Assessing differences in self-reported dietary intake variables by weighed food records compared to weighed food records plus photos in post-menopausal women with healthy weight and with obesity

Avinash Pokala

The Ohio State University

Nutritional Sciences

April 15th, 2019

Thesis Committee Members:

Advisor: Tonya Orchard, PhD, MS, RD

Kellie Weinhold, MS, RD

Julie Kennel, PhD, MS, RD

Introduction/ Background

Insight into dietary intake and eating behavior is crucial to understanding many human diseases. Researchers need to have ways to accurately and reliably assess dietary intake in humans. There are many dietary assessment methods that researchers routinely use, but each one has its own benefits and drawbacks. The common forms of self-reported dietary assessment methods include: dietary records, twenty-four-hour recall, food frequency questionnaires (FFQs), diet history, and the weighed food record. These are the big general assessment methods, but there are variations of how each one is employed. Multiple methods are also often combined for increased accuracy.[1,2]

Dietary records involve recording foods and beverages as they are consumed, this allows for accurate estimation of dietary intake because each item is being recorded in real time.[3] This may lessen omission of food and allow for a more accurate description of food eaten compared to other methods. A disadvantage of this is that individuals are more aware of what they eat, leading to dietary changes.[4] For example, in a study investigating sugar intake a participant may become aware they ate copious sugary foods already and modify their diet based of that. This could lead to data that is not truly representative of the participant's usual intake. This outcome has also been used as a positive weight loss tool in some studies.[5] This point acknowledges that the type of dietary assessment methods used is very study specific. Participants need to be trained beforehand on the detail necessary to complete a dietary record, amount of food consumed, brand name, preparation method, and portion sizes. The two different ways dietary records are collected are open-ended and close ended forms. Typically, they are collected in open-ended forms, but there are also close ended forms. Close ended forms resemble FFQs, but whereas FFQs are designed to capture data on usual dietary intake over a longer period of time (e.g. months or years), dietary records are for daily recording.[6] The calculated underestimation of dietary intake variables of interest inherent to dietary records is around 4-37%.[3] Underestimation is thought to be prevalent throughout all studies, so dietary records are precise tools but are not very accurate. Furthermore, underestimation has been observed more strongly in individuals with high body mass, specifically women.[7]

Twenty four hour dietary recalls involve individuals being interviewed by a professional about all the foods and beverages they consumed in the past 24 hours. This type of dietary assessment is easier on the subject because the subject does not need to worry about recording food down on paper or a computer constantly throughout the day. This assessment relies a lot on a trained interviewer to properly probe the subject. Probing allows for the researcher to gather important information, such as how they cooked said food.[3] Twenty four-hour dietary recalls can also be used without an interviewer. One such instrument, independent of an interviewer, is the US. Department of Agriculture's Automated Multiple-Pass Method.[8] This method uses five passes (quick list, forgotten foods list, time and occasion, detail and review, and final review) to estimate dietary intake. [8] The main disadvantage of using this method involves participants cognitive memory of recalling all ingested products in the past 24-hours.[3] Underestimation is also prevalent in 24-hour recalls but at narrower range of 12-23%.[9]

Food frequency questionnaires (FFQs) require individuals to report how frequently they eat certain foods from a list for a given period of time.[10] FFQs are the most commonly used dietary assessment instrument in prospective cohort studies due to the practicality and low cost in administering them.[11] There are many different types of FFQ's adapted for different study designs or designed for specific population groups.[3] FFQ's are helpful for understanding long term diet patterns in many people, this data could help identify disease outcomes and other important questions. The main limitation for FFQs involve limited listing of food items on the form. This is why FFQs are most valuable when creating them for a specific study/population. An FFQ designed for one ethnic population would not work for a different ethnic population.[12]

Diet history also often known as the Burke diet history focuses on past dietary habits. The Burke diet history is quite comprehensive because it requires three elements: detailed interview about usual diet intake, food list asking for amount and frequency of food eaten, and a three-day dietary record.[3] The diet history is often compared to the FFQ because of the previous components but diet history is more thorough. Diet history can account for preparation methods. This would be helpful for a study model following how eating fried foods causes different disease outcomes. Diet history provides insight into general eating habits.[3]

The current gold standard of self-reported dietary assessment methods is a weighed food record.[13] When filled out properly, 24-hour weighed food records represent near ideal recording of food intake of a participant. They are the best at quantifying food intake because each food item's weight is recorded, and any waste (not eaten) is also recorded. Preparation and brand names are also recorded as to identify food intake more accurately.

