Using Paradata to Investigate Food Reporting Patterns in AMPM

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1. Introduction

USDA's Automated Multiple-Pass Method (AMPM), written in Blaise version 4.8, collects 24-hour dietary recalls for the What We Eat in America (WWEIA), National Health and Nutrition Examination Survey (NHANES). Each year it is used in approximately 10,000 interviews which ask individuals to recall the foods and beverages that were consumed the day before the interview. WWEIA collects two days of dietary intakes 3 to 10 days apart. The first interview is an in-person interview which takes place in the NHANES Mobile Exam Center. The second interview is by telephone. AMPM uses a research-based, multiple-pass approach designed to encourage complete and accurate food recall and to reduce respondent burden. The 5-step multiple-pass method used in AMPM is the result of more than 10 years of research by USDA to improve the 24-hour dietary recall methodology. The basis of the multiple-pass is to lead the respondent through the 24-hour period of the recall more than once using different approaches to assist the respondent in recalling foods and beverages without being repetitive (Raper et. al., 2004). AMPM provides a structured interview with standardized questions combined with unstructured opportunities for respondents to use their own individual strategies to remember and report foods. The success of this approach was demonstrated by the AMPM validation study conducted by the Food Surveys Research Group in collaboration with the Food Components and Health Laboratory, in which the energy intake collected by the AMPM was underreported by < 3% of the energy expenditure as measured by doubly-labeled water for normal weight individuals (Moshfegh et. al., 2008). Individuals report foods, at each of the 5 steps in AMPM on both days of the interview. "Food" is used throughout this paper to represent all foods and beverages, including water. The percent of foods and daily energy intake contributed by each step is shown in Table 1.

Table 1. Comparison of Contribution of AMPM Steps

AMPM Step	Day 1 Interview		Day 2 Interview	
	Percent of Foods*	Percent of Energy	Percent of Foods*	Percent of Energy
Quick list	65	77	73	84
Forgotten foods	9	6	5	5
Time and occasion	3	2	2	1
Detail cycle	22	12	19	10
Final probe	1	< 0.5	1	< 0.5

WWEIA, NHANES 2007-2008, Ages 12 and over, MEC weights

*"Food" comprises all foods and beverages, including water

The AMPM 24-hour dietary interview with the multiple-pass approach and flexibility to add foods at any point in the interview is a large and complex instrument. In order to maintain the coherence of the interview, it must keep track of a large amount of interview process information. This information about the process of the interview or paradata can be used to explore the dietary interview process and how individuals report foods. AMPM keeps track of the step in which the food was reported and also the order in which foods are reported in the interview. It also designates foods as primary foods such as coffee or as additions to foods such as milk added to the coffee. This data can be used to describe how individuals report foods during the AMPM interview and how the reporting changes between the first and second interviews.

2. Collecting Foods

2.1 Quick List

The AMPM interview begins with the Quick List where respondents are asked to report all the foods and beverages including water consumed from midnight to midnight the day before the interview. The Quick List is an unstructured, uninterrupted listing of foods which the respondent can report in any order. This allows respondents to use their own strategies to recall and report the foods consumed. A number of memory cues are included within the question. The day before the interview is referred to both as yesterday and by the day of the week. Memory cues in the question suggest that the respondent think about whom they were with and what they were doing such as working, eating out, or watching television. The question also includes references to foods eaten at home and away, and foods such as snacks, coffee, soft drinks, water, and alcoholic beverages. Approximately 69% of foods are collected during the Quick List making up 80% of the energy intake for the day.

2.2 Forgotten Foods

The next step is Forgotten Foods in which the respondent is asked 6 questions about specific types of foods and beverages that respondents frequently forget to include (beverages; alcoholic beverages; sweets; savory snacks; fruits, vegetables, and cheese; breads and rolls). The foods listed in each question provide memory cues to the respondent to think about these specific types of food. The respondent can report any type of food recalled at any of these questions. The seventh and last question is open asking the respondent if they can remember any other foods not yet reported. This step collects about 7% of foods accounting for 7% of daily energy intake.

