2011-01-01

Comparison Of Four Methods Of Dietary Assessment: Food Records Vs. Combined Food Records With Digital Photography

Sara Lynne Peidle
University of Texas at El Paso, slpeidle@yahoo.com

COMPARISON OF FOUR METHODS OF DIETARY ASSESSMENT: FOOD RECORDS VS. COMBINED FOOD RECORDS WITH DIGITAL PHOTOGRAPHY VS. DIGITAL PHOTOGRAPHY VS. DIGITIAL PHOTOGRAPHY WITH LIMITED DOCUMENTATION

SARA PEIDLE

Department of Kinesiology

APPROVED:

George A. King, PhD., Chair

Joe Tomaka, PhD.

Sandor Dorgo, PhD.

Rebecca Reed-Jones, PhD.

Benjamin C. Flores, PhD.
Acting Dean of the Graduate School

COMPARISON OF FOUR METHODS OF DIETARY ASSESSMENT: FOOD RECORDS VS.

COMBINED FOOD RECORDS WITH DIGITAL PHOTOGRAPHY

VS. DIGITAL PHOTOGRAPHY VS. DIGITIAL

PHOTOGRAPHY WITH LIMITED

DOCUMENTATION

by

SARA PEIDLE, RD, LD

THESIS

Presented to the Faculty of the Graduate School of

The University of Texas at El Paso

in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

Department of Kinesiology

THE UNIVERSITY OF TEXAS AT EL PASO

August 2011

Abstract

Methods for collecting dietary intakes of free-living individuals have been studied over the past century and there are many limitations. Collection of dietary intakes from individuals is best done in food diary format and researchers have investigated both written and photographic records. The purpose of this study was to add to the body of literature on studies of collecting dietary intakes by comparing written food records (FR), digital food records (DP), written and digital food records combined (FRDP), and digital food records with limited documentation (DPR) to one another and to a known, criterion value. This study included 50 Registered Dietitians (RD) who analyzed four meal sets each set comprised of three meals for calories, macronutrients and fiber. Means for each group of dietitians were compared between subjects to analyze differences between methods. Relative error was the difference of the known value (the weighed record) from the estimated value for calories and macronutrients and absolute error was defined as the mathematical absolute value of the relative error. Relative error was calculated and used to detect bias between methods and absolute error was used to determine accuracy of the methods. The results showed statistically significant differences between the FR and DP groups for carbohydrate and between the FR and DPR groups for fiber. For relative error the only statistically significant value was for the FR method, and for absolute error the only significant difference was for the FR method for protein. The findings of this study suggest that the use of digital photograph records is a viable option for collecting dietary intakes from free-living individuals.

Keywords: dietary analysis, food record, photograph, weighed record

Table of Contents

List of Tables

Page

Introduction

Dietary assessment of free-living individuals is of questionable accuracy, usually because of under- or over-reporting of intakes (Bingham, 1987). This has led to extensive research since the early part of the 20^{th} century on improving methods to increase the validity of dietary self-reports (Bingham, 1987). Tools such as the 24-hour recall and 3- and 7-day food journals measure specific food consumption of an individual over a period of time while food frequency questionnaires measure habitual food intake of populations (Bingham, 1987). Detailed 3- and 7-day food records are tools used for measuring individual dietary intake by registered dietitians (RD) and, despite limitations, have been reported to be the most valid in terms of free-living individuals (Schoeller, 1995).

One reason for decreased accuracy of dietary intake is underreporting of food consumption either by underestimating portion sizes, omitting foods at a meal, or omitting foods eaten between meals. Underreporting is speculated to be multifactorial with many researchers finding that obese participants are more likely to underreport energy intake than lean participants (Heitmann & Lissner, 1995). Participants often report that detailed food records of three days or more are burdensome leading researchers to believe that this decreases compliance and contributes to errors such as: underreporting intake, inaccurate or absence of measured portions and inadequate descriptions of food in self-reports (Macdiarmid & Blundell, 1997). Researchers interested in the collection of dietary intake of free-living individuals have seen a need for increasing compliance and accuracy of detailed food records while decreasing the burden on participants (Macdiarmid & Blundell, 1997).

Photography has been used to increase the accuracy of detailed food records (Bird & Elwood, 1983; Elwood & Bird, 1983; Kaczkowski, Jones, Feng, Bayley, 2000; Wang,

Kogashewa, Ohta, & Kira, 2002; Wang, Kogashiwa, Kira, 2006; Williamson, Allen, Martin, Alfonso, Gerald, Hunt, 2003; Yon, Johnson, Harvey-Berino, Gold, 2006). Advancements in technology have made photographing and tracking food more convenient. Some research suggests that the use of digital photography combined with food records increases validity and reliability of self-reported intakes (Wang et al., 2002; Wang et al., 2006; Williamson et al., 2003). One study reported problems with the use of technology, a personal digital assistant (PDA), for collecting food intake data of overweight and obese participants and reported no improvement in the validity of food records (Yon et al., 2006). This finding suggests that there are possible limitations to the use of technology, especially with overweight and obese populations. A study by Wang et al. (2006) investigated the validity of a one day weighted food record versus a digital photo and found that the use of digital photography alone led to increased reliability when compared to food records alone. This study had *one* registered dietitian analyze 28 food records, weighed and photographed in addition to a 24-hour recall. This study however did not compare inter-dietitian differences in and accuracy of food records (Wang et al., 2006).

Registered Dietitians find it difficult to assess an individual's intake with food records alone as many people have limited knowledge of portion sizes and have trouble keeping detailed food records (Schwartz & Byrd-Bredbenner, 2006). From the current literature, it is unclear if digital photography alone compared to digital photography combined with food records provides enough information to accurately assess an individual's intake; warranting further studies in this area. Therefore, the purpose of this study was to compare the use of digital photography alone, digital photography combined with food records, digital photography with limited documentation, and food records alone using a large sample size of Registered Dietitians. The project had one specific aim: To compare the validity of four different assessment tools for

nutrient composition when analyzed by Registered Dietitians; specifically the use of 1) digital photography alone, 2) digital photography combined with food records, 3) food records alone and 4) digital photography with limited documentation of ambiguous or difficult to identify items (i.e. diet dressing, melted butter, etc). Weighed food records for each meal were the criterion measurement method.

This study was focused on the ability of Registered Dietitians to accurately estimate the nutrient composition of meals when dietary records are provided in four different forms: digital photography alone, digital photography with limited documentation, digital photography combined with food records, and food records alone. This investigation involved the assessment of dietary records created by the investigator and analyzed by a group of dietitians. The meal records were of known nutrient composition and content. To assess the accurate estimation of meal composition by Registered Dietitians, the dietary record values returned by each dietitian were compared to the known values for the meal.

It was hypothesized that the digital photography combined with food records would have the greatest validity of the nutrient composition of each meal assessed. The digital photography only and the digital photography with limited documentation groups should be very close in accuracy to the combined group while the group given food records alone will have the least accurate food intake measurements. In a review by Bingham, (1987) it was concluded that 10% average error in measurement intake is acceptable and this study aims to fall within this percentage.

Methods

Study Design

This study was designed as a split plot, hierarchal analysis of four meal Sets each comprised of 3 meals analyzed by 4 different groups of Registered Dietitians for calories, grams of fat, grams of carbohydrate, grams of protein and grams of fiber. Each meal record was nested within a Set so that each record Set contained three different meals. This design was chosen to control for variation between the meals and to ensure that all 12 meals were analyzed in all four analysis methods. Dietitians were recruited form all five regions of the United States (Northeast, Southeast, Midwest, Southwest, and West) to participate in this study. The study protocol was approved by the Institutional Review Board of the University of Texas at El Paso (UTEP).

Participants

Registered Dietitians were identified and contacted for a request to participate in the study via email listings provided by the American Dietetic Association (ADA) to state affiliate Presidents within the United States and to Dietetic Practice Groups (DPG) within ADA. Each state or district ADA chapter president and DPG chair that was contacted and willing to participate sent out an email request on behalf of the researcher asking for study participants. It is not anticipated that this selection bias (ADA membership) affected the generalizability of results to all Registered Dietitians. Inclusion criteria were Registered Dietitian with a minimum of one-year experience actively working in the field and a member of ADA. Exclusion criteria were retired status for greater than two years, not actively working in the field for greater than 2 years, or non-ADA member.

Study Protocol

The purpose of this study was to evaluate the validity of non-weighed food records supplemented with digital photography (FRDP) compared to a food record alone (FR), digital photography alone (DP), and digital photography with limited documentation (DPR) of ambiguous or difficult to identify items (i.e. diet dressing, melted butter, etc) when compared to a weighed record of known value. This study began by randomly assigning a group of Registered Dietitians each to one of four groups: A, B, C or D. In this design, each group received a total of twelve dietary records, three dietary records in each of the four assessment forms (i.e. FRDP, FR, DP, DPR). Each group of three records comprised one food record Set.

To control for an order effect, the four assessment methods were provided to each group in a counter-balanced order with each assessment method including three meals in one of the four methods so that no RD saw the same meal more than once (Table 1). For each meal, the researcher created a dietary record for each of the four assessment methods. Each dietitian saw each of the twelve meal records but never the same record in more than one assessment method.

Table 1: Dietary Record Distribution Order Chart

Group	Dietary Record Distribution Order			
	1st Dietary Record Set	2nd Dietary Record Set	3rd Dietary Record Set	4th Dietary Record Set
A	FR	FRDP	DPR	DP
B	FRDP	DP	FR	DPR
C	DP	DPR	FRDP	FR
D	DPR	FR	DP	FRDP

FR=food record alone, DP=Digital photograph alone, FRDP=food record with digital photograph, DPR=Digital Photograph with limited recording

Each meal was created by the researcher, contained different food items, and was of known nutrient composition using the weighted record procedure (Bingham et al., 1994). Similarly, for each meal, the exact portion of each food item was weighed using a 1015WH Salter 7lb capacity digital scale to create the criterion weighed food record. Each individual dietitian was asked to determine the nutrient composition of each meal using the database supplied by www.fitday.com and a general username and password. Each dietitian returned the nutrient composition data and coding information for the three different meals given in each of the four assessment forms to the researcher. These assessments were compared to the known nutrient composition of the weighed record for accuracy of each dietitian's ability to assess the meal composition.

Outcome Measures

A priori power analysis (GPOWER, Company, State) using means and standard deviations from Elwood and Bird (1983), which compared weighed records to journals supplemented with photography, was calculated to determine sample size. A two-tailed test with an alpha error probability of 0.05 and 80% power yielded an effect size of 0.489 or a difference of approximately 150 calories with a sample size of 50 RD's (Table 2). A medium effect size is warranted due to the nature of the study in that there should be a clinically significant difference between methods which would yield long-term consequences if used in population settings (i.e. 150 calories over 7 days yields 1050 calories per week, 54,600 calories over one year with a potential 15 lb difference in participant weight). To account for an anticipated 10% attrition, the target sample size was 60 total dietitians (N = 15 per group). The final achieved sample size for the study was N = 50.

Table 2: Power Analysis for Sample Size

Tails	2
Effect size	0.489
Alpha error probability	0.05
Power	0.8
Calorie difference between methods	150
Estimated sample size	50
Target sample size	60

Food record. A written record that established foods and beverages consumed during a given time interval. Information that was included: Meal record number, food(s) consumed, and amounts of food and beverages consumed (by household measures). The record was in typical detail using household measures to estimate portion sizes. General information about food preparation (cooking methods, casserole ingredients, etc.) and any brand names was identified.

Digital photography. Photographs of meals/snacks and beverages were taken before consumption with a digital camera at approximately a 45 degree angle. Photographs were taken in a well-lit area with all foods presented as best as possible (i.e. burgers open face with condiments applied, wrappers included, etc.). An after photograph was taken as well showing any food that was not consumed.

Food records with digital photography. A written record supplemented with digital photographs as described above.

Digital Photography with limited documentation: The digital photography was done as stated above and included a written statement identifying ambiguous or difficult to identify items (i.e. diet dressing, melted butter, etc).

Energy and Macronutrients: Each meal was analyzed for total calories, grams of protein, grams of carbohydrate, grams of fat, and grams of fiber.

Nutrient Database: All meals were analyzed using the database at Fitday.com. In addition, each dietitian submitted the codes that they used for all foods analyzed by the database.

Procedures

Registered dietitians were contacted via email listings from ADA membership lists by state and/or district presidents within individual states of the United States and were told about the study and asked if they were willing to participate**.** Emails were sent to all members of each participating district within a state and those who responded wanting to participate and who met the inclusion criteria were enrolled in the study. When a dietitian expressed interest in participating in the study the informed consent and an initial survey were emailed to them. Once the informed consent and survey were returned completed, each dietitian was randomly placed into one of four groups (A, B, C, D). A total of 12 meals were meticulously prepared and recorded by the researcher. Each meal was documented in each of the four assessment forms (FR, DP, FRDP, DPR) and in the weighed record form for researcher validation. Dietitians received the meal records via email and were asked to return the meal composition data and records within approximately one week. The accuracy of each dietitian in determining the nutrient composition of each meal was validated against the known composition (weighed record) and tested for accuracy between the four conditions. Meal composition included total calories, grams of protein, grams of fat, grams of carbohydrate, and grams of fiber.

Meal records were sent in sets of three meals on four separate occasions. No dietitian saw the same meal twice and each record was assessed in all four assessment methods (i.e. Group A may only have seen a meal record in DP where as group B only in FR, etc.) for calories, grams of fat, grams of protein, grams of carbohydrate, and grams of fiber (Table 1).

