Journal Pre-proof

The accuracy of portion size reporting on self-administered online 24-hour dietary recalls among women with low incomes

Sharon I. Kirkpatrick, PhD RD, Associate Professor, Patricia M. Guenther, PhD RD, Research Professor, Carrie Durward, PhD, Associate Professor, Deirdre Douglass, MS RD, Research Nutritionist, Thea Palmer Zimmerman, MS RD, Research Nutritionist, Lisa L. Kahle, BA, Programmer, Abiodun T. Atoloye, PhD, Postdoctoral Research Associate, Michelle L. Marcinow, PhD, Research Associate, Mateja R. Savoie-Roskos, PhD, MPH, RD, Associate Professor, Kirsten A. Herrick, PhD RD, Program Director, Kevin W. Dodd, PhD, Mathematical Statistician

PII: S2212-2672(22)00175-7

DOI: https://doi.org/10.1016/j.jand.2022.03.018

Reference: JAND 55411

To appear in: *Journal of the Academy of Nutrition and Dietetics*

Received Date: 8 July 2020

Revised Date: 27 March 2022

Accepted Date: 30 March 2022

Please cite this article as: Kirkpatrick SI, Guenther PM, Durward C, Douglass D, Zimmerman TP, Kahle LL, Atoloye AT, Marcinow ML, Savoie-Roskos MR, Herrick KA, Dodd KW, The accuracy of portion size reporting on self-administered online 24-hour dietary recalls among women with low incomes, *Journal of the Academy of Nutrition and Dietetics* (2022), doi: https://doi.org/10.1016/j.jand.2022.03.018.

The accuracy of portion size reporting on self-administered online 24-hour dietary recalls among women with low incomes

Keywords: 24-hour dietary recall; portion size; low income; feeding study; validation

Word counts:
Abstract – 318
Text – 4945

Sharon I. Kirkpatrick PhD RD (corresponding author and contact for reprints)
Associate Professor
School of Public Health Sciences
University of Waterloo, Waterloo, ON, Canada
519-888-4567 x37054
sharon.kirkpatrick@uwaterloo.ca

Patricia M. Guenther PhD RD
Research Professor
Department of Nutrition and Integrative Physiology
University of Utah, Salt Lake City, UT
801-449-0726
Patricia.Guenther@utah.edu

Carrie Durward PhD
Associate Professor
Department of Nutrition, Dietetics and Food Sciences
Utah State University, Logan, UT
435-797-5843
carrie.durward@usu.edu

Deirdre Douglass MS RD
Research Nutritionist
Westat
Rockville, MD
240-314-2389
DeirdreDouglass@westat.com

Thea Palmer Zimmerman MS RD
Research Nutritionist
Westat
Rockville, MD
240-314-2413
TheaZimmerman@westat.com

Lisa L. Kahle BA
Programmer
Information Management Services, Inc.
Rockville, MD
717-385-8524
KahleL@imsweb.com

Abiodun T. Atoloye PhD
Postdoctoral Research Associate
Rudd Center for Food Policy and Obesity
University of Connecticut, Hartford, CT
860-380-1210
abiodun.atoloye@uconn.edu

Michelle L. Marcinow PhD
Research Associate
Institute for Better Health
Trillium Health Partners, Mississauga, ON, Canada
416-565-6732
Michelle.Marcinow@thp.ca

Mateja R. Savoie-Roskos PhD, MPH, RD
Associate Professor
Department of Nutrition, Dietetics and Food Sciences
Utah State University, Logan, UT
435-797-5777
mateja.savoie@usu.edu

Kirsten A. Herrick PhD RD
Program Director
Division of Cancer Control and Population Sciences
National Cancer Institute, Bethesda, MD
240-276-5734
kirsten.herrick@nih.gov

Kevin W. Dodd PhD
Mathematical Statistician
Division of Cancer Prevention, National Cancer Institute
Bethesda, MD
240-276-7021
doddk@mail.nih.gov

Author contributions: P.M.G. and C.D. conceived of the study; D.D and T.P.Z. oversaw data collection; S.I.K. and K.W.D. oversaw the analytic approach; and L.L.K. conducted the statistical

analyses. S.I.K. drafted the paper and all authors provided critical edits. S.I.K. had primary responsibility for the final content.

Funding/financial disclosures: Data collection was funded by a grant from the USDA National Institute of Food and Agriculture (2015-09151). The current analyses were supported by the National Cancer Institute. At the time the initial analyses were conducted, Sharon I. Kirkpatrick was supported by a Canadian Cancer Society Research Institute (CCSRI) Capacity Development Award (grant 702855) and Michelle Marcinow was supported by funding from Alberta's Tomorrow Project and the aforementioned CCSRI award.

Conflict of interest disclosure: There are no conflicts of interest to report.

Acknowledgements: The authors gratefully acknowledge valuable advice provided by Dr. Amy F. Subar during the planning of this study. Dr. Subar has provided permission to be acknowledged.

The accuracy of portion size reporting on self-administered online 24-hour dietary recalls among women with low incomes

Research Snapshot

Research Question: What is the accuracy of portion size estimation among women with low incomes who completed Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) recalls, independently or with assistance?

Key Findings: On average across foods and beverages, reported portion sizes were 7.4 grams and 6.4 grams higher than observed portion sizes in the independent and assisted conditions, respectively. Portion sizes were overestimated for small pieces and shaped foods in both conditions, as well as for amorphous/soft foods in the assisted condition, and underestimated for single unit foods in both conditions. Misestimation was fairly consistent by race/ethnicity, education, and body mass index.

The accuracy of portion size reporting on self-administered online 24-hour dietary recalls among women with low incomes

Abstract

Background. Accurately estimating portion sizes remains a challenge in dietary assessment. Digital images used in online 24-hour dietary recalls may be conducive to accuracy.

Objective: The current analyses were conducted to examine the accuracy of portion size estimation by women with low incomes who completed 24-hour dietary recalls using the online Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) in the Food and Eating Assessment STudy (FEAST) II.

Design: True dietary intake was observed for three meals on one day through a controlled feeding study conducted from May through July, 2016. The following day, participants completed an unannounced 24-hour dietary recall using ASA24, independently or with assistance in a small group setting.

Participants/setting. Participants included 302 women aged 18 to 82 years living in the Washington, DC area who met the income thresholds for the Supplemental Nutrition Assistance Program.

Main outcome measures. The accuracy of portion size estimation was assessed by comparing the weight truly consumed (observed) and the weight reported for pre-determined categories of foods and beverages.

Statistical analyses performed. The differences between observed and reported portions were examined and linear regression tested differences by recall condition. Analyses were conducted

by condition and repeated with stratification by racial/ethnic identity, education, and body mass index.

Results. On average across foods and beverages, reported portion sizes were 7.4 grams (95% CI, 4.3-10.5) and 6.4 grams (95% CI, 2.8-10.0) higher than observed portion sizes in the independent and assisted conditions, respectively. Portion sizes were overestimated for small pieces and shaped foods in both conditions, as well as for amorphous/soft foods in the assisted condition and underestimated for single unit foods in both conditions. Misestimation was fairly consistent by participants' race/ethnicity, education, and body mass index, to varying magnitudes.

Conclusions. Women with low incomes overestimated the amounts of foods and beverages consumed across several categories using online 24-hour dietary recalls with digital images to support portion size estimation. Assistance with ASA24 had little impact on accuracy.

The accuracy of portion size reporting on self-administered online 24-hour dietary recalls among women with low incomes

Introduction

The presence of measurement error in self-reported dietary intake data has been extensively studied.[1–6] Given findings suggesting food frequency questionnaires are affected by systematic bias to a larger extent than 24-hour dietary recalls,[2,5,6] there have been efforts to leverage technology to alleviate the burden associated with interviewer-administered recalls. Self-administered 24-hour dietary recall systems, such as the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24) developed in the US and similar instruments developed in other contexts, eliminate the need for highly-trained interviewers and coders, enabling collection of multiple recalls in large-scale studies.[7–11] Online systems can also integrate digital images tailored to specific foods and beverages.[7–12] Nonetheless, error persists in any self-report data and it is important to enhance our understanding of this error to inform improvements to instruments. Errors can occur in reporting of the occurrence or frequency of consumption, estimation in portion size, and in the coding process and underlying food composition databases.

It has long been recognized that the misestimation of portion sizes is likely a major contributor to error in 24-hour dietary recall data.[13,14] Portion size estimation is a complex process, involving perception, conceptualization, and memory.[15] Consequently, a number of portion size estimation aids, including food models, household measures, and food images, have been developed, with a review of validation studies suggesting images may be associated

with higher accuracy than other aids.[16] Prior research suggests portions of different types of foods are reported with differing levels of accuracy.[16] For example, amorphous foods (e.g., pasta, mashed potatoes) may be estimated with less accuracy than those with a defined shape, such as single-unit foods (e.g., bagels, cheese cubes),[14,16,17] and amounts of foods typically eaten in small quantities (e.g., spreads) may be reported less accurately than other types of foods.[15,18] The existing research also provides some indication that individual characteristics may be associated with differential misestimation. For example, in a study focused on food photographs, Nelson et al.[15] found that being female and ≥65 years of age were associated with a small degree of overestimation whereas having a body mass index (BMI) ≥30 kg/m^2 was associated with underestimation of portion size. However, a more recent study found that females estimated portion size more accurately than males, with no differences in relation to education.[19] Researchers have also drawn attention to the need for portion size estimation aids to be relevant to different cultural groups.[20]

Online 24-hour dietary recalls and records take advantage of digital images to facilitate portion size estimation.[8] Unlike traditional interviewer-administered recalls, digital images within online automated platforms can be tailored to specific food and beverage types,[14,21] potentially supporting the accuracy of portion size estimates. Additionally, multiple images can be shown at a time, consistent with Nelson et al.'s[15] finding that a series of eight photographs was associated with small errors in estimation and Subar et al.'s[14] subsequent finding that presenting more images was associated with higher accuracy than presenting fewer images.