2.3 Time and Occasion

The time the food was eaten and the name of the eating occasion are collected in this step. Examples of eating occasions include breakfast, lunch, dinner, snack, and beverage. This information is collected for each food reported in the first two steps. While reporting this information, the respondent can also report additional foods. Foods reported during this step account for about 2% of foods and 2% of daily energy intake.

The foods are stored in the Respondent Food List which is a block containing an array of foods. Each food has 54 fields associated with it. As each food is reported it is stored in the next position of the array. At this point in the interview, AMPM sorts all of the foods reported by the time of day they were consumed. It does this by assigning a sort order value to each food and does not change the position of the foods in the array. Since the position of the foods in the array is not changed, the order the foods were reported is maintained. AMPM also groups foods by time and eating occasion and establishes intervals between midnight and the first eating occasion, between each eating occasion, and between the last eating occasion and midnight. It should be noted here that foods consumed at the same time are not allowed to be assigned more than one eating occasion by the respondent.

2.4 Detail Cycle

AMPM then begins the next step which is the Detail Cycle. This step has two different types of questions. The first type is standardized questions which collect descriptive details about the food, additions to the food (such as milk to coffee), the amount consumed, the source of the food and whether it was eaten at home. The second type is review questions for each meal and each interval between eating occasions. For each interval, the respondent is asked if they had anything between the start of the interval and the end of the interval. The first interval is between midnight at the beginning of the 24-hour period and the first eating occasion. Then the question is asked for the interval between each eating occasion and finally between the last eating occasion and midnight at the end of the 24-hour period. When the standardized detail questions have been completed for all the foods in an eating occasion, the respondent is read a list of the foods reported for that eating occasion and asked if they ate anything else. Here the foods already reported serve as memory cues. At any

point during this step, if a respondent reports a new food, that food can be added to the Respondent Food List. All foods added during this step, including additions, are stored as separate foods in the next position in the food array. If the food was an addition it is assigned several values which mark it as an addition and link it to the food in the food array to which it was added. Additions are assigned the same eating occasion and time as the food to which they were added. Foods added as a result of the review questions may be part of an eating occasion for which foods were already reported or they may be a new occasion. Although most of the foods reported at an interval question will create new eating occasions, the respondent may also have remembered a food to add to an existing occasion. This is also true of the questions which review the eating occasion. Most of the foods will be added to that eating occasion, although respondents will also report new eating occasions.

Foods reported for an occasion or time of day which has already been asked, are held until the end of the detail cycle. At this point all remaining foods are asked. When the food added has created a new occasion, there are no new intervals created and no interval questions are asked but the review question for a new occasion is asked. Approximately 21% of foods and 11% of daily energy intake is collected during the detail cycle.

2.5 Final Probe

The last step is the Final Probe question which asks the respondent if they can remember any other foods including water and emphasizing even small amounts of foods which the respondent may not have felt were worth reporting. This question includes memory cues about foods consumed in the car, at meetings, or while shopping, cooking, and cleaning up and accounts for about 1% of foods and less than 1% of daily energy intake.

3. Using the Paradata

Information on where in AMPM foods are reported and the order in which they are reported does not impact the results of the survey which monitors food and nutrient intake in the U.S. population. However, this data can be used to investigate how the methodology of the AMPM succeeds in collecting complete and accurate 24-hour dietary recalls.

For this analysis, variables stored in the Respondent Food List food array were selected. These variables include the position of the food in the array or the array food number, the AMPM step in which the food was reported, and the type of the food (primary or addition). A food in AMPM is any food or beverage, including water. The foods were sorted by the eating time and occasion which produced a listing of foods in the order they were consumed within the 24-hour recall period. Each eating occasion was numbered sequentially beginning with 1. An eating occasion is defined as a unique combination of the time the food was consumed and what the respondent called it (breakfast, lunch, dinner, snack, beverage, etc.). Each food within an eating occasion was assigned the same number.

