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Dietary Assessment of Individuals with Chronic Kidney Disease

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Abstract

Examining the quality and quantity of food intake by appropriate methods is critical in the management of patients with chronic kidney disease (CKD). The four commonly used dietary assessment methods in CKD patients include short term dietary recalls, several days of food records with or without dietary interviews, urea kinetic based estimates such as protein nitrogen appearance calculation, and food histories including food screeners and food frequency questionnaires (FFQ). There are a number of strengths and limitations of these dietary assessment methods. Accordingly, none of the four methods is suitable in and of itself to give sufficiently accurate dietary information for all purposes. FFQ, which is the preferred method for epidemiological studies, should be used for dietary comparisons of patients within a given population rather than individual assessment. Food histories including FFQ and dietary recalls may underestimate important nutrients, esp in CKD patients. Given the large and increasing number of dialysis patients and work responsibilities of renal dietitians, routine analysis of dietary records and recalls is becoming less feasible. Ongoing and future studies will ascertain additional strengths and limitations of dietary assessment methods in CKD populations including the assessment of food intake during an actual hemodialysis treatment.

Keywords

Dietary assessment; chronic kidney disease (CKD); dialysis; dietary recalls; food records; urea dynamic based estimates of dietary protein intake; dialysis food frequency questionnaire (FFQ)

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In the general population, accurate assessment of dietary intake is imperative for health promotion and prevention of disease. Dietary evaluation is of particular importance in those subgroups at risk for overnutrition or undernutrition.(1) Examining the quality and quantity of diverse types of nutrients is also critical in assessing the dietary intake in those groups of individuals who need to extensively modify their nutrient intake. The patients with chronic kidney disease (CKD) have this requirement .(2) Hence, selecting the best methods to measure the type and amount of each nutrient in the ingested diet is of substantial importance to the management of the CKD patient. Furthermore, comprehensive assessment of dietary intake over time may allow more reliable investigation of the relationship between food intake pattern and both comorbid conditions and clinical outcomes in CKD populations. This may be particularly useful among chronic dialysis patients in whom mortality is quite high and where there is a strong association between mortality with their nutritional status.(3) (4) Better knowledge of nutrition and nutritional support among CKD patients will help to optimize their clinical response.

Methods to Assess Dietary Intake in CKD

In both the general population as well as in CKD patients, the commonly used methods for dietary assessment include dietary recalls over short periods of time (e.g. 24 hrs), food records with or without supplementary dietary interviews, conducted over short periods of time (e.g. 3 to 7 days), and longer term (weeks to months) food histories in the form of food frequency questionnaires (FFQs).(5) Additionally, in hemodialysis (HD) patients (particularly those with little or no residual renal function) the extent of the rise in serum urea between two consecutive HD treatments allows protein intake to be estimated. (6) Modifications of this method can be used in nondialyzed CKD patients and chronic peritoneal dialysis patients as well.(7) Each of these 4 methods is described below.

A. 24-Hour Dietary Recalls

The 24-hr diet recalls are relatively quick assessment modalities to obtain the most recent information about food intake.(8) The recall is usually implemented by an experienced dietitian during a face to face or telephone interview and pertains to the food intake during the day before. The task involves precise and relatively comprehensive questioning of the details of subject's food and drink intake during the entire 24 hrs.(5) Prompts are provided to aid memory of actual food or drink consumed, the composition of dishes, the cooking method, and additional items added (e.g., spread on bread, type of milk in drinks, fat added to vegetables). The subject is asked to estimate portion sizes using household measures; the dietitians use their knowledge of portion sizes to aid the subject on their recall. The main advantages of 24 hrs recall are convenience and rapidity and the fact the patients do not need to provide or prepare records of diaries.(1) The method's main limitations are its reliance on patient's memory and willingness to be accurate, interviewer's comprehensiveness, the effectiveness of their prompts, and the accuracy of extrapolating 24 hrs of dietary intake to a longer period,(1) especially in dialysis patients whose food intake pattern on dialysis and non-dialysis days may be significantly different.(9) To overcome these limitations, usually several 24-hr recalls are obtained in order to yield more accurate averaged data.(5)

