Chapter 4

Dietary Assessment in Behavioral Medicine

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1 Overview of Dietary Assessment in Behavioral Medicine

Nutritional status is one of the most important predictors of health risk. Research consistently demonstrates that diets rich in fruit, vegetables, whole grains, and lean meats from poultry and fish are inversely associated with risk of age-related chronic diseases such as cardiovascular disease, cancer, and diabetes (Kushi et al, 2006; Lampe, 1999; Neuhouser, 2004; Pool-Zobel et al, 1997; Prentice et al, 2004; World Cancer Research Fund/AICR, 2007). Conversely, diets high in refined grains and added sugars, but low in diverse plant foods, increase risk for obesity and obesity-related disorders including cardiovascular disease, cancer, and diabetes (Boynton et al, 2007; Kristal et al, 2000; National Research Council Committee on Diet and Health, 1989; Patterson et al, 2004). Despite the strong and consistent diet–disease associations and recommendations to the public to make healthy food choices and limit or avoid added fats, sodium, and empty calorie-type foods, consumers still, for the most part, select poor diets (Kant and Graubard, 2006). For example, only 11% of American adults obtain the recommended 5–9 servings of fruit and vegetables per day (Casagrande et al, 2007). Equally concerning is the high prevalence of daily consumption of sugar-laden empty calorie beverages, such as a soft drink; such high consumption is a common practice among young children, adolescents, and adults (Dubois et al, 2007; French et al, 2003; Rajeshwari et al, 2005; Rampersaud et al, 2003). This discrepancy between available knowledge of nutritional benefits and food intake patterns suggests a strong influence of culture and behavior on dietary practices.

Food choice is a complex behavior. Individuals and groups make dietary selections based on food familiarity, availability, cost, cultural norms, ease of preparation, individual taste, convenience, and many other factors (Drewnowski, 1997; Glanz et al, 1998a, b; Popkin et al, 2005). Therefore, assessment of diet, particularly for the purposes of promoting dietary change or improvement in dietary patterns, must include attention to the behavioral aspects of food intake (van Duyn et al, 2001). Dietary behaviors are extremely personal and efforts to promote healthful dietary changes that are based only on knowledge about foods are not likely to succeed.

Apart from behavioral predictors of food intake, measuring what people eat is particularly complicated for several reasons. To illustrate this point, we can compare the assessment challenges for two exposures: playing golf or tennis and diet. Playing golf or tennis is a single (yes/no) activity – people are either players or not, so individuals usually report with good accuracy whether or not they engage in these activities. Further, since for many people, these activities

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occur on a weekly or monthly basis, most people would record with reasonable accuracy that they play golf or tennis once a week. In comparison, over the course of even 1 week, an individual can consume hundreds, even thousands of distinct food items in various combinations, making it cognitively challenging for respondents to accurately report on their intake. Meals can be prepared by others (e.g., in a restaurant, by a spouse, as prepackaged food) so that the respondent may not be cognizant of preparation details such as fat or salt used in cooking or portion size. Further, food choices often vary with seasons and other life activities (e.g., weekends, social engagements, holidays, vacations). In fact, in today's modern food environment with so many choices, particularly, myriad ready-to-eat choices available to consumers, the day-to-day variability in food intake can be so large that it is difficult to identify any underlying consistent pattern. Collectively, these issues make dietary assessment a very complex task for both researchers and clinicians.

2 Standard Dietary Assessment Tools for Use in Behavioral Medicine

Dietary assessment requires asking participants about their usual food habits. This process can take several forms, such as a structured interview, a self-administered questionnaire, or a diary. This section describes the more commonly used dietary assessment tools.