Multiple dietary assessment methods can also be combined, increasing accuracy to record food intake among individuals.[14] Certain methods are more likely to be used among specific samples of the population as well. One study found that using dietary recall combined with photo records enhanced food record data in children aged 9-12 years old.[15] Photographic records are also employed within adult populations with intellectual and developmental disabilities and in rural populations.[16] Photographic records are helpful in these populations because it requires less motor/cognitive skills to take a photograph than providing detailed handwritten records.[16] Further, many studies combine FFQs and 24-hour recalls together.[11]

Making sure the dietary assessment method is accurate and reliable is important in capturing true dietary intake, but there is also a constant interplay between increasing accuracy and reliability versus decreasing participant burden within each dietary assessment method. Decreasing the burden on a participant without sacrificing accuracy and reliability of results increases the likelihood of participant compliance and may decrease the risk of under- and/or over-estimation of intake.[17] Research investigating the benefit of using photographic records in an older population is limited.

One often underreported value is added sugar intake, especially in obese individuals.[18] In today's society added sugar is an extremely important nutrient to examine. There are a lot of studies that link intake of added sugar to increased risk for various cancers, obesity, and metabolic syndrome.[19] However, due to the problems with self-reported dietary assessments, most of this research has been left inconclusive.[20] Research is needed to further elucidate how added sugar intake affects the human body.

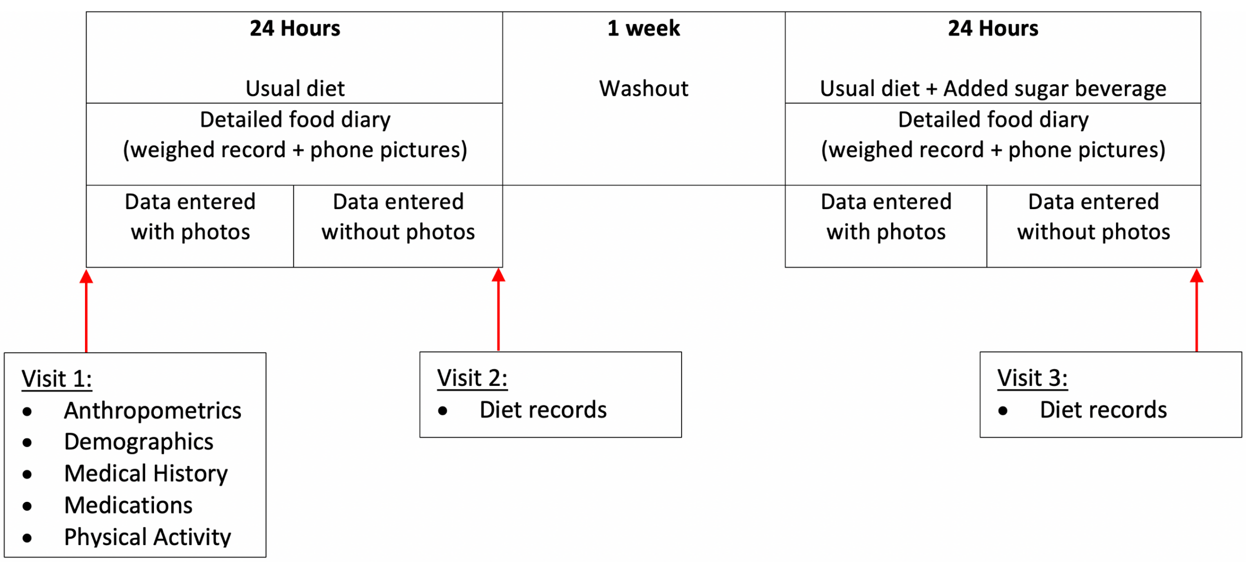
The purpose of this research project was to examine the potential benefit of adding photographic records of dietary intake to self-reported dietary intake obtained by a weighed food record, specifically in postmenopausal females with healthy weight and obesity. We explored whether or not having participants provide photos of their food intake along with their written weighed food records significantly changed estimation of intake. Weighed food records with the assistance of photographic records were also used to explore if they provided additional information on added sugars compared to weighed food records alone.

Methods

This project was part of a larger study examining relationships between dietary added sugar intake and sugars excreted in the urine, titled Added Sugar Biomarker Study (ASBS). Thirty healthy postmenopausal women were enrolled into ASBS; 15 with healthy weight (BMI 18.5-24.9 kg/m^2) and 15 with obesity (BMI $\geq$30 kg/m^2). The participants were recruited from ResearchMatch (researchmatch.org) and from printed fliers distributed around the OSU

Columbus campus. Interested individuals were screened over the phone. Participants were eligible if they were postmenopausal females (natural amenorrhea of at least 12 months) with BMI between 18.5-24.9 kg/m2 (healthy) or ≥30 kg/m2 (obese), possessed a mobile phone with camera capabilities, spoke English, and were able to provide written informed consent. Participants were excluded if they had a history of diabetes mellitus, prediabetes, renal disease, gastrointestinal disorders, or other conditions that might affect sucrose metabolism and excretion, and pregnant or nursing women. During the participants' first visit written informed consent was documented, anthropometric measurements (weight, height, BMI) were taken and various questionnaires (demographic, medical, lifestyle, and physical activity) were completed (illustrated in **Figure 1**).