Data Analysis

Meal composition for total calories, grams of fat, grams of protein, grams of carbohydrate, and grams of fiber was assessed and compared between each of the four assessment methods, and to the criterion weighed record. Inter-rater means were calculated to determine the accuracy of each group of dietitians. A One-Way Analysis of Variance (ANOVA) calculating group means for calories, grams of carbohydrate, grams of protein, grams of fat and grams of fiber compared each of the four assessment methods and a post-hoc Tukey test compared the group means between methods to determine specific areas of significance.

Difference scores were calculated by subtracting the known value (the weighed record value) from the estimated value for calories and nutrients for all participants to determine relative error. Then a one-sample t-test was calculated for each method to determine if the relative error was significantly different from zero. Because the error found within each RD was either less than, equal to, or greater than the actual known value, the relative error was used to detect bias within a method by looking for systematic verses random over- or underestimation for each of the four methods.

Absolute error was defined as the mathematical absolute value of the relative error (eliminating negative signs). Then a one-sample t-test was calculated for the absolute difference scores for each method to determine if the absolute error was significantly different from zero. Absolute error was used to determine overall accuracy of each method. For all analyses of variance, significance was set at $\alpha \leq 0.05$. A Bonferroni adjustment was made to alpha for multiple one-sample t-tests resulting in a level of significance at $p \leq 0.01$.

Results

Study Adherence

Each dietitian was briefed and reminded about the importance of remaining in the study for the time agreed upon. Individual issues were handled on a case-by-case basis and any needs for each dietitian were met (extended deadlines, changing form of which they receive the record or return the analysis, etc.) to limit attrition to the least amount possible. The level of attrition attained was 15%.

Participants

Information gathered from the Registered Dietitians who participated in the study is presented in Table 3. There were no statistically significant differences observed between the four groups for age (p=0.69), height (p=0.92), weight (p=0.23), degree level (Bachelor, Master, Doctoral, other) (p=0.61), or average number of meal records coded per month (p=0.47). Of the 50 participants, 17 dietitians worked in acute clinical care (primarily hospital) settings, 6 worked in long-term care, 2 worked in private practice, 12 worked in outpatient clinics, and 13 worked in other areas (primarily at Universities as professors and researchers). There were no statistically significant differences found between the groups for work setting (p=0.61). Only two of the dietitians were men, the rest were women. There were 20 dietitians with greater than 20 years of working experience, 1 had 16-20yrs experience, 5 dietitians had 11-15yrs experience, 7 dietitians had 6-10 years experience, and 18 dietitians had 1-5years experience. There was no statistically significant differences found between the groups for work experience (p=0.89).

Table 3: Mean (±SD) Selected Characteristics of Registered Dietitians by Group

Characteristic	Group A (N = 13)	Group B (N = 11)	Group C (N = 14)	Group D (N = 12)
Age (years)	41.8±13.7	39.5±13.9	42.3±16	47.4±8.7
Height (cm)	162.6±12.5	169.4±8.2	160.2±10.1	164±6.1
Weight (kg)	69.5±10.9	74.9±20.3	63.11±9.6	62.4±10.9
Average # meal records coded per month	1-5	1-5	1-5	1-5

There were no significant differences between groups for any descriptive variables (p>0.05).

Comparison Between Methods

Due to the nature of this study and the complexity involved in evaluating every meal and Set, it was decided to only analyze and compare each of the four methods. Each record Set contained 3 meals, one meal being a breakfast, one a lunch, and one a dinner together comprising a one day food record. Standard practice is to record full-day dietary intake; therefore, the reported values for this study are in Set format and comparisons were made between methods only. Table 4 presents the mean (±SD) values for the four food record sets by method for calories and macronutrients. Significance was determined between method totals only. Refer to Table 1 for information on the distribution of the methods per group for each record set. Table 5 presents the actual values of the sets from the criterion weighed record. Significant differences were found for carbohydrate between the FR and DP methods and for fiber between the FR and DPR methods.

Table 4: Mean (±SD) Estimated Calories and Macronutrient Values by Method for Each of the Four Diet Record Sets

Set and Method	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
SET 1					
DP	1342.1±271.9	55.6±17.5	157.4±36.7	59.7±7.6	23.2±6.9
FRDP	1290.8±164.6	51.8±8.0	166.1±28.1	48.9±5.2	22.25±3.9
DPR	1480.5±264.7	66.7±13.9	164.1±34.4	63.9±17.5	21.2±6.2
FR	1360.6±126.6	48.7±9.08	191.1±24.3	49.7±3.8	24.4±4.0
SET 2					
DP	1560.1±333.4	70.4±19.2	150.3±33.9	83.8±12.6	11.8±2.2
FRDP	1875.1±166.8	85.5±14.6	182.1±33.1	96.7±30.6	13.8±1.9
DPR	1845.1±242.7	89.4±19.6	165.9±20.2	95.4±22.3	12.3±3.1
FR	2013.8±115.5	93.0±10.5	197.8±12.9	92.9±6.2	14.5±1.9
SET 3					
DP	2136.9±453.3	90.3±21.5	231.6±66.4	102.2±35.5	16.6±3.9
FRDP	1822.6±211.3	74.9±8.5	226.9±39.7	28.8±7.2	16.4±3.4
DPR	2044.4±274.5	88.8±21.2	231.7±35.6	84.5±17.3	16.2±6.4
FR	1722.3±108.7	71±6.7	210.4±12.3	27.7±4.3	16.9±2.8
SET 4					
DP	1477.2±210.6	48.4±12.9	207.7±32.3	62.2±15.1	17.8±3.7
FRDP	1685.1±129.7	52.5±9.4	256.7±24.7	60.3±5.6	23.2±2.8
DPR	1464.2±228.4	45.9±9.8	215.7±39.7	58.3±7.9	19.4±5.6
FR	1738±134.2	84±106.6	261.8±26.5	58.0±5.9	23.4±2.2
Method Total					
DP	1615.9±439	65.3±23.7$	186.7±54.7	75.9±26.4	17.7±6.1
FRDP	1686.2±278.9	67.2±17.8	209.0±47.3	69.6±23.9	18.7±4.9
DPR	1725.6±348.7	70.2±34.7	193.6±43.9	76.9±22.8	17.0±6.3$
FR	1702.6±263.3	74.1±57.9‡	216.7±35.3	66.3±17.1	20.1±5.1*

DP=Digital photograph alone, FRDP=food record with digital photograph, DPR=Digital Photograph with limited recording, FR=food record alone; CHO=carbohydrate, PRO=protein; $=Significant Difference from FR, †=Significant Difference from FRDP, ‡=Significant Difference from DP, *=Significant Difference from DPR, p≤0.05.

Table 5: Weighed Record Values for Each of the Four Diet Record Sets

Set	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
Set 1	1527	54.8	206.5	55.1	30.7
Set 2	1801	80.6	174.8	95.9	10.4
Set 3	1919	82	224.1	77.34	14.3
Set 4	1632	51	218.8	69.3	19.3

CHO=carbohydrate, PRO=protein

Relative Error

Difference scores, calculated by subtracting the weighed value from the estimated value for calories and macronutrients of each method, were used to evaluate relative error. Only the combined method totals were compared for differences. The results of the one-sample t-test revealed that the only value significantly different from zero was for the FR for protein.

The relative error was used to detect bias for each method by determining whether or not a method systematically or randomly under- or overestimated values compared to the known value (the weighed record). In looking at the relative difference error no systematic pattern appears to exist causing a bias in any of the methods, as all differences appear to be random.

Table 6: Mean (±SD) Relative Error of Estimated Calories and Macronutrient Values by Method for Each of the Four Diet Record Sets

Set and Method	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
Set 1					
DP	-184.9±271.9	0.8±17.5	-49.1±36.7	4.6±7.6	-7.5±6.9
DPR	-46.5±264.7	11.8±13.9	-42.4±34.3	8.8±17.5	-9.5±6.2
FR	-166.4±126.6	-6.1±9.1	-15.4±24.3	-5.4±3.8	-6.3±4.0
FRDP	-236.2±164.6	-3.0±8.01	-40.4±28.1	-6.2±5.2	-8.4±3.9
Set 2					
DP	-240.9±333.4	-10.2±19.2	-24.5±33.9	-12.1±12.6	1.4±2.2
DPR	44.1±242.7	8.8±19.5	-8.9±20.2	-0.5±22.3	1.9±3.1
FR	212.8±115.5	12.5±10.5	22.9±12.9	-3.0±6.2	4.1±6.2
FRDP	74.1±166.8	4.9±14.6	7.3±33.1	0.8±30.6	3.4±1.9
Set 3					
DP	217.9±453.3	8.3±21.5	7.5±66.4	24.9±35.5	2.3±3.9
DPR	125.4±274.5	6.8±21.2	7.6±35.6	7.2±17.3	1.9±6.4
FR	-196.7±108.7	-11±6.7	-13.7±12.3	-9.7±4.28	2.6±2.8
FRDP	-96.4±211.3	-7.0±8.5	2.8±39.7	-8.5±7.2	2.1±3.4
Set 4					
DP	-154.8±210.5	-2.6±12.9	11.3±32.3	-7.0±15.1	-1.5±3.7
DPR	-167.8±228.4	-5.2±9.8	-3.0±39.7	-10.9±7.9	0.1±5.6
FR	106±134.2	33±106.6	42.9±26.5	-11.3±5.9	4.1±2.2
FRDP	53.1±129.7	1.5±9.4	37.9±24.7	-9.0±5.6	3.9±2.8
Method Total					
DP	-92.2±362.4	-0.7±18.5	-20.2±47.9	2.8±24.1	-1.6±6.0
DPR	-3.1±268.4	5.9±17.7	-11.4±36.8	1.4±18.6	-1.2±7.1
FR	-46.9±207.7	-1.0±11.2	2.9±41.4	-5.7±16.5*	0.6±5.72
FRDP	-5.8±210.7	8.2±58.2	10.5±32.4	-7.4±6.0	1.1±5.3

*=Significantly Different from Zero, $p \leq 0.01$. Relative error calculated as actual value minus estimated value.

Absolute Error

Absolute difference scores, calculated by subtracting the weighed value from the estimated value for calories and macronutrients of each set and taking the absolute value (eliminating negative signs), were used to evaluate absolute error. Absolute error was used to detect overall accuracy of a method regardless of over or underestimation. The results of the one-sample t-test revealed that all values were statistically significant from zero except for the FR group for fat.

Table 7: Mean (±SD) Absolute Error of Estimated Calories and Macronutrient Values by Method for Each of the Four Diet Record Sets

Set and Method	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
Set 1Total					
DP	272.1±176.3	14.0±9.7	54.9±26.2	7.9±3.7	8.8±4.9
DPR	204±164.3	12.9±12.9	42.7±33.9	12.8±14.6	9.8±5.7
FR	179.1±106.0	8.4±6.7	26.2±10.2	5.5±3.6	6.4±3.7
FRDP	247.6±144.9	6.7±4.9	43.9±21.6	6.5±4.9	8.5±3.9
Set 2					
DP	373.3±147.4	18.9±9.4	35.8±20.1	14.3±9.8	1.8±1.7
DPR	199.8±134.2	17.3±11.9	18.5±11.1	16.5±14.3	2.2±2.9
FR	212.8±115.5	14.4±7.3	22.9±12.9	5.4±4.2	4.1±1.9
FRDP	150.2±96.5	12.6±8.1	25.5±21.1	18.1±24.1	3.4±1.8
Set 3					
DP	429.8±236.2	18.3±13.1	50.6±41.0	33.8±26.2	3.5±2.8
DPR	207.1±214.4	18.1±11.9	25.9±24.4	12.8±13.4	4.7±4.6
FR	196.7±108.7	11±6.7	14.5±11.3	9.7±4.3	2.8±2.6
FRDP	197.6±112.3	9.1±6.1	26.0±29.3	9.7±5.4	2.8±2.8
Set 4					
DP	207.5±153.7	10.8±6.9	26.7±20.1	13.4±9.3	3.3±2.2
DPR	229.5±158.9	9.2±5.6	33.2±19.2	11.5±7.2	4.8±2.6
FR	144.4±87.4	35.9±105.6	42.9±26.5	11.8±4.6	4.2±2.1
FRDP	108.6±83.8	6.1±7.1	38.8±23.2	9.26±5.2	4.3±2.2
Method Total					
DP	315.4±196.4*	15.3±10.2*	42.4±26.6*	16.9±17.2*	4.6±4.2*
DPR	209.2±165.5*	14.7±11.4*	29.5±24.4*	13.5±12.7*	5.±4.9*
FR	181.4±104.3*	18.1±55.9	27.5±19.6*	8.2±4.9*	4.4±2.9*
FRDP	17439±118.6*	8.8±7.0*	32.9±24.8*	11.1±13.4*	4.6±3.4*

*Significantly Different from zero, p≤0.01. Absolute error calculated as the mathematical absolute value of actual value minus estimated value.

Discussion

Primary Findings

There are many challenges presented to researchers when investigating individual intakes using written food records as many individuals find daily written food records to be tedious, time consuming and often will omit information due to lack of motivation or time, or the perception that a food is unhealthy (Macdiarmid & Blundell, 1997; Heitmann & Lissner, 1995). Research has also indicated that individuals within the general population are unable to correctly identify portion sizes, which can adversely affect the accuracy of a written food record (Harnack, Steffen, Arnett, Gao, Luepker, 2004; Frobisher & Maxwell, 2003). Because of the inherent limitations with written food records researchers have been trying to find better solutions to collecting this information from research participants including the use of photographic records (Bird & Elwood, 1983; Elwood & Bird, 1983; Kaczkowski et al., 2000; Wang et al., 2002; Wang et al., 2006; Williamson et al., 2003; Yon et al., 2006). The current study aimed to investigate the accuracy of four different food record methods: written records alone (FR), written records with digital photography (FRDP), digital photography alone (DP) and digital photography with a limited document for ambiguous items (DPR).

