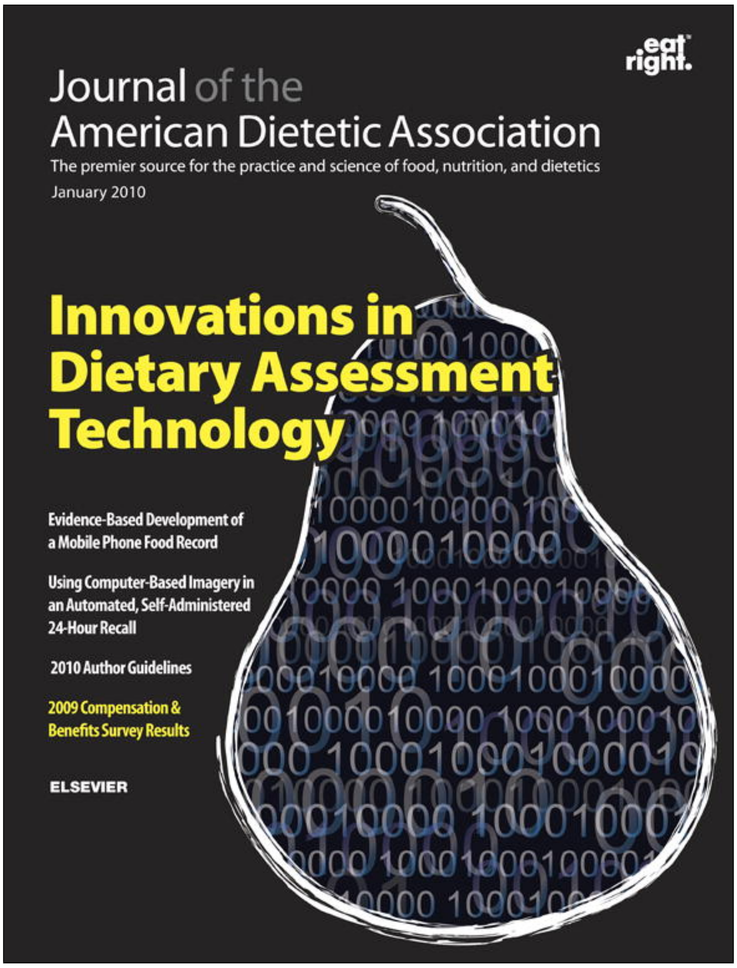
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RESEARCH

Research and Professional Briefs

Use of Household Supermarket Sales Data to Estimate Nutrient Intakes: A Comparison with Repeat 24-Hour Dietary Recalls

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ABSTRACT

Electronic supermarket sales data provide a promising, novel way of estimating nutrient intakes. However, little is known about how these data reflect the nutrients consumed by an individual household member. A cross-sectional survey of 49 primary household shoppers (age [mean±standard deviation age]=48±14 years; 84% female) from Wellington, New Zealand, was undertaken. Three months of baseline electronic supermarket sales data were compared with individual dietary intakes estimated from four random 24-hour dietary recalls collected during the same 3-month period. Spearman rank correlations between household purchases and individual intakes ranged from 0.54 for percentage of energy from saturated fat ($P<0.001$) to 0.06 for sodium ($P=0.68$). Other correlation coefficients were: percentage of energy from carbohydrate, 0.48; and protein, 0.44; energy density of nonbeverages, 0.37 (kcal/oz); percentage of energy from total fat, 0.34; sugar, 0.33 (oz/kcal); and energy density of beverages, 0.09 (oz/kcal; all P values <0.05). This research suggests that household electronic supermarket sales data may be a useful surrogate measure of some nutrient intakes of individuals, particularly percentage of energy from saturated and total fat. In the case of a supermarket intervention, an effect on household sales of percentage energy from saturated and total fat is also likely to impact the saturated and total fat intake of individual household members.
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Globally, nutrition-related risk factors, such as high blood pressure, high cholesterol, high body mass index (calculated as kg/m^2), and low fruit and vegetable intake are major causes of chronic noncommunicable diseases, including cardiovascular disease; diabetes mellitus; and some cancers (1). In order to investigate such diet–disease relationships, it is essential to collect and assess individual dietary intake data (2). Traditional dietary assessment methods (ie, 24-hour diet recall, diet record, food frequency questionnaire, and diet history) have strengths and weaknesses, and there is no single, ideal method (2-4). Electronic supermarket sales data provide a novel and promising way of estimating nutrient intakes without the substantial participant burden associated with more traditional methods of dietary assessment. Providing there is a means for identifying individual customer purchases (such as a loyalty card), electronic supermarket sales data can be used to estimate household purchases of nutrients found in common foods (5). Although subject to many of the same food composition database errors as traditional dietary assessment methods (3,4,6,7), electronic supermarket sales data do not rely on subject memory and reporting. Further, electronic data can be collected directly from the retailer, which minimizes participant burden and makes this method suitable for use with all age groups and literacy levels. Supermarkets provide the largest category of food expenditure in the United States, the United Kingdom, and New Zealand (8-10). However, little is known about how these data reflect nutrients consumed by an individual household member, and consequently what impact a supermarket intervention might have on the nutrient intake of individual household members. The aim of this research was to compare electronic supermarket sales data from a supermarket intervention trial as a means of estimating household purchases of nutrients found in common foods, with individual nutrient intakes measured using a traditional dietary assessment method (repeat 24-hour recalls) during the same time period.