Ideally, studies to assess measurement error in estimates of dietary intake should include unbiased reference measures.[22] Controlled feeding studies yield detailed reference data on the

foods and beverages consumed, including amounts in grams. Therefore, they enable examination of the accuracy of portion size estimation (rather than only the overall structure of the measurement error, as is the case in biomarker-based studies). In a prior controlled feeding study of 81 men and women who completed a 24-hour dietary recall independently using ASA24 or an interviewer-administered 24-hour dietary recall,[21] the use of digital images in ASA24 appeared to offer some advantage compared to the US Department of Agriculture Food Model Booklet,[23] three-dimensional measuring cups and spoons, and a ruler. Reported portion sizes were 4 grams higher on average than observed portions for ASA24 dietary recalls and 12 grams higher on average than observed portions for interviewer-administered dietary recalls conducted using the US Department of Agriculture's Automated Multiple-Pass Method.[21] However, it is not known whether the findings are generalizable to key audiences for monitoring and intervention, such as those with low incomes.

The objective of the analyses presented here was to examine the accuracy of portion size reporting by women with low incomes, using ASA24 24-hour dietary recalls completed either independently or with assistance in a controlled feeding study. Accuracy was examined for all foods and beverages, overall and by race/ethnicity, education, and BMI, characteristics shown to be associated with reporting error in other studies.[5,6,15,19] Accuracy was also examined for categories of foods and beverages shown previously to be estimated with varying degrees of error.[14,15,17,18,21,24]

Methods

Data collection was conducted from May through July, 2016.[25] The study was approved by the Institutional Review Board at Utah State University and the Westat Institutional Review Board. Written informed consent was provided by all participants.

Sample

Eligible participants in the Food and Eating Assessment STudy (FEAST) II were women, aged 18 to 82 years, who met the income thresholds for the Supplemental Nutrition Assistance Program.[26] This study focused on individuals with lower incomes to inform the use of ASA24 to evaluate nutrition programs targeted to lower-income groups.[25] Women in particular were included because participants in nutrition education programs, such as the Expanded Food and Nutrition Education Program (EFNEP) and the Supplemental Nutrition Assistance Program Education, are primarily women.[26] Potential participants were recruited from a database of research volunteers living in the Washington, DC area maintained by EurekaFacts. Based on information on sex, age range, and racial/ethnic identity, quota sampling was used to recruit a racially and ethnically diverse sample and an effort was made to oversample women with less than a high school education. Exclusion criteria included being unable to read and understand English or Spanish (the two languages in which ASA24 is available within the U.S.); dietary allergies, practices, or preferences that would interfere with the study protocol; being pregnant; or having previously had bariatric surgery. The target sample size was 300 women, calculated to allow detection of a five percent difference in the proportions of food and beverage items that were truly consumed and accurately reported between the two conditions

(independent completion of ASA24 versus completion of ASA24 with assistance),[25] assuming they were matched on characteristics related to food consumption based on randomization.

A total of 377 participants were eligible, enrolled, and mailed a welcome package, with 306 (81%) participating in the study. Two participants did not complete ASA24, and another two did not complete the demographic questionnaire described below. Excluding these participants resulted in an analytic sample of 302 women.

Ascertainment of observed and reported intake

The methods, including the feeding protocol and menu, followed those of a prior validation study.[21,27] On the first of two consecutive days on which women visited the study center, they were invited to select and consume meal-appropriate foods and beverages from a buffet for each of breakfast, lunch, and dinner and to consume their meals in a communal dining area. The buffet and communal dining area were designed to simulate a conventional eating environment,[14,28] with the overall presentation intended to be similar to how foods and drinks might be encountered at home and in other settings. A range of meal-appropriate foods and beverages were offered (Table 1), with variation in terms of perceived healthfulness (e.g., fresh fruit, brownies, potato chips) and in how amounts can be reported in ASA24 (e.g., bag of chips, a bagel, mounds for amorphous foods, and items served in glasses or bowls). Offerings included prepared multi-ingredient items (e.g., salads, sandwiches, lasagna) and potential additions, such as sweeteners and spreads. Participants served themselves from communal containers, including platters and bowls. The original packaging was used for some single-serve items, such

as yogurt and potato chips, to enable participants to be aware of details such as the fat level of milk.

Participants visited the buffet one at a time, in 8- to 10-min intervals, and were then escorted to the communal dining area. A room monitor was present to discourage sharing, discarding of waste, and the introduction of external foods and beverages into the meals. Repeat visits to the buffet were not permitted. Participants were offered a quiet area with Internet access to spend the time between meals or could leave the center and return for the next meal. Participants were not advised to avoid eating and drinking outside of the study center meals.

Each food container was inconspicuously weighed before and after each participant served themself to determine the amount of each item taken. Plate waste was determined by weighing items remaining after each meal in an area not visible to participants. Leftover solid foods were placed on plastic wrap for weighing. Multi-ingredient foods served as premade items, such as the bread, cheese, and lettuce from a sandwich, were weighed together. For liquids, the scale was tared and the leftovers poured into a plastic cup. Weights were taken with Ultra Ship 35 scales (My Weigh, Phoenix, AZ), which have a precise accuracy of 0.1 ounces (2.8 g) for items weighing up to 2 pounds (0.91 kg) and 0.2 ounces (5.7 g) for items weighing >2 pounds (0.91 kg). Each item was weighed independently by two technicians; if the two weights did not match to the gram, a third weight was taken and the mean of the two closest weights used. The weight consumed was calculated as the weight of the food taken minus the weight of the food left.

The following morning, participants returned to the study center and were asked to complete an unannounced 24-hour dietary recall for the prior day from midnight to midnight using ASA24-2016 on iPads. ASA24 is based on the Automated Multiple-Pass Method[21] but is meal-based in that respondents report the details of a meal (e.g., eating occasion, time), then add the foods and beverages consumed.[8] Respondents can report meals in the order they choose, with meal gap reminders used to check for missed eating occasions. Repeated reminders to include all eating occasions, foods, and beverages are integrated.

ASA24 includes over 10,000 food and beverage digital images[12] (a demonstration version is available at https://asa24.nci.nih.gov/demo/). For each food or beverage, a series of images ranging from small to large portions is presented. For example, images for cereal range from ¼ cup to 2 cups by increments of ¼ cup, with options for participants to report amounts less than or greater than the minimum and maximum. Participants are prompted to report the amount actually consumed. ASA24 was completed on 9.7" iPads; on this screen size, one portion size image appears in the center and the respondent can scroll through the other images stacked to the left and right. Within ASA24, foods are displayed on plates or bowls, as appropriate, and framed with cutlery. Images are shown from an overhead view, except for foods for which depth is relevant (e.g., layer cake), which are photographed at a 45-degree angle. For foods usually consumed in small amounts (e.g., condiments), images of household measures (e.g., teaspoons) are shown. For amorphous foods like mashed potatoes, mounds are shown. For foods that vary in size (e.g., bread), the respondent is prompted to indicate size (e.g., thin, regular), followed by the amount consumed (e.g., 2 pieces). For beverages, participants choose

a container type and size and then indicate the amount consumed by scrolling through stacked images that show different levels of liquid within the selected container size.

Half of the participants were randomized to complete ASA24 independently and the other half completed ASA24 in a small group setting with assistance from a paraprofessional. Those who completed ASA24 independently were provided with assistance in getting started on an iPad and had the option of calling a telephone helpdesk. The group setting was intended to mimic the educational environment offered by EFNEP.[29] Those in the group setting received a 15-minute overview of ASA24 using a PowerPoint presentation and were assisted with logging in to ASA24 and entering their first eating occasion by the paraprofessional, who was then available for questions but did not offer assistance in recalling foods and beverages offered or consumed. Just over 20% of participants completed ASA24 in Spanish and the remainder completed in English. All participants wore headphones playing white noise so they would not overhear questions or comments from others.

<u>Comparison of observed and reported intake</u>

ASA24 data from each participant were reviewed by two members of the research team, who did not have access to the observed dietary intake data, to identify eating occasions not part of the study meals. These eating occasions may have occurred prior to attending the study center for breakfast, after dinner, or between meals. A total of 134 respondents reported non-study eating occasions; these eating occasions were excluded from analysis because it was not possible to determine whether the reported foods and beverages were truly consumed nor

the amounts consumed. Additionally, six women did not attend the study center for breakfast but did attend for lunch and dinner; their data for these meals were included in the analyses.