The foods were then sorted by their position in the food array which represents the order in which they were reported. Foods were grouped by eating occasion using the same definition, and sequential numbers were assigned to each eating occasion as it was reported beginning with 1. Foods from the same eating occasion that were reported in different steps on the AMPM have different reported order values. The exception is foods that are additions which were assigned the same reported order of the food to which they were added. For example, for a breakfast eaten at 7 am consisting of coffee, cereal, and milk, if the cereal was the first food reported on the Quick List, it was assigned a reported order of 1. The milk added during the Detail Cycle, because it was an addition, was also assigned a reported order of 1. If the coffee was reported during the Forgotten Foods step, it received a different reported order which was the next sequential number. This allows the analysis to look at how both foods and eating occasions are reported.

Figure 1 is an example of order assignment and the calculation of order difference. The respondent had 4 eating occasions: a 7 am breakfast with coffee and cereal with milk, a 9 am beverage which was a soft drink, a 1 pm lunch of pizza, and a 3 pm snack which was a cookie. The consumed and reported orders for the cereal and the milk are the same. The order values for the other foods are different. Order difference was calculated by subtracting the consumed order from the reported order.

Figure 1. Example of Order Assignment and Calculation of Order Difference

Reported Order Number	Reported on AMPM Quick List		Consumed Order Number	Order Difference
1	7 am Breakfast:	cereal	1	0
2	1 pm Lunch:	pizza	3	-1
3	3 pm Snack:	cookie	4	-1
	Forgotten Foods			
4	7 am Breakfast:	coffee	1	3
	Detail Cycle			
1	7 am Breakfast:	milk added to cereal	1	0
5	9 am Beverage:	soft drink	2	3

4. Statistical methods

Statistical analyses were performed with PC-SAS software (version 9.2; SAS Institute Inc, Cary, NC). Patterns in which individuals report foods were tested between the order that foods were reported and the order in which they were consumed using the nonparametric sign test provided by the Univariate SAS procedure for two related samples. Mean order differences were classified by selected demographic and food reporting variables. A two by two mean order difference comparison was performed using Tukey's multiple comparison method within the General Linear Model SAS procedure.

5. Results

This analysis was done using males and females age 12 and over from the 2007-2008 WWEIA, NHANES. Intakes for respondents younger than age 12 were not included because they are collected using assisted and proxy interviews. All the analysis was done separately by the day of interview. There were a total of 6,575 respondents with day 1 interviews and 86% (5,663) of these respondents also had a day 2 interview for a total of 12,238 dietary intake interviews. There were a total of 160,609 foods reported in the AMPM during these interviews. Overall, respondents reported an average of 13.2 foods in the day 1 interviews and 13.1 foods on day 2 showing no difference in the number of foods reported between the two interviews. As Table 2 shows, females report slightly more foods than males and older individuals report more foods than do younger.

Table 2. Average Number of Foods Reported by Day of Interview

Age (years)	Day 1		Day 2	
	Males	Females	Males	Females
12-29	11.0	11.6	10.3	10.8
30-59	13.3	13.5	13.0	13.6
60 and over	14.5	14.9	15.0	15.4
12 and over	12.9	13.4	12.8	13.4

Table 3 shows the percentage of interviews by day and gender in which respondents reported new foods (i.e., foods not reported in the Quick List) for each subsequent AMPM step. More respondents reported new foods on these AMPM steps on day 1 than they did on day 2. For both days, a higher percentage of male respondents reported new foods on the Forgotten Foods step than did females. On the other 3 steps, there is little difference between the percentages for males and females on both days. The report of new foods in the Detail Cycle includes additions to foods and, as expected, there were more interviews with new foods added in this step. During the last step in AMPM, which is a single final probe with memory cues, 13% of males and 12% of females reported new foods in the day 2 interviews. Therefore, these data demonstrate that the final step of the AMPM is important in helping to collect complete dietary recalls. Furthermore, even though these foods counted for only 1% of total foods reported and <0.5% of daily energy intake, they contributed nutrients to at least 12% of the dietary intakes.