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METHODS

Participants and Setting

A random sample of 50 participants was selected from the Supermarket Healthy Options Trial, a large, randomized controlled trial of strategies to improve supermarket food purchases (C. Ni Mhurchu, T. Blakely, Y. Jiang, H. Eyles, A. Rodgers, unpublished data, 2009). This sample size corresponded with a hypothesized correlation coefficient of 0.6 between nutrient purchases and intakes with a P value of 0.05 when tested against the null hypothesis (11). The study was approved by the University of Auckland Human Ethics Committee (reference number 2006/462). Shoppers were eligible for inclusion in the substudy if they met inclusion criteria for the main study (12), were not planning to leave New Zealand or go on vacation for more than 3 weeks in the subsequent 12 weeks, and identified as non-Maori, non-Pacific ethnicity.

Electronic Supermarket Sales Data (Nutrient Purchases)

Electronic supermarket sales data were collected via hand-held barcode scanning terminals operated by study participants (13). Shoppers carried the scanners (which were readily available at no cost to all supermarket shoppers) as they proceeded around the supermarket and used them to scan grocery items as they placed them in their shopping carts. A specific checkout was used to pay and (with the exception of random checking) groceries did not need to be rescanned, saving shopper time. Three months of baseline shopping data were collected directly from the supermarket data warehouse for each substudy participant. Food purchases were converted to nutrient purchases by merging with a specially developed, brand-specific, supermarket food and nutrient database. Methods for development of the supermarket food and nutrient database have been described in detail elsewhere (14). However, 12 months of retrospective sales data from six stores participating in the trial were used to identify 3,000 top-selling foods and nonalcoholic beverages for the database (from a total list of 18,012 products). Alcohol was excluded because the focus of the trial was to deliver nutrition education based on food purchases and alcohol intake was excluded from the education (C. Ni Mhurchu, T. Blakely, Y. Jiang, H. Eyles, A. Rodgers, unpublished data, 2009).

Repeat 24-Hour Dietary Recalls (Nutrient Intakes)

Nutrient intakes were assessed using four telephone-administered 24-hour dietary recalls collected during the 3-month baseline phase of the trial. A list of preselected, computer-generated dates was used to allocate 3 random weekdays and 1 weekend day to each participant for recall. When a diet recall could not be collected on the allocated day, the participant was called on the following week or weekend day as appropriate, until they could not be contacted within 1 month of their last allocated recall day.

Twenty-four–hour recalls were collected using a multiple three-pass method involving collection of a "quick" list of all foods consumed during the previous 24 hours; detailed information for each food on the quick list, including where it was purchased/obtained, the method of preparation, and the quantity consumed; and any additional foods and beverages not already recorded. Interviewer prompting was used during step three. Methodology for collection of dietary recalls was based on the 24-hour recall methodology used in the New Zealand Adult Nutrition Survey (15) and United States National Health and Nutrition Examination Surveys (16). A "food serving sizes" booklet (including pictures of different-sized bowls, cups, and serving sizes for commonly consumed foods) was provided to help participants describe the amount of foods and beverages consumed.

