<td>32.6 ± 6.5</td>
</tr>
<tr>
<td>Hypercholesterolaemia, n (%)</td>
<td>82 (43.6)</td>
</tr>
<tr>
<td>Hypertension, n (%)</td>
<td>83 (44.1)</td>
</tr>
<tr>
<td>Impaired glucose tolerance/</td>
<td></td>
</tr>
<tr>
<td>impaired fasting glucose, n (%)</td>
<td>21 (11.2)</td>
</tr>
<tr>
<td>Insulin resistance, n (%)</td>
<td>9 (4.8)</td>
</tr>
<tr>
<td>Overweight, n (%)</td>
<td>137 (72.9)</td>
</tr>
<tr>
<td>Other medical condition, n (%)</td>
<td>19 (10.1)</td>
</tr>
<tr>
<td>Type 2 diabetes mellitus, n (%)</td>
<td>42 (22.3)</td>
</tr>
</tbody>
</table>

(a) Data excluded for n = 2 owing to typographical errors.

At the time of the present study, missing or incomplete data were found for 57 of the 200 patients. No significant relationships were found for age, gender or BMI, and stage of completion. Of the remaining 143 patients who completed their dietary assessment, 32.3% underreported their intakes, 21.7% overreported their intakes, and 46.2% were on target with their reporting. No relationships were found for the reporting status with BMI (P = 0.19), gender (P = 0.77) or age (P = 0.58) (Table 2).

DISCUSSION

Use of computer technology in the field of dietetics not only has the ability to speed up the interview and analysis process, but it appears also to encourage patients to report their intakes more accurately when compared with values in the literature. This pilot study found that underreporting was less common than being on target or overreporting. Limiting the amount of face-to-face contact during the diet history interview process appears to encourage reporting of more food items rather than less. Within the study limitations, there was no association of reporting status with age, sex or BMI. In addition, allowing the patients to complete the assessment in the comfort of their own home may further encourage accurate reporting. Findings show that patients with a higher BMI, a group known to underreport their food intakes, were more likely to use the computer at home than in a public setting.

Studies using automated dietary assessment technology are not yet widely available. Using a three-day multiple-pass 24-hour recall, Jonnalagadda et al. found men to underestimate regardless of reporting period and women to be influenced by the recording circumstances. A similar study by Yanek et al., also using automated 24-hour recall technology, found that 88% of users reported low energy levels. These results differ from the findings of the present study (only 32% underreported). This may primarily be due to the different assessment methods, as the Yanek et al. study used telephone-based computer-assisted interviewing. However, both the participants in the Yanek et al. study and in the present study had a mean BMI of 32 kg/m² (i.e. obese). The results in the Yanek et al. study did not improve when completing the multiple-pass computerised assessment in person (91% underreporting) despite intensive training of the participants in portion size estimation. This may suggest that a longer reporting period is more effective when using computerised assessment methods. As automated dietary assessment is an emerging field of dietetics, no studies using automated diet history studies were identified for comparison. Face-to-face diet history assessments, however, found that 48% of non-obese subjects were underreporting their intakes, while overweight subjects were found to decrease their reported EI (kJ) with each 1-point increment (kg/m²) in BMI. However, owing to the methodological differences between studies, a further study has been designed in which face-to-face diet histories are specifically compared with automated diet histories using the same population group.

Double the number of women to men used the website from a wide range of age groups. This may be due to willingness to volunteer for a diet-related study. Women are also known to underreport their food intakes. Furthermore, older women are more likely to underreport than their younger counterparts. The present study, despite having a large proportion of women and a mean age of 49 years, did not see any significant links to reporting status.

Reporting when using the computer appears not to be related to the patient characteristics of BMI, gender and age as is seen in a diet history with a dietitian. However, it must be noted that biased self-reporting of height (overestimation) and weight (underestimation) data is common, which may have affected the BMI data of this patient group. Furthermore, the findings of the present study were limited to patients with metabolic syndrome. This may have affected the range of different ages and range of different BMIs (primarily lower) available for comparison within the analysis. Further studies would be required to determine whether the findings of the present study can be applied to other groups.
The present study found that patients using the computer appear to be more willing to report all foods eaten to the computer than to a dietitian. From observations of patients using the computer in the present study, underreporting appeared to be influenced by computer troubles/errors rather than a bias of the reported food items. For example, some patients were only entering information for one meal owing to troubles with the Internet connection. This was then managed by the dietitian reviewing the patients’ reported food intake to determine whether whole meals, for example, appear to be missing, and telephone the patient. It could then be determined whether the patient did only consume a limited intake, or whether computer or website concerns were the reason for the limited foods being reported. For patients whose dietary information was incomplete, the dietitians requested the patient complete the questionnaire within a given time period. For some patients, however, despite completing the questionnaire their information was still not correct. Therefore, computer problems may be seen as a limitation of automated technologies.

Overreporting, conversely, appears to be influenced by patients reporting all foods eaten, rather than their usual intake (data not shown). The limited face-to-face contact during the dietary interview decreases the social desirability bias, which may influence reporting when seeing a dietitian. It is reasonable to assume that patients feel comfortable at the computer and, as they work through the list of foods in the website, each food acts as a prompt. Rather than limiting the reported foods to those eaten most often, the patient may report all foods consumed with less attention to the frequency of consumption in one-week-long time frame. This would result in a higher reported nutrient intake, as the frequency of consumption section of the website may not be accurately completed. Although this limits the accuracy of the reporting, the dietitian would still be able to determine patterns of intake and develop a more accurate dietary prescription than they would for a patient who has not reported enough food items. A future study has been planned to specifically look at the degree of reporting accuracy when using the DietAdvice website.

The use of a computer to assist dietitians in their consultations may allow for added time to be spent on face-to-face education and counselling patients towards dietary change. This is especially important with the growing incidence of metabolic syndrome worldwide. Although the automation provided by computers will be useful in the field of dietetics, the professional judgement and expertise provided by the dietitian themselves cannot be automated. Computers should therefore be used as an adjunct to dietary consultations rather than a replacement.

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REFERENCES

5 Rosell MS, Hellenius ML, de Faire UH, Johansson GK. Associations between diet and the metabolic syndrome vary with the validity of dietary intake data. Am J Clin Nutr 2003; 78: 84–90.