Table 3. Percent of Interviews with New Foods Reported during each AMPM Step

Interview	Forgotten Foods		Time and Occasion		Detail Cycle		Final Probe	
	Males	Females	Males	Females	Males	Females	Males	Females
Day 1	70%	65%	27%	26%	90%	91%	17%	15%
Day 2	53%	45%	17%	16%	87%	90%	13%	12%

In the day 1 interview, about 66% of individuals began reporting foods on the Quick List with their first eating occasion for that day. However, only about 17% reported all their eating occasions on the Quick List in the order they were consumed. In the day 2 interview, with respondents now familiar with the AMPM, these percentages increased to 83% and 35%, respectively. The reference to the time frame from midnight to midnight in the Quick List question leads respondents to begin reporting with their first eating occasion of the day. However, these numbers show that few respondents continued reporting foods in the order they were consumed, even on the Quick List.

Over the entire interview, only 8% of respondents on day 1 and 20% of respondents on day 2 reported all their foods in the order they were consumed. These correct order reporters were evenly distributed between males and females.

Statistical comparisons of the reported order and the consumed order are shown in Table 4. The table shows the mean differences between the reported and consumed order of foods, the standard errors and the significance levels for day 1 and day 2, males and females, and 5 age groups. Significance levels are indicated by asterisks as described in the table footnotes. Smaller mean differences indicate that respondents reported foods closer to the order in which the foods were consumed. In all of the age and gender groups for both days, the mean difference is statistically significant at either $p < .001$ or $p < .01$, as shown in Table 4, except for females age 60 and over on day 2. This does not appear to be due to reporting fewer numbers of foods, because they are also the group who reported the most foods on the AMPM (15.4) as shown in Table 2. In an analysis comparing mean daily energy intake between day 1 and day 2, females age 60 and over are also the only age and gender group in which the within-person variation is lower than the between-person variation as shown in Table 5 (Anand, et. al., 2011). Although these factors may not be related, they do indicate that this age gender group

is different. These women may pay more attention to foods since they are likely to have been responsible for years of shopping and meal preparation. The effect may be less in younger women because time spent on meal preparation and related activities has decreased by 7 hours per week for full time homemakers and 3.5 h per week for employed women between 1965 and 1999 (Rose, 2007).

Table 4. Mean Differences in Food Ordering Between Reported and Consumed

Interview	Gender and Age (years)	N	Order Difference Mean (SE)
Day 1		6,575	.78 (.03)**[A]
	Males	3,268	.84 (.05)**[C]
	12-29	1,044	.94 (.08)**
	30-39	472	.88 (.12)**
	40-49	417	.87 (.13)**
	50-59	439	.75 (.12)**
	60 and over	896	.76 (.08)**
	Females	3,307	.73 (.04)**[D]
	12-29	1,000	.81 (.08)**
	30-39	485	.63 (.11)**
	40-49	465	.72 (.12)**
	50-59	432	.58 (.12)*
	60 and over	925	.77 (.08)**
Day 2		5,663	.5 (.03)**[B]
	Males	2,750	.51 (.04)**[E]
	12-29	847	.52 (.06)**
	30-39	379	.58 (.11)**
	40-49	346	.57 (.11)**
	50-59	385	.51 (.10)*
	60 and over	793	.46 (.07)**
	Females	2,913	.49 (.04)**[E]
	12-29	869	.5 (.06)**
	30-39	404	.48 (.09)**
	40-49	415	.5 (.09)**
	50-59	388	.48 (.10)**
	60 and over	837	.48 (.07)

** Significantly different from 0 at $p < .001$

* Significantly different from 0 at $p < .01$

[A,B,C,D,E] Means with different letter superscripts are significantly different at $p<0.01$