2.1 Food Records and Diaries

Multiple day food records or diaries require individuals to record all foods and beverages consumed over a specified period of time, often 3–7 days. Participants are typically asked to carry the paper record or diary with them and to record foods in real time as eaten. However, in reality, many participants will record everything at the end of the day due to the burden of recording in real time. Some protocols require participants to weigh and/or measure foods before eating, while less stringent protocols use food models, photographs of food, measuring cups, and other aids to instruct respondents on estimating serving sizes. Often the food diary is carefully reviewed or documented by a trained dietitian to confirm food portion sizes, ingredients added in cooking and at the table (such as salt, oils, salad dressings, butter, and other condiments), and additional food details. However, this type of detailed review and documentation can add greatly to the participant burden since the minutiae required can seem overwhelming and time consuming to participants. In addition, this type of very detailed documentation adds to the overall cost of food record collection, but may not add significant or necessary food details. One study showed that when detailed, step-by-step instructions on food recording are provided to participants (including specific examples) prior to starting the diary, the detailed documentation by a dietitian may not be necessary (Kolar et al, 2005). Review by a dietitian can still occur during the data entry phase and follow-up queries can be made to the participants, as necessary, but the face-to-face questions and queries could be skipped when sufficient instruction is provided.

Regardless of the data collection protocol, ultimately the food consumption information from records/diaries must be coded and entered into a software program for calculation of nutrient intakes (Schakel et al, 1997). This data entry step is a time consuming task and requires trained data technicians or nutritionists. One reason these complex tasks are so time consuming is that the large food databases typically contain 15,000–20,000 individual food items, which represent only a fraction of the universe of food possibilities. Thus, the trained nutrition coder must make decisions about which foods to enter as substitutes. For example, an individual records "one 4-inch by 4-inch by 4-inch portion of 'Mama's' brand frozen lasagna." If "Mama's" is not listed among the various frozen lasagna choices in the database, the coder must make an

informed decision about which brand is the closest match to "Mama's" in terms of total energy, protein, fat, and other nutrients. Some misclassification is unavoidable, but a well-trained and knowledgeable nutritionist should be able to select comparable substitutes.

Food records are somewhat burdensome for clients or study participants to complete. In fact, some studies have shown that individuals might change their food intake on recording days to consume more easy-to-prepare items that require less recording, but the ultimate influence of this practice is unknown (Craig et al, 2000; Rebro et al, 1998). Clients or study participants should always be reminded to eat as they normally do during the food-recording period. Advances in digital mobile devices (phones, cameras, PDAs) now make it possible to record and transmit food record data, which alleviates some of this participant burden and may provide more accurate data (Beasley et al, 2005; Kretsch and Fong, 1990; Wang et al, 2002). Digital devices are becoming such a routine part of people's lives that real-time digital recording of one's food and beverage intake may not feel as burdensome as a paper and pencil diary. Other disciplines in medicine, physical activity, and pain monitoring have been successfully using technological advances for quite sometime (Berg et al, 1998; Jamison et al, 2001). In addition, digital recording of food intake may alleviate problems with portion size estimation, which is a frequent source of error in dietary data collection (Williamson et al, 2003, 2004). In the future, pencil and paper food diaries are likely to disappear in favor of digital collection methods.

2.2 Dietary Recalls

A 24-h dietary recall is a structured interview in which detailed questions are asked about all foods and beverages consumed over the previous 24 h. Dietary recall interviews can be conducted in person or by telephone and typically last 20–30 min. Data from 24-h recalls have been used to characterize large populations in the United States via the survey, "What We Eat in America" (Conway et al, 2004; Dwyer et al, 2003a). When conducted in large population groups, recalls provide a general "snapshot" of population dietary intake.

Regardless of whether 24-h dietary recalls are done in-person or over the telephone, the protocols work best when interviewer scripts are standardized on a computer screen with direct data entry into a software program. It is very important that the interviewer be well trained since tone of voice, body posture (when in-person), and reactions to participant descriptions of foods consumed can influence the quality of the data, including omissions or phantom food additions (Conway et al, 2004). Sometimes interviewers need to redirect the conversation back to the structured questions, should the respondent deviate off-topic, which can be a problem when assessing specific population subgroups, such as the elderly. As with food records, the use of portion size estimate aides, such as life-size food models, photographs, or dimensional aides including rulers and measuring cups, increases the ability to estimate portion size thereby improving the reliability of the recall data (Pietinen et al, 1988; Williamson et al, 2003).