Based on all foods and beverages reported, a key was developed to identify the foods and beverages considered matches for foods and beverages offered. This entailed generating a list of codes assigned by ASA24 to foods and beverages reported by participants, which was assessed by two members of the team, who did not have access to the true intake data, to determine whether each was an exact, close, or far match for any foods and drinks offered. Items that were not a match (i.e., not offered) were considered intrusions. The resulting match key was reviewed by the full study team, and observed and reported intakes were compared to determine whether each participant reported a match for each of the foods and drinks truly consumed.[25] Prior analysis indicated that those who completed ASA24 independently reported matches for 72% of items truly consumed, compared to 74% among those who completed ASA24 with assistance (p=0.56).[25] On average, those in the independent and assisted conditions reported 2.4 and 2.5 intrusions, respectively (p=0.57).[25]

Considering all foods and beverages observed and reported at all three eating occasions, women in the independent condition consumed 1907 grams and reported 1882 grams, for a difference of 25.0 grams (95% CI, -77.7, 128). Those in the assisted condition consumed 1864 grams and reported 1902 grams, for a difference of -38.0 grams (95% CI, -139, 62.8). The analyses reported subsequently consider foods and beverages for which a match was reported, such that a difference in gram weights can be constructed at the level of individual foods and beverages. Based on prior research suggesting that foods with different characteristics are estimated with differential accuracy[14–18] and the ways in which images are presented in ASA24,

240 foods and drinks were categorized into all foods excluding liquids, liquids, amorphous/soft
241 foods, single unit foods, small pieces, shaped foods, and spreads (Table 1). Coding of these
242 categories was conducted by a registered dietitian and verified by a team of dietitians and
243 researchers with nutrition training.
244
245 Demographic and health characteristics
246 After completing ASA24, participants were asked to complete a brief self-administered
247 questionnaire that queried demographic characteristics (e.g., age, racial/ethnic identity, highest
248 level of education, employment status), weight and height, receipt of food assistance, and
249 where and how often they accessed the internet. Questions were based on the Behavioral Risk
250 Factor Surveillance Survey.[30] Additional items querying methods used for internet access and
251 frequency of accessing email were developed for this study. BMI was calculated based on self-
252 reported height and weight (kg/m^2).[31]
253
254 Statistical analyses
255 Analyses were conducted using SAS, version 9.4.[32]
256 The distribution of differences between reported and observed portion sizes in the original
257 scale were highly skewed. The distribution of differences in the log-transformed values of
258 reported and observed portion sizes (equivalently, the log of the ratio of reported to observed
259 portion sizes) against the log of observed portion size values was practically symmetric.
260 Regression models, described below, were thus fit to the log-transformed data.

A three-part mixed-effects model was used to investigate the components of variance in the accuracy of portion size reporting. Fixed effects included participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)[33] and use of phone to access the Internet because earlier analyses indicated women in the two recall conditions differed on these characteristics.[25] Two random effects plus an error term were included. One random effect corresponded to the food and beverage category and the second random effect corresponded to the individual. This model was used to estimate intra-class correlations of accuracy (i.e., the proportion of variance in log ratio of reported to observed intake) at different levels of aggregation.

The geometric means of the ratio of reported to observed and its 95% confidence interval were calculated (by exponentiating the average difference in the log scale and the confidence interval bounds for that log-scale average), across foods and beverages overall and for each of the pre-defined categories. The confidence intervals were used to assess whether each ratio was different from 1.0 within each study condition. To test whether agreement between observed and reported portion sizes differed by study condition, the coefficient of the condition indicator was tested in linear regression models fit to the differences in log-transformed values, with models run for all foods and beverages and for the pre-defined categories. The regression models testing for differences by condition included variables indicating participation in WIC[33] and whether the participant typically accessed the Internet on a phone.

The percentages of reported portion sizes within 10% and 25% of observed portion size were estimated from the original scale data; these thresholds were selected based on prior research[14,21] since there does not appear to be a consensus in terms of what range of accuracy

283 is acceptable.[17] Logistic regression was used to examine differences in the odds of meeting the
284 10% and 25% criteria by study condition for all foods and drinks and for the pre-defined
285 categories, including variables indicating participation in WIC[33] and use of phone to access the
286 Internet.[25] Finally, the ratios of reported to observed portion sizes and percentages within 10%
287 and 25% of truth within each recall condition were calculated for strata defined by racial/ethnic
288 identity, educational attainment, and BMI.

289 Each individual may have consumed multiple foods and beverages per category of interest.
290 As a result, the contributions of the individual's data to the overall per category estimate were
291 correlated. Thus, the effective degrees of freedom for standard errors of estimates could be
292 substantially smaller than the raw numbers of observations comprising the estimate. Therefore,
293 the delete-one jackknife procedure,[34] a resampling method appropriate to clustered data, was
294 used to estimate standard errors. Specifically, the per category average of the differences in
295 logs were recomputed from subsamples omitting each person's data sequentially. The
296 variability among the estimates computed from the subsamples was used to compute a
297 standard error for the full-sample estimate.

298 Inferences about statistical significance were based on $p<0.05$.

299

300 **Results**

301 Among the subsample who completed ASA24 independently (n=148), 49% identified as
302 Hispanic, 30% as non-Hispanic Black, 12% as non-Hispanic white, and 9% as another
303 racial/ethnic identity (including American Indian, Native Hawaiian or other Pacific Islander,
304 Asian, or another race). Among those who completed ASA24 with assistance (n=154), 40%

identified as Hispanic, 38% as non-Hispanic Black, 14% non-Hispanic white, and 8% as another racial/ethnic identity (including American Indian, Native Hawaiian or other Pacific Islander, Asian, or another race). In the independent group, 53% had annual household incomes under $20,000 USD, whereas this proportion was 57% in the assisted group. In the independent group, 28% had completed some or finished high school, 47% had completed some college, and 25% were college graduates. In the assisted group, these proportions were 31%, 35%, and 33%. Half (50%) and 41% of those in the independent and assisted groups, respectively, were employed. Based on self-reported weight and height, 29% of those in the independent group and 38% of those in the assisted group had a BMI <25; 22% and 25%, respectively, had a BMI ≥25 and <30; and 43% and 36%, respectively, had a BMI ≥30 (9 women in the independent group and 3 in the assisted group did not provide their weights and heights). Over three-quarters (78% in the independent group and 76% in the assisted group) reported accessing email every day. The samples did not differ on these characteristics.[25]

The three-part mixed-effects model revealed that the between-food group ICC was larger than the between-person ICC, though most of the variability in the log ratios was unexplained, i.e., random error. Specifically, 5.5% of the variation in portion size accuracy was attributable to variation at the food group level and 4.0% was due to variation at the individual level. The remainder is unexplained.

Table 2 provides mean observed and reported portion sizes, mean differences, and geometric mean ratios of reported to observed portion size for all foods and drinks and for each of the food and drink categories for the two recall conditions. Confidence intervals for the ratios are not symmetric because they were calculated from average differences in the log

scale, as described above. For all foods and drinks for which a match was reported, on average, reported portion size was 7.4 grams (95% CI, 4.3-10.5) higher than observed portion size in the independent condition and 6.4 grams (95% CI, 2.8-10.0) higher than observed portion size in the assisted condition. The ratio of the amount reported to observed was significantly higher than one (indicative of overestimation) for all foods and beverages (only when excluding liquids in the assisted condition), small pieces, and shaped foods in both conditions, as well as for amorphous/soft foods in the assisted condition. The ratio was significantly lower than one for single unit foods in both conditions. Agreement between observed and reported portion sizes, as measured by the ratios, did not differ by study condition for any category of foods and beverages (data not shown).

Table 2 also shows the percentages of foods and drinks for which reported portion sizes were within 10% and 25% of observed portion sizes. For all foods and drinks, the percentages within 10% of truth were 12.8 for the independent condition and 14.9 for the assisted condition (p=0.06 for condition); the percentages within 25% of truth were 29.6 and 32.0 for the two conditions, respectively (p=0.05). In each case, the lowest percentages were observed for amorphous/soft foods and small pieces and the largest proportions for single unit foods and liquids. Table 3 provides the mean differences between observed and reported portion sizes and the geometric mean ratios of reported to observed portion sizes, by recall condition, for each food and drink individually.

Table 4 shows mean observed and reported portion sizes, mean differences, geometric mean ratios of reported to observed portion size, and proportions of foods and drinks for which reported portion sizes were within 10% and 25% of observed sizes for all matched foods and

drinks, by race/ethnicity, education, and BMI. In the independent condition, the ratio of the amount reported to the amount observed was significantly higher than 1.0 among those identifying as white, participants who had completed some college, and the lower two BMI categories. In the assisted condition, the ratio of the amount reported to amount observed was not significantly different from 1.0 in any subgroup.

Discussion

The findings of this study indicate that women with low incomes overestimated portion sizes of foods and beverages across several categories when reporting dietary intake for the prior day using ASA24 dietary recalls, with underestimation of single unit foods. This pattern was fairly consistent among subgroups defined by racial/ethnic identity, educational attainment, and BMI. Providing assistance on the completion of ASA24 did not have a marked effect on the accuracy of portion size estimation, suggesting independent completion of ASA24 is viable.

A recent systematic review found that images were associated with higher accuracy of portion size estimation compared to other aids.[16] A prior study using consistent feeding methods and the same menu offerings with a smaller sample of men and women suggested an advantage conferred by the use of tailored digital images within ASA24 to facilitate portion size estimation as compared to generic portion size aids used in interviewer-administered recalls.[21] In that study, participants completed ASA24 on desktop computers and could view multiple portion size images on the screen at one time, informed by cognitive and usability testing indicating a preference for multiple simultaneous images.[14] Given the development of a

responsive ASA24 interface that adapts to different screen sizes and the use of iPads in the current study, participants in the current study could see only one image at a time but could scroll through multiple images. Overall, the differences in the accuracy of portion size estimation are not marked between the two studies, perhaps supporting the advantage of availability of ASA24 on mobile devices, which enables its usage in a range of settings. Nonetheless, as noted in the systematic review, even if a portion size aid, such as digital images, improves accuracy of estimation, there can still be substantial error.[16]

Inaccurate portion size estimation is only one source of error in self-reported dietary intake data. Prior analyses of these data indicated few significant differences between observed and reported nutrient and food group intakes, even though participants excluded approximately one in four foods truly consumed.[25] Overestimation of portion sizes appears to have counteracted the effects of the exclusions on estimated intake to some extent. For example, items truly consumed such as tomatoes, peppers, cucumbers, and lettuce were frequently excluded from the 24-hour dietary recalls. The current analysis suggests participants who reported consuming these items tended to overestimate the amounts consumed, consistent with the finding that intake of total vegetables was higher based on reported versus observed dietary intake.[25] In contrast, estimates of protein and meat were lower based on reported compared to observed dietary intake, even though the main meat sources were not as frequently omitted by those who truly consumed them as other items.[25] The current analyses suggest underestimation of amounts of foods in the meat group, including chicken breasts and legs and turkey breast. The reporting of items not actually consumed (intrusions) on 24-hour dietary recalls also plays a role in overall estimates of intake, as do errors in the databases used

to convert from foods and beverages to nutrients and food groups. Taken together, the findings highlight that errors in self-reported dietary intake data are multiple and not necessarily additive.