B. Food Diaries and Records

Diet diaries and records capture dietary information over several days, usually 3 or 7 days. (8) Their assessment may be augmented with a supplementary dietary interview, in that a trained dietitian reviews the records and obtains additional relevant information in a face-to-face or telephone interview. Most food records providea booklet with color photographs representing small, medium, or large portions and instructions to guide the details and types

of information to be reported. (10) Household measures and standard units are also used to describe amounts of foods consumed. Dietitians, trained to standardized protocols, provide instructions on how to complete the 3 or 7-day diary. Subjects are provided with a dietetic scale for weighing food servings whenever possible. Alternative methods employing common dietary household measures may be taught for use when the subject is away from home. The participants are asked to complete the 3 or 7 day diary and then mail the diary back to the study center.

The strength of this method includes the expected real time recording of the ingested food and the extended period of time beyond 24 hrs. Supplementary dietary interviews may enhance completeness and accuracy. Its limitations include varying patient compliance with instructions, missing or inaccurate recordings of food items, and inability to capture seasonal or other cycling variations in dietary pattern. Keeping daily diaries is burdensome for many people, and the accuracy of diaries that are maintained beyond about three days has been questioned. We have used the 3-day diet diary with diet interviews by a trained dietitian in the Study of Nutrition and Inflammation in Dialysis Patients (NIED) (11–13) over the last HD treatment day of the week (usually Friday or Saturday) and the two subsequent non-dialysis days in order to achieve a better representation of the dietary pattern of the participating subjects.(see NIED Study website at www.NIEDStudy.org for more details)

C. Urea Dynamic Based Estimates of Dietary Protein Intake

By virtue of end-stage renal failure, most maintenance HD patients cannot excrete a significant amount of urinary nitrogen. Hence, the rate of increase in serum urea nitrogen between two consecutive HD sessions reflects dietary nitrogen intake, provided that the individual is not in substantially negative or positive nitrogen balance. This indirect but conveniently available measure of protein intake is referred to as the urea kinetic based protein equivalent of total nitrogen appearance (PNA) or protein catabolic rate (PCR), which is usually normalized (n) for the patient's body weight or an estimate of the volume of distribution of urea; hence the term, nPNA or nPCR.(14, 15) Some protocols also collect urinary urea excretion and add this to the calculations for nPNA. nPNA, as a measure of dietary protein intake, may have a bearing on clinical outcome in HD patients, and so several studies have examined the association between nPNA and survival in dialysis patients.(15, 16)

D. Dietary Screeners and Food Frequency Questionnaires

In dietary screeners and FFQs (8) dietary intake is estimated from a self- or interviewer-administered semi-quantitative questionnaire that can be brief (food screeners) or comprehensive (food questionnaires). The FFQ usually includes a large number of commonly ingested food items with multiple choices for the frequency of ingested food, e.g. from once or more a day to one a week or a month or even less often. Food item questions may also be associated with specified serving sizes corresponding to natural portions or standard weight and volume measures of the servings commonly consumed in the study population. For each food item, the participant indicates his/her average frequency of consumption over the past several months to years (usually 6 to 12 months). The selected frequency category for each food item is then converted to a daily intake value. Nutrient intake is computed by multiplying the frequency of food consumption by the nutrient content of the specified standard portion.(17) The main strength of the FFQ is its convenience, esp. if self-administered, for use in large populations such as the Nurses Health Study.(18) The advantages of FFQs are its large temporal catchment (months to years) which may provide a better estimate of usual intake, and the efficiency and cost savings

from automated data entry and analysis using computerized scanning methods and data calculations. Hence, FFQ is a useful tool for nutritional epidemiology research.(19)

Despite its relatively high reliability in ranking subjects across each food item(20), FFQ may under- or even over-estimate nutrient intake at the individual level,(21–24) and hence should rarely, if ever, be used for a dietary assessment of a given individual. The FFQ has occasionally been used in epidemiologic studies of CKD patients.(25–32) Whereas the FFQ is a reliable tool for ranking individuals according to their dietary intake, the Food and Nutrition Board cautions that FFQ data may not be accurate enough to assess the adequacy of dietary intakes of individuals or small groups of people. This inaccuracy is due to three limitations: (1) lack of direct quantitative assessment of individual amounts of nutrients consumed; thus, precise quantification of intake is not feasible, and the calculated intake of nutrients may underestimate the total intake of that nutrient; (2) inadequate coverage of FFQ items to include all available food items; and (3) inclusion of diverse varieties of a given food under one single food item question, and hence, failure to capture significant differences among different subtypes.(28)

