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Computerized dietary assessments compare well with interviewer administered diet histories for patients with type 2 diabetes mellitus in the primary healthcare setting

Abstract

Using a context-based case-control trial, 41 adults with type 2 diabetes mellitus were randomized into four groups to complete dietary assessments (computerized or interviewer administered) at 0, 2 and 8 weeks and food records at 0 and 2 weeks. Repeatability of reported energy, total fat, saturated, polyunsaturated and monounsaturated fatty acids between the computerized and interviewer administered methods were assessed using repeated measures ANOVA. Paired t-tests and Pearson's correlations determined relative validity of the assessments.

Keywords

dietary assessment, dietitian, computer, repeatability, primary healthcare

Disciplines

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Computerized dietary assessments compare well with interviewer administered diet histories for patients with type 2 diabetes mellitus in the primary healthcare setting

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Computerized dietary assessments compare well with interviewer administered diet histories for patients with type 2 diabetes mellitus in the primary healthcare setting

Objective: To test repeatability and relative validity of a computerized and interviewer administered assessment.

Methods: Using a context based case-control trial, forty-one adults with type 2 diabetes mellitus were randomized into four groups to complete dietary assessments (computerized or interviewer administered) at zero, two and eight weeks and food records at zero and two weeks. Repeatability of reported energy, total fat, saturated, polyunsaturated and monounsaturated fatty acids between the computerized and interviewer administered methods were assessed using repeated measures ANOVA. Paired t-tests and Pearson's correlations determined relative validity of the assessments.

Results: Thirty-one patients completed all visits. Statistically significant differences were found between computerized and interviewer administered data for total fat ($p=0.048$) and saturated fatty acids ($p=0.019$) between zero and two weeks. Computerized assessments correlated better with food records ($r=0.16-0.52$) compared with interviewer administered assessments ($r=-0.02-0.51$).

Conclusion: Computerized assessments saw a learning effect with repeated use indicating that users were becoming more familiar with the website with repeated use. Relative validity suggests that the website may capture more foods though this requires further investigation.

Practice Implications: By allowing patients to self-report their intakes on a computer, dietitians will have the ability to spend increased time with their patients counseling them toward change.

Keywords: dietary assessment, dietitian, computer, repeatability, primary healthcare

1. Introduction

Dietary advice is dependant on dietary assessment, and despite a progressive movement towards computerized healthcare (1-4) and the many advantages of computer-assisted interviewing (5), few studies have addressed the possibilities within dietary assessment (6-8). Computer-assisted self-interviewing (9) is not new and nor are computers in nutrition. They are used in education (10) and data analysis (9), yet computerized dietary assessment has mainly been limited to 24-hour recall (11) and food frequency questionnaire methodology.

A new website for dietary assessment using a meal based framework was designed in the Illawarra region of Australia, to allow patients to self-report their dietary intake in the primary healthcare setting. Utilizing design concepts from the diet history interview and food frequency questionnaire methodologies, the website was developed based on an analysis of food intake data from the last Australian National Nutrition Survey (12). Usability testing of the website during its development revealed it to be user friendly and comparable in length to a diet history interview with a dietitian and analysis of the food data post interview (13). The website was developed using a multiple-pass approach in which the user first answers demographic questions, followed by those on meal consumption, broad food group consumption within meals, specific food consumption within groups, food portion size and frequency of consumption (13). After the user has finished using the website, data is electronically passed to a dietician to develop an individualized dietary prescription using the 'dieticians interface' of the website.

The website was implemented in the primary healthcare setting from November 2004 to October 2005 in fourteen different medical practices. During this time 224 patients logged on to the website. They were recruited into the study via the general practitioners in the medical centers

and dietary prescriptions developed by the dietitians were sent back to the corresponding general practitioner to discuss with the patient. Comparative repeatability and validity assessments of the dietary data were conducted from June to September 2005 in one of the fourteen medical practices. Ethics approval was provided by the University of Wollongong Human Research Ethics Committee. All patients provided written consent prior to participation.