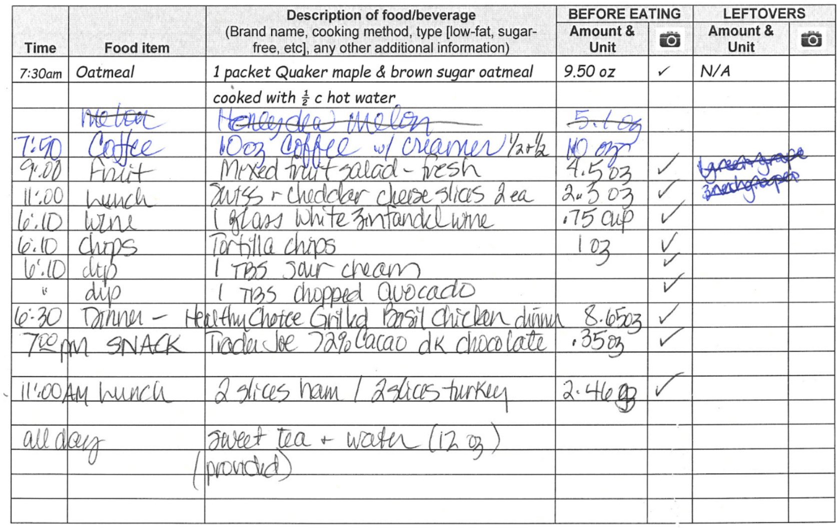
Figure 1: Study Design



Participants were instructed on how to complete a weighed food record and take photographic pictures of food intake. These women were asked to complete two 24-hour weighed food records with photos of foods and beverages captured before and after eating. The first 24-hour food record (Day 1) was of usual dietary intake; the second (Day 2) was usual intake plus one commercially produced 18.5 fl oz sweet tea in order to explore differences in urinary sucrose and fructose excretion with varying amounts of added sugar intake. Food records were completed 1-week apart. Twenty-four hour weighed food records and accompanying photographs from ASBS were used for the present project. The intake data were entered by two different members of the research team into the University of Minnesota's nutritional analysis software: Nutrient Data System for Research (NDSR). The first researcher entered food intake data using the weighed food record with the assistance of the photographic records. Two separate files were created for each participant, Day 1 food intake with photographic records and Day 2 food intake with photographic records. An example of how this worked is as follows: researcher first pulls participant's weighed food record (**Figure 2**) and starts by reading and inputting the first line of food into NDSR, the food item's name, weight, and amount are entered into NDSR. When inputting food data into NDSR, it asks questions, such as "fat free, low fat, low sodium, medium size, family size, with oil, without oil, etc" if this information was not provided on the weighed food record, the researcher would turn to the photographic record (**Figure 3**) of the meal. This would allow for a more accurate input of food data. The second researcher entered the same set of weighed food record's as the first researcher but did not have access to the photographic records. Two additional data files were created for each participant, Day 1 food intake *without* photographic records and Day 2 food intake *without* photographic records. The same process as above was used during this step, but if the researcher read the entry "one apple" the researcher would input "one medium apple". Another example, if the researcher read "Oreos" regular Oreos would be entered. This could result in inaccurate representation of intake data. Another example, if the researcher read "yogurt" the researcher entered a generic yogurt instead of a specific brand name. This could lead to significant nutrient profile differences. If details were not listed on the weighed food record, the researcher entered items with the classification as medium, regular fat, regular sodium, etc.

Figure 2: Sample photo record

Figure 3: Sample weighed food record



Time	Food item	Description of food/beverage (Brand name, cooking method, type [low-fat, sugar-free, etc], any other additional information)	BEFORE EATING Amount & Unit	BEFORE EATING 📷	LEFTOVERS Amount & Unit	LEFTOVERS 📷
7:30am	Oatmeal	1 packet Quaker maple & brown sugar oatmeal	9.50 oz	✓	N/A	
		cooked with ½ c hot water				
	~~melon~~	~~Honeydew melon~~	~~5.6 oz~~			
7:50	Coffee	10oz coffee w/ creamer ½ + ½	10 oz			
9:00	Fruit	Mixed fruit salad - fresh	4.5 oz	✓	[illegible]	
11:00	lunch	Swiss + cheddar cheese slices 2 ea	2.3 oz	✓		
6:10	wine	1 glass White Zinfandel wine	.75 cup	✓		
6:10	chips	Tortilla chips	1 oz	✓		
6:10	dip	1 TBS sour cream		✓		
"	dip	1 TBS chopped avocado		✓		
6:30	Dinner -	Healthy Choice Grilled Basil chicken dinner	8.65 oz	✓		
7:00pm	SNACK	Trader Joe 72% Cacao dk chocolate	.35 oz	✓		
11:00AM	lunch	2 slices ham / 2 slices turkey	2.46 oz	✓		
all day		sweet tea + water (12 oz) (provided)				