Table 5. Within- and Between-Person Variance in Energy

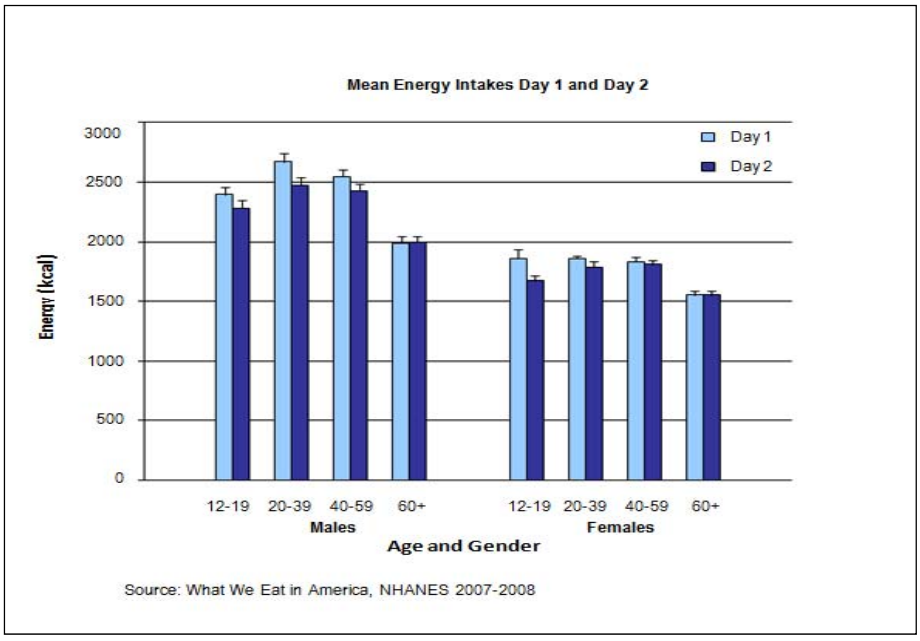
Age and Gender		Two day mean energy (kcal)	Within-person variance %	Between-person variance %
Males	12-19	2341	56.5	43.5
	20-39	2575	62.6	37.4
	40-59	2487	50.6	49.4
	60 +	1994	57.2	42.8
Females	12-19	1768	73.6	26.4
	20-39	1825	56.1	43.9
	40-59	1821	63.5	36.5
	60 +	1553	40.5	59.5

Source: What We Eat in America, NHANES 2007-2008, all individuals with 2 days of dietary data, 2 day weights

Comparing the order difference means between day 1 (.78) and day 2 (.5) shows a significant difference ($p < .01$). This means that respondents reported foods closer to the order they were consumed on day 2. The order difference means are also significant between males (.84) and females (.73) on day 1 ($p < .01$). But the order difference means are not significant between males (.51) and females (.49) on day 2. These significance levels are indicated by the letters A-E in Table 4. Although both males and females reported foods closer to the order they were consumed on day 2, there was a larger change in the reporting behavior of males between day 1 and day 2.

Although there are differences in how respondents report foods in terms of order on the AMPM between day 1 and day 2, there are no significant differences in the mean energy intakes as shown in Figure 2 (Anand, et. al., 2011). This demonstrates that different food reporting patterns in AMPM between day 1 and day 2 did not impact mean energy intakes within age and gender groups.

Figure 2. Comparison of Mean Energy Intake Day 1 and Day 2



6. Conclusion

Analysis of food reporting patterns from AMPM interviews shows the importance of the multiple-pass methodology to produce complete and accurate dietary intakes. Regardless of day, gender, and

age, new foods are reported on every AMPM step and few respondents report foods in the order they were consumed.

This investigation, using paradata from AMPM to look at food reporting patterns, suggests that this analysis could be extended in a number of directions. These include types of foods and beverages reported at each step, the number of new eating occasions added at each step, and the effect of the time of day the interview is conducted. Since most respondents do not report foods in order, describing patterns in food reporting could glean information that would lead to improvements in the AMPM.

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