The aim of this study was to compare the repeatability and relative validity of the computerized dietary assessments with interviewer administered diet histories in the primary healthcare setting. It was hypothesized that the computerized assessments would be repeatable and would correlate better with the food record as a result of increased accuracy of the data due to the decreased social desirability bias (16) of using a computer.

2. Methods

A multiple visit context based (set in the primary healthcare setting) case-control design was applied to test the performance of the website relative to 3-day food records and interviewer administered assessment with a dietitian. Similar methods have been used to comparatively test other computerized dietary assessment instruments (6, 7). Demographic (age, place of birth, language spoken at home, employment status) and anthropometric (height, weight) data were collected by questionnaire (computerized or interviewer administered) prior to the dietary assessment. For patients attending the interviewer administered assessments height and weight were measured, while patients using the computer self-reported their weight without measurement.

2.1 Subjects and methods

Patients were recruited through a medical practice in the Illawarra region of NSW, Australia in June 2005. Electronic patient files using Medical Director patient management software (version 3, 2005: Health Communications Software, NSW, Australia) were searched for patients aged 18 to 75 years with type 2 diabetes mellitus. Eligible patients were mailed a letter of invitation. Interested patients were randomly allocated to one of four study arms blinded to the researchers. The patients were required to visit the medical practice on three separate occasions. Group A had three computerized assessments, group B had three interviewer administered assessments, group C has two computerized and one interviewer administered assessments and group D has two interviewer administered and one computerized assessments consecutively.

A computer was provided for the web-based dietary assessments and a spare room in the medical practice was used for interviewer administered assessments with an Accredited Practising Dietician. Patients utilizing the computer were assisted by a researcher for computer related difficulties only. The researcher was instructed not to provide assistance for any dietary recall activities. All information was available on screen including the portion size images. The dietitian providing the interviewer administered assessments had no previous contact with the website. The dietitian used a paper-based form of the demographic questionnaire, undertook a structured diet history interview (15) and measured height and weight. Food portions were identified using conventional household measures such as cups and measuring spoons. No portion images were available.

The first two visits to the medical practice were separated by two weeks for a repeat dietary assessment. After each visit, all patients were given 3-day food record booklets to complete. Patients were required to measure and record all food items eaten over two weekdays and one

weekend day. After the second visit all patients were provided with an individualized dietary prescription from an Accredited Practicing Dietitian containing dietary goals to achieve over the next six weeks (reported elsewhere). Patients returned to the medical practice six weeks after receiving their advice for another dietary assessment.

Repeatability was assessed from repeated dietary assessment measures conducted two weeks apart and before any dietary advice was provided. Differences in reported total fat and fatty acids were compared for the computerized and interviewer administered assessments.

Relative validity was assessed by comparing computerized assessments with food record data for reported intakes of energy, total fat and type of fat. A similar validity assessment was conducted on data from the interviewer administered diet history interview to enable comparisons.

This was a context based analysis comparing computerized assessments with interviewer administered assessment and further, assessments with 3-day food record in the primary healthcare setting. There isn't a gold standard presently available with which to compare the computerized assessments, though the modes of administration have been reported to be equal (despite small variations) (7).

2.2 Statistical analyses

Weight and body mass index (BMI) from the computerized and interviewer administered assessments were compared using repeated measures ANOVA (GLM) in SPSS for Windows (version 12.0.1, 2003: SPSS Incorporated, Chicago, USA). Demographic data from the patients was descriptively analyzed with mean \pm SD values calculated for age at baseline only.