Once all four records were complete, Day 1 and Day 2 weighed food records with photographic records were compared against Day 1 and Day 2 weighed food records without photographic records. Descriptive statistics were completed, and t-tests were used to assess differences between record entry methods for energy (kcal), fat (g), carbohydrate (g), protein (g), fructose (g), sucrose (g), total sugars (g), added sugars (g), saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids (g), dietary fiber (g), linoleic acid (g), linolenic acid (g), and alpha-linolenic acid (g). Differences between record entry methods were also assessed within the two weight categories (women with healthy weight, women with obesity).

NDSR was used to compile total values for variables of interest on each day for each participant. This was done for both records with photos and records without photos. These totals were exported into excel and descriptive statistics and t-tests were used to evaluate differences between dietary assessment methods for nutrients of interest on day 1 and day 2 in all participants and by weight category.

Results

Demographic characteristics of the women in ASBS are described in **Table 1**. Women in this study had a mean(SD) age of 60.0(5.0) years. The vast majority (93%) were nonhispanic white and over 70% held postsecondary degrees.

Table 1: Baseline Demographic Characteristics collected from 30 post-menopausal women during visit one

	Mean (SD[a])
Age (years)	60.0 (5.0)
BMI (kg/m^2)	30.7 (8.4)
	N (% of total)
Race/Ethnicity:	
Nonhispanic black	2 (6.7)
Nonhispanic white	28 (93.3)
Education:	
Highschool Diploma, GED	1 (3.33)
Some College/ Associates Degree	8 (26.67)
Bachelor's degree	7 (23.33)
Advanced degree	14 (46.67)
Employment:	
Work > 40 hours a week	11(33.67)
Work < 40 hours a week	10 (33.33)
Homemaker	1 (3.33)
Retired	7 (23.33)
Unemployed	1 (3.33)

[a]SD=Standard deviation.

Differences between records with and without photos on study Day 1 for the whole cohort are described in **Table 2a**. Mean(SD) energy intake on day 1 was 1822(607) kcal for records alone, and 1615(489) kcal for records with photos. Mean(SD) added sugar intake on day 1 was 53.6(57.9)g for records alone, and 40.5(28.6)g for records with photos. No significant differences were found on Day 1 for dietary intake variables of interest between records with and without photos (all p>0.05).

Table 2a: Mean values of dietary intake variables gathered by weighed food records with the assistance of photos provided by 30 post-menopausal women compared to the same food records without the assistance of photos

	Records with Photos		Records Without Photos		
	Day 1[a]		Day 1[a]		
	Mean	SD[b]	Mean	SD[b]	P-Value[c]
Energy (kcal)	1615.51	489.19	1822.79	607.54	0.151
Total Fat (g)	65.05	32.99	71.76	38.46	0.471
Total Carbohydrate (g)	196.84	76.46	232.98	99.63	0.121
Total Protein (g)	69.44	27.30	73.25	33.45	0.631
Fructose (g)	17.03	10.81	18.33	13.02	0.674
Sucrose (g)	33.15	22.24	47.39	55.60	0.200
Total Sugars (g)	78.92	38.26	93.59	59.10	0.259
Added Sugars (by Carb (g)	40.54	28.69	53.66	57.91	0.273
%kcal fat	35.57	11.72	36.76	11.49	0.853
%kcal carb	49.65	13.50	49.94	12.16	0.597
%kcal protein	17.02	3.87	15.13	5.00	0.374
%kcal added sugars	10.40	7.35	19.45	6.79	0.676

[a]Day 1= study visit 2 (usual intake)
[b]SD= standard deviation.
[c] P-value= T-tests compared means between records with and without photos.

Differences between records with and without photos on study Day 2 for the whole cohort are described in **Table 2b**. Mean(SD) energy intake on day 2 was 1856(597) kcal for records alone, and 1798(476) kcal for records with photos. Mean(SD) added sugar intake on day 2 was 90.5(46.1)g for records alone, and 87.2(42.7)g for records with photos. No significant differences were found on Day 2 for dietary intake variables of interest between records with and without photos (all $p>0.05$).