Twenty-four–hour diet recalls were coded manually using FoodWorks (version 2006, Xyris Software, Food-Works Professional Edition, Queensland, Australia) dietary analysis computer software, which converts foods to nutrients using the New Zealand Food Composition Database (New Zealand's largest food composition database containing nutrient information for >2,600 largely generic foods and beverages commonly consumed in New Zealand) (17). Random cross-checks were completed using the 24-hour recall forms. Although Food Works includes composition data for alcoholic beverages, alcohol intake was excluded from the analyses for consistency with analysis of purchases (see Electronic Supermarket Sales Data).

Statistical Methods

Statistical analyses were performed using Statistical Analysis Systems SAS for Windows (version 9.1.3, 2005, SAS Institute, Cary, NC). All statistical tests were two-sided at a 5% significance level. Based on relevance to the main trial objectives (C. Ni Mhurchu, T. Blakely, Y. Jiang, H. Eyles, A. Rodgers, unpublished data, 2009) and to nutrition-related disease (1,18), the following seven nutrients were evaluated: saturated fat, total fat, carbohydrate, protein, sugar, sodium, and energy density. Energy density was assessed separately for beverages and nonbeverages as beverages may disproportionately affect energy density values (19,20).

Associations between nutrient purchases and intakes were evaluated using Spearman correlation coefficients. Paired *t* tests were also conducted to test the difference in means between household purchases and individual nutrient intakes. Data were normally distributed for all nutrients except energy density, where moderate deviation from normality was detected (although not sufficient to violate statistical testing).

RESULTS

Participants

Data from 49 of 50 participants were included in the analyses (one participant was excluded because this individual did not shop regularly at a participating supermarket). Four diet recalls were collected for 47 (96%) participants, and three diet recalls were collected for the remaining two (4%) participants. The substudy population was predominantly female (84%) with a high level of education (53% had university/tertiary qualifications) and income (39% earned ~US$49,000 [NZ$100,001] or more) compared with the general New Zealand population (21). Mean±standard deviation age was 48±14 years.

Comparison of Purchases and Intakes

Spearman correlation coefficients ranged from 0.54 for percentage of energy from saturated fat ($P<0.001$) to 0.06 for sodium ($P=0.68$). Other correlation coefficients were: percentage of energy from carbohydrate, 0.48 ($P=0.001$); and protein, 0.44 ($P=0.001$); energy density of nonbeverages, 0.37 (kcal/oz; $P=0.009$); percentage of energy from

Table. Intakes and purchases of selected nutrients for 49 sub-study participants in the Supermarket Healthy Options Trial[a]

Nutrient	Mean	Standard deviation	Standard error	Minimum	Maximum	*P* value
Energy density kcal/oz (MJ/kg) nonbeverage						
Intakes	185.91 (5.65)	37.51 (1.14)		107.59 (3.27)	279.35 (8.49)	
Purchases	235.26 (7.15)	69.76 (2.12)		118.78 (3.61)	494.21 (15.02)	
Difference	−49.36 (−1.50)	69.43 (2.11)	9.87 (0.30)	−299.42 (−9.10)	118.78 (3.61)	**0.000**
Energy density kcal/oz (MJ/kg) beverage						
Intakes	4.94 (0.15)	5.59 (0.17)		0.00 (0.00)	23.69 (0.72)	
Purchases	68.44 (2.08)	51.00 (1.55)		1.32 (0.04)	268.16 (8.15)	
Difference	−63.18 (−1.92)	51.99 (1.58)	7.90 (0.24)	−266.52 (−8.10)	−0.66 (−0.02)	**0.000**
Percentage energy from saturated fat						
Intakes	14	4		7	24	
Purchases	14	5		7	32	
Difference	−1	4	1	−13	7	0.121
Percentage energy from total fat						
Intakes	34	6		21	46	
Purchases	35	9		21	68	
Difference	−1	8	1	−22	18	0.245
Percentage energy from carbohydrate						
Intakes	47	6		32	63	
Purchases	50	8		20	66	
Difference	−3	7	1	−18	13	**0.006**
Percentage energy from protein						
Intakes	19	4		11	28	
Purchases	14	5		5	28	
Difference	4	5	1	−12	14	**0.000**
Sugar oz/kcal (g/MJ)						
Intakes	29.12 (13.33)	4.97 (3.36)		9.80 (6.63)	30.42 (20.58)	
Purchases	21.79 (14.74)	5.68 (3.84)		7.95 (5.38)	36.79 (24.89)	
Difference	−2.10 (−1.42)	6.07 (4.11)	0.87 (0.59)	−16.35 (−11.06)	12.55 (8.49)	**0.020**
Sodium oz/kcal (mg/MJ)						
Intakes	525.45 (355.51)	134.82 (91.22)		311.83 (210.98)	913.93 (618.35)	
Purchases	402.62 (272.41)	110.72 (74.91)		84.91 (56.96)	655.08 (443.22)	
Difference	122.84 (83.11)	164.98 (111.62)	23.57 (15.95)	−215.26 (−145.64)	472.58 (319.74)	**0.000**