Food data from interviewer administered assessments was analyzed in FoodWorks (version 4.0.158, 2005: Xyris Software Pty Ltd, Queensland, Australia) by the dietician who completed the assessments, and computerized assessments were downloaded into the 'Dieticians Interface' of the website (modeled on the FoodWorks program). As the website used grouped food data (19) and to ensure comparability of the food data, interviewer administered assessment data from FoodWorks was transformed into grouped food data by assigning each food item into a corresponding food group from the website database using look-up tables in Microsoft Excel (2003 version, 2003 Microsoft Corporation, Washington, USA) (17). The lookup table method allowed the database code of each food item to be linked automatically to the database code of the correct food group. This then allowed comparisons of the food data to be made as both databases were based on grouped information originating from the AUSNUT database (18). Data from the 3-day food records were similarly analyzed in FoodWorks by the dietitian and transformed into grouped food data using the look-up table method. This allowed comparisons to be made between the data sets..

Values for reported intakes of total energy, total fat, saturated fatty acids, polyunsaturated fatty acids and monounsaturated fatty acids were calculated for each patient. Repeated measures ANOVA (GLM) were conducted to assess the repeatability of the data for each nutrient value for week zero and week two and separately for week two and week eight for the two assessment forms and for the four groups. Post hoc Bonferroni analyses were conducted to determine within subject differences for the groups.

Mean food record and diet history data for week zero and week two were calculated and compared using paired samples t-tests and Pearson's correlation of the interviewer administered and computerized assessments and food records were used to determine the relative validity. Results were considered significant at $p < 0.05$.

3. Results

A total of 105 patients from the medical practice were eligible for the study. Upon being contacted by the researchers, 13 were not interested. Of the remaining 92 patients who received details of the study in the mail, 43 returned signed consent forms. Two withdrew before randomization and a further three withdrew before the study began. Thus, 38 patients began the study at baseline. A further two withdrew (one for psychosocial reasons, one relocated) leaving 36 (97.4%) patients completing the repeatability component. The food record booklet was returned by 30 patients for relative validity analyses. Another five patients withdrew prior to week eight (two illness, two other commitments, one reason not given) leaving 31 (86.1%) completing all dietary assessments.

3.1 Profile of patients

Although the patients recruited from the patient database in the surgery were defined as having only type 2 diabetes mellitus, other lifestyle related conditions were also identified. For example, 15 patients (39.5%) also self-reported being overweight. Thirty-three (86.8%) patients were born in Australia, 37 (97.8%) spoke English at home and 27 (71.1%) were retired. More than half of the patients ($n=21$) were female and majority of the patients were classed as overweight based on their calculated BMI ($>25\text{kg/m}^2$) (Table 1).

GLM ANOVA revealed a significant difference between week zero and week two for reported weight ($p=0.03$) and BMI ($p=0.03$) (Table 1) with all groups decreasing their weight. No differences were identified within or between the groups. No significant differences were identified for weight or BMI between week two and week eight although the two groups who crossed over to the other assessment form decreased their weight (group C -1.6kg, group D - 3.3kg) the interviewer administered group (group B) remained stable and the computerized assessment group (group A) increased their weight (+0.5kg). The variability of the self-reported data also decreased with time with smaller differences seen between week two and eight than between week zero and two.

3.2 Repeatability

Reported total fat intake was highly variable (large SD) for the computerized assessment (week 0 118.37 ± 91.89 g, week 2 79.78 ± 60.88 g) and was consistently higher in the computerized than interviewer administered assessments. Statistically significant interaction effects were found for repeated measures of reported energy ($p=0.05$) and monounsaturated fatty acids ($p=0.05$) intakes between week zero and week two (Table 2). All other nutrients interactions for the time effect were found to be independent of the group effect and group effects were found to be independent of the time effects. A significant time effect was found for reported saturated fatty acids intakes ($p=0.02$) and total fat ($p=0.05$) between week zero and week two (Table 2). Statistically significant group effects were identified between week zero and week two for all reported nutrients intakes except saturated fatty acids intakes, with the computerized assessment giving higher values (Table 2). The data for the computerized assessment underwent larger changes between week zero and week two than compared with the interviewer administered data with the variability of the results (SD) decreasing between week zero and week two. Nutrient data for

reported energy, total fat, saturated fatty acids and monounsaturated fatty acids decreased for groups A and C while polyunsaturated fatty acids increased for all groups except group C (Table 3). Repeated measures ANOVA of reported energy and nutrient intakes did not show statistically significant differences between week two and week eight (Table 3).