Table 2b: Mean values of dietary intake variables gathered by weighed food records with the assistance of photos provided by 30 post-menopausal women compared to the same food records without the assistance of photos

	Records with Photos		Records Without Photos		
	Day 2[a]		Day 2[a]		
	Mean	SD[b]	Mean	SD[b]	P-Value[c]
Energy (kcal)	1798.04	476.97	1856.65	597.84	0.676
Total Fat (g)	74.01	32.41	73.39	34.38	0.944
Total Carbohydrate (g)	226.13	87.20	237.03	103.68	0.661
Total Protein (g)	65.38	20.77	71.05	21.67	0.306
Fructose (g)	13.18	13.73	12.41	10.77	0.810
Sucrose (g)	78.40	40.30	86.23	37.63	0.440
Total Sugars (g)	118.45	53.38	124.32	51.10	0.665
Added Sugars (by Carb (g)	87.27	42.79	90.05	46.08	0.711
%kcal fat	34.98	12.77	35.10	11.02	0.570
%kcal carb	51.65	15.50	50.60	10.93	0.826
%kcal protein	16.10	4.02	16.09	5.26	0.471
%kcal added sugars	11.35	9.82	19.65	7.33	0.912

[a]Day 2= study visit 3 (woman consumed usual intake plus one commercially produced 18.5 fl oz sweet tea).
[b]SD= standard deviation.
[c] P-value= T-tests compared means between records with and without photos.

Differences between records with and without photos on study Day 1 for both women with healthy weight and women with obesity are described in **Table 3a**. Among women with healthy weight, mean(SD) energy intake on day 1 was 1662(313) kcal for records alone, and 1566(400) kcal for records with photos. Mean(SD) added sugar intake on day 1 was 50.5(36.7)g for records alone, and 42.6(26.7)g for records with photos. Among women with obesity, mean(SD) energy intake on day 1 was 1883(781) kcal for records alone, and 1664(574) kcal for records with photos. Mean(SD) added sugar intake on day 2 was 56.7(74.6)g for records alone, and 38.4(31.3)g for records with photos. No significant differences were found among women with healthy weight or women with obesity on Day 1 for dietary intake variables of interest estimated by records with and without photos (all p>0.05).

Table 3a: Mean values of dietary intake variables gathered by weighed food records with the assistance of photos provided by 30 post-menopausal women vs the same food records without the assistance of photos separated by weight categories for day 1 intake

	Lean Women[a]		Lean Women[a]			Obese Women[b]		Obese Women[b]		
	Day 1[c]		Day 1[c]			Day 1[c]		Day 1[c]		
	Records With Photos		Records Without Photos			Records With Photos		Records Without Photos		
	Mean	SD[d]	Mean	SD[d]	P-Value[e]	Mean	SD[d]	Mean	SD[d]	P-Value[e]
Energy (kcal)	1566.83	400.19	1927.15	477.93	0.474	1664.18	574.87	1668.92	455.09	0.213
Total Fat (g)	61.18	33.26	83.89	36.10	0.967	68.91	33.40	64.12	25.77	0.328
Total Carbohydrate (g)	201.01	61.00	234.88	72.06	0.320	192.68	91.39	217.38	101.95	0.243
Total Protein (g)	62.19	26.13	65.35	21.32	0.894	76.68	27.36	65.42	20.95	0.489
Fructose (g)	16.33	8.96	10.21	8.71	0.510	17.72	12.68	16.14	17.19	0.930
Sucrose (g)	33.58	21.26	82.46	49.33	0.555	32.73	23.92	74.34	29.94	0.267
Total Sugars (g)	79.15	27.69	118.79	48.12	0.521	78.69	47.59	118.11	59.89	0.363
Added Sugars (by Carb (g)	42.62	26.69	88.17	50.18	0.503	38.47	31.37	86.37	35.66	0.390
%kcal fat	34.25	10.60	38.47	10.15	0.810	36.89	12.98	35.05	12.82	0.968
%kcal carb	52.59	12.41	48.70	9.25	0.644	46.71	14.32	51.19	14.75	0.757
%kcal protein	15.54	4.11	14.16	4.74	0.499	18.50	3.09	16.09	5.23	0.513
%kcal added sugars	11.78	7.93	18.23	7.58	0.825	9.03	6.70	20.67	5.89	0.704

[a]Women with healthy weight= BMI 18.5-24.9 kg/m^2. n=15
[b]Women with obesity= BMI ≥30 kg/m^2. n=15
[c]Day 1= study visit 2 (usual intake).
[d]SD= standard deviation.
[e]T-test comparing means between records with and without photos

Differences between records with and without photos on study Day 2 for both women with healthy weight and women with obesity are described in **Table 3b**. Among women with healthy weight, mean(SD) energy intake on day 2 was 1882(473) kcal for records alone, and 1927(477) kcal for records with photos. Mean(SD) added sugar intake on day 1 was 87.5(51.7)g for records alone, and 88.1(50.1)g for records with photos. Among women with obesity, mean(SD) energy intake on day 2 was 1830(717) kcal for records alone, and 1668(455) kcal for records with photos. Mean(SD) added sugar intake on day 2 was 92.3(41.3)g for records alone, and 86.3(35.6)g for records with photos. No significant differences were found among women with healthy weight or women with obesity on Day 2 for dietary intake variables of interest between records with and without photos (all p>0.05).