Regarding the actual process of conducting the 24-h recall interviews, the currently most widely accepted methods follow the protocol established by the United States Department of Agriculture (USDA) and used in the "What We Eat in America" survey (Conway et al, 2003; Dwyer et al, 2003a, b). This five-step method includes the following sequence of queries:

1) *Quick list* – trained interviewers first ask participants to list all foods and beverages consumed during the previous 24 h.
2) *Forgotten food list* – interviewer asks detailed probes about foods or additions to foods that are frequently forgotten. Examples of foods that are often added to this list are milk on cereal, sugar in coffee, and between-meal snacks and beverages.
3) *Time and place* – the interviewer asks the participant to recall the time of day and the

location (e.g., home, school, restaurant) of the food consumption. This time and place memory probe frequently helps participants to better recall the foods consumed.

4) *Detail cycle* – the interviewer probes for details about each food named in the quick list and forgotten list, including cooking methods, portion size, brand names, type, and amount of fat added during cooking and at the table. The detail cycle includes the collection of information on mixed dishes and recipes. The questions in the detail cycle are highly standardized with computerized prompts to ensure uniform data collection.
5) *Final review* – the interviewer does a final review of the foods and beverages consumed and queries participants about any additional items that may have been omitted.

2.3 Food Frequency Questionnaires

Food frequency questionnaires (FFQ) are self-administered instruments that obtain data on frequency and portion size on anywhere from 60 to 150 foods or food groups. Respondents indicate on the form whether they eat a certain food and how often (i.e., once a month or several times a day). These instruments usually include various types of questions: (1) adjustment questions on food preparation or frequency of restaurant eating, (2) the food list, and (3) summary questions. The adjustment questions permit more refined analyses of fat intake by asking about food preparation practices (e.g., removing skin from chicken), types of added fats (e.g., use of butter vs. margarine on vegetables), or type of milk usually used (e.g., whole, skim, soy). Because details about food preparation are not obtained with FFQ in the same manner as food records and recalls, these adjustment questions can be useful approaches to fine-tune the food selections.

The main section of an FFQ consists of a food or food group list, with questions on usual frequency of intake and portion size. To allow for machine scanning of these forms, frequency responses are typically categorized from "never or less than once per month" to "2+ per day" for foods and "6+ per day" for beverages. Portion sizes are often assessed by asking respondents to mark "small," "medium," or "large" in comparison to a given medium portion size. However, some questionnaires only ask about the frequency of intake of a "usual" portion size (e.g., 3 ounces meat). Often a cartoon-type picture or very small photograph is provided as a "reference point" for the medium portion size. However, since the pictures must be small to fit onto the questionnaire, it is unclear how useful they may be in the long run.

FFQ food lists or line items are created to capture data on (1) major sources of energy and nutrients in the population of interest, (2) between-person variability in food intake, and (3) specific scientific hypotheses (Willett, 1998). Since the food list possibly cannot include the universe of all food and food combination possibilities, decisions must be made about which foods to include and which ones to omit. For example, one approach is to use national consumption data from 24-h dietary recalls to determine the most commonly eaten foods and major nutrient sources in the diet (Block et al, 1994, 1986; Willett, 1998). Details about nutrients are limited though for foods consumed in specific population groups (e.g., certain ethnic foods) and there are limited data on bioactive constituents of foods that are not considered nutrients but nonetheless have biological actions (e.g., isothiocyanates, polyphenols). Finally, to save space and reduce respondent burden, similar foods are often grouped into a single-line item (e.g., apples, peaches, plums). When grouping foods, important considerations include whether they are nutritionally similar enough to be grouped and whether the group will make cognitive sense to the respondent. For example, a food group composed of three types of fruit may have similar amounts of vitamin C, but be very different for other bioactive compounds such as flavonoids or carotenoids. These issues must be considered when selecting a dietary assessment instrument.

2.4 Advantages and Disadvantages of Standard Dietary Assessment Instruments

Dietary records and recalls provide similar types of data: detailed information on all foods and beverages consumed on specified days. While these methods are intended to capture data on actual foods consumed, there is a somewhat large respondent burden of recording (or recalling) food intake that can cause people to alter their food intake such that they consume less complex foods or they may avoid eating foods perceived to be less healthful (i.e., sweets, salty snacks). Further, even when participants record foods in real time, mistakes can still occur in food descriptions, portion size estimation, and lack of food composition data on various ethnic foods and complex mixtures. Theoretically, unannounced interviewer administered 24-h dietary recalls avoid the problem of changes in food intake since respondents cannot change what they ate retrospectively. However, a disadvantage of dietary recalls is that they rely on the respondent's memory and ability to estimate portion sizes, though the latter limitation can be alleviated by the use of portion size aides. An important advantage of recalls is that they are appropriate for low-literacy populations and children where use of diaries or records would not be appropriate (Sobo et al, 2000).