The findings of this study indicate that none of the methods studied have any particular bias to either over- or underestimate calories or macronutrients. This study also suggests that digital photograph (DP) records can be used as a means of collecting data from free-living individuals provided there is proper training of both the person keeping the record and the person interpreting and analyzing it.

According to the absolute values, there was only one difference that was not statistically significantly different from the known value. All of the methods had greater than a 150 calorie error as well. These findings indicate that while all of the methods were inaccurate for both

statistically significant differences and for practical applicability when compared against the known values (the weighed record), the digital photograph methods were not less accurate overall than the food record methods.

While this study used researcher controlled photographic records where meal item identification was very seriously considered, photographs derived from the general population will not likely be of similar quality. Limitations to digital food record photographs made by the general public are generally related to quality due to lighting, camera quality or inappropriate angling in photographic food records (Wang et al., 2002). Untrained people may photograph foods in a hurry with little thought to the picture quality or the ability of another person to see details within it. It is important for the individual creating the photographs to do so at the proper angle and when possible place a common object in the photograph for a frame of reference. Training of individuals who are being asked to keep photographic records will most likely lead to better photographs and therefore greater accuracy when analyzing them.

In both the Wang et al. (2002) and Wang et al. (2006) studies, a device called a Wellnavi was used. This device was a handheld PDA with a camera and mobile phone card, which allowed a person to photograph their food with the ruler-like stylus included in the photo, write on the photograph directly via the stylus on the PDA screen and then send the photograph to a dietitian who was familiar with the Wellnavi device. Participants in both studies were trained to use the instrument and kept a one day weighed record alongside the digital photograph record using the Wellnavi. Both studies found no significant differences for participants for calories or macronutrients but did for fiber. Participants also stated that the Wellnavi method was much less burdensome than the weighed record and took, on average, 5 minutes. This suggests that trained individuals using a device that combines a photograph with limited documentation can be a

practical solution to the dilemma of collecting dietary intakes of free-living individuals. However, devices such as this one may be too expensive or impractical for large scale research. While some mobile phone devices do have applications that involve photographing food records, no device similar to the Wellnavi is known to exist or to have been studied in the United States.

This study has shown that while limitations of digital photographs exist, just as they do with written food records, there are ways to increase their overall accuracy. Basic experience and training in analyzing digital photograph records would likely lead to greater accurately when analyzing them. None of the dietitians in this study indicated using digital photographs in their previous experience or current line of work but all stated that they felt the photograph enhanced the written record. It is inferred that the more information provided to an observer about the foods presented the more accurately s/he can analyze the meal. Considering the limitations of both the written food record alone and the digital photograph alone, a more practical, similarly accurate solution may be derived from a combination of the two. The digital photograph with limited documentation group did relatively well compared to both written food record methods in this study.

There are very important points to keep in mind to optimize the effectiveness of both the limited document and the photograph. While a complete written food record can be time consuming and tedious a limited written record is less so. A limited document that includes at least a basic title of the food (for example-hamburger, fries, Coke) would at least give the person analyzing the records a point of reference. Including added fats, diet and fat free items, and brand/restaurant names is also helpful when analyzing a meal. For the digital photograph, a good quality camera with a review feature is important. Also, taking photos in a well-lit area at a 45 degree angle with good presentation of all foods items will increase the chances of proper

food and portion identification. Placing food containers in the picture (for example a box of cereal, can of soda, fast food wrapper, etc) and choosing a common object to place in the photo near the food as a frame of reference for size will improve accuracy.

Strengths and Limitations

This study had a number of strengths absent from previous studies of similar design. This study had the unique advantage of having researcher created, meticulously prepared meals, high quality food records (weighed, written and photograph) and all meals were analyzed for their actual content by the researcher, a Registered Dietitian, who is familiar with keeping a written, weighed and photograph record and familiar with food coding and nutrient analysis. This study did not need to rely on a participant to keep a detailed weighed record accurately. This study also had a large sample size of RD's analyze the food records as opposed to previous reports with only a few.

In the Williamson et al. (2003) study, three observers analyzed meals and reported a high correlation between direct observation of a meal and a digital photograph of the same meal. While a strong correlation does not necessarily equate to accuracy, it can be inferred from this finding that a trained person can identify portion sizes and foods within an acceptable range of accuracy from a digital photograph. This is, of course, limited by the quality of the photograph, the placement of the foods and picture angle for the photograph, the experience of the person analyzing the foods, and the database used.

A major limitation in a study such as this one is the coding variability and errors of the individual dietitians. Braakhuis et al. (2003) compared coding between 53 Australian sports dietitians and reported a 20-54% within athlete coefficient of variation in energy (20%) and nutrient (20-54%) intake between dietitians for the sampling period of one day (Braakhuis,

Meredith, Cox, Hopkins, & Burke, 2003) While coding variability was not investigated in the current study, it was observed that most dietitians chose not to use the customized code feature where they could create a code based on a name brand or known item. A given database will often contain many food coding options for a single food item thus coding variability and error present a challenge to the results of this study.

It is difficult to find Registered Dietitians who code food records on a regular basis therefore RD's with limited or no current working experience with food record coding were included in the study. While the education and expertise determine the ability of the RD to assess food records there were many who stated that they did not analyze or code food records on a regular basis at their current place of employment likely putting them at a disadvantage to those who do. It can be assumed that with practice one could become better at analyzing food records in digital photograph form which would lead to greater accuracy. Using only those RD's who analyze food records on a regular basis and have had some experience with digital records may have reduced the impact of this limitation.

The inability to analyze this data within subjects also posed some limitations. Because of the potential for a learning effect from a dietitian seeing the same record in more than one method, each dietitian only saw each meal one time. This limited the possibility of evaluating the four methods within an individual participant.

The database itself (www.fitday.com) may have imposed limitations on this study as well. Several of the dietitians expressed in a follow up survey that they felt that the database was limited in options and presented challenges to finding foods and finding them within a timely manner. This may have led many participants to choose a food code that was similar to the one they wanted but not exactly correct. While the online database that was used is generally

considered to be user-friendly and is a free database accessible to anyone with internet access, it may not have been the most appropriate database for this study. The RD's who participated in this study were recruited from every region of the United States and from a variety of settings. To minimize any possible effect of the food code database, the nutrition program needed to be standardized. Considering the cost of commonly used professional nutrition software packages, it was not practical nor cost efficient to use a more widely accepted nutrition program. However, other databases that are accessible to large groups of people via the internet or otherwise should be investigated and may help improve the accuracy of analyzing food records.

Another limitation was the digital photographs themselves. Since there was no identification of even basic information (foods presented), many dietitians had difficulty identifying the foods in the photographs. This was especially true for foods covered with a topping (i.e., cheese) or foods mixed together (i.e., salad or casserole). This led to an increase in coding errors which then contributed to increased errors in determining portion sizes. In most cases, if a dietitian was able to identify the food properly, s/he was able to assess the portion size accurately. Those photographs of meals that included food boxes, labels and brand names, similar to the information included in the limited document made foods easier to identify than those without.

Conclusion

This study suggests that digital photograph (DP) records can be used as a means of collecting data from free-living individuals provided both the person creating the record and the person interpreting and analyzing the record are properly trained. When a device is impractical or where a person refuses to purchase or use one, a digital camera and pen and paper can be appropriate tools to collect dietary information from an individual. It is also practical to say that

written and digital photograph food records can be created and sent electronically to dietitians and researchers within the same day by sending a written record in typed format. It is important, however, when considering using this method with anyone from the general population that they be trained on photographing and writing the written portion prior to beginning a study or keeping the journal as a client for a dietitian.

Future Directions

This study poses questions for future studies in this area including the practicality of using digital photograph food records created by the general public and use of those records with large groups. Since camera quality and participant training are limitations in large group studies due to financial and time constraints, it would be beneficial to investigate the accuracy of analyzing digital photographs when the records are not of high quality. The question of coding variability between observers (dietitians) and how to control for that variability is another area for future research. Future studies may want to investigate food coding databases to better understand them and their corresponding food codes which would benefit studies involving food analysis. Understanding of nutrition analysis systems and coding variability within those systems may lead to study designs that are better able to control for this variability. Identification of higher quality, practical food analysis systems may also be identified for future studies investigating both food coding and accuracy of food record analysis.

References

Bingham, S. A. (1987). The dietary assessment of individuals; methods, accuracy, new techniques and recommendations. *Nutrition Abstracts Reviews, 57*, 705-742.

Bird, G., & Elwood, P. C. (1983). The dietary intakes of subjects estimated from photographs compared with a weighed record. *Human Nutrition and Applied Nutrition, 37A*, 470-473.

Braakhuis, A. J., Meredith, K., Cox, G. R., Hopkins, W. J., & Burke, L. M. (2003). Variability in estimation of self-reported dietary intake data from elite athletes resulting from coding by different sports dietitians. *International Journal of Sport Nutrition and Exercise Metabolism, 13*, 152-165.

Elwood, P. C., & Bird, G. (1983). A photographic method of diet evaluation. *Human Nutrition and Applied Nutrition, 37A*, 474-477.

Frobisher, C., & Maxwell, S. M. (2003). The estimation of food portion sizes: a comparison between using descriptions of portion sizes and a photographic food atlas by children and adults. *Journal of Human Nutrition and Dietetics, 16*, 181-188.

Harnack, L., Steffen, L., Arnett, D. K., Gao, S., & Luepker, R. V. (2004). Accuracy of estimation of large food portions. *Journal of the American Dietetic Association, 104*, 804-806.

Heitmann, B. L., & Lissner, L. (1995). Dietary underreporting by obese individuals-is it specific or non-specific? *British Medical Journal, 311*, 986-989.

Kaczkowski, C. H., Hones, P. J. H., Feng, J., & Bayley, H. S. (2000). Four-day multimedia diet records underestimate energy needs in middle-aged and elderly women as determined by doubly-labeled water method. *Journal of Nutrition, 130*, 802-805.

Macdiarmid, J. I., & Blundell, J. E. (1997). Dietary under-reporting: what people say about recording their food intake. *European Journal of Clinical Nutrition, 51*, 199-200.

Schoeller, D. A. (1995). How accurate is self-reported dietary energy intake? *Nutrition Reviews, 48,* 373-379.

Schwartz, J., & Byrd-Bredbenner, C. (2006). Portion distortion: typical portion sizes selected by young adults. *Journal of the American Dietetic Association, 106,* 1412-1418.

Wang, D. H., Kogashewa, M., Ohta, S., & Kira, S. (2002). Validity and reliability of a dietary assessment method: the application of a digital camera with a mobile phone card attachment. *Journal of Nutritional Sciences and Vitaminology, 48,* 498-504.

Wang, D. H., Kogashiwa, M., & Kira, S. (2006). Development of a new instrument for evaluating individuals dietary intakes. *Journal of the American Dietetic Association, 106,* 1588-1593.

Williamson, D. A., Allen, H., Martin, P. D., Alfons, A. J., Gerald, B., & Hunt, A. (2003). Comparison of digital photography to weighed and visual estimation of portion sizes. *Journal of the American Dietetic Association, 103,* 1139-1145.

Yon, B. A., Johnson, R. K., Harvey-Berino, J., & Gold, B. C. (2006). The use of a personal digital assistant for dietary self-monitoring does not improve the validity of self-reports of energy intake. *Journal of the American Dietetic Association, 106,* 1256-1259.

REVIEW OF LITERATURE

Introduction

Accurate dietary intake assessment is important for dietitians and researchers to evaluate the nutrient composition of individual diets. Since the early 20th century, researchers have been working to find a valid and reliable method to assess individual intakes among the general population to determine recommended dietary intakes for health and wellness (Bingham, 1987). Although no method of intake assessment is without limitations, weighed food records have been studied and determined to be the gold standard for gathering diet assessments from individuals and have been validated against chemical composition of foods (Bransby, Daubney, & King, 1948).

Weighed food records-The Gold Standard

Weighed food records involve the weighing of all food items consumed while keeping a written record for a minimum of 24 hours (Bingham, 1987). However, this process can be time consuming and disruptive to free-living individuals who normally would not weigh or keep records of foods eaten throughout the day. This disruption leads to limitations in data collection to include: participants changing their dietary habits to only consume easy to weigh foods, changing habitual patterns to always be near a scale, and underreporting food as they did not want to weigh and record it (Bingham, 1987). Because the weighed food record is labor intensive and disrupts habitual intake of participants, other assessment tools have been developed such as 24-hour recalls, food frequency questionnaires (FFQ), various forms of diet histories and food diaries. These additional assessment methods have been studied in an attempt to validate them against weighed food records (Acheson, Campbell, Edholm, Miller, & Stock, 1980;

Bingham & Day, 1997; Bingham et al., 1995; Mullen, Krantzler, Frivetti, Schutz, & Meiselman, 1984).

Dietary assessment forms: 24-hour recall, FFQ, diet history, and food diary

Although the weighed food record is the gold standard, it is time consuming and burdensome on participants. A widely used tool that is relatively simple and easy to administer is a 24-hour recall where a dietitian will ask the participant to recall all foods consumed in the previous 24 hours. Although this tool is simple and quick, it is not without limitations such as individuals not remembering foods and 24 hours not being a long enough time period to assess an individual's habitual intake (Bingham, 1987). A food frequency questionnaire (FFQ) involves a listing of foods by grouping (examples include dairy foods, fruits, vegetables, meats, etc.) and the participant is asked to write down how many times per week they consume those foods. Food frequency questionnaires do not provide detailed information on diet, but instead general characteristics and are most useful in determining the general diet of a sample in a population (Bingham, 1987).