3.3 Relative validity

Reported energy intake was significantly different between the computerized assessment and food record for both week zero (SEM 1065.97kJ) and week two (SEM 916.93kJ). Although large differences are visible for all remaining nutrients of the computerized assessments, no statistically significant differences were found. For data on fat, however, the computerized assessment produced the strongest correlation between the diet history interview and food record data in week two ($r=0.42-0.52$). The interviewer administered assessment saw weak correlations between the reported total fat ($r=0.02$; $r=0.12$), saturated fatty acids ($r=0.16$; $r=0.21$) and polyunsaturated fatty acid ($r=0.12$; $r=0.01$) intakes for both week zero and week two (Table 2). Reported total fat intake for the computerized assessment had the strongest consistent correlation ($r=0.52$), whilst for the interviewer administered assessment the correlations saw large differences between week zero ($r=0.02-0.51$) and week two ($r=-0.02-0.47$).

4. Discussion and conclusion

4.1 Discussion

This study assessed the repeatability and relative validity of computerized dietary assessment in the primary healthcare setting. It found a potential learning effect for the repeated computerized assessments with patients becoming more familiar with the website as they used it more often and stronger correlations between the computerized assessment and the food records. As this was a

context based evaluation set in the primary healthcare setting, the focus of the repeatability and relative validity analysis was on the performance of the computerized assessment compared to that of the practitioner (dietitian).

4.1.1 Profile of patients

The patients of this study were primarily aged between 50 and 60 years, and retired. While not representative of the general population in the Illawarra region - only 13% aged 45-54 years and 24% retired/not in labor force in 2001 (20), the patients in this study represented a group likely to benefit from this service.

The significant difference in weight and BMI between week zero and week two was anticipated due to the large differences in the self-reported weight (Table 1). 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.

4.1.2 Repeatability

We believe that the differences in the nutrient data between week zero and week two may be the result of patients reading the computer screen more accurately and becoming more aware of the expectations of the website by their subsequent visits (learning effect) (21, 22). This can be seen by the changes in the variability (SD) of the nutrient data between week zero and week two as no dietary advice had been provided at these timepoints. It was observed during their first visit (week zero), that 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 in the website.

Although statistically significant differences were observed between weeks zero and two for reported fat intake data, the actual foods items consumed regularly were similarly reported at both time points. Furthermore, the differences were primarily seen between groups rather than with time (Table 2). The only nutrient variable that displayed differences with time was saturated fatty acids intake. All other nutrient data were repeatable with time. Data on saturated fatty acids intake (Table 2) may have been affected by the analysis for time as the foods higher in saturated fatty acids appeared to be foods consumed occasionally and therefore were reported less as patients became more aware of the one week reporting period. No significant interaction effects were observed for any of the reported nutrient intakes. Repeatability results may have been affected by the small size of the groups within this study rather than the two week period between assessment methods.

The time and group effects for the reported nutrient data for week zero and week two also indicated that the factors influencing the patients were not independent of one another. It is proposed that the repeatability component of the study may have been influenced by the previous assessment and the context in which the assessment was conducted (primary healthcare setting), as found in the literature (22). Data for groups A and C using the computerized assessment were consistently higher for all nutrients than the interviewer administered assessment visits both at week zero and week two. When considering this in combination with the ‘picture’ of the usual diet obtained from both assessment methods in this study this suggests more foods are captured by the computer than the dietitian, and in a repeatable fashion on face value.