Table 3b: Mean values of dietary intake variables gathered by weighed food records with the assistance of photos provided by 30 post-menopausal women vs the same food records without the assistance of photos separated by weight categories for day 2 intake

	Lean Women[a]		Lean Women[a]			Obese Women[b]		Obese Women[b]		
	Day 2[c]		Day 2[c]			Day 2[c]		Day 2[c]		
	Records With Photos		Records Without Photos			Records With Photos		Records Without Photos		
	Mean	SD[d]	Mean	SD[d]	P-Value[e]	Mean	SD[d]	Mean	SD[d]	P-Value[e]
Energy (kcal)	1662.05	313.20	1882.72	473.16	0.799	1983.53	781.74	1830.58	717.64	0.468
Total Fat (g)	61.64	27.68	80.16	36.44	0.780	81.87	45.58	66.63	31.99	0.815
Total Carbohydrate (g)	226.68	76.99	230.60	67.79	0.863	239.27	120.61	243.46	132.60	0.551
Total Protein (g)	61.05	20.16	67.19	19.93	0.808	85.45	39.90	74.91	23.31	0.251
Fructose (g)	18.48	8.60	9.35	5.28	0.746	18.19	16.64	15.48	13.86	0.906
Sucrose (g)	39.46	31.86	88.70	45.26	0.720	55.32	72.48	83.76	29.53	0.393
Total Sugars (g)	87.27	39.57	121.01	45.65	0.897	99.90	74.73	127.63	57.46	0.660
Added Sugars (by Carb (g)	50.58	36.79	87.75	51.70	0.982	56.74	74.65	92.35	41.39	0.546
%kcal fat	33.28	11.30	37.25	10.34	0.745	36.68	14.29	32.96	11.61	0.643
%kcal carb	54.76	13.11	49.09	8.82	0.904	48.53	17.46	52.11	12.83	0.856
%kcal protein	14.61	3.24	15.02	5.25	0.641	17.60	4.27	17.16	5.23	0.581
%kcal added sugars	12.30	7.38	18.53	7.14	0.912	10.39	11.98	20.78	7.59	0.967

[a]Women with healthy weight= BMI 18.5-24.9 kg/m^2.
[b]Women with obesity= BMI ≥30 kg/m^2.
[c]Day 2= Study visit 3 (women consumed usual intake plus one commercially produced 18.5 fl oz sweet tea).
[d]SD= standard deviation.
[e]T-test comparing means between records with and without photos

Overall, weighed food records alone tended to show greater intake for all of the above variables than food records with photos. However, there were no significant differences (all p>0.05) between record entry methods for any of the dietary variables of interest. The same nonsignificant trend was found when looking at differences in record entry method within weight categories (women with healthy weight, women with obesity).

Discussion

Although there was no statistically significant difference between estimates of nutrient intake from records with photos and records without photos, the mean of most nutrients of interest in records without photos were higher than records with photos. This trend remained when examining differences in record method within weight categories, with the exception of Day 2 among women with obesity. In this case, some dietary intake variables (energy, total fat, total protein, fructose) from records without photos were lower than records with photos, but variables related to sugar intake (total sugar, added sugar, sucrose) were actually higher from records without photos than records with photos. When looking back at the records with photos many women ate low fat foods, small sized fruits, and low-calorie foods. If these descriptions were not recorded on the weighed food record they were revealed by the photographic records. When the records without photos were being input these details were not known so they were not recorded, perhaps leading to higher estimation of food intake. The reason for this was because if the participant wrote Cheese-its, for example, on their weighed food record, the default action of the researcher would be to enter it as regular/original Cheese-its if photos were not included to provide this additional information.