Diet history forms are similar to FFQ in that they estimate general characteristics of an individual's diet over the past 4-6 weeks but with less direction (individuals are asked to check boxes next to foods and also to write free-hand what foods they generally consume at breakfast, lunch, dinner and snacks) and also poses the issue of participants having to rely on memory. Diet history is also limited in information and best used in situations where general diet information about a group is of concern (Bingham, 1987). Food diaries are often used to estimate an individual's intake over anywhere from one to seven days. Most commonly, the food consumed, the time food is eaten, and the amounts of food consumed are written down by

the participant for a minimum of three days. Food diaries provide the most detail for a free-living individual diet assessment but also pose more of a burden to the participant (Bingham, 1987).

Comparison of dietary assessment tools

A 1985 study compared 24-hour recalls versus 2-day food diaries, quantitative FFQ, and modified diet history (Sorenson, Calkin, Connolly, & Diamond, 1985). The modified diet history was described as a combination of the 24-hour diet recall, traditional diet history and the food-frequency questionnaire. Each instrument was administered between two and five weeks apart to control for seasonal variation. Fifty participants (33 female and 17 male) completed each of the four assessment tools. Each measurement tool was compared for variance of a number of nutrients including energy, protein, fat, carbohydrate, fiber, and various vitamins and minerals. This was accomplished by using analysis of variance for a complete block design to analyze data by mean differences across all instruments and by simple correlations and Kappa statistics between instrument pairs. The FFQ gave higher mean estimates than the other instruments for all nutrients except thiamin; however, the authors of this study concluded that the 24-hour recall, modified diet history, and 2-day food records were not significantly different in nutrition analysis of nutrients. The authors also concluded that comparison of diet assessment tools meant for short term and or group means (24-hour recall, food-frequency questionnaire, modified diet history) should not be compared with instruments meant for greater than twenty-four hour time spans and that go into detail about individual intake (food diary, weighed food records) (Sorenson et al., 1985).

Other studies which have compared assessment methods have found: FFQ overestimate intake compared with diet histories and 7-day food records (Jain, Howe, & Rohan, 1996); 7-day food records are more accurate compared to FFQ and 24-hour recalls when validated against urinary nitrogen and potassium (Bingham et al., 1995; Bingham et al., 1994); and that the use of a FFQ with a 2-week food diary was more accurate than a FFQ alone when validated against weighed food records (Riboli, Elmstahl, Saracci, Gullberg, & Lindgarde, 1997). Conclusions to draw from studies which have compared the FFQ, 24-hour recall, diet history, and multi-day food diaries are: the multi-day food diary is most accurate when compared against weighed food records, the FFQ and 24-hour recall tend to overestimate intake compared to multi-day food diaries, and use of more than one dietary assessment tool increases the validity of the intake data. The current study evaluated the validity of the use of food diaries combined with digital photographs.

A 1987 review on dietary assessment of individuals (Bingham, 1987) concluded that when compared to the weighed food record, a food diary was the most valid and reliable method for assessing individual dietary intake. Because of day-to-day variations in habitual intake, the general consensus among researchers has been to have participants complete a full seven days of food intakes to estimate habitual diet patterns (Bingham, 1987). Group assessment of dietary intake for general population studies is done most practically with the use of tools such as the food-frequency questionnaire, a diet history form and or the 24-hour recall method in order to establish population estimates (Bingham, 1987). The current study was an evaluation of food diaries.

Validation of a multi-day food diary

The doubly-labeled water (DLW) method is a tool often used to determine energy needs of an individual and is limited to the measurement of gross energy expenditure without the ability to assess specific macro- or micronutrients. This method uses the concept of energy balance as a valid measure of habitual energy intake, i.e. energy intake and energy expenditure must be relatively equal to maintain body weight and normal body function. In practice, doses of doubly-labeled water for metabolic work are prepared by mixing a dose of deuterium oxide (90 to 99%) with a second dose of $H_2{}^{18}O$, which is water that has been separately enriched with O-18 but otherwise contains normal hydrogen. The mixed water sample then contains both types of heavy atoms, in a far higher concentration than normal water, and is now doubly-labeled. The free interchange of hydrogen's between water molecules (via normal ionization) in liquid water ensures that the pools of oxygen and hydrogen in any sample of water will be separately equilibrated in a short time with any added heavy isotope(s) (Schoeller, 1995). This method is considered the gold standard for determining gross energy expenditure though is not without some limitations in non-laboratory settings with approximately 1% error (Schoeller, 1995). An additional limitation of the DLW method is that it is cost prohibitive for use in large populations and requires the collection and processing of blood, urine, or respiratory water.

The 7-day food diary has been validated against weighed food records and against estimated energy needs for maintenance of body weight (Black, Goldberg, Jebb, Livingstone, Cole, & Prentice, 1991; Kaczkowski et al, 2000; Martin, Su, Jones, Lockwood, Tritchler, & Boyd, 1996). Methods such as indirect calorimetry and doubly-labeled water have been used to determine energy intake needed to maintain body weight and compared with individual reported

intakes. Multi-day food diaries have also been validated against biomarkers of dietary intake such as urinary nitrogen and potassium (Bingham et al., 1995; Bingham & Day, 1997).

Many studies which have compared reported dietary intake with estimated energy needed to maintain body weight have found that participants often underreport intake relative to estimated expenditure (Black, Prentice, Goldberg, Jebb, Bingham, Livingstone, & Coward, 1993; Hallfrisch, Steele, & Cohen, 1982; Kaczkowski et al., 2000; Martin et al., 1996; Mertz et al., 1991). Although the current study was not designed to evaluate the energy requirement or the extent of underreporting for an individual, the use of digital photography may enhance the accuracy of dietary analyses by improving the ability of the registered dietitian to estimate portion size, and by reducing the burden to the individual thereby increasing compliance.

Bias of self-reported dietary intake

Bias in estimating nutrient intake refers to underreporting of the diet either by selective alterations in the diet, selectively underreporting certain foods, or the inability to accurately estimate portion size (Livingstone & Black, 2003). The reasons for participants underreporting intake is believed to be multifactorial and not well defined (Bingham, 1987). A literature review by Livingstone and Black (2003) summarized some of the common variables surrounding underreporting of dietary intake such as: weight status (obese underreport more than normal weight), age-sex effects, socioeconomic status and educational effects, health consciousness, and cultural and behavioral effects. The authors of this review found that in most studies, individuals of lower socioeconomic status, education below the high school level, women under age 55, individuals of minority groups (specifically Hispanic and African American), and those who do not identify themselves as health conscious were likely to underreport dietary intake

(Livingstone & Black, 2003). Herbert et al. (1995) found that women tend to underreport intake to a greater extent than men (Herbert, Clemow, Pbert, Ockene, & Ockene, 1995).

A study published by Goris et al. (2001) had 26 male and 23 female normal and overweight elderly participants keep a 7-day food record on two separate occasions approximately 12 weeks apart as part of an exercise program. Energy expenditure was determined from measurement of basal metabolic rate by open-circuit (hood) calorimetry with a physical activity factor. Relative to estimated energy needed to maintain body weight, they found underreporting was approximately 6% greater for the second food diary compared with the first food diary. There was selective underreporting of fat and overreporting of protein overall for most participants, regardless of overall accuracy. Those participants who overreported their intake on the first diary also did so on the second and those who underreported on the first diary also did so on the second. The researchers found that for the second diary participants were likely to report approximately 15% lower intakes and this was believed to be due to the burden of record keeping and a change in dietary habits to alleviate this (Goris, Meijer, & Westerterp, 2001).

Obesity and dietary underreporting

Obese participants tend to underreport intake to a greater extent than those individuals who are of normal or low (under) weight. Studies done during the 1960's showed that those participants who were considered overweight or obese reported similar or lower energy intake compared with their normal weight counterparts (Adelson, 1960; Rose & Williams, 1961). For nearly two decades researchers studied the hypothesis that overweight and obese participants had a lower energy expenditure and lower resting metabolic rate than their normal weight

counterparts (Livingstone & Black, 2003). Current evidence however, suggests that dietary misreporting, specifically underreporting intake and over-reporting of physical activity account for the low reported intake and estimated energy expenditure of overweight and obese participants (Braam, Ocke, Bueno-de-Mesquita, Seidell, 1998; Briefel, Sempos, McDowell, Chien, & Alaimo, 1997; Lichtman et al., 1992).

Other studies of underreporting have compared obese to non-obese participants and indicated that obese tend to underreport to a greater extent than non-obese individuals (Bandini, Schoeller, Cyr, & Dietz, 1990; Braam et al., 1998; Heitmann & Lissner, 1995; Lansky & Brownell, 1982; Macdiarmid & Blundell, 1997). The doubly-labeled water method has been used to identify underreporters and is especially sensitive in studies of obesity. There is the question of whether obese persons are equally represented in some studies, however, as many fail to complete study requirements and often their data is eliminated from study results (Lissner, 2002).

In a review of seven studies, Black and Cole (2001) found that many researchers agree that those individuals who underreport their intake in one instance are likely to always underreport their intake. A study undertaken by Macdiarmid & Blundell (1997) involved asking participants, after having completed food journals, if they had intentionally misreported their intakes. Those who admitted to altering their diets stated that the main reasons for doing so included: inconvenience, difficulty with estimating portion sizes, and guilt for consuming foods they believed to be unhealthy (Macdiarmid & Blundell, 1997). Other researchers have found that lack of dietary restraint and percentage body fat are confounding factors leading to underreporting energy intake and overestimation of physical activity (Braam et al., 1998; Briefel

et al., 1997; Lichtman et al., 1992). If the results of the current study are positive, the use of digital photography may enhance the accuracy of dietary reports.

Issues with estimating portion size

Underreporting bias is a major limitation to food records not only because of insufficient food reporting but also due to each participant's inability to accurately estimate portions sizes. Harnack et al. (2004) reported a study with 50 people who were all fed an identical meal in a hotel restaurant that was large in portion size while researchers unobtrusively observed them. Twenty-four hours later, all participants were called back to the hotel where some were asked to estimate the portion size of those foods eaten the day before using USDA standard serving size food models while others were asked to do so with either standard size food models or models of larger food portions. The authors of this study found that when participants were given the opportunity to choose between standard serving size food models and larger size food models, the larger size food models were chosen and more accurately reflected the actual intake of the participants (Harnack, Steffen, Arnett, Gao, & Luepker, 2004). It is thought the actual size of the portion may have a significant effect on how much an individual will over or underestimate portion sizes with large portions contributing most heavily to underestimation of portion size (Frobisher & Maxwell, 2003).

Other studies asking participants to estimate portion sizes have found the majority of participants either consistently underestimate (Harnack et al., 2004; Schwartz & Byrd-Bredbenner, 2006) or consistently overestimate portion size (Faggiano, Vineis, Cravanzola, Pisani, Xompero, Riboli, & Kaaks, 1992; Frobisher & Maxwell, 2003). Scwartz & Byrd-Bredbenner (2006) chose to look at young adults at a major northeastern university eating from a

buffet and concluded that portion distortion may have contributed to the underestimation of portion sizes. Many of these participants, when later asked could not identify a standard serving size accurately (Scwartz & Byrd-Bredbenner, 2006).

Faggiano et al. (1992) had a population of randomly selected blood donors aged 35-64 years who were allowed to freely choose portions of foods provided in a restaurant setting. After each person plated their portions of food, the food was weighed by the researchers prior to the participant being allowed to eat. The next day each participant was asked to do a 24-hour recall with the aid of pictures in which the majority of people overestimated the portions that they had consumed at the test meal the previous day. The authors concluded that overestimation may have been due to the use of the pictures which lacked appropriate representation of the foods consumed (Faggiano et al., 1992).

Frobisher & Maxwell (2003) had a mixed population of adults and children consisting of university personnel and family. All participants were served restaurant style and allowed to self-select portions of foods which were weighed and recorded by researchers prior to individual consumption. Portions sizes were estimated directly after the meal and again 3-4 days later using a food atlas and standard descriptions of serving sizes. The results showed that children were more likely to have errors than adults, and the use of the food atlas and pictures had the most error overall. The authors concluded that portion sizes with exactly the same appearance as in the photographic booklet were estimated more correctly than portion sizes that differed in food size and type (Frobisher & Maxwell, 2003). Studies that have involved training participants to estimate portion sizes using food models and household measures have found that even one hour of training can improve the ability of people to visually estimate portion sizes of foods (Howat,

Moha, Champagne, Monlexun, Wozniak, & Bray, 1994; Weber, Tinsly, Houtkooper, & Lohman, 1997).

A major limitation to estimation of portion sizes by the public stems from confusion over portion versus serving size. While the general public may consider a portion to be synonymous with a serving, a portion is what is seen on a plate but a serving size is a measured and defined standard amount of that food (Hogbin & Hess, 1999). This means that the typical restaurant may serve 3-4 servings of a food item as a single portion increasing the amount of food that consumers perceive as a standard serving size. Serving size is merely a unit of measure and may or may not equal a portion that one would typically consume (Hogbin & Hess, 1999). The need for an individual to estimate portion size may be alleviated with the use of digital photography by allowing a trained dietitian to indirectly observe the food consumed.