[a]n=49 participants, statistically significant differences indicated by *P* value <0.05 in bold type.

total fat, 0.34 (P=0.017); sugar, 0.33 (oz/kcal; P=0.02); and energy density of beverages, 0.09 (oz/kcal; P=0.578). There were no significant differences between purchases and intakes of percentage energy from saturated and total fat (mean differences ~1%; P=0.12 and 0.25, respectively). Mean differences for the other five nutrients were larger and statistically significant (all P values <0.05; Table). The Figure shows the scatter plots of purchases vs intakes for percentage energy from saturated and total fat, and supports the findings of the Spearman correlations and paired t tests. In addition, intake data were analyzed by source of food (eg, "other store or supermarket," café, or food prepared in someone else's home) to determine likely causes of discrepancies between supermarket purchases and total dietary intakes. These data are available on request from the primary author.

DISCUSSION

To the best of the author's knowledge, this is the first published research to compare electronic supermarket sales data with an individual dietary assessment method. Moderate correlations were observed between household purchases and individual intakes for percentage energy from saturated and total fat, carbohydrate, and protein; and sugar (oz/kcal; all P values <0.05). Significant agreement was found between purchases and intakes for percentage of energy from saturated and total fat (mean differences ~1% total energy; P>0.01).

Electronic supermarket sales data have several advantages over traditional methods of dietary assessment, particularly in placing little or no burden on participants, and in being an efficient and objective measure, which is particularly advantageous for groups with poor memory

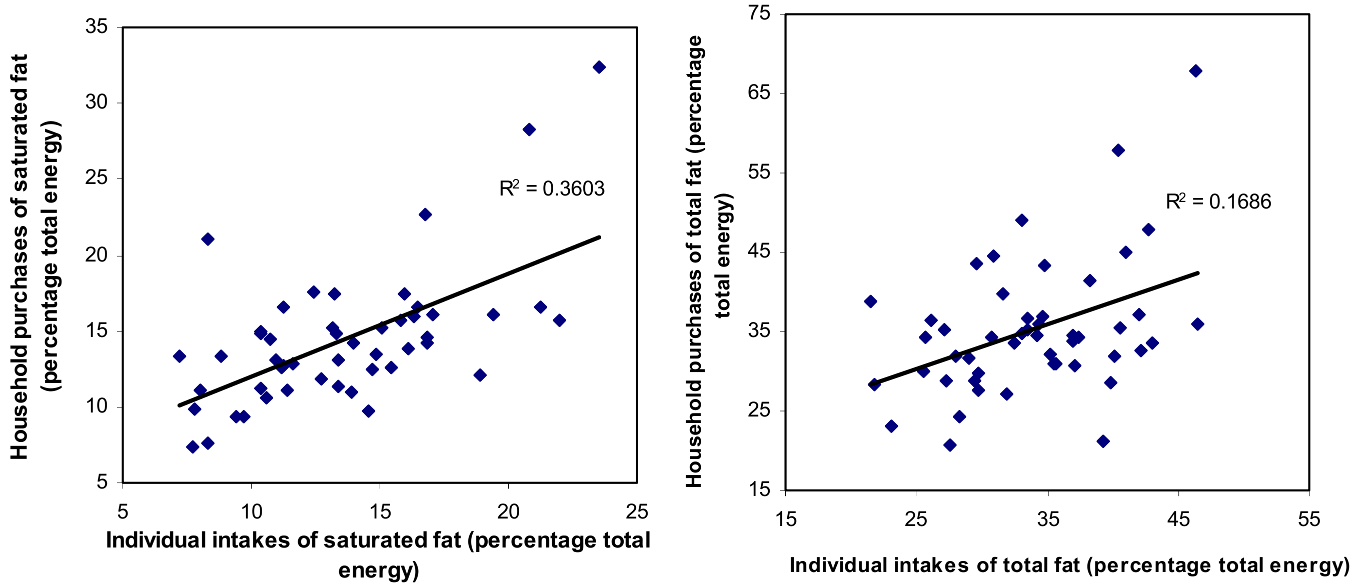

Figure. Purchases vs intakes of saturated and total fat for 49 sub-study participants in the Supermarket Healthy Options Trial.

and/or low levels of literacy. While the periods of assessment varied (3 months vs 4 random days), the percentage-based measurements chosen for analyses are comparatively less sensitive to differences in quantity than absolute measures.