4.1.3 Relative validity

Significant differences observed between the diet history and food record data for the computerized assessment group suggest that the website was capturing a greater amount of dietary information than the food record. Reported energy intake was significantly different between the computerized assessment and food record and large non-significant differences were found for all remaining nutrients of the computerized assessments. Data reported by the patients using the website also correlated better with the 3-day food records ($r= 0.16-0.52$) suggesting a consistent bias possibly toward under-eating with the food record (23). Correlations for the computerized assessment were less varied (a maximum at $r=0.52$ for total fat and were lowest at $r=0.16$ for saturated fatty acids data) than for the interviewer administered assessment (highest correlation for energy at $r=0.47$ and lowest at $r=0.01$ for monounsaturated fatty acids intake). Better correlations between self-administered assessment and food records have been reported in the literature (23) though computerized 24-hour recalls saw correlations similar to that found in our study (6). The computerized assessment results were lower than those reported on other face-to-face diet history and 3-day food record validity studies (23, 24) related to clinical trials with volunteers. This may again be due to the context of the interview (primary health care setting) in our study and would require further investigation.

When groups C and D crossed-over, a decreased reporting of total fat in the week eight data corresponded with the patients visiting the dietitian while the higher reporting corresponded with the patients using the computer (Table 3). This also suggests that the computerized assessment may be capturing a fuller picture of dietary intake, though further research is required to confirm this.

4.1.4 Limitations

Recruitment practices are vital to a study and should be considered according to the numbers required. Due to the type and setting of the study no power calculations were performed. Of the 110 patients contacted, less than 40% were recruited to the study. In keeping with similar studies, however (21, 25), once committed to the study, withdrawal rates were relatively low with 78% of all patients completing this study. It is assumed that as the burden of a study increases, the completion rate of a study decreases and this may reflect the personal circumstances and level of motivation of the participants.

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 were identified. Further studies would be required to determine whether the nutrient intake data found for the computerized assessment group are linked to the actual intake of individuals with type 2 diabetes mellitus. The potential learning effect identified in this study should also be pursued, though it has been identified in other health technology studies (26).

4.2 Conclusion

The differences between the computerized and interviewer administered assessments were noticeable. 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 computerized assessment groups. This may indicate that the use of a list of food groups, as seen in the computerized assessment website, 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.

4.3 Practice Implications

The identified potential learning effect may need consideration when dietitians move from the interviewer administered face-to-face assessments to computerized methods. Further research using a larger sample size and more accurate patient weight information will be useful to clarify the degree of this effect. However, with further refinement use of computerized dietary assessment may be a method for improved time efficiency of dietary services allowing dietitians to spend more time with their patients educating them and counseling them toward change.

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Table 1: Comparison of computerized and interviewer administered patient demographic data at weeks zero and two

Measure	Computerized assessment		Interviewer administered assessment		Total
	Group A	Group C	Group B	Group D	
Week 0	n=10	n=10	n=9	n=9	n=38
Age, years (mean \pm SD)	58.3 \pm 10.8	66.3 \pm 6.7	62.0 \pm 8.8	60.7 \pm 9.8	61.8 \pm 9.3
Weight, kg ^a (mean \pm SD)	85.0 \pm 13.6	89.2 \pm 20.2	79.2 \pm 13.5	96.1 \pm 22.0	85.0 \pm 14.7
Week 2	n=10	n=9	n=9	n=8	n=36
Weight, kg (mean \pm SD)	82.4 \pm 16.0	85.9 \pm 19.4	78.8 \pm 13.1	88.4 \pm 9.9	83.8 \pm 15.1

^aWeight measured for interviewer administered assessment and self-reported for computerized assessment

1

2 **Table 2: Repeated measures ANOVA of self-report nutrient data and Pearson's correlations for week zero and two**