Studies have found that the act of keeping an accurate food journal may improve weight loss in many individuals by increasing awareness and stressing mindful eating (Rebro, Patterson, Kistal, & Cheney, 1998; Streit, Stevens, & Stevens, 1991). There are researchers who would say that the majority of participants in weight loss programs and trials do not underreport in general but instead underreport specific foods for reasons such as social desirability or guilt (Heitman & Lissner, 1995; Herbert et al., 1995; Macdiarmid & Blundell, 1997). A second problem of underreporting is lack of a convenient, quick and non-invasive method of keeping a food log throughout the day. Of those who have the discipline to keep a food record, there becomes the issue of visual estimation of food portions and the inability to do so accurately (Champagne, Bray, Kurtz, Monteiro, Tucker, Volaufova, & Delany, 2002).

Champagne et al. (2002) completed a study comparing dietitians to non-dietitians for accuracy in keeping food records. They found that non-dietitians underreported their intakes by about 429 ± 142 calories per day while dietitians were within approximately 100 calories per day when compared to caloric need determined by the doubly-labeled water method (Champagne et al., 2002). This study poses the question of what method of recording dietary intake best allows the dietitian to indirectly observe and accurately estimate caloric consumption while minimizing the client's burden of completing the record?

Photography as a supplement to a food diary

The first two published studies that involved the use of photographs to supplement food diaries were done by Elwood and Bird in 1983. In one study published in two parts, they gave 16 participants a camera and recording book and asked them to take before and after photographs of all foods consumed over a four-day period while also estimating portion sizes with a written record. In addition to this, a second record was kept containing the weighed values of the same foods eaten during the four-day period. The two records (photography with a diary versus weighed food records) were compared and the findings indicated that there were no statistical differences in energy, protein, fat, carbohydrate, saturated fat, polyunsaturated fat, fiber, or vitamin C between the two records (Bird & Elwood, 1983; Elwood & Bird, 1983).

Since this study, other researchers have been working on the best way to incorporate photography with written food records. The studies done by Bird and Elwood suggested that the photograph should be taken at a 45-50 degree angle for optimum viewing of all foods. Subsequent studies have agreed with this finding while investigating the use of digital photography to supplement food diaries in an attempt to ease participant burden and increase

accuracy (Martin, Newton, Anton, Allen, Alfonso, Han, et al., 2007; Swanson, 2008; Wang, Kogashewa, & Kira, 2006; Wang, Kogashewa, Ohta, & Kira, 2002).

Williamson et al. (2003) compared weighed food records to direct observation of, or a digital photograph of, 60 meals. Three research associates were trained in visual estimation of food from direct observation and three other research associates were trained in estimation of food portions with digital photography. Each observation was validated against a weighed food record kept by an independent research associate not involved in the other two observations. This study found a high correlation between both methods of observation and the weighed food records with correlations for estimates of food selections at r = 0.94, estimates of plate waste at r = 0.91 and estimates of food intake at r = 0.92 (Williamson, et al., 2003). Since its publication, this study has been cited by other investigators using digital photography to validate its use in assessing dietary intakes (Martin et al., 2007; Swanson, 2008).

Some studies using digital photography compared to food diaries have found high correlations between both methods for: a one day photo record versus a weighed food record in 20 participants (Wang et al., 2002), and high correlations of 43 children's intake photographs assessed by two individual dietitians (Martin et al., 2007). A study by Swanson (2008) looked at digital photography as a tool to measure school cafeteria consumption and found approximately 92% accuracy within 10% measurement error between three different observers and within 826 meals (Swanson, 2008). Of the cited studies, none have used more than three different observers or dietitians and none have compared the food diary to a food diary supplemented with digital photography or to digital photography alone for variance in measurements between assessment tools. The current study asked multiple dietitians to assess twelve different food records in four different forms (digital photograph alone, food record alone, digital photograph with food record,

and digital photograph with a limited document for difficult and/or ambiguous items) which were compared to a weighed record of known nutrient composition.

Coding measures of Registered Dietitians

A study done by Braakhuis et al. (2003) compared variability in food coding between sports dietitians. This study had 53 sports dietitians recruited from the Sports Dietitians Australia group and asked randomly selected athletes of the 1996 Australian Olympic team to provide 7-day food diaries. There were a total of 52 athletes and 53 dietitians with athletes each providing one 7-day food journal. There were 3-5 RD coders for each 7-day journal for a total of 1,820 days of food journals. The statistical analysis examined the variability between RD coders for estimated daily energy and key nutrient intake. The results showed a 20-54% within athlete coefficient of variation in energy (20%) and nutrient (20-54%) intake between dietitians for the sampling period of one day. This study, however, did not compare actual known energy or nutrient intake to estimated intake determined by dietitians from the food diaries (Braakhuis, Meredith, Cox, Hopkins, & Burk, 2003). The variability in that study may be attributed to coding errors, reporting errors or both coding and reporting errors but it is not clear as actual values were not known.

To this point, no known study has evaluated the ability of more than three dietitians, or observers, to accurately estimate the nutrient composition of diets recorded by digital photography alone, digital photography supplemented with a food record, or a food record alone compared to known nutrient values. The current study addressed these issues by evaluating the reliability and validity of registered dietitians to accurately analyze meals of known nutrient composition when recorded by four different assessment tools; specifically the use of digital

photography alone (DP), digital photography combined with food records (FRDP), food records alone (FR) and digital photography with a limited written document (DPR). This study contributes to the current body of literature by using a large sample of registered dietitians to analyze food records of known nutrient composition for accuracy of and differences between the four methods. This study may also support the use of digital photography alone as a more convenient and less intrusive method of dietary analysis, which may also enhance participant compliance.

Conclusion

In summary, collection of dietary intake data from free living individuals can be a difficult and daunting task often associated with inaccuracy. Digital photograph (DP) records are a viable option for collecting dietary intakes of individuals provided there is proper training of both of the person keeping the record and the person analyzing it, the digital photographs are of high quality and include as much detail as possible the photograph is accompanied by a limited document that provides basic information and detail on difficult to identify and ambiguous items.

References

Adelson, S. F. (1960). Some problems in collecting dietary data from individuals. *Journal of the American Dietetic Association, 36*, 453-461.

Acheson, K. J., Campbell, I. T., Edholm, O. G., Miller, D. S., & Stock, M. J. (1980). The measurement of food and energy intake in man-an evaluation of some techniques. *American Journal of Clinical Nutrition, 33*, 1147-1154.

Bandini, L. G., Schoeller, D. A., Cyr, H. N., & Dietz, W. H. (1990). Validity of reported energy intake in obese and non-obese adolescents. *American Journal of Clinical Nutrition, 52,* 421-425.

Black, A. E., & Cole, T. J. (2001). Biased over- or underreporting is characteristic of individuals whether over time or by different assessment methods. *Journal of American Dietetic Association, 101*, 70-80.

Black, A. E., Goldberg, G. R., Jebb, S. A., Livingstone, M. B., Cole, T. J., & Prentice, A. M. (1991). Critical evaluation of energy intake data using fundamental principles of energy physiology: Evaluating the results of published studies. *European Journal of Clinical Nutrition, 45*, 583-599.

Black, A. E., Prentice, A. M., Goldberg, G. R., Jebb, S. A., Bingham, S. A., Livingstone, M. B. E., & Coward, W. A. (1993). Measurements of total energy expenditure provide insights into the validity of dietary measurements of energy intake. *Journal of American Dietetic Association*, *93*, 572-579.

Bingham, S. A. (1987). The dietary assessment of individuals; methods, accuracy, new techniques and recommendations. *Nutrition Abstracts Reviews, 57,* 705-742.

Bingham, S. A., Cassidy, A., Cole, T. J., Welch, A., Runswick, S. A., Black, A. E., Thurnham, D., et al., (1995). Validation of weighed records and other methods of dietary assessment using the 24h urine nitrogen technique and other biological markers. *British Journal of Nutrition, 73,* 531-550.

Bingham, S. A., & Day, N. E. (1997). Using biochemical markers to assess the validity of prospective dietary assessment methods and the effect of energy intake adjustment. *American Journal of Clinical Nutrition, 65*, 1130-1137.

Bingham, S. A., Gill, C., Welch, A., Day, K, Cassidy, A., Khaw, K. T., Sneyd, M. J., et al., (1994). Comparison of dietary assessment methods in nutrition epidemiology weighed records v 24h recalls, food-frequency questionnaires and estimated-diet records. *British Journal of Nutrition, 72*, 619-643.

Bird, G., & Elwood, P. C. (1983). The dietary intakes of subjects estimated from photographs compared with a weighed record. *Human Nutrition and Applied Nutrition, 37A*, 470-473.

Braakhuis, A. J., Meredith, K., Cox, G. R., Hopkins, W. J., & Burke, L. M. (2003). Variability in estimation of self-reported dietary intake data from elite athletes resulting from coding by different sports dietitians. *International Journal of Sport Nutrition and Exercise Metabolism, 13*, 152-165.

Braam, L. A. J. L. M., Ocke, M. C., Bueno-de-Mesquita, H. B., & Seidell, J. C. (1998). Determinants of obesity-related underreporting of energy intake. *American Journal of Epidemiology, 147*, 1081-1086.

Bransby, E. R., Daubney, C. J., & King, J. (1948). Comparison of results obtained by different methods of individual dietary survey. *American Journal of Epidemiology, 112*, 89-110.

Briefel, R. R., Sempos, C. T., McDowell, M. A., Chein, S., & Alaimo, K. (1997). Dietary methods research in the Third National Health and Nutrition Examination Survey: underreporting of energy intake. *American Journal of Clinical Nutrition, 65*, 1203S-1209S.

Champagne, C. M., Bray, G. A., Kurtz, A. A., Monteiro, J. R. R., Tucker, E., Volaufova, J., & Delany, J. P. (2002). Energy intake and energy expenditure: a controlled study comparing dietitians to non-dietitians. *Journal of the American Dietetic Association, 102*, 1428-1432.

Elwood, P. C., & Bird, G. (1983). A photographic method of diet evaluation. *Human Nutrition and Applied Nutrition,* 37A, 474-477.

Faggiano, F., Vineis, P., Cravanzola, D., Pisani, P., Xompero, G., Riboli, E., & Kaaks, R. (1992). Validation of a method for the estimation of food portion size. *Epidemiology, 3,* 397-382.

Frobisher, C., & Maxwell, S. M. (2003). The estimation of food portion sizes: a comparison between using descriptions of portion sizes and a photographic food atlas by children and adults. *Journal of Human Nutrition and Dietetics, 16*, 181-188.

Goris, A. H. C., Meijer, E. P., & Westerterp, K. R. (2001). Repeated measurement of habitual food intake increases under-reporting and induces selective under-reporting. *British Journal of Nutrition, 85*, 629-634.

Hallfrisch, J., Steele, P., & Cohen, L. (1982). Comparison of seven-day diet record with measured food intake of twenty-four subjects. *Nutrition Research*, 2, 263-273.

Harnack, L., Steffen, L., Arnett, D. K., Gao, S., & Luepker, R. V. (2004). Accuracy of estimation of large food portions. *Journal of the American Dietetic Association, 104,* 804-806.

Heitmann, B. L., & Lissner, L. (1995). Dietary underreporting by obese individuals-is it specific or non-specific? *British Medical Journal, 311,* 986-989.

Herbert, J. R., Clemow, L., Pbert, L., Ockene, I. S., & Ockene, J. K. (1995). Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. *International Journal of Epidemiology, 24*, 389-398.

Hogbin, M., & Hess, M. (1999). Public confusion over food portions and servings. *Journal of the American Dietetic Association, 34*, 879-883.

Howat, P. M., Mohan, R., Champagne, C., Monlezun, C., Wozniak, P. & Bray G. A. (1994). Validity and reliability of reported dietary intake data. *Journal of the American Dietetic Association, 94*, 169-173.

Jain, M., Howe, G. R., & Rohan, T. (1996). Dietary assessment in epidemiology: comparison of a food frequency and a diet history questionnaire with a 7-day food record. *American Journal of Epidemiology, 143,* 953-960.

Kaczkowski, C. H., Jones, P. J. H., Feng, J., & Bayley, H., S. (2000). Four-day multimedia diet records underestimate energy needs in middle-aged and elderly women as determined by doubly-labeled water method. *Journal of Nutrition, 130*, 802-805.

Lansky, D., & Brownell, K. D. (1982). Estimates of food quantity and calories: errors in self-report among obese patients. *American Journal of Clinical Nutrition, 35,* 727-732.

Lichtman, S. W., Pisarska, K., Berman, E. R., Pestone, M., Dowling, H., Offenbacher, E., Weisel, H., et al., (1992). Discrepancy between self-reported and actual caloric intake and exercise in obese subjects. *New England Journal of Medicine, 327*, 1893-1898.

Lissner, L. (2002). Part D. New approaches to assessing diets of diverse populations measuring food intake in studies of obesity. *Public Health Nutrition, 5*, 889-892.

Livingstone, M. B. E., & Black, A. E. (2003). Markers of the validity of reported energy intake. *Journal of Nutrition, 133*, 895S-920S.

Macdiarmid, J. I., & Blundell, J. E. (1997). Dietary under-reporting: what people say about recording their food intake. *European Journal of Clinical Nutrition, 51*, 199-200.

Martin, C. K., Newton, R. L., Anton, S. D., Allen, H. R., Alfonso, A., Han, H., Stewart., T. et al., (2007). Measurement of children's food intake with digital photography and the effects of second servings upon food intake. *Eating Behaviors*, 8, 148-156.

Martin, L. J., Su, W., Jones, P. J., Lockwood, G. A., Tritchler, D. L., & Boyd, N. F. (1996). Comparison of energy intakes determined by food records and doubly labeled water in women participating in a dietary-intervention trial. *American Journal of Clinical Nutrition, 63*, 483-490.

Mullen, B. J., Krantzler, N. J., Grivetti, L. E., Schutz, H. G., & Meiselman, H. L. (1984). Validity of a food frequency questionnaire for the determination of individual food intake. *American Journal of Clinical Nutrition, 39*, 136-143.