However, the following limitations should be considered: analyses were somewhat limited by omission of a number of products from the supermarket food and nutrient database (including alcohol). Nevertheless, the supermarket database encompassed 65% of total sales expenditure (dollars spent on products in the database compared with all available food products) and 78% of sales volume (quantities purchased of products in the database compared with all available products), and thus covered most foods and beverages typically purchased. Future supermarket databases could also include alcohol (if found to be a top-selling item). A further limitation is that there were no data available regarding participant's use of the self-scanner. It is possible (especially for small supermarket shopping trips) that participants forgot/chose not to use the scanner every time they shopped, thus omitting some purchases from the analyses.

Also, different food composition databases were used to convert food purchases to nutrient purchases (5) and food intakes to nutrient intakes (17), respectively. The specially developed supermarket food and nutrient database was highly relevant for converting food purchases to nutrient purchases. However, the supermarket database could not be used to assess intake of nutrients because the 24-hour recalls collected foods and beverages purchased/obtained from outside the supermarket. Nevertheless, the use of two different food composition databases for analyses was likely to result in more conservative estimates of associations between nutrient purchases and intakes because the food composition database used to assess nutrient intakes was generic (17), and thus likely to be less precise. Lastly, the analyses were subject to common limitations of all food composition databases, including natural variability in the composition of foods, inaccuracies in the food composition data, and constant changes in the food supply (6,7,22).

The range of correlations between supermarket purchases and dietary intakes was likely the result of several factors: for energy density and sodium, poor correlations were expected due to the inclusion of tap water in the 24-hour diet recalls but not in the purchase data, and the fact that there is a greater daily variation in sodium (23) compared with other nutrient intakes, respectively (24,25). Variation in sodium intakes is commonly due to discretionary/table salt and manufactured foods (26). Also, the types and thus nutrient profiles of foods and beverages purchased at participating supermarkets differed compared to those purchased from other sources (additional data available on request). Further, the primary household shoppers who completed the diet recalls may have consumed a different diet compared with other household members, such as children and other adults who were also consuming supermarket food purchases (the New Zealand National Nutrition surveys for adults and children indicate that children (younger than 15 years of age) consume on average slightly more carbohydrate and less total fat and protein than adults (16 years and older) (27,28). Lastly, purchased foods and beverages are subject to waste and consumption by visitors from outside the household, which are factors that do not affect food and beverage intakes (29,30).

The agreement observed between household purchases and individual intakes for total fat (r=0.34; P<0.05) was similar to that reported by Ransley and colleagues in the United Kingdom (n=214; r=0.51) (31) and Nelson and colleagues in the United States (n=82; P>0.05 for mean difference) (29), despite the fact that these studies compared household purchases with household intakes. Similarly, in a Polish sample (n=1,215 households), total amounts of saturated fat, total fat, and protein were comparable between household purchases and intakes (mean difference; $P>0.05$), although amount of sodium was different ($P<0.05$) (32).

The findings of this research provide support for the use of supermarket sales data as a reasonable means of estimating the nutrient intake of individuals, particularly percentage of energy from saturated and total fat. Similar supermarket food and nutrient databases could be used in the future to evaluate interventions and public health programs, and to monitor food purchases more frequently at the national level. Further, food and nutrition practitioners could use individualized supermarket sales to educate patients regarding more healthful versions of less healthful supermarket foods usually purchased, as well as to collect more objective information regarding individual intakes. However, rather than a hand-held scanner, a specially developed card that could be scanned at any checkout may provide greater ease of use for participants and generalizability of this method to other countries. Further research to validate supermarket sales as a method of dietary assessment should include a greater number of participants and collect several dietary recalls/food records in order to assess usual intake of more variable nutrients such as sugar and energy density. Also, dietary intake of all household members should be assessed. Nevertheless, in the case of a supermarket intervention, an effect on household sales of percentage energy from saturated and total fat is likely to also impact the saturated and total fat intake of individual household members.

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