There were large differences between some means (207 kcal difference for energy intake on day 1) but no statistically significant differences; reasons for this could be due to small sample size and high standard deviation. High standard deviation may have resulted from the reliability within the measurement tool (records with photos/ records without photos). In order to further strengthen the results of this study the reliability of the measurement tools should be tested. One method to do this would be to have more than one researcher completely enter the food records into NDSR. This should be done for both records with photos and records without photos. This would provide more than one set of means for each nutrient of interest for both record types. If the nutrients of interest values are similar between sets of the same record type, then the results of this study would be stronger. Another reason for these differences could result from the NDSR database not having the food item listed on the weighed food record. If this was the case each researcher made their best judgment call to match the nutrient profile of the participant's eaten food item. We had hypothesized, using photo records would result in higher estimation of energy intake than without photo records in obese women. This hypothesis was based on previous studies showing that obese women tend to underreport food intake.[3] The photo records would have provided more information and therefore less room for underreporting. We in fact saw the opposite. This is unlike other studies, for example the EPIC-Norfolk study showed that when comparing self-reported added sugar intake vs actual sugar intake using an objective sucrose and fructose biomarker, the obese participants underreported.[20] Although it is fair to mention that the study design and study population of the EPIC study and this study were different. The EPIC study followed 77,630 men and women aged 39-79 for seven days of dietary intake, whereas the added sugar biomarker study (ASBS) only followed 30 women for 2 days of dietary intake. The small sample size would have minimized the power to detect statistical significance. This discrepancy could also result from the women in the ASBS being older. The majority of women in ASBS have advanced degrees, generally this group of people have a higher socioeconomic status (SES) and individuals with high SES tend to report dietary intake data more accurately.[22] The weighed food record is the gold standard of dietary intake. Since the participants completed the gold standard it is fair to assume dietary intake was already being recorded with high accuracy. Along with using the gold standard of measurement, this study also had a registered dietitian go over the weighed food records with participants before data entry of the record. The registered dietitian asked follow up questions about recipes, handwriting issues, and leftover portions. These follow up questions may have played a role in negating large differences between weighed food records alone and weighed food records plus photographic records. If we used a less rigorous dietary assessment method and compared if photographic evidence provided a statistical difference, there probably would be bigger differences. If we asked participants to provide more than two days of dietary intake, we might also see larger differences.

Overall, we found that there were no significant differences between records with photos and records without photos. This suggests that there may not be any added benefit to asking participants in research studies to capture photos of everything they eat and drink, in addition to the demands of a 24-hour weighed food record. This is beneficial to know, because not asking participants to provide photographic evidence decreases participant burden. This is important because decreasing burden generally increases compliance.[21] Although, there are still other potentially beneficial uses for having participants provide photo records of their food, such as, do consumers purchase "fat free" products more than regular products. In our study we noted that using photos helped the researcher identify information that would otherwise be missed. Future research should compare photographic records alone to written, weighed records alone to explore the potential utility and benefit of photographic dietary records. Quickly snapping a photo has the potential to drastically decrease participant burden compared to writing/tracking dietary intake on a piece of paper. Many adults have access to mobile phones with advanced technology that can provide high quality photos. These photos have the potential to help researchers quickly input data without having to decipher participants handwriting. Having a better way to assess dietary intake can benefit research studies that focus on the health and wellbeing of individuals everywhere.

It is important to note that statistical significance is not the be-all and end-all benchmark of significance. Clinical significance is also important to consider when dealing with health-related research.[23] For example, in this study we saw that on day one records with photos estimated %kcal of added sugar intake to be 10.40% and records without photos estimated 19.45%. Currently, the recommended daily allowance for added sugars are 10% of daily caloric intake.[24] The first method estimates this to be right at that intake guideline, but the second method estimates added sugar intake to be twice as high than the recommended value. This is important because using one method over the other could significantly alter how researchers interpret their data. One set of data is telling researchers that the participants are following the guideline and one set of data is telling researchers that the participants are eating too much added sugar.

Conclusion.

Results of this study suggest that among healthy postmenopausal women, there is no added benefit to photographic food records along with written weighed food records. Additional research is required to further validate these findings.

References

[1] Illner AK, Harttig U, Tognon G, et al.: Feasibility of innovative dietary assessment in epidemiological studies using the approach of combining different assessment instruments. *Public Health Nutr*. 2011; 14(6): 1055–63.

[2] Natarajan L, Rock CL, Major JM, Thomson CA, Caan BJ, Flatt SW, Chilton JA, Hollenbach KA, Newman VA, Faerber S, Ritenbaugh CK, Gold E, Stefanick ML, Jones LA, Marshall JR, Pierce JP. On the importance of using multiple methods of dietary assessment. *Epidemiology*. 2004 Nov;15(6):738-45.

[3] A.F. Subar, V. Kipnis, R.P. Troiano, D. Midthune, D.A. Schoeller, S. Bingham, et al., Using intake biomarkers to evaluate the extent of dietary misreporting in a large sample of adults: the OPEN study, *Am. J. Epidemiol*. 158 (2003) 1-13.

[4] S.M. Rebro, R.E. Patterson, A.R. Kristal, C.L. Cheney, The effect of keeping food records on eating patterns, *J. Am. Diet. Assoc*. 98 (1998) 1163-1165.

[5] Bray, G. A., Heisel, W. E., Afshin, A., Jensen, M. D., Dietz, W. H., Long, M., … Inge, T. H. (2018). The Science of Obesity Management: An Endocrine Society Scientific Statement. *Endocrine reviews*, 39(2), 79–132.