Our findings are consistent with others in showing different magnitudes and directions of error for foods with different characteristics,[14–18] though overall, overestimation was most common. The mixed-effects model revealed that most of the variation in misestimation of portion size reporting was unexplained. That is, portion size misestimation is pervasive across the food and beverage categories and there is not a strong tendency toward misestimation in a consistent direction across foods and beverages at the person level. Similarly, though the study wasn't formally powered to test for differences in the magnitude of portion size misestimation across subgroups defined by race/ethnicity, education, and BMI, there appeared to be some degree of overestimation in some subgroups. The small amount of variability explained at the individual level suggests that targeting personal characteristics to improve portion size estimation may not be promising, though others have suggested the importance of portion size aids that allow flexibility with respect to estimation of traditional recipes and how food is eaten (e.g., using shared plates), underscoring that tailoring the approach to the target population remains of import.[16,20] Nonetheless, efforts are needed to overcome the cognitive challenges inherent to portion size estimation in general. Researchers have suggested training respondents to improve the accuracy of estimation.[16] Novel technology-based methods may also alleviate this source of error in dietary assessment. For example, image-based mobile food record-assisted recalls[16] may prove to be beneficial and with ongoing attention to automated

processing of images taken using mobile food record applications, the need for participants to report their portions may be eliminated.

This study used a controlled feeding design to enable examination of the accuracy of reporting at the level of foods and beverages. Examinations at the level of grams consumed and reported avoid conflation with database errors since no conversions were required. However, the study was limited to consideration of dietary intake reported for three meals consumed in a single day within a controlled setting. It is possible participants were more aware of amounts consumed than usual due to the unfamiliar setting, though efforts were made to simulate a conventional eating environment.[14,28] Further, a limited menu of foods was available, with small numbers and limited variability of items in some categories considered. The determination of categories for analysis was a judgment call among multiple dietitians and nutritionists, and some of the food offerings could have been considered to fit in other categories. However, these categories were identified *a priori* based on previous research and the provision of results for each food and beverage offered in Table 3 enables readers to construct their own categories of interest. The sample consisted of paid volunteers who may have been more highly motivated to accurately report their intake compared to participants in other studies. Additionally, participants had the ability to read and understand English or Spanish, limiting generalizability to subgroups with low literacy, and few participants were older than 70 years, hindering generalizability to older adults, who may have limited computer literacy compared to other age groups.[35] Finally, the study was not powered to assess differences in the magnitude of misestimation by personal characteristics, such as BMI.

436 **Conclusions**

437 This study suggests some degree of overestimation of portion size across most food
438 categories among women with low incomes who completed ASA24 24-hour dietary recalls,
439 either independently or with assistance. This pattern was fairly consistent among subgroups
440 defined by racial/ethnic identity, educational attainment, and BMI, and little variability in
441 portion size estimation was explained at the individual level. Improvements to facilitate
442 accurate portion size estimation are needed given the small number of reported portion sizes
443 that fell within 10% to 25% of the observed portion sizes.

References

1. Beaton GH, Burema J, Ritenbaugh C. Errors in the interpretation of dietary assessments. Am J Clin Nutr. 1997;65(4 Suppl):1100S-1107S.
2. Kipnis V, Subar AF, Midthune D, Freedman LS, Ballard-Barbash R, Troiano RP, Bingham S, Schoeller DA, Schatzkin A, Carroll RJ. Structure of dietary measurement error: results of the OPEN biomarker study. Am J Epidemiol. 2003;158(1):14-16.
3. Prentice RL, Mossavar-Rahmani Y, Huang Y, Van Horn L, Beresford SA, Caan B, Tinker L, Schoeller D, Bingham S, Eaton CB, Thomson C. Evaluation and comparison of food records, recalls, and frequencies for energy and protein assessment by using recovery biomarkers. Am J Epidemiol. 2011;174(5):591-603.
4. Gibson RS, Charrondiere UR, Bell W. Measurement errors in dietary assessment using self-reported 24-hour recalls in low-income countries and strategies for their prevention. Adv Nutr. 2017;8(6):980-91.
5. Freedman LS, Commins JM, Moler JE, Arab L, Baer DJ, Kipnis V, Midthune D, Moshfegh AJ, Neuhouser ML, Prentice RL, Schatzkin A. Pooled results from 5 validation studies of dietary self-report instruments using recovery biomarkers for energy and protein intake. Amer J Epidemiol. 2014;180(2):172-88.
6. Freedman LS, Commins JM, Moler JE, Willett W, Tinker LF, Subar AF, Spiegelman D, Rhodes D, Potischman N, Neuhouser ML, Moshfegh AJ. Pooled results from 5 validation studies of dietary self-report instruments using recovery biomarkers for potassium and sodium intake. Amer J Epidemiol. 2015;181(7):473-87.
7. Baranowski T, Islam N, Douglass D, Dadabhoy H, Beltran A, Baranowski J, Thompson D,

Cullen KW, Subar AF. Food Intake Recording Software System, version 4 (FIRSSt4): a self-completed 24-h dietary recall for children. J Hum Nutr Diet. 2014;27:66-71.

8. Subar AF, Kirkpatrick SI, Mittl B, Zimmerman TP, Thompson FE, Bingley C, Willis G, Islam NG, Baranowski T, McNutt S, Potischman N. The Automated Self-Administered 24-hour dietary recall (ASA24): a resource for researchers, clinicians, and educators from the National Cancer Institute. J Acad Nutr Diet. 2012;112(8):1134-7.
9. Carter MC, Albar SA, Morris MA, Mulla UZ, Hancock N, Evans CE, Alwan NA, Greenwood DC, Hardie LJ, Frost GS, Wark PA. Development of a UK online 24-h dietary assessment tool: myfood24. Nutrients. 2015;7(6):4016-32.
10. Jacques S, Lemieux S, Lamarche B, Laramée C, Corneau L, Lapointe A, Tessier-Grenier M, Robitaille J. Development of a web-based 24-h dietary recall for a French-Canadian population. Nutrients. 2016;8(11):724.
11. Simpson E, Bradley J, Poliakov I, Jackson D, Olivier P, Adamson AJ, Foster E. Iterative development of an online dietary recall tool: INTAKE24. Nutrients. 2017;9(2):118.
12. Islam NG, Dadabhoy H, Gillum A, Baranowski J, Zimmerman T, Subar AF, Baranowski T. Digital food photography: Dietary surveillance and beyond. Proc Food Sci. 2013;2:122-8.
13. Cypel YS, Guenther PM, Petot GJ. Validity of portion-size measurement aids: a review. J Amer Diet Assoc. 1997;97(3):289-92.
14. Subar AF, Crafts J, Zimmerman TP, Wilson M, Mittl B, Islam NG, McNutt S, Potischman N, Buday R, Hull SG, Baranowski T. Assessment of the accuracy of portion size reports using computer-based food photographs aids in the development of an automated self-administered 24-hour recall. J Amer Diet Assoc. 2010;110(1):55-64.

15. Nelson M, Atkinson M, Darbyshire S. Food photography I: the perception of food portion size from photographs. Br J Nutr. 1994;72(5):649-63.

16. Amoutzopoulos B, Page P, Roberts C, Roe M, Cade J, Steer T, Baker R, Hawes T, Galloway C, Yu D, Almiron-Roig E. Portion size estimation in dietary assessment: a systematic review of existing tools, their strengths and limitations. Nutr Rev. 2020;78(11):885-900.

17. Hernández T, Wilder L, Kuehn D, Rubotzky K, Moser-Veillon P, Godwin S, Thompson C, Wang C. Portion size estimation and expectation of accuracy. J Food Compos Anal. 2006;19:S14-21.

18. Robson PJ, Livingstone MB. An evaluation of food photographs as a tool for quantifying food and nutrient intakes. Public Health Nutr. 2000;3(2):183-92.

19. Salvesen L, Engeset D, Øverby NC, Medin AC. Development and evaluation of image-series for portion size estimation in dietary assessment among adults. J Nutr Sci. 2021;10.

20. Almiron-Roig E, Aitken A, Galloway C, Ellahi B. Dietary assessment in minority ethnic groups: a systematic review of instruments for portion-size estimation in the United Kingdom. Nutr Rev. 2017;75(3):188-213.

21. Kirkpatrick SI, Potischman N, Dodd KW, Douglass D, Zimmerman TP, Kahle LL, Thompson FE, George SM, Subar AF. The use of digital images in 24-hour recalls may lead to less misestimation of portion size compared with traditional interviewer-administered recalls. J Nutr. 2016;146(12):2567-73.

22. Kirkpatrick SI, Baranowski T, Subar AF, Tooze JA, Frongillo EA. Best practices for conducting and interpreting studies to validate self-report dietary assessment methods. J Acad Nutr Diet. 2019;119(11):1801-16.

23. Blanton CA, Moshfegh AJ, Baer DJ, Kretsch MJ. The USDA Automated Multiple-Pass Method accurately estimates group total energy and nutrient intake. J Nutr. 2006;136(10): 2594-9.

24. Timon CM, Cooper SE, Barker ME, Astell AJ, Adlam T, Hwang F, Williams EA. A comparison of food portion size estimation by older adults, young adults and nutritionists. J Nutr Health Aging. 2018;22(2):230-6.