Nutrient (<u>Mean±SD</u>)	Computerized assessment (<u>n=17</u>)				Interviewer administered (<u>n=18</u>)				<u>RMANOVA</u>		
	Week 0 <u>DH</u>	Week 2 <u>DH</u>	FR1/ DH1 ^a	FR2/ DH2 ^b	Week 0 <u>DH</u>	Week 2 <u>DH</u>	FR1/ DH1	FR2/ DH2	P (grp) ^c	P (time) ^d	P (int) ^e
Energy(kcal)	3273.04±1797.00	2493.62±1404.53	0.26	0.31	1739.19±422.33	1826.29±729.21	0.30	0.47	0.00	0.11	0.05
Total fat (g)	118.37±91.89	79.78±60.88	0.25	0.52	61.01±16.53	60.36±20.93	0.12	0.02	0.03	0.05	0.06
SFA (g)	37.72±26.74	25.35±18.77	0.16	0.42	22.88±8.40	20.91±7.89	0.16	0.21	0.07	0.02	0.08
PUFA (g)	22.29±17.55	16.61±14.83	0.22	0.51	10.28±3.62	10.45±4.35	0.02	0.01	0.02	0.13	0.11
MUFA (g)	47.18±42.96	29.86 ± 23.29	0.30	0.47	21.77±6.23	22.97±8.46	0.51	-0.02	0.03	0.08	0.05

Food record (FR), Diet history (DH), Saturated fatty acids (SFA), Polyunsaturated fatty acids (PUFA), Monounsaturated fatty acids (MUFA)

^a FR1/DH1 = Pearson's correlation at week 0

^b FR2/DH2 = Pearson's correlations at week 2

^c Repeated measures ANOVA Group effect (grp)

^d Repeated measures ANOVA (RMANOVA) Time effect (time)

^e Repeated measures ANOVA Interaction effect (int),

n=1 data excluded: not physiologically plausible (>100,000kJ [23,894kcal])

3 **Table 3: Self-report diet history nutrient data (mean \pm SD) for week two and eight showing all four groups**

Nutrient	Group	Week 2	Week 8
Energy (kcal) (Mean \pm SD)	C ^a	<u>2642.72\pm1500.45</u>	<u>1966.44\pm688.31</u>
	B ^b	<u>1853.71\pm388.75</u>	<u>1878.81\pm592.22</u>
	A ^c	<u>2312.15\pm840.48</u>	<u>2339.33\pm948.63</u>
	D ^d	<u>1896.43\pm947.15</u>	<u>2295.28\pm707.98</u>
	All groups	<u>2211.61\pm1027.06</u>	<u>2137.51\pm765.86</u>
Total fat (g) (Mean \pm SD)	C	81.74 \pm 57.71	72.32 \pm 25.13
	B	64.76 \pm 17.99	70.60 \pm 20.69
	A	72.61 \pm 30.38	68.73 \pm 31.60
	D	61.32 \pm 17.47	72.18 \pm 31.25
	All groups	70.84 \pm 35.22	70.87 \pm 26.57
SFA (g) (Mean \pm SD)	C	27.22 \pm 20.29	22.17 \pm 9.67
	B	21.80 \pm 7.19	24.17 \pm 12.03
	A	23.22 \pm 11.46	21.41 \pm 11.83
	D	22.05 \pm 6.85	25.28 \pm 12.61

	All groups	23.73±12.61	23.07±11.03
PUFA (g) (Mean ± SD)	C	17.87±12.77	15.34±6.05
	B	11.13±3.73	14.15±5.53
	A	13.36±4.73	13.84±6.39
	D	9.21±4.22	12.07±6.45
	All groups	13.15±7.90	13.89±5.95
MUFA (g) (Mean ± SD)	C	28.69±20.93	26.01±9.54
	B	21.67±4.42	29.53±5.87
	A	28.49±12.26	26.05±11.31
	D	23.83±7.24	27.28±11.22
	All groups	26.09±13.05	27.02±9.55

Saturated fatty acids (SFA), Polyunsaturated fatty acids (PUFA), Monounsaturated fatty acids (MUFA)

^a Group A: 3 computerized diet history interviews

^b Group C: 3 computerized and 1 interviewer administered diet history interviews

^c Group B: 3 interviewer administered diet history interviews

^d Group D: 2 interviewer administered and 1 computerized diet history interviews

n=1 data excluded, not physiologically plausible (>100,000kJ [23,894kcal])

5 **Figure 1**