Today's modern diets give consumers a large amount of choice in food selection – both for home-prepared and ready-to-eat meals. As a result, there is quite high day-to-day variability in intake. In practice, for accurate dietary assessment, this means that several days of records/recalls are required to adequately assess "true" intake. Some foods may be consumed rather infrequently, but if they are an important contributor toward intake of specific nutrients, then many days of intake are needed to increase the probability of consumption of that food. For example, fatty fish, such as tuna, salmon, or mackerel, may be consumed only once a week or less, but these fish are very important sources of long-chain omega-3 fatty acids that are associated with reduced risk of cardiovascular disease and several other chronic health problems. A record or recall with insufficient days may not capture this fish intake. Unfortunately, research has also shown that reported energy intake, nutrient intake, and recorded numbers of foods decrease with increasing numbers of recorded days (Rebro et al, 1998). Thus, simply changing a protocol to increase the number of recorded days so as to capture this dietary variability may not be sufficient.

The major advantage of FFQs is that they attempt to assess usual, long-term diet, either current or in the past. In addition, they have relatively low respondent burden and are simple and inexpensive to analyze because they can be self-administered and are machine scannable. A disadvantage of these questionnaires is that respondents must estimate usual frequency of consumption of 100 or more foods and the associated usual portion sizes. These cognitive tasks can be exceedingly difficult for many respondents, and may contribute to the observed measurement error from FFQs (Neuhouser et al, 2008; Subar et al, 2003; Tooze et al, 2004). Another major disadvantage of these questionnaires is related to the close-ended nature of the form. For example, use of an FFQ with a typical American fixed-food list is not likely to be useful in some special populations or in places outside the United States. In addition, a questionnaire with appropriate foods and portion sizes for one population group (e.g., older African-American women) may be inappropriate for another subgroup (e.g., adolescent Hispanic females). Fortunately, some work has been completed to develop culturally appropriate FFQs. For example, FFQs have been developed for use in specialized populations, such as the elderly, rural residents, and various ethnic groups (Patterson et al, 1999; Resnicow et al, 2000; Yaroch et al, 2000). Finally, the fixed portion sizes on FFQs may make it extremely difficult to obtain accurate data. For example, most FFQs list a 12-ounce soft drink as a medium portion, when it is more likely a "small" using today's portion standards. Similarly, a medium hamburger from the 20th century was a 2-ounce

patty, but in the 21st century, a medium hamburger is six ounces (Nielsen and Popkin, 2003; Nielsen et al, 2002). These fixed portion size issues do not occur with the open-ended records and recalls.

3 Non-traditional Dietary Assessment Instruments Used in Behavioral Medicine

Non-traditional assessment instruments have been a useful addition to the dietary assessment repertoire. For example, household food inventories, cash register receipts, and instruments focused more on behavioral aspects of eating, rather than absolute intake of nutrients have been useful.

3.1 Household Food Inventories

Household food inventories are ecological measures of diet. They cannot give information on an individual or even a family's absolute intake, but they provide a snapshot of eating behaviors or even "food culture." For example, households that have many high-fat, nutrient-poor foods (i.e., potato chips, candies, sweets, and other prepared snacks) and few fruits and vegetables may be more likely to have overall high-fat diets or be at risk for obesity. A common approach for family-level weight management programs is for the nutritionist to conduct a food inventory of the pantry and advise the family to discard items with excess energy and poor nutritional value. This point is illustrated in one study reporting that the presence (in the house) of 15 high-fat foods was found to correlate with household members' individual dietary fat intake at 0.42 ($p < 0.001$) (Patterson et al, 1997). Individuals with $\leq$4 high-fat foods in their house had a mean of 32% energy from fat compared to 37% for those with $\geq$8 high-fat foods. Household inventories can also provide information about poverty and food availability. Poor household food availability may be associated with greater individual-level measures of food insecurity and is paradoxically associated with risk for obesity (Burdette and Whitaker, 2004; Mobley et al, 2006; Townsend, 2006). Appropriate referrals and interventions can be made when it is known that little food or poor nutrient quality food exists in the home. Finally, household inventories may be particularly good assessment tools to use with new immigrants where language or cultural barriers may preclude use of records, recalls, or FFQs (Satia et al, 2000, 2001a, b).