25. Kirkpatrick SI, Guenther PM, Douglass D, Zimmerman T, Kahle LL, Atoloye A, Marcinow M, Savoie-Roskos MR, Dodd KW, Durward C. The provision of assistance does not substantially impact the accuracy of 24-hour dietary recalls completed using the Automated Self-administered 24-h Dietary Assessment Tool among women with low incomes. J Nutr. 2019;149(1):114-22.

26. United States Department of Agriculture. Assistance for People of All Ages. No date. https://www.fns.usda.gov/program/assistance-people-all-ages. Accessed July 22, 2021.

27. Kirkpatrick SI, Subar AF, Douglass D, Zimmerman TP, Thompson FE, Kahle LL, George SM, Dodd KW, Potischman N. Performance of the Automated Self-Administered 24-hour Recall relative to a measure of true intakes and to an interviewer-administered 24-h recall. Amer Jour Clin Nutr. 2014;100(1):233-40.

28. Kretsch MJ, Fong AK. Validation of a new computerized technique for quantitating individual dietary intake: the Nutrition Evaluation Scale System (NESSy) vs the weighed food record. Amer J Clin Nutr. 1990;51(3):477-84.

29. United States Department of Agriculture. The Expanded Food and Nutrition Education Program Policies. 2015. Available from https://nifa.usda.gov/sites/default/files/program/EFNEP%20Policy%20Document%202015

%20Update%20P1.pdf. Accessed July 22, 2021.

30. Centers for Disease Control and Prevention. Behavioral Risk Factor Surveillance System. 2014. Available from https://www.cdc.gov/brfss/about/index.htm. Accessed July 22, 2021.

31. Centers for Disease Control and Prevention. Body Mass Index (BMI). 2021. Available from https://www.cdc.gov/healthyweight/assessing/bmi/index.html. Accessed July 22, 2021.

32. SAS, Version 9.4. SAS Institute, Cary, NC.

33. United States Department of Agriculture. Special Supplemental Nutrition Program for Women, Infants, and Children. No date. Available from https://www.fns.usda.gov/wic. Accessed July 22, 2021.

34. Korn EL, Graubard BI. Analysis of Health Surveys. John Wiley & Sons; 2011.

35. Kirkpatrick SI, Gilsing AM, Hobin E, Solbak NM, Wallace A, Haines J, Mayhew AJ, Orr SK, Raina P, Robson PJ, Sacco JE. Lessons from studies to evaluate an online 24-hour recall for use with children and adults in Canada. Nutrients. 2017;9(2):100.

Table 2: Mean observed and reported portion sizes and differences, geometric mean ratio of amount reported to amount observed, and proportion of reported portion sizes within 10% and 25% of truth for foods and drinks for which a match was reported, by category and recall condition, among 302 women in the Food and Eating Assessment STudy (FEAST) II, May-July 2016

	Completed ASA24[a] independently (n=148 individuals, 2771 observations)							Completed ASA24[a] with assistance (n=154 individuals, 2909 observations)						
	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b], g (95% CI)	Geometric mean ratio of amount reported to amount observed (95% CI)	% within 10% of truth	% within 25% of truth	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b], g (95% CI)	Geometric mean ratio of amount reported to amount observed (95% CI)	% within 10% of truth	% within 25% of truth
All foods and drinks	2771	84.2	91.6	7.4 (4.3, 10.5)	1.05 (1.01, 1.11)	12.8	29.6	2909	83.5	89.9	6.4 (2.8, 10.0)	1.03 (0.99, 1.08)	14.9	32.0
All foods excluding liquids	2155	56.1	62.6	6.5 (4.0, 9.1)	1.06 (1.01, 1.12)	11.4	27.5	2309	54.8	62.5	7.7 (5.0, 10.3)	1.06 (1.01, 1.11)	13.3	29.4
Liquids	616	182	193	10.4 (1.7, 19.1)	1.03 (0.97, 1.09)	17.5	37.0	600	194	196	1.6 (-10.1, 13.3)	0.95 (0.89, 1.01)	20.8	42.2
Amorphous/ soft	1055	59.1	67.5	8.5 (4.2, 12.7)	1.05 (0.98, 1.13)	9.2	21.9	1145	58.7	71.4	12.7 (8.2, 17.2)	1.08 (1.01, 1.16)	11.1	23.6
Single unit	614	69.6	68.6	-1.0 (-4.6, 2.7)	0.93 (0.87, 0.99)	16.4	38.9	668	67.7	65.1	-2.6 (-5.9, 0.7)	0.91 (0.86, 0.96)	18.7	40.4
Small pieces	186	13.0	24.6	11.6 (7.5, 15.7)	1.69 (1.46, 1.97)	8.6	21.5	204	13.5	21.7	8.2 (5.8, 10.6)	1.48 (1.32, 1.65)	9.3	24.5
Shaped foods	195	55.3	70.7	15.4 (9.2, 21.7)	1.19 (1.07, 1.32)	10.3	29.2	191	54.5	70.8	16.2 (8.1, 24.3)	1.17 (1.04, 1.31)	12.0	29.8
Spreads	87	8.3	8.4	0.09 (-3.1, 3.2)	0.87 (0.73, 1.03)	12.6	27.6	96	6.2	5.4	-0.80 (-1.8, 0.3)	0.91 (0.78, 1.07)	14.6	32.3

[a] ASA24, Automated Self-administered 24-hour Dietary Assessment Tool.

[b] Mean differences are expressed as reported minus observed portion size. Thus, positive differences are indicative of overestimation and negative differences are indicative of underestimation of portion size.

Table 3: Mean observed and reported portion sizes and differences, geometric mean ratio of amount reported to amount observed, and proportion of reported portion sizes within 10% and 25% of truth for foods and drinks for which a match was reported, by recall condition, among 302 women in the Food and Eating Assessment STudy (FEAST) II, May-July 2016

Food/beverage	Completed ASA24[a] independently (n=148 individuals, 2771 observations)							Completed ASA24[a] with assistance (n=154 individuals, 2909 observations)						
	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b] g (95% CI[c])	Geometric mean ratio of amount reported to amount observed (95% CI[c])	% within 10% of truth	% within 25% of truth	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b] g (95% CI[c])	Geometric mean ratio of amount reported to amount observed (95% CI[c])	% within 10% of truth	% within 25% of truth
Apple, raw	16	111	145	34.1 (15.5, 52.6)	1.36 (1.16, 1.59)	12.5	43.8	20	117	142	24.5 (4.60, 44.3)	1.20 (0.99, 1.46)	15.0	35.0
Bagel	107	87.9	70.4	-17.5 (-24.1, -11.0)	0.84 (0.73, 0.96)	14.0	40.2	91	79.7	61.9	-17.8 (-24.7, -10.9)	0.77 (0.67, 0.87)	17.6	38.5
Banana, raw	25	101	88.3	-12.3 (-22.8, -1.8)	0.87 (0.75, 1.00)	48.0	68.0	28	108	90.8	-17.2 (-31.7, -2.7)	0.73 (0.54, 0.97)	28.6	60.7
Bread, garlic	31	21.2	29.4	8.1 (-1.5, 17.8)	1.04 (0.75, 1.42)	3.23	9.68	44	18.3	24.4	6.2 (-0.5, 12.8)	1.12 (0.86, 1.45)	9.09	22.7
Bread, white	128	30.6	26.9	-3.7 (-6.9, -0.5)	0.80 (0.72, 0.90)	7.03	32.0	153	31.3	29.3	-1.9 (-4.7, 0.8)	0.84 (0.77, 0.93)	14.4	39.2
Broccoli, cooked, from fresh, fat added in cooking	83	44.3	58.2	13.8 (3.3, 24.4)	1.11 (0.94, 1.30)	14.5	31.3	89	43.1	56.7	13.5 (4.0, 23.1)	1.12 (0.97, 1.30)	15.7	37.1
Cake, chocolate, devil's food, or fudge, with icing	82	66.0	85.0	19.0 (6.9, 31.0)	1.05 (0.86, 1.27)	14.6	23.2	79	64.5	83.5	19.0 (3.8, 34.2)	1.06 (0.91, 1.24)	16.5	27.8
Carrots, cooked, from fresh, fat added in cooking	59	58.8	49.5	-9.2 (-28.0, 9.5)	0.49 (0.35, 0.68)	0.0	13.6	83	59.6	65.1	5.5 (-8.4, 19.4)	0.68 (0.51, 0.89)	3.61	15.7
Cheerios	8	27.2	22.0	-5.2 (-17.5, 7.1)	0.73 (0.42, 1.30)	12.5	25.0	12	22.0	22.8	0.83 (-6.9, 8.6)	0.90 (0.59, 1.38)	16.7	41.7
Cheese, cream	79	18.5	19.4	0.9 (-2.4, 4.2)	1.23 (0.98, 1.55)	10.1	22.8	65	15.0	17.8	2.8 (-0.2, 5.8)	1.22 (0.98, 1.52)	15.4	24.6
Cheese, natural, Cheddar or American type	66	12.2	18.3	6.1 (3.2, 9.1)	1.31 (1.10, 1.57)	6.06	15.2	89	14.2	21.4	7.2 (4.1, 10.3)	1.35 (1.16, 1.56)	14.6	28.1
Chicken, breast or leg, roasted, broiled, baked	118	116.1	111.1	-4.8 (-15.7, 6.2)	0.91 (0.82, 1.00)	16.9	43.2	127	118	108	-9.9 (-20.7, 0.9)	0.87 (0.79, 0.96)	15.7	39.4
Coffee, made from ground, regular	74	127	175	48.2 (33.2, 63.2)	1.37 (1.19, 1.56)	6.76	29.7	51	144	180	35.6 (8.1, 63.0)	1.22 (0.99, 1.51)	9.80	41.2
Cookie, brownie, with icing	69	33.3	470	13.7 (8.4, 19.0)	1.40 (1.25, 1.57)	7.25	40.6	67	33.2	47.0	13.9 (4.7, 23.0)	1.36 (1.14, 1.61)	8.96	32.8
Cream, half and half	35	34.2	48.9	14.7 (-5.6, 35.1)	1.19 (0.81, 1.77)	8.57	20.0	26	31.2	41.7	10.5 (-0.9, 21.8)	1.32 (0.94, 1.86)	7.69	38.5