Mertz, W., Tsui, J. C., Judd, J. T., Reiser, S., Hallfrisch, J., Morris, E. R., Steele, P. D., et al., (1991). What are people really eating? The relation between energy intake derived from estimated diet records and intake determined to maintain body weight. *American Journal of Clinical Nutrition, 54*, 291-295.

Rebro, S. M., Patterson, R. E., Kirstal, A. R., & Cheney, C. L. (1998). The effect of keeping food records on eating patterns. *Journal of the American Dietetic Association, 98*, 1163-1165.

Riboli, E., Elmstahl, S., Saracci, R., Gullberg, B. & Lindgarde, F. (1997). The Malmo food study: validity of two dietary assessment methods for measuring nutrient intake. *International Journal of Epidemiology*, 26, 161-173.

Rose, F., & Williams, R. (1961). Metabolic balance studies on large and small eaters. *British Journal of Nutrition, 15*, 1-9

Schoeller, D. A. (1995). How accurate is self-reported dietary energy intake? *Nutrition Reviews, 48,* 373-379.

Schwartz, J., & Byrd-Bredbenner, C. (2006). Portion distortion: typical portion sizes selected by young adults. *Journal of the American Dietetic Association, 106*, 1412-1418.

Sorenson, A. W., Calkins, B. M., Connolly, M. A., & Diamond, E. (1985). Comparison of nutrient intake determined by four dietary intake instruments. *Journal of Nutrition Education 17*, 92-99.

Streit, J., Stevens, V., & Stevens, J. (1991). Food records: a predictor and modifier of weight change in a long-term weight loss program. *Journal of the American Dietetic Association, 91*, 213-217.

Swanson, M. (2008). Digital Photography as a tool to measure school cafeteria consumption. *Journal of School Health, 78,* 432-437.

Wang, D. H., Kogashewa, M., Ohta, S., & Kira, S. (2002). Validity and reliability of a dietary assessment method: the application of a digital camera with a mobile phone card attachment. *Journal of Nutritional Sciences and Vitaminology*, 48, 498-504.

Wang, D. H., Kogashiwa, M., & Kira, S. (2006). Development of a new instrument for evaluating individuals dietary intakes. *Journal of the American Dietetic Association,* 106, 1588-1593.

Weber, J., Tinsley, A., Houtkooper, L., & Lohman, T. (1997). Multimethod training increases portion-size estimation accuracy. *Journal of the American Dietetic Association, 22*, 882-885.

Williamson, D. A., Allen, H., Martin, P. D., Alfons, A. J., Gerald, B., & Hunt, A. (2003). Comparison of digital photography to weighed and visual estimation of portion sizes. *Journal of the American Dietetic Association*, *103*, 1139-1145.

Yon, B. A., Johnson, R. K., Harvey-Berino, J., & Gold, B. C. (2006). The use of a personal digital assistant for dietary self-monitoring does not improve the validity of self-reports of energy intake. *Journal of the American Dietetic Association*, *106*, 1256-1259.

Appendix

Additional Tables

Table 8: Mean Estimated Values by Method for Calories and Macronutrients for Each of the Twelve Meals and Four Diet Records Sets

Set and Method	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
Meal 4					
DP	203±73.59	2.31±1.96	44.54±19.10	3.9±0.98	5.8±1.80
FRDP	220.4 ±45.50	2.67±0.74	47.31±11.32	5.2±1.87	6.5 ± 1.59
DPR	184.75±73.46	2.25±2.44	40.76±14.13	3.4±1.70	3.4±1.69
FR	279±10.92	3.05±0.19	60.53±2.56	6.13±0.27	7.54±1.12
Meal 8					
DP	615.86±122.15	31.44±11.70	58.56±15.88	25.64±5.92	13.84±5.99
FRDP	524.27±73.72	26.19±5.95	54.95±11.77	18.9±2.97	12.06±2.86
DPR	646.58±168.65	35.86±12.60	55.27±17.55	26.18±9.00	11.95±3.65
FR	468.77±74.58	20.47±7.00	56.35±10.40	16.95±2.62	12.36±2.76
Meal 3					
DP	523.21±147.66	21.86±10.57	54.35±19.73	30.2±4.88	3.59±1.14
FRDP	546.09±98.71	22.89±4.51	22.89±4.51	63.8±15.24	24.75±2.85
DPR	632.08±131.21	27.64±7.29	67.34±22.78	33.26±9.99	3.83±2.17
FR	612.85±106.48	25.19±4.68	74.21±19.76	26.6±3.36	4.51±1.93
SET 1					
DP	1342.1±271.9	55.6±17.5	157.4±36.7	59.7±7.6	23.2±6.9
FRDP	1290.8±164.6	51.8±8.0	166.1±28.1	48.9±5.2	22.25±3.9
DPR	1480.5±264.7	66.7±13.9	164.1±34.4	63.9±17.5	21.2±6.2
FR	1360.6±126.6	48.7±9.08[$]	191.1±24.3	49.7±3.8[*]	24.4±4.0
SET TWO					
Meal 1					
DP	464.18±67.97	21.96±6.03	50.68±7.79	17.46±4.19	1.21±0.29
FRDP	509.38±53.24	23.07±4.65	55.88±11.40	21.15±9.69	1.19±0.31
DPR	508.29±103.90	24.74±7.54	54.48±7.92	18.23±4.30	1.13±0.27
FR	499.67±31.48	21.90±1.84	59.60±6.15	15.51±2.19	1.3±0.28
Meal 2					
DP	480.45±193.18	23.77±13.72	37.79±14.93	30.65±8.39	5.86±1.68
FRDP	778.92±144.65	41.54±10.14	56.36±17.15	46.83±10.02	8.7±1.83
DPR	680.64±121.10	36.38±9.71	49.19±10.70	40.95±12.66	6.79±2.61
FR	864.67±164.37	45.68±12.10	68.25±19.79	44.92±5.37	9.2±1.93
Meal 5					
DP	615.45±148.64	24.65±8.55	61.81±17.29	35.66±8.15	4.71±2.10
FRDP	586.77±83.61	20.86±4.45	69.88±21.73	28.7±13.73	3.88±1.14
DPR	656.14±180.95	28.3±13.95	62.27±10.81	36.26±13.35	4.41±1.23
FR	649.5±99.06	25.45±7.05	69.93±10.17	29.45±6.43	4.03±0.71
SET 2					
DP	1560.1±333.4	70.4±19.2	150.3±33.9	83.8±12.6	11.8±2.2
FRDP	1875.1±166.8	85.5±14.6	182.1±33.1	96.7±30.6	13.8±1.9
DPR	1845.1±242.7	89.4±19.6	165.9±20.2	95.4±22.3	12.3±3.1

FR	2013.8±115.5	93.0±10.5	197.8±12.9	92.9±6.2	14.5±1.9
SET THREE					
Meal 10					
DP	794.5±221.59	36.66±10.08	93.55±32.88	23.77±7.77	5.79±1.39
FRDP	763.38±86.09	27.92±4.27	108.9±13.98	21.51±1.36	4.81±10.7
DPR	849.46±167.11	39.85±14.90	99.27±21.10	25.56±7.12	5.13±1.78
FR	719.73±54.24	26.58±1.61	101.11±12.79	21.55±0.66	4.32±0.47
Meal 11					
DP	431.33±104.98	22.25±4.36	41.73±12.81	16.33±4.82	3.17±1.03
FRDP	486.57±162.44	25.58±7.77	45.81±25.27	18.7±6.73	3.93±1.19
DPR	509.85±171.85	25.5±8.17	52.09±22.75	18.92±6.23	3.25±1.35
FR	435.82±75.18	25.15±5.63	36.72±10.37	17.16±3.78	4.73±2.21
Meal 6					
DP	911.08±308.99	31.42±15.66	96.38±46.21	62.14±34.79	7.69±2.69
FRDP	572.64±104.59	21.46±5.54	72.18±17.73	28.59±3.10	7.69±2.73
DPR	685.08±191.23	23.5±8.14	80.39±34.41	40.02±17.19	7.85±6.07
FR	566.73±87.89	19.27±4.06	72.55±15.11	28.96±1.96	7.87±1.51
SET 3					
DP	2136.9±453.3	90.3±21.5	231.6±66.4	102.2±35.5	16.6±3.9
FRDP	1822.6±211.3	74.9±8.5	226.9±39.7	28.8±7.2	16.4±3.4
DPR	2044.4±274.5	88.8±21.2	231.7±35.6	84.5±17.3	16.2±6.4
FR	1722.3±108.7	71±6.7	210.4±12.3	27.7±4.3	16.9±2.8
SET FOUR					
Meal 7					
DP	322.38±83.15	6.26±4.02	63.5±15.43	7.42±8.36	3.04±0.90
FRDP	454.17±65.51	10.6±1.93	85.95±12.06	6.87±1.35	4.03±1.14
DPR	308.36±71.99	7.38±3.17	58.13±13.18	4.93±1.16	3.49±1.42
FR	528.57±66.19	13.29±3.56	98.16±10.61	7.79±0.80	5.07±0.50
Meal 12					
DP	627.46±134.72	20.45±7.34	76.78±17.44	36.47±9.10	10.78±3.35
FRDP	731.75±48.09	27.37±2.61	86.23±11.96	36.76±4.78	15.31±1.92
DPR	610.82±142.82	20.68±7.94	76.06±22.86	33.52±9.09	11.25±4.13
FR	667.29±52.42	23.36±3.74	82.13±13.71	33.89±4.10	14.66±2.10
Meal 9					
DP	527.38±126.27	21.72±8.54	67.39±20.23	18.37±6.28	3.98±1.49
FRDP	499.17±109.09	14.53±7.33	84.52±18.34	16.63±2.75	3.89±0.82
DPR	545±106.97	17.85±5.88	81.56±14.37	19.89±4.93	4.67±1.38
FR	542.14±95.73	47.35±81.46	81.49±14.29	16.32±3.51	3.69±0.52
SET 4					
DP	1477.2±210.6	48.4±12.9	207.7±32.3	62.2±15.1	17.8±3.7
FRDP	1685.1±129.7	52.5±9.4	256.7±24.7	60.3±5.6	23.2±2.8
DPR	1464.2±228.4	45.9±9.8	215.7±39.7	58.3±7.9	19.4±5.6
FR	1738±134.2	84±106.6	261.8±26.5	58.0±5.9	23.4±2.2

Mean and standard deviation for each nutrient. DP=Digital photograph alone, FRDP=food record with digital photograph, DPR=Digital Photograph with limited recording, FR=food record alone; Group A N=13, Group B N=11, Group C N=14, Group D N=12

Table 9: Weighed Record Values for 12 Meals and 4 Sets

Meal/Set	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
Meal 4	246	2.9	53.3	5.3	6.9
Meal 8	507	18	68.4	20.4	13.8
Meal 3	774	33.9	84.8	29.4	10
Set 1	1527	54.8	206.5	55.1	30.7
Meal 1	511	28	51.5	17.7	0.8
Meal 2	839	38.4	71	53.1	7.3
Meal 5	451	14.2	52.3	25.1	2.3
Set 2	1801	80.6	174.8	95.9	10.4
Meal 10	691	26.1	95.4	20.4	4.2
Meal 11	600	32.3	48.7	25.84	1.5
Meal 6	628	23.6	80	31.1	8.6
Set 3	1919	82	224.1	77.34	14.3
Meal 7	588	15	78.1	6.4	3.4
Meal 12	464	15.2	53.5	30.9	7.3
Meal 9	580	20.8	87.2	32	8.6
Set 4	1632	51	218.8	69.3	19.3

Table 10: Mean (±SD) Estimated Relative Values by Method for Each of the Twelve Meals and Four Diet Record Sets

Set/Meal	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
Meal 4					
DP	-43±73.59	-0.59±1.97	-8.76±19.10	-1.4±0.98	-1.1±1.80
DPR	-61.25±43.46	-0.68±2.44	-12.58±14.13	-1.9±1.7	-0.92±2.46
FR	33±10.92	0.15±0.19	7.23±2.56	0.83±0.27	0.64±1.12
FRDP	-25.55±45.50	-0.23±0.74	-5.99±11.33	-0.1±1.87	-0.34±1.59
Meal 8					
DP	108.86±122.15	13.44±11.70	-9.84±15.88	5.24±5.92	0.04±5.99
DPR	139.58±168.65	17.86±12.60	-13.13±17.55	5.78±9.00	-1.85±3.65
FR	-38.23±74.58	2.47±6.99	-12.05±10.40	-3.44±2.62	-1.44±2.76
FRDP	17.27±73.72	8.19±5.94	-13.45±11.77	-1.5±2.97	-1.74±2.86
Meal 3					
DP	-250.79±147.66	-12.04±10.58	-30.45±19.73	0.8±4.88	-6.41±1.14
DPR	-141.92±131.21	-6.26±7.29	-17.46±22.78	3.86±9.99	-6.18±2.7
FR	-161.15±106.48	-8.71±4.68	-10.59±19.76	-2.8±3.36	-5.50±1.93
FRDP	-227.91±98.71	-11.01±4.51	-21±15.24*	-4.65±2.85	-6.38±1.50
Set 1					
DP	272.1±176.3	14.0±9.7	54.9±26.2	7.9±3.7	8.8±4.9
DPR	204±164.3	12.9±12.9	42.7±33.9	12.8±14.6	9.8±5.7
FR	179.1±106.0	8.4±6.7	26.2±10.2	5.5±3.6	6.4±3.7
FRDP	247.6±144.9	6.7±4.9	43.9±21.6	6.5±4.9	8.5±3.9