3.2 Targeted Instruments

Targeted instruments are those that are focused on a particular behavior or intake of a limited number of foods, such as fruit and vegetables, snacks, or sweets. While not useful for comprehensive dietary assessment, they are useful when evaluating or conducting an intervention on focused dietary behaviors. These types of targeted dietary assessment instruments are most useful when the target food/nutrient is not distributed throughout the food supply. For example, dietary fat is widely distributed in dairy foods, meats, added fats, desserts, prepared foods, etc. Therefore, short instruments that attempt to estimate fat intake tend to be imprecise since a short number of questions cannot capture this complex behavior (Neuhouser et al, 1999). A good example of a targeted instrument is one that was recently developed to assess soft drink and snack consumption among adolescents. Due to the tremendous and rapid increase in obesity among the entire population, including adolescents (French et al, 2003), many school districts are limiting the on-campus sale of sugar-laden beverages, such as soft drinks and other high-calorie drinks with few nutrients. To evaluate whether such policies are effective at reducing consumption of these beverages, researchers developed a short beverage and snack questionnaire. Similar to an FFQ in form, the questionnaire asks about frequency

and location (at school or not at school) of soft drinks, sports-type drinks, fruit punch, and other sugar-sweetened beverages (Neuhouser et al, 2009). Other targeted instruments are those that assess fruit/vegetable, salty/savory snacks intake and food likes and dislikes (food propensity) (Neuhouser et al, 2000, 2001; Subar et al, 2006; Thompson et al, 2000, 2002). However, it is important to note that one disadvantage of these short checklists is that they may underestimate consumption of fruit and vegetables in particular. For example, "servings" of vegetables, such as a serving of green beans or green peas, is a relatively easy cognitive task. On the other hand, vegetables that are components of more complex dishes, such as vegetables on pizza or in casseroles, soups, and stews, are a bigger challenge for participants to deconstruct and record on a short questionnaire.

3.3 Eating Behavior Instruments

A class of dietary assessment instruments particularly well suited for behavioral medicine are those focused specifically on eating behaviors (in contrast to absolute intake measures in standard instruments). The development of these dietary behavior instruments was initially motivated by problems with assessing dietary intervention effectiveness, particularly low-fat interventions (Kristal et al, 1990). The fat-related diet habits questionnaire was based on an anthropologic model that described low-fat dietary change as four types: (1) avoiding high-fat foods (exclusion); (2) altering available foods to make them lower in fat (modification); (3) using new, specially formulated or processed, lower fat foods instead of their higher fat forms (substitution); and (4) using preparation techniques or food ingredients that replace the common higher fat alternative (replacement) (Shannon et al, 1997). A recently developed "mindful eating questionnaire" was designed as a cognitive approach for dietary assessment and intervention tool and incorporates a body awareness framework often used in the practice of yoga (Framson et al, 2009).

4 Summary and Conclusions

In conclusion, dietary assessment is a complex task. While it might seem intuitive to simply ask study participants or patients to recall foods eaten or complete a form on eating patterns, food intake behaviors are difficult to capture with reasonable accuracy due to the complex and varied items available to consumers, the burden that may be associated with asking participants to record foods and beverages and limitations in standard instruments that are currently available. In addition, underreporting of dietary intake has been identified as a significant problem in dietary assessment. Newer methods of dietary assessment that rely on PDAs, mobile phones, and other electronic technologies will likely be increasingly used in the future with the hope that more accurate data will be obtained. Nontraditional dietary assessment methods may be particularly useful. While not designed to measure absolute intake of foods or nutrients, they are intended to capture dietary behaviors, such as fat intake behaviors, food likes and dislikes (which may predict consumption), and intake of soft drinks and sweets. Despite the challenges in dietary assessment, efforts must continue to understand what people eat and offer dietary modification advice, as needed.

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