Food/beverage	Completed ASA24[a] independently (n=148 individuals, 2771 observations)							Completed ASA24[a] with assistance (n=154 individuals, 2909 observations)						
	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b] g (95% CI[c])	Geometric mean ratio of amount reported to amount observed (95% CI[c])	% within 10% of truth	% within 25% of truth	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b] g (95% CI[c])	Geometric mean ratio of amount reported to amount observed (95% CI[c])	% within 10% of truth	% within 25% of truth
Creamy dressing with sour cream and/or buttermilk	42	24.4	21.2	-3.2 (-10.1, 3.7)	0.71 (0.53, 0.95)	4.76	23.8	40	31.4	26.0	-5.4 (-12.0, 1.1)	0.70 (0.54, 0.91)	17.5	35.0
Cucumber, raw	37	6.69	21.4	14.7 (8.7, 20.8)	2.87 (2.30, 3.60)	8.11	13.5	39	6.94	19.6	12.7 (9.4, 15.9)	2.61 (2.13, 3.20)	10.3	12.8
Lettuce, raw	215	12.5	26.8	14.3 (10.6, 17.9)	1.29 (1.12, 1.49)	4.19	10.7	235	12.7	28.3	15.6 (11.5, 19.7)	1.24 (1.07, 1.44)	5.96	11.1
Frosted Flakes, Kellogg's	16	44.1	32.8	-11.3 (-17.8, -4.9)	0.64 (0.51, 0.80)	6.25	25	13	34.4	34.2	-0.3 (-7.7, 7.2)	0.95 (0.68, 1.34)	23.1	46.2
Fruit salad	116	115	111	-3.7 (-16.7, 9.4)	0.86 (0.75, 0.98)	19.0	27.6	119	121	130	8.8 (-4.6, 22.2)	1.00 (0.89, 1.12)	14.3	31.9
Italian dressing, low calorie	33	18.6	24.1	5.5 (-2.0, 12.9)	1.11 (0.85, 1.44)	9.09	27.3	36	17.5	18.0	0.5 (-4.1, 5.1)	0.83 (0.63, 1.08)	5.56	19.4
Italian dressing, made with vinegar and oil	20	23.8	17.2	-6.6 (-12.1, -1.2)	-0.67 (0.50, 0.90)	10.0	30.0	28	19.2	17.8	-1.4 (9.7, 6.8)	0.77 (0.51, 1.16)	3.57	21.4
Jelly, all flavors	18	15.2	18.1	2.9 (-12.6, 18.3)	0.83 (0.48, 1.42)	11.1	22.2	9	14.9	7.98	-6.9 (-13.3, -0.6)	0.54 (0.30, 0.97)	0.0	33.3
Lasagna, meatless, with vegetables	104	161	136	-25.6 (-42.1, -9.1)	0.74 (0.64, 0.84)	12.5	29.8	98	149	139	-10.0 (-29.6, 9.5)	0.80 (0.70, 0.93)	15.3	26.5
Margarine-like spread, tub, salted	21	10.9	7.76	-3.2 (-6.1, -0.3)	0.74 (0.53, 1.03)	28.6	47.6	14	8.97	4.49	-4.5 (-7.4, -1.6)	0.57 (0.33, 0.97)	0.0	14.3
Mayonnaise, regular	32	5.83	6.56	0.7 (-1.2, 2.6)	0.97 (0.76, 1.23)	6.25	25.0	38	6.42	7.04	0.6 (-0.6, 1.8)	0.99 (0.84, 1.16)	18.4	31.6
Milk, cow's, fluid, 1% fat	37	124	154	29.7 (-26.9, 86.3)	1.14 (0.88, 1.47)	13.5	27.0	23	108	122	13.8 (-22.0, 49.6)	0.97 (0.62, 1.50)	21.7	21.7
Milk, cow's, fluid, 2% fat	8	53.7	30.9	-22.8 (-50.0, 4.4)	0.62 (0.34, 1.16)	12.5	12.5	5	33.9	32.4	-1.6 (-30.0, 26.9)	1.17 (0.29, 4.70)	20.0	20.0
Mustard	16	2.03	1.97	-0.1 (-0.7, 0.6)	0.91 (0.68, 1.22)	6.25	12.5	35	2.56	3.29	0.7 (1.2, 1.3)	1.16 (0.99, 1.36)	20.0	40.0
Oatmeal, cooked, regular, fat not added in cooking	34	107	137	30.0 (10.2, 49.7)	1.25 (1.04, 1.51)	11.8	26.5	43	133	159	25.9 (-3.0, 54.9)	1.01 (0.77, 1.31)	14.0	25.6
Orange juice, canned, bottled or in a carton	83	165	195	29.7 (9.8, 49.6)	1.14 (1.00, 1.30)	12.0	37.3	92	166	183	17.1 (-1.6, 35.7)	1.05 (0.92, 1.19)	15.2	39.1
Pasta with pesto sauce	65	73.3	123	49.9 (32.5, 67.4)	1.59 (1.38, 1.84)	4.62	23.1	77	69.9	117	47.0 (34.0, 60.1)	1.57 (1.40, 1.78)	7.79	24.7
Pepper, sweet, green, raw	35	16.5	27.5	11.0 (3.9, 18.0)	1.49 (1.15, 1.93)	14.3	34.2	28	16.9	25.4	8.5 (2.6, 14.3)	1.33 (1.02, 1.72)	10.7	21.4
Pie, apple, two crust	44	69.8	81.4	11.6 (-1.2, 24.4)	1.15 (0.93, 1.43)	6.82	22.7	45	68.8	83.6	14.8 (0.5, 29.2)	1.09 (0.85, 1.40)	8.89	28.9
Raisin Bran, Kellogg's	6	43.6	30.1	-13.5 (-30.1, 3.0)	0.61 (0.34, 1.11)	16.7	16.7	8	47.9	28.9	-18.9 (-40.8, 2.9)	0.56 (0.30, 1.07)	0.0	12.5

Food/beverage	Completed ASA24[a] independently (n=148 individuals, 2771 observations)							Completed ASA24[a] with assistance (n=154 individuals, 2909 observations)						
	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b] g (95% CI[c])	Geometric mean ratio of amount reported to amount observed (95% CI[c])	% within 10% of truth	% within 25% of truth	Number of observations	Mean amount observed, g	Mean amount reported, g	Mean difference[b] g (95% CI[c])	Geometric mean ratio of amount reported to amount observed (95% CI[c])	% within 10% of truth	% within 25% of truth
Rice pilaf	93	74.1	100	26.1 (14.9, 37.2)	1.34 (1.15, 1.55)	8.60	33.3	96	81.5	112	30.1 (18.6, 41.7)	1.29 (1.15, 1.46)	15.6	29.2
Soft drink, cola-type	60	273	264	-8.7 (-36.4, 19.0)	0.93 (0.83, 1.05)	30.0	50.0	51	272	221	-50.6 (-80.8, -20.4)	0.74 (0.61, 0.91)	31.4	56.9
Soft drink, cola-type, sugar-free	11	244	288	43.8 (-0.6, 88.2)	1.24 (1.01, 1.52)	54.5	54.5	16	208	185	-23.5 (-89.1, 42.2)	0.84 (0.57, 1.25)	0.0	25.0
Soft drink, fruit-flavored, caffeine free	43	258	259	1.4 (-27.3, 30.0)	0.99 (0.86, 1.13)	25.6	53.5	39	267	245	-21.6 (-48.8, 5.7)	0.92 (0.80, 1.05)	17.9	59.0
Sugar substitute (sucralose, aspartame, saccharin)	19	1.53	2.79	1.3 (0.2, 2.7)	1.40 (1.00, 1.95)	26.3	47.4	22	1.59	2.02	0.4 (-0.1, 1.0)	1.29 (0.99, 1.68)	31.8	40.9
Sugar, white, granulated or lump	36	10.4	7.91	-2.5 (-5.1, 0.2)	0.74 (0.55, 0.99)	11.1	16.7	36	10.2	6.67	-3.5 (-5.5, -1.5)	0.78 (0.59, 1.03)	19.4	25.0
Tea, leaf, unsweetened	29	189	207	17.2 (-14.5, 48.9)	1.16 (0.95, 1.41)	24.1	37.9	26	229	203	-26.6 (-62.0, 8.8)	0.80 (0.66, 0.97)	23.1	42.3
Tomatoes, raw	114	14.0	24.7	10.7 (5.0, 16.4)	1.48 (1.24, 1.78)	7.02	20.2	137	14.7	21.6	6.9 (4.3, 9.5)	1.28 (1.15, 1.44)	8.76	28.5
Tuna salad	75	43.7	64.5	20.8 (5.4, 36.2)	1.07 (0.88, 1.30)	9.33	20.0	82	45.6	57.4	11.8 (3.5, 20.0)	1.01 (0.86, 1.19)	2.44	17.1
Turkey or chicken breast, prepackaged or deli, lunch meat	55	37.9	30.5	-7.4 (-13.9, -0.8)	0.68 (0.56, 0.83)	10.9	34.5	71	39.3	37.0	-2.4 (-8,0, 3.3)	0.75 (0.64, 0.89)	12.7	32.4
Water, bottled, unsweetened	131	331	319	-12.4 (-39.4, 14.5)	0.96 (0.86, 1.07)	25.2	43.5	159	331	343	11.6 (-23.8, 47.0)	1.01 (0.91, 1.13)	36.5	50.9
White potato, chips	62	23.5	29.1	5.7 (3.4, 7.9)	1.25 (1.08, 1.43)	30.6	56.5	58	22.0	27.8	5.9 (3.8, 8.0)	1.33 (1.18, 1.50)	34.5	63.8
Yogurt, fruit variety, low-fat milk	53	136	171	35.2 (15.9, 54.5)	1.24 (1.04, 1.48)	22.6	26.4	54	147	166	18.4 (0.6, 36.2)	1.05 (0.90, 1.24)	29.6	40.7

[a] ASA24, Automated Self-administered 24-hour Dietary Assessment Tool.