Meal 1					
DP	-46.82±67.97	-6.04±6.03	-0.82±7.79	-0.24±4.19	0.41±0.29
DPR	-2.71±103.90	-3.26±7.54	2.98±7.92	0.53±4.3	0.33±0.27
FR	-11.33±31.48	-6.1±1.84	8.1±6.15	0.81±2.10	-0.5±0.28
FRDP	-1.62±53.24	-4.93±4.65	4.38±11.40	3.45±9.69	0.39±0.08
Meal 2					
DP	-358.55±193.18	-14.63±13.72	-33.21±14.93	-22.45±8.39	-1.44±1.68
DPR	-158.36±121.10	-2.02±9.71	-21.81±10.71	-12.15±12.65	-0.51±2.61
FR	25.67±164.37	7.28±12.10	-2.75±19.79	-8.18±5.37	1.9±1.94
FRDP	-60.08±144.65	3.14±10.14	-14.64±17.15	-6.27±10.02	1.4±1.83
Meal 5					
DP	164.45±148.64	10.45±8.55	9.51±17.28	10.56±8.15	2.41±2.10
DPR	205.14±180.95	14.1±13.95	9.97±10.81	11.16±13.35	2.11±1.23
FR	198±99.06	11.25±7.05	17.63±10.17	4.35±6.43	1.73±0.71
FRDP	135.77±83.61	6.66±4.45	17.58±21.73	3.6±13.73	1.58±1.14
Set 2					
DP	373.3±147.4	18.9±9.4	35.8±20.1	14.3±9.8	1.8±1.7
DPR	199.8±134.2	17.3±11.9	18.5±11.1	16.5±14.3	2.2±2.9
FR	212.8±115.5	14.4±7.3	22.9±12.9	5.4±4.2	4.1±1.9
FRDP	150.2±96.5	12.6±8.1	25.5±21.1	18.1±24.1	3.4±1.8
Meal 10					
DP	103.5±221.59	10.56±10.08	-1.85±32.88	3.37±7.77	1.59±1.39
DPR	158.46±167.11	13.75±14.90	3.87±24.10	5.16±7.12	0.93±1.79
FR	28.73±54.24	0.48±1.61	5.71±12.79	1.15±0.66	0.12±0.47
FRDP	86.09±3.15	4.27±1.6	13.5±13.99*	1.11±1.36	0.61±1.07
Meal 11					
DP	-168.67±104.98	-10.05±4.36	-6.98±12.81	-9.52±4.82	1.67±1.03
DPR	-90.15±171.85	-6.8±8.17	3.39±22.75	-6.92±6.32	1.75±1.35
FR	-164.18±75.18	-7.15±5.63	-11.98±10.37	-8.68±3.79	3.23±2.21
FRDP	-113.43±162.44	-6.72±7.77	-2.89±25.27	-7.14±6.73	2.43±1.19
Meal 6					
DP	283.08±309	7.82±15.66	16.73±46.21	31.04±34.97	-0.91±2.70
DPR	57.08±191.23	-0.1±8.13	0.39±39.41	8.92±17.19	-0.75±6.07
FR	-61.27±87.89	-4.43±4.06	-7.45±15.12	-2.14±1.96*	-0.73±1.51
FRDP	-55.36±104.59	-2.14±5.54	-7.82±17.73	-2.51±3.1	-0.91±2.73
Set 3					
DP	429.8±236.2	18.3±13.1	50.6±41.0	33.8±26.2	3.5±2.8
DPR	207.1±214.4	18.1±11.9	25.9±24.4	12.8±13.4	4.7±4.6
FR	196.7±108.7	11±6.7	14.5±11.3	9.7±4.3	2.8±2.6
FRDP	197.6±112.3	9.1±6.1	26.0±29.3	9.7±5.4	2.8±2.8
Meal 7					
DP	-265.62±83.15	-8.74±4.02	-14.6±15.43	1.02±8.36	-0.36±0.90
DPR	-279.64±71.99	-7.62±3.17	-19.97±13.18	-1.47±1.16	0.09±1.42
FR	-59.43±66.19	-1.71±3.56	20.06±10.61	1.39±0.80	1.67±0.50
FRDP	-133.83±65.51	-4.4±1.93	7.85±12.06	0.47±1.35	0.63±1.14

Meal 12					
DP	163.46±134.71	5.25±7.34	23.28±17.44	5.57±9.10	3.48±3.35
DPR	146.82±142.82	5.48±7.94	22.56±22.86	2.62±9.09	3.95±4.13
FR	203.29±52.42	8.15±3.74	28.63±13.71	2.99±4.10	7.36±2.10
FRDP	267.75±48.10	12.17±2.61	32.73±11.96	5.86±4.78	8.01±1.92
Meal 9					
DP	-52.62±126.27	0.92±8.51	-19.81±20.22	-13.63±6.28	-4.62±1.49
DPR	-35±106.97	-2.95±5.88	-5.64±14.37	-12.11±4.93	-3.93±1.39
FR	-37.86±95.73	26.55±102.42	-5.74±14.29	-15.68±3.51	-4.91±0.52
FRDP	-80.83±109.89	-6.28±7.33	-2.68±18.34	15.37±2.75	-4.71±0.82
Set 4					
DP	-154.8±210.5	-2.6±12.9	11.3±32.3	-7.0±15.1	-1.5±3.7
DPR	-167.8±228.4	-5.2±9.8	-3.0±39.7	-10.9±7.9	0.1±5.6
FR	106±134.2	33±106.6	42.9±26.5	-11.3±5.9	4.1±2.2
FRDP	53.1±129.7	1.5±9.4	37.9±24.7	-9.0±5.6*	3.9±2.8

Group A N=13, Group B N=11, Group C N=14, Group D N=12

Table 11: Mean (±SD) Estimated Absolute Values by Method for Each of the Twelve Meals and Four Diet Record Sets

Set/Meal	Calorie (kcal)	Fat (g)	CHO (g)	PRO (g)	Fiber (g)
Meal 4					
DP	75.4±35.8	1.4±1.4	18.2±9.5	1.4±0.9	1.7±1.1
DPR	85.8±38.3	1.9±1.6	16.5±8.7	2.1±1.4	2.0±1.5
FR	33±10.9	0.2±0.1	7.2±2.6	0.8±0.3	0.9±0.8
FRDP	43±27.5	0.6±0.5	9.8±7.8	1.45±1.1	1.1±1.2
Meal 8					
DP	136.6±87.2	15.6±8.2	13.8±12.2	6.8±3.9	4.2±4.2
DPR	154.1±154.3	17.7±12.6	17.6±12.5	7.1±7.9	3.5±1.9
FR	64.8±50.9	6.5±3.1	14.37±6.5	3.7±2.1	2.6±1.6
FRDP	58.5±44.6	8.12±5.9	14.2±10.7	2.5±2.0	2.7±1.9
Meal 3					
DP	251.6±146.1	14.1±7.4	30.5±19.6	3.9±2.9	6.4±1.1
DPR	145.9±126.3	7.3±6.2	22.3±17.5	6.9±7.9	6.2±2.2
FR	177.9±71.9	8.7±4.7	20.7±7.0	3.3±2.7	5.5±1.9
FRDP	228.6±96.8	11.0±4.5	24±9.1	4.6±2.8	6.4±1.5
Set 1					
DP	272.1±176.3	14.0±9.7	54.9±26.2	7.9±3.7	8.8±4.9
DPR	204±164.3	12.9±12.9	42.7±33.9	12.8±14.6	9.8±5.7
FR	179.1±106.0	8.4±6.7	26.2±10.2	5.5±3.6	6.4±3.7
FRDP	247.6±144.9	6.7±4.9	43.9±21.6	6.5±4.9	8.5±3.9
Meal 1					
DP	65.9±47.5	6.7±5.2	5.9±4.8	2.7±3.1	0.4±0.3
DPR	76.7±66.8	7.5±2.9	7.0±4.4	2.7±3.3	0.3±0.3
FR	25±21.2	6.1±1.8	8.1±6.1	1.8±1.2	0.5±0.3
FRDP	38.2±35.4	6.1±2.8	9.2±7.6	3.9±9.5	0.4±0.3
Meal 2					
DP	378.5±145.3	17.9±8.3	33.2±14.9	22.4±8.4	1.9±1.0
DPR	165.8±109.9	8.0±5.4	21.8±10.7	15.7±7.3	2.1±1.5
FR	129.2±97.7	12.1±6.6	12.9±14.8	8.2±5.4	2.4±1.1
FRDP	128.8±82.7	9.3±4.4	15.8±15.94	10.3±5.3	2.0±1.0

Meal 5					
DP	171.2±140.0	11.7±6.5	13.7±13.8	10.6±8.1	2.4±2.1
DPR	226.6±150.9	15.7±11.9	12.2±7.9	12.5±12.0	2.1±1.2
FR	204.2±85.6	11.2±7.0	18.5±8.4	4.6±6.3	1.7±0.7
FRDP	135.8±83.6	6.7±4.4	23.8±13.9	7.9±11.6	1.7±0.9
Set 2					
DP	373.3±147.4	18.9±9.4	35.8±20.1	14.3±9.8	1.8±1.7
DPR	199.8±134.2	17.3±11.9	18.5±11.1	16.5±14.3	2.2±2.9
FR	212.8±115.5	14.4±7.3	22.9±12.9	5.4±4.2	4.1±1.9
FRDP	150.2±96.5	12.6±8.1	25.5±21.1	18.1±24.1	3.4±1.8
Meal 10					
DP	198.7±133.1	12.8±6.6	27.1±16.8	6.6±5.0	1.9±0.9
DPR	163.7±161.6	14.5±14.1	19.4±13.8	5.7±6.6	1.2±1.6
FR	52.5±28.5	1.2±1.3	12.2±5.9	1.1±0.7	0.4±0.2
FRDP	102.1±42.8	3.6±2.8	18.2±5.8	1.3±1.2	0.9±0.8
Meal 11					
DP	184.3±70.6	10.0±4.4	11.4±8.6	9.9±3.6	1.7±1.0
DPR	163.8±96.2	8.46±6.3	17.3±14.3	7.8±5.0	1.7±1.3
FR	164.2±75.2	7.2±5.5	14.2±6.5	8.7±3.8	3.2±2.2
FRDP	164.9±104.8	8.4±5.8	16.5±18.8	8.7±4.3	2.4±1.2
Meal 6					
DP	335.2±245.5	11.5±12.9	32.8±35.4	35.9±29.3	2.4±1.4
DPR	168.8±96.1	7.1±3.4	27.7±26.9	13.0±14.1	4.4±4.0
FR	89.8±54.6	5.4±2.1	14.6±7.4	2.5±1.4	1.3±0.9
FRDP	93.9±68.8	4.9±2.9	15.7±10.6	3.2±2.2	2.2±1.8
Set 3					
DP	429.8±236.2	18.3±13.1	50.6±41.0	33.8±26.2	3.5±2.8
DPR	207.1±214.4	18.1±11.9	25.9±24.4	12.8±13.4	4.7±4.6
FR	196.7±108.7	11±6.7	14.5±11.3	9.7±4.3	2.8±2.6
FRDP	197.6±112.3	9.1±6.1	26.0±29.3	9.7±5.4	2.8±2.8
Meal 7					
DP	265.6±83.2	8.7±4.0	18.8±9.2	3.6±7.5	0.8±0.5
DPR	279.6±71.9	7.6±3.2	22.5±7.3	1.7±0.8	1.1±0.9
FR	64±6.43	3.4±1.8	22.4±1.8	1.4±0.7	1.7±0.5
FRDP	133.8±65.1	4.4±1.9	12.7±6.0	0.9±1.0	1.2±0.5
Meal 12					
DP	167.8±128.9	7.2±5.3	23.3±17.4	8.1±6.7	3.6±3.2
DPR	169.7±111.5	7.4±6.0	23.2±22.2	7.5±5.3	4.0±4.0
FR	203.3±52.4	8.5±3.7	28.6±13.7	4.4±2.4	7.4±2.1
FRDP	267.7±48.1	12.2±2.6	32.7±11.9	6.2±4.3	8.0±1.9
Meal 9					
DP	106.5±81.6	5.5±6.4	22.7±16.7	13.6±6.3	4.6±1.5
DPR	89±6.86	5.7±3.8	11.8±9.3	12.1±4.9	3.9±1.4
FR	76.9±65.9	33.7±100.1	10.7±10.7	15.7±3.5	4.9±0.5
FRDP	112±72.3	9.2±2.2	13.0±12.6	15.4±2.7	4.7±0.8
Set 4					
DP	207.5±153.7	10.8±6.9	26.7±20.1	13.4±9.3	3.3±2.2
DPR	229.5±158.9	9.2±5.6	33.2±19.2	11.5±7.2	4.8±2.6
FR	144.4±87.4	35.9±105.6	42.9±26.5	11.8±4.6	4.2±2.1
FRDP	108.6±83.8	6.1±7.1	38.8±23.2	9.26±5.2	4.3±2.2