Strengths and Weaknesses of Dietary Assessment Methods

Table 1 shows the strengths and limitations of these dietary assessment methods. In our opinion none of the above four methods is suitable in and of itself to give sufficiently accurate dietary information for all purposes.(33) There are a number of factors that can affect the precision of diet assessment. These include the selected dietary survey instruments used , whether the measured food intake is usual or actual , the number of days evaluated, whether it is interviewer-based or self-administered, the type of interview conducted (direct or by proxy), the data entry method, e.g. whether data entry was via computerized scanning and software or if information was individually codified and entered manually.(22–24) The voluntary or involuntary error in reporting foods consumed may lead to under- or over-reporting of intake both in quantity and in types of foods and nutrients, e.g. by virtue of omission of foods that were consumed but not captured or by reporting foods that were indeed not consumed.(22–24)

Cultural variations in subgroups of patients under study may also affect the computations; e.g., Hispanic or Asian dialysis patients in the United States may ingest food items that are not usually listed in food questionnaires. Errors can often arise in the estimation of portion sizes.(33, 34) In addition, when the objective is to measure not only food in general but also micro- and macro-nutrient intake, there may be even more confounding factors that can affect the correct estimation.(22, 35, 36) Food composition data and tables that are used as the reference may or may not be up-to-date with regard to nutrient composition; (22, 35, 36) e.g., the amount of phosphorus additives in food may change frequently.(37)

Dietary records and recalls focus on single to several day periods.(5) The 24-hr recalls can be performed rather fast, usually requiring around 20 minutes for a trained interviewer, and can be performed over the phone.(5) However, its success depends on the memory, cooperation and communication ability of the subjects, the experience and skills of the interviewer, and his/her familiarity with background food culture.(5) Dietary records usually cover 3 to 7 days, but they, too, are amenable to the aforementioned limitations including non-representativeness of the period of time studied, and the fact that many subjects cannot complete such records completely and accurately. Unlike recalls and records, a single administration of a FFQ can estimate the long term dietary intake. Because of the issues discussed above, its estimates at the individual level may be imprecise, but it can be a valuable source for dietary data at the population level.(38)

All these dietary assessment methods also differ in terms of cost and the demands on the time and effort of the participant. Hence, understanding the strengths and limitations of each of these tools is important for making appropriate decisions concerning which instrument(s) to employ for a specific objective. Because short-term recalls and records are thought to represent current diet most accurately,(8, 19, 39, 40) when they are administered over a sufficient number of days they also provide a means to evaluate the validity of other assessment tools, such as the FFQ, that are more feasible for large scale epidemiologic studies.

Creation of a Dialysis Population-Specific FFQ

Since the FFQ has become a primary method for measuring dietary intake in studies related to nutritional epidemiology, the selection and potentially modification of available FFQs might further enhance its effectiveness and utility for the creation of most appropriate one for the CKD patients. Design of a CKD or dialysis population-specific FFQ is based on examining data on nutrients or food intake that are most likely to be ingested by these specific patient populations.(41) Given the large number of dialysis patients, currently over 400,000 in the USA,(42) and given the other work related responsibilities of renal dietitians in dialysis clinics, the routine or even common use of dietary records or recalls are not feasible in many dialysis centers. Hence, the prospect of using a FFQ has become increasingly popular in patient care and nutrition research.(10) Major steps and challenges in designing a dialysis FFQ are the same as a typical FFQ which are the following:(1)

(I) Food list

Before designing a new FFQ, an important step is to define its purpose and the target nutrients of interest. A main step in designing a population-specific FFQ is to ascertain which food items and how many food items are needed for the FFQ which are partly determined by the nutrients of interest. For CKD patients, dietary phosphorus and potassium are the nutrients of paramount importance due to the disarray in their concentrations and metabolism in CKD and the potential impact of this disarray on clinical outcomes.(43