[b] Mean differences are expressed as reported minus observed amount eaten. Thus, positive differences are indicative of overestimation and negative differences are indicative of underestimation of amount eaten.

[c] Jackknife confidence intervals for some individual foods/drinks may be unreliable due to a combination of small frequencies of consumption and small numbers of distinct respondents comprising the mean.

Table 1: Foods and beverages offered, by category for analysis of accuracy of portion size estimation,[a] to 302 women in the Food and Eating Assessment STudy (FEAST) II (May through July, 2016) to assess the construct validity of the Automated Self-Administered 24-hour Dietary Assessment Tool (ASA24)

Liquids	Bottled water Coffee Tea Orange juice Soda (3 varieties) Milk Cream (for coffee) Salad dressing
Amorphous/soft	Cold cereal (3 varieties) Oatmeal Fruit salad Lettuce (green salad) Grated cheese (for salad) Cream cheese (for bagels) Tuna salad (on sandwiches) Pesto pasta salad Rice pilaf Broccoli Carrots Vegetarian lasagna Sugar (for coffee, cereal)
Single unit	Yogurt (single container) Chicken breasts and legs Turkey breast (on sandwiches) Bread slices (on sandwiches, garlic bread) Bagels Apples Bananas Potato chips (single-serve bags) Sugar substitutes (3 varieties, in single-serve packages)
Small pieces	Tomato pieces/slices (in salad and on sandwiches) Cucumber pieces (in salad) Red and green peppers (in salad)
Spreads	Margarine Jelly Mayonnaise (on turkey sandwich) Mustard (on turkey sandwich)
Shaped foods	Apple pie (pre-cut) Chocolate cake (pre-cut) Brownies (pre-cut)

[a] This table was initially published in the Journal of Nutrition and is reproduced with permission. Kirkpatrick SI, Potischman N, Dodd KW, Douglass D, Zimmerman TP, Kahle LL, Thompson FE, George SM, Subar AF. The use of digital images in 24-hour recalls may lead to less misestimation of portion size compared with traditional interviewer-administered recalls. J Nutr 2016;146(12):2567-73.

Table 4: Mean observed and reported portion sizes and differences, geometric mean ratio of amount reported to amount observed, and proportion of reported portion sizes within 10% and 25% of truth for all foods and drinks for which a match was reported, by recall condition and individual characteristics, among 302 women in the Food and Eating Assessment STudy (FEAST) II, May-July 2016

	Completed ASA24[a] independently (n=148 individuals, 2771 observations)							Completed ASA24[a] with assistance (n=154 individuals, 2909 observations)						
	Number of observations	Mean amount observed g	Mean amount reported g	Mean difference[b] g (95% CI)	Geometric mean ratio of amount reported to amount observed (95% CI)	% within 10% of truth	% within 25% of truth	Number of observations	Mean amount observed g	Mean amount reported g	Mean difference[b] G (95% CI)	Geometric mean ratio of amount reported to amount observed (95% CI)	% within 10% of truth	% within 25% of truth
All participants	2771	84.2	91.6	7.4 (4.3, 10.5)	1.05 (1.01, 1.11)	12.8	29.6	2909	83.5	89.9	6.40 (2.82, 9.99)	1.03 (0.99, 1.08)	14.9	32.0
Race/ethnicity														
Hispanic	1272	88.9	95.9	7.0 (2.6, 11.3)	1.03 (0.96, 1.10)	13.3	30.2	1133	84.3	89.0	4.8 (0.3, 9.2)	1.05 (0.99, 1.11)	14.7	30.9
Black, non-Hispanic	848	80.9	85.3	4.4 (-1.9, 10.6)	1.02 (0.93, 1.12)	12.6	28.2	1089	82.3	90.0	7.7 (0.02, 15.3)	1.05 (0.97, 1.14)	14.7	32.5
White, non-Hispanic	368	75.7	90.2	14.6 (6.4, 22.8)	1.17 (1.05, 1.32)	12.5	31.0	424	85.4	92.2	6.9 (-0.8, 14.5)	0.97 (0.85, 1.10)	17.2	34.0
Other[c]	283	83.9	92.8	9.0 (-2.2, 20.1)	1.13 (0.94, 1.36)	11.3	29.7	263	81.9	89.4	7.5 (-4.7, 19.7)	1.03 (0.88, 1.20)	12.9	31.9
Education														
Some or completed high school or GED	695	92.9	99.8	6.9 (0.5, 13.4)	0.99 (0.89, 1.10)	12.9	29.2	869	79.2	86	6.8 (0.7, 12.9)	1.03 (0.95, 1.12)	14.4	29.0
Completed some college	1288	82.9	90.7	7.8 (3.6, 12.0)	1.09 (1.03, 1.16)	11.7	28.8	981	85.4	92.8	7.4 (-0.6, 15.3)	1.05 (0.98, 1.12)	14.7	33.6
College graduate	777	78.6	86.1	7.5 (0.6, 14.4)	1.06 (0.96, 1.18)	14.4	31.4	1035	85.5	90.8	5.3 (0.5, 10.0)	1.03 (0.96, 1.11)	15.5	33.0
Body mass index (kg/m²)														
<25	840	82.3	93.8	11.5 (6.2, 16.9)	1.13 (1.04, 1.23)	11.8	28.9	1105	83.4	93.2	9.8 (5.3, 14.3)	1.07 (1.00, 1.15)	15.3	31.9
25<30	552	88.3	95.0	6.7 (0.1, 13.3)	1.11 (1.02, 1.22)	13.0	30.4	733	76.9	78.9	2.0 (-4.3, 8.3)	0.99 (0.90, 1.10)	12.3	28.9
≥30	1237	83.6	89.4	5.8 (0.9, 10.8)	1.01 (0.94, 1.09)	12.9	29.3	1009	87.2	92.8	5.6 (-2.2, 13.4)	1.03 (0.96, 1.10)	16.5	34.6

[a] ASA24, Automated Self-administered 24-hour Dietary Assessment Tool.

[b] Mean differences are expressed as reported minus observed portion size. Thus, positive differences are indicative of overestimation and negative differences are indicative of underestimation of portion size.

[c] Other racial/ethnic identities included American Indian, Native Hawaiian or other Pacific Islander, Asian, or another race

OXFORD UNIVERSITY PRESS LICENSE
TERMS AND CONDITIONS

Mar 29, 2022

This Agreement between Dr. Sharon Kirkpatrick ("You") and Oxford University Press ("Oxford University Press") consists of your license details and the terms and conditions provided by Oxford University Press and Copyright Clearance Center.

License Number	5278310864956
License date	Mar 29, 2022
Licensed Content Publisher	Oxford University Press
Licensed Content Publication	The Journal of Nutrition
Licensed Content Title	The Use of Digital Images in 24-Hour Recalls May Lead to Less Misestimation of Portion Size Compared with Traditional Interviewer-Administered Recalls
Licensed Content Author	Kirkpatrick, Sharon I; Potischman, Nancy
Licensed Content Date	Nov 2, 2016
Type of Use	Journal
Requestor type	Author of this OUP content
Pharmaceutical support or sponsorship for this project	No
Format	Print and electronic

Portion	Figure/table
Number of figures/tables	1
Will you be translating?	No
Circulation/distribution	85000
Title of new article	The accuracy of portion size reporting on self-administered online 24-hour dietary recalls among women with low incomes
Lead author	Kirkpatrick Sharon I
Title of targeted journal	Journal of the Academy of Nutrition and Dietetics
Publisher	Elsevier
Expected publication date	Jun 2022
Portions	Table 1 on page 2569
Requestor Location	Dr. Sharon Kirkpatrick 200 University Ave. W. Waterloo, ON N2L 3G1 Canada Attn: Dr. Sharon Kirkpatrick
Publisher Tax ID	GB125506730
Total	0.00 CAD

Terms and Conditions

STANDARD TERMS AND CONDITIONS FOR REPRODUCTION OF MATERIAL FROM AN OXFORD UNIVERSITY PRESS JOURNAL

1. Use of the material is restricted to the type of use specified in your order details.

2. This permission covers the use of the material in the English language in the following territory: world. If you have requested additional permission to translate this material, the terms and conditions of this reuse will be set out in clause 12.

3. This permission is limited to the particular use authorized in (1) above and does not allow you to sanction its use elsewhere in any other format other than specified above, nor does it apply to quotations, images, artistic works etc that have been reproduced from other sources which may be part of the material to be used.

4. No alteration, omission or addition is made to the material without our written consent. Permission must be re-cleared with Oxford University Press if/when you decide to reprint.

5. The following credit line appears wherever the material is used: author, title, journal, year, volume, issue number, pagination, by permission of Oxford University Press or the sponsoring society if the journal is a society journal. Where a journal is being published on behalf of a learned society, the details of that society must be included in the credit line.