[6] M.J. Kretsch, A.K. Fong, Validity and reproducibility of a new computerized dietary assessment method: effects of gender and educational level, *Nutr. Res*. 13 (1993) 133-146.

[7] D.L. Taren, M. Tobar, A. Hill, W. Howell, C. Shisslak, I. Bell, et al., The association of energy intake bias with psychological scores of women, Eur. J. *Clin. Nutr*. 53 (1999) 570-578.

[8] Raper, N., Perloff, B., Ingwersen, L., Steinfeldt, L., & Anand, J. (2004). An overview of USDA's Dietary Intake Data System. *Subtropical plant science, 17*, 545.

[9] A.J. Moshfegh, D.G. Rhodes, D.J. Baer, T. Murayi, J.C. Clemens, W.V. Rumpler, et al., The U.S. Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes, Am. J. *Clin. Nutr*. 88 (2008) 324-332.

[10] S.N. Zulkifli, S.M. Yu, The food frequency method for dietary assessment, J. Am. Diet. *Assoc*. 92 (1992) 681-685.

[11] Carroll RJ, Midthune D, Subar AF, et al.: Taking advantage of the strengths of 2 different dietary assessment instruments to improve intake estimates for nutritional epidemiology. *Am J Epidemiol*. 2012; 175(4): 340–7.

[12] G. Block, P. Wakimoto, C. Jensen, S. Mandel, R.R. Green, Validation of a food frequency questionnaire for Hispanics, Prev. *Chronic*. Dis. 3 (2006) A77.

[13] Carlsen, M. H., Lillegaard, I. T., Karlsen, A., Blomhoff, R., Drevon, C. A., & Andersen, L. F. (2010). Evaluation of energy and dietary intake estimates from a food frequency

questionnaire using independent energy expenditure measurement and weighed food records. *Nutrition journal*, 9, 37. doi:10.1186/1475-2891-9-37

[14] L.A. Lytle, M.Z. Nichaman, E. Obarzanek, E. Glovsky, D. Montgomery, T. Nicklas, et al., Validation of 24-hour recalls assisted by food records in third-grade children: the CATCH Collaborative Group, *J. Am. Diet. Assoc*. 93 (1993) 1431-1436.

[15] Davison, Brittany K., Robin Quigg, and Paula M. L. Skidmore. "Pilot Testing a Photo-Based Food Diary in Nine- to Twelve-Year Old- Children from Dunedin, New Zealand." *Nutrients* 10.2 (2018): 240.

[16] Ptomey, Lauren T. et al. "Photo-Assisted Recall Increases Estimates of Energy and Macronutrient Intake in Adults with Intellectual and Developmental Disabilities." *Journal of the Academy of Nutrition and Dietetics* 113.12 (2013): 10.1016.

[17] Spears, K.E., Himler, H.l. Advantages and Disadvantages of an Automated Weighed Intake Dietary Assessment Tool Requiring Minimal Participant Burden for Use at Congregate Meal Sites. *Journal of the Academy of Nutrition & Dietetics*, 2013;113(1), 31-34

[18] Lineback DR, Jones JM. Sugars and Health Workshop: summary and conclusions. *Am J Clin Nutr*. 2003 Oct;78(4):893S-897S.

[19] Card MM, Abela JF. Just a Spoonful of Sugar Will Land You Six Feet Underground: Should the Food and Drug Administration Revoke Added Sugar's GRAS Status? *Food Drug Law J*. 2015;70(3):395-408

[20] Kuhnle, G. G., Tasevska, N., Lentjes, M. A., Griffin, J. L., Sims, M. A., Richardson, L., Khaw, K. T. (2015). Association between sucrose intake and risk of overweight and obesity in a prospective sub-cohort of the European Prospective Investigation into Cancer in Norfolk (EPIC-Norfolk). *Public health nutrition*, *18*(15), 2815–2824.

[21] K.A. Balter, O. Balter, E. Fondell, Y.T. Lagerros, Web-based and mailed questionnaires: a comparison of response rates and compliance, *Epidemiology* 16 (2005) 577-579.

[22] D.D. Stallone, E.J. Brunner, S.A. Bingham, M.G. Marmot, Dietary assessment in Whitehall II: the influence of reporting bias on apparent socioeconomic variation in nutrient intakes, *Eur. J. Clin. Nutr*. 51 (1997) 815-825.

[23] Page P. (2014). Beyond statistical significance: clinical interpretation of rehabilitation research literature. *International journal of sports physical therapy*, 9(5), 726–736.

[24] World Health Organization. World Health Organization. Guidelines: sugars intake for adults and children. http://www.who.int/nutrition/publications/guidlines/sugars_intake/en/. Published 2015