Group A N=13, Group B N=11, Group C N=14, Group D N=12

Digital Photograph Records-Set 1

Meal 3: Breakfast-Before

Meal 3: Breakfast-After

Meal 4: Lunch-Before

Meal 4: Lunch-After

Meal 8: Dinner-Before

Meal 8: Dinner-After

Digital Photograph Records-Set 2

Meal 1: Breakfast-Before

Meal 1: Breakfast-After

Meal 2: Lunch-Before

Meal 2: Lunch-After

Meal 5: Dinner-Before

Meal 5: Dinner-After

Digital Photograph Records-Set 3

Meal 10: Breakfast-Before

Meal 10: Breakfast-After

Meal 11: Lunch-Before

Meal 11: Lunch-After

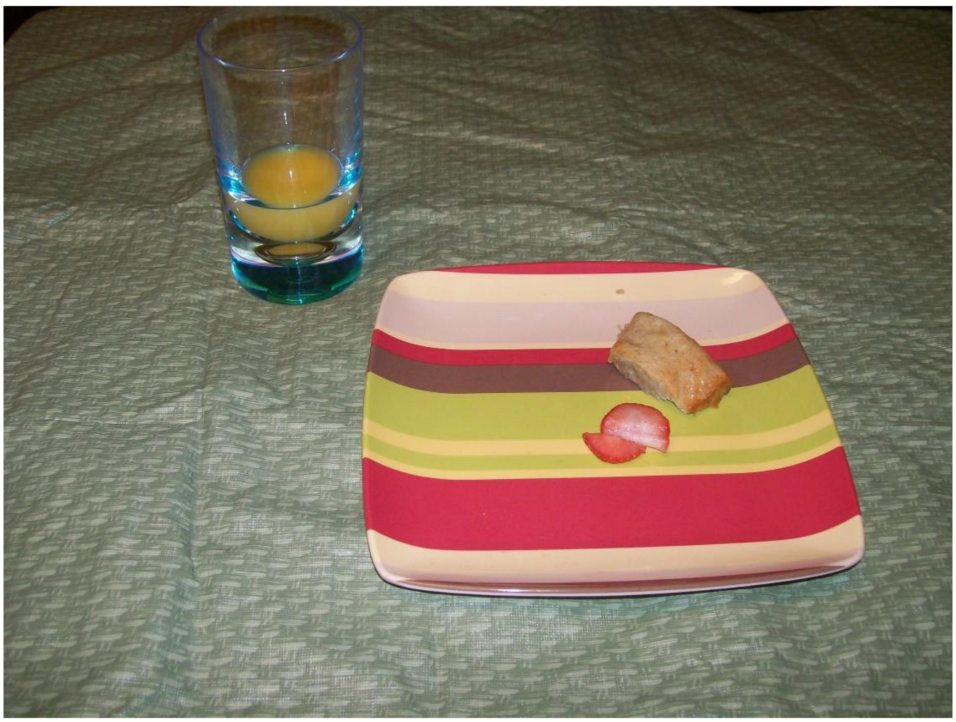
Meal 6: Dinner-Before

Meal 6: Dinner-After

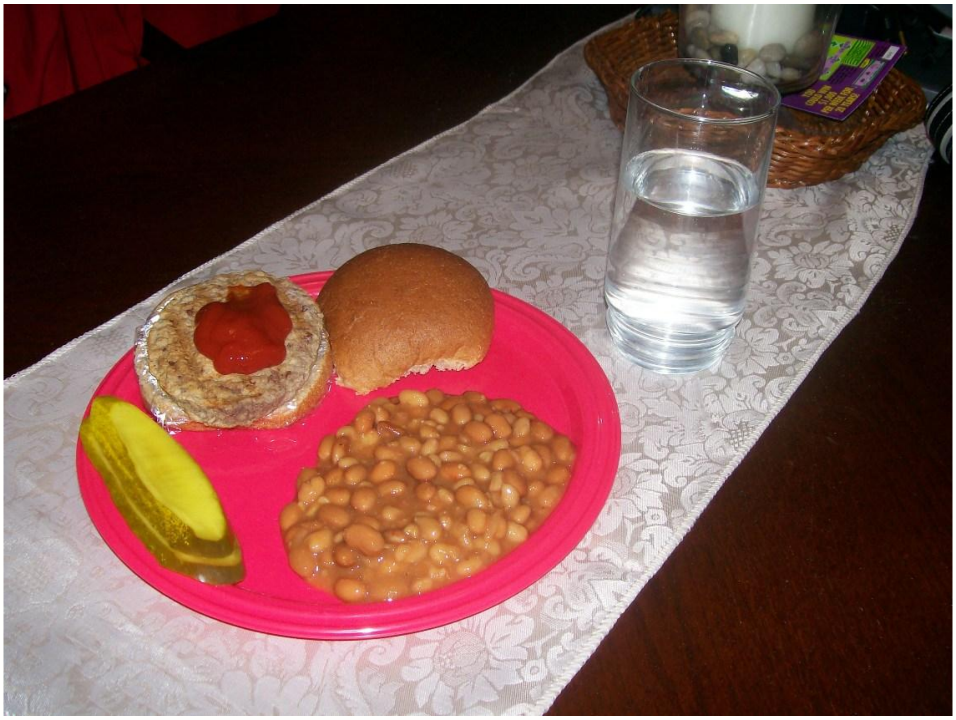
Digital Photograph Records-Set 4

Meal 7: Breakfast-Before

Meal 7: Breakfast-After



Meal 12: Lunch-Before



Meal 12: Lunch-After

Meal 9: Dinner-Before

Meal 9: Dinner-After

Initial Survey for Registered Dietitian

Please fill out the following survey as a prelude to beginning the study.

Personal Information:

Age: ______ years

Height: ______ ft ______in OR ______ meters

Weight: ______ lb OR ______ kg

Sex: ☐ Female ☐ Male

Job Demographics:

1. How many years have you been working as a registered dietitian?

☐ <1y ☐ 1-5y ☐ 6-10y ☐ 11-15y ☐ 16-20y ☐ >20y

2. Institution where you completed your registered dietitian training? ______

Was it a ☐ coordinated program or ☐ separate internship?

3. What is your highest degree earned?

☐ BAS/BS/BA ☐ MAS/MS/MA ☐ PhD/EdD ☐ other ______

4. What is your current job setting?

☐ acute care ☐ long-term care ☐ private practice

☐ outpatient, please specify ______ ☐ Other ______

5. What are your primary job responsibilities? ______

6. On average, how many meal records do you code?

☐ none ☐ 1-5/month ☐ 6-10/month ☐ >10/month

7. What software do you normally use to code food records? ______

Follow-up Survey: Registered Dietitian

After having coded in each of four methods, please answer a few questions about your experience with them.

1. Which method of dietary assessment was easiest to input codes (took the least amount of time, easiest to read/see/understand)?
   ☐ digital photo alone ☐ digital photo with diary
   ☐ diary alone ☐ photo with limited information

   Which was the most difficult?
   ☐ digital photo alone ☐ digital photo with diary
   ☐ diary alone ☐ photo with limited information

   Comments: ______

2. Please rank the four dietary assessment methods according to your ability to accurate evaluate an individual's food intake (1 = most accurate; 4 = least accurate).
   ______ Digital photograph alone
   ______ Food record alone
   ______ Digital photograph with limited information
   ______ Digital photograph combined with food records

   Comments: ______

3. Would you use these methods with patients/client in your own job setting?

Digital photograph alone	☐ yes	☐ no
Food record alone	☐ yes	☐ no
Digital photograph with limited information	☐ yes	☐ no
Digital photograph combined with food records	☐ yes	☐ no

4. Which method of dietary assessment did you prefer?
   ☐ digital photo alone ☐ digital photo with diary
   ☐ diary alone ☐ photo with limited information

   Please explain why? ______

Registered Dietitian Informed Consent

University of Texas at El Paso (UTEP) Institutional Review Board

Informed Consent Form for Research Involving Human Subjects

Protocol Title: Comparison of Four Methods of Dietary Assessment: Food Records vs. Combined Food Records with Digital Photography vs. Digital Photography with Limited Documentation vs. Digital Photography Alone

Principal Investigator: Sara Peidle RD, LD, Department of Kinesiology

George A. King PhD, Department of Kinesiology

UTEP: Kinesiology Department

1. Introduction

You are being asked to take part voluntarily in the research project described below. Please take your time making a decision and feel free to discuss it with your friends and family. Before agreeing to take part in this research study, it is important that you read the consent form that describes the study. Please ask the study researcher or the study staff to explain any words or information that you do not clearly understand.

2. Why is this study being done?

You have been asked to take part in a research study that compares four methods of dietary assessment. The methods include hand-written food records, hand-written food records with the addition of digital photography of all foods recorded, digital photography of foods eaten alone, and digital photography with limited documentation of difficult to identify items (i.e. diet soda).

Approximately, 60 dietitians will be enrolling in this study at UTEP.

You are being asked to be in the study because you are a registered dietitian with a minimum of one-year experience actively working in the field of dietetics and are a member of the American Dietetic Association.

If you decide to enroll in this study, your involvement will last about four weeks.

3. What is involved in the study?

If you agree to take part in this study, the research team will send (via email) a set of 3 dietary records in one of the above mentioned formats on 4 separate occasions. Your are asked to analyze the meals for total calories, grams of fat, grams of protein, grams of carbohydrate, and grams of fiber and return within 1 week. In addition, all codes used in the nutrient analysis system need to be retained for the researcher (i.e. cup of rice, (Uncle Bens)). You are asked to evaluate each meal set using a free web-based nutrient analysis system. To access the website, you will be provided. When you returned the meal set, a new meal set will be sent to you for evaluation using the same procedures. You will receive a total of 4 meal sets and you are asked to return your assessment of each within 1 week.

4. What are the risks and discomforts of the study?

There are no known risks associated with this research

5. What will happen if I am injured in this study?

The University of Texas at El Paso and its affiliates do not offer to pay for or cover the cost of medical treatment for research related illness or injury. No funds have been set aside to pay or reimburse you in the event of such injury or illness. You will not give up any of your legal rights by signing this consent form. You should report any such injury to Sara Peidle at 915-760-0174 or George King at 915-747-7284 and to the UTEP Institutional Review Board (IRB) at (915-747-8841) or irb.orsp@utep.edu.

6. Are there benefits to taking part in this study?

There will be no direct benefits to you for taking part in this study. This research may help us to understand how to better obtain accurate meal composition data from individuals.

7. What other options are there?

You have the option not to take part in this study. There will be no penalties involved if you choose not to take part in this study.

8. Who is paying for this study?

Internal Funding:
Funding for this study is provided by UTEP Department of Kinesiology

9. What are my costs?

There are no direct costs to you for participating. However, you may incur some incidental expenses related to internet/email access from your service provider.

10. Will I be paid to participate in this study?

You will not be paid for taking part in this research study.

11. What if I want to withdraw, or am asked to withdraw from this study?

Taking part in this study is voluntary. You have the right to choose not to take part in this study. If you do not take part in the study, there will be no penalty.

If you choose to take part, you have the right to stop at any time. However, we encourage you to talk to a member of the research group so that they know why you are leaving the study. If there are any new findings during the study that may affect whether you want to continue to take part, you will be told about them.

The researcher may decide to stop your participation without your permission, if he or she thinks that being in the study may cause you harm or bias the data in a negative way.

12. Who do I call if I have questions or problems?

You may ask any questions you have now. If you have questions later, you may call Sara Peidle at 915-760-0174 or slpeidle@yahoo.com George King at 915-747-7284 or gking@utep.edu

If you have questions or concerns about your participation as a research subject, please contact the UTEP Institutional Review Board (IRB) at (915-747-8841) or irb.orsp@utep.edu.

13. What about confidentiality?

1. Your part in this study is confidential. None of the information will identify you by name. All records will be maintained solely by the principal researcher and all participants will be identified by only a number.

2. Every effort will be made to keep your information confidential. Your personal information may be disclosed if required by law. Organizations that may inspect and/or copy your research records for quality assurance and data analysis include, but are not necessarily limited to:

- The sponsor or an agent for the sponsor
- Department of Health and Human Services
- UTEP Institutional Review Board

Because of the need to release information to these parties, absolute confidentiality cannot be guaranteed. The results of this research study may be presented at meetings or in publications; however, your identity will not be disclosed in those presentations.

All records will be kept confidential and no information will be shared with anyone outside the research team. All participant data will be coded by number rather than by name. The results of this research will be published; however, no publication will contain information which will allow you to be identified.

14. Mandatory reporting

N/A

15. Authorization Statement

I have read each page of this paper about the study (or it was read to me). I know that being in this study is voluntary and I choose to be in this study. I know I can stop being in this study without penalty. I will get a copy of this consent form now and can get information on results of the study later if I wish.

Please 'reply' to this email stating:

1. "I have read this form, understand its contents, and have been given the opportunity to ask questions to clarify my role in the study."
2. "My reply to this email represents my digital signature indicating that I agree to serve as a participant in this research study."

Masters Thesis Defense

Comparison of Four Methods of Dietary Assessment: Food Records vs. Combined Food Records with Digital Photography vs. Digital Photography alone and Digital Photography with Limited Documentation

Sara Peidle, RD, LD

Friday July 29th @ 3:00

Location: New teaching lab room 136

Curriculum Vita

Sara Peidle was born and raised in Western Pennsylvania and she attended Hiram College in Hiram, OH for only one year before transferring to Youngstown State University (YSU) in Youngstown, OH enrolling in the Coordinated Dietetics program. She completed her Bachelors degree in Food and Nutrition and Coordinated Dietetic Internship from YSU in August of 2005 and passed the registration examination for dietitians via the Commission on Dietetic Registration in early 2006. She began her career at Del Sol Medical University in El Paso, TX as a Clinical Dietitian in March 2006 working on the coronary critical care and telemetry units and educating patients in the outpatient cardiac rehab program. She has also worked for University Medical Center as a clinical dietitian and as a consultant for Choice Home Health Care as well as some private practice on the side. She is also a certified Pilate's trainer and Yoga instructor and has been training clients in El Paso since early 2007. In the fall of 2007 she entered the Graduate School at The University of Texas at El Paso in the Kinesiology Department.

Permanent Address: 5890 Bandolero Dr.

El Paso, TX 79912