6. For the reproduction of a full article from an Oxford University Press journal for whatever purpose, the corresponding author of the material concerned should be informed of the proposed use. Contact details for the corresponding authors of all Oxford University Press journal contact can be found alongside either the abstract or full text of the article concerned, accessible from www.oxfordjournals.org Should there be a problem clearing these rights, please contact journals.permissions@oup.com

7. If the credit line or acknowledgement in our publication indicates that any of the figures, images or photos was reproduced, drawn or modified from an earlier source it will be necessary for you to clear this permission with the original publisher as well. If this permission has not been obtained, please note that this material cannot be included in your publication/photocopies.

8. While you may exercise the rights licensed immediately upon issuance of the license at the end of the licensing process for the transaction, provided that you have disclosed complete and accurate details of your proposed use, no license is finally effective unless and until full payment is received from you (either by Oxford University Press or by Copyright Clearance Center (CCC)) as provided in CCC's Billing and Payment terms and conditions. If full payment is not received on a timely basis, then any license preliminarily granted shall be deemed automatically revoked and shall be void as if never granted. Further, in the event that you breach any of these terms and conditions or any of CCC's Billing and Payment terms and conditions, the license is automatically revoked and shall be void as if never granted. Use of materials as described in a revoked license, as well as any use of the materials beyond the scope of an unrevoked license, may constitute copyright infringement and Oxford University Press reserves the right to take any and all action to protect its copyright in the materials.

9. This license is personal to you and may not be sublicensed, assigned or transferred by you to any other person without Oxford University Press's written permission.

10. Oxford University Press reserves all rights not specifically granted in the combination of (i) the license details provided by you and accepted in the course of this licensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment terms and conditions.

11. You hereby indemnify and agree to hold harmless Oxford University Press and CCC, and their respective officers, directors, employs and agents, from and against any and all claims arising out of your use of the licensed material other than as specifically authorized pursuant to this license.

12. Other Terms and Conditions:

v1.4

Questions? customercare@copyright.com or +1-855-239-3415 (toll free in the US) or +1-978-646-2777.

Academy of Nutrition and Dietetics

JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

COPYRIGHT TRANSFER AND AUTHORSHIP AGREEMENT FORM

Please note that ALL AUTHORS MUST FILL OUT AND SIGN THIS AGREEMENT. A signed fax or copy of this form is considered legally binding.

Article Title:

The accuracy of portion size reporting on self-adminstered online 24-hour recalls among women with low incomes

Corresponding author: Sharon I. Kirkpatrick

COPYRIGHT TRANSFER

I hereby assign to the *Academy of Nutrition and Dietetics* the copyright in the manuscript named above (the "article") in all forms and media (whether now known or hereafter developed), throughout the world, in all languages, for the full term of copyright and all extensions and renewals thereof, effective when and if the article is accepted for publication. This transfer includes the right to adapt the presentation of the article for use in conjunction with computer systems and programs, including reproduction or publication in machine-readable form and incorporation in retrieval systems.

AUTHORSHIP RESPONSIBILITY

The International Committee of Medical Journal Editors recommends that authorship be based on four criteria. **Please confirm your responsibilities as an author and check all of the boxes below that apply to your role as an author:**

- ☑ I made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- ☑ I drafted the work or revised it critically for important intellectual content; AND
- ☑ I gave final approval of the version to be published; AND
- ☑ I agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

In addition, I understand that a large number of author uses are retained or permitted (without the need to obtain permission from the *Academy of Nutrition and Dietetics)* to enable continued use of the article for traditional scholarship communications, for teaching, and for distribution within my organization.

I confirm that I have read and understand the full list of rights retained by authors and also agree to the other *General Terms of Publication* (see page 2).

Please mark the appropriate box(es) below that applies to your manuscript. If none of these statements apply to your manuscript, then leave them blank:

- ☐ This article is work performed in the scope of employment and I am signing as and authorized representative of the employing company.
- ☐ I am a US Government employee and there is no copyright to transfer, but I affirm the author warranties.
- ☐ I am an employee of the UK, Canadian, or Australian Government but affirm that the Academy may use the article under an apparent license and affirm the author warranties apply.
- ☐ I am an employee of the UK who is not claiming Crown Copyright.

Acknowledgements: I confirm that if Acknowledgements are included with this article, written consent from those mentioned has been received. This consent is to be presented to the *Journal* only upon request, with email and fax consent binding.

RDN/NDTR CREDENTIAL

Are you a registered dietitian nutritionist (RDN) or nutrition and dietetics technician, registered (NDTR), with current registration status with the Commission on Dietetic Registration (CDR)?

- ☑ Yes
- ☐ No

If so, enter your CDR registration ID number: 1036532

If you are a registered dietitian credentialed by an organization other than CDR, please indicate full credential and administering country:

FINANCIAL/CONFLICT OF INTEREST DISCLOSURES

Funding/Support:

- ☑ I certify that all financial and material support for this research and work are clearly identified in the author page of the submission.
- ☑ **National Institutes of Health (NIH) Funding**. The article was supported in part, or in whole, by the NIH. In accordance with the NIH Public Access Policy, I understand that my manuscript, should it be accepted for publication, will be submitted to PubMed Central. I understand that my manuscript will therefore be freely accessible by the public via PubMed Central 12 months from the date of publication.

My NIH grant or project number is:

Personal Financial Disclosure/Conflict of Interest:

- ☑ I certify that all my affiliations with or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript are disclosed in the author page of the submission. Such conflicts would include employment, grants/research support, expert testimony, consultancy, stock holding, an honorarium, membership, or other financial/material support.
- ☑ I acknowledge that if a manuscript, article, or other work that I have authored is being considered for publication by the *Academy of Nutrition and Dietetics*, as author, I have a duty to disclose with the submission of this manuscript any conflict or duality of interest that might be perceived as affecting my objectivity and credibility or as creating an appearance of external influence.

Sign: Mateja Savoie Roskos

Print Name: Mateja R. Savoie Roskos

Date: 7/3/2020

Title and Affiliation: _____
(if employer representative)

Academy of Nutrition and Dietetics

JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

COPYRIGHT TRANSFER AND AUTHORSHIP AGREEMENT FORM

Please note that ALL AUTHORS MUST FILL OUT AND SIGN THIS AGREEMENT. A signed fax or copy of this form is considered legally binding.

Article Title:

The accuracy of portion size reporting on self-adminstered online 24-hour recalls among women with low incomes

Corresponding author: Sharon I. Kirkpatrick

COPYRIGHT TRANSFER

I hereby assign to the *Academy of Nutrition and Dietetics* the copyright in the manuscript named above (the "article") in all forms and media (whether now known or hereafter developed), throughout the world, in all languages, for the full term of copyright and all extensions and renewals thereof, effective when and if the article is accepted for publication. This transfer includes the right to adapt the presentation of the article for use in conjunction with computer systems and programs, including reproduction or publication in machine-readable form and incorporation in retrieval systems.

AUTHORSHIP RESPONSIBILITY

The International Committee of Medical Journal Editors recommends that authorship be based on four criteria. **Please confirm your responsibilities as an author and check all of the boxes below that apply to your role as an author:**

- ☑ I made substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- ☑ I drafted the work or revised it critically for important intellectual content; AND
- ☑ I gave final approval of the version to be published; AND
- ☑ I agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

In addition, I understand that a large number of author uses are retained or permitted (without the need to obtain permission from the *Academy of Nutrition and Dietetics)* to enable continued use of the article for traditional scholarship communications, for teaching, and for distribution within my organization.

I confirm that I have read and understand the full list of rights retained by authors and also agree to the other *General Terms of Publication* (see page 2).

Please mark the appropriate box(es) below that applies to your manuscript. If none of these statements apply to your manuscript, then leave them blank:

- ☑ This article is work performed in the scope of employment and I am signing as and authorized representative of the employing company.
- ☐ I am a US Government employee and there is no copyright to transfer, but I affirm the author warranties.
- ☐ I am an employee of the UK, Canadian, or Australian Government but affirm that the Academy may use the article under an apparent license and affirm the author warranties apply.
- ☐ I am an employee of the UK who is not claiming Crown Copyright.

Acknowledgements: I confirm that if Acknowledgements are included with this article, written consent from those mentioned has been received. This consent is to be presented to the *Journal* only upon request, with email and fax consent binding.

RDN/NDTR CREDENTIAL

Are you a registered dietitian nutritionist (RDN) or nutrition and dietetics technician, registered (NDTR), with current registration status with the Commission on Dietetic Registration (CDR)?

- ☒ Yes
- ☐ No

If so, enter your CDR registration ID number: 1107255

If you are a registered dietitian credentialed by an organization other than CDR, please indicate full credential and administering country:

_____

FINANCIAL/CONFLICT OF INTEREST DISCLOSURES

Funding/Support:

- ☑ I certify that all financial and material support for this research and work are clearly identified in the author page of the submission.
- ☑ **National Institutes of Health (NIH) Funding.** The article was supported in part, or in whole, by the NIH. In accordance with the NIH Public Access Policy, I understand that my manuscript, should it be accepted for publication, will be submitted to PubMed Central. I understand that my manuscript will therefore be freely accessible by the public via PubMed Central 12 months from the date of publication.

My NIH grant or project number is:

_____

Personal Financial Disclosure/Conflict of Interest:

- ☐ I certify that all my affiliations with or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript are disclosed in the author page of the submission. Such conflicts would include employment, grants/research support, expert testimony, consultancy, stock holding, an honorarium, membership, or other financial/material support.
- ☐ I acknowledge that if a manuscript, article, or other work that I have authored is being considered for publication by the *Academy of Nutrition and Dietetics*, as author, I have a duty to disclose with the submission of this manuscript any conflict or duality of interest that might be perceived as affecting my objectivity and credibility or as creating an appearance of external influence.

Sign: Carrie Durward

Print Name: Carrie Durward

Date: July 17, 2020

Title and Affiliation: Associate Professor, USU
(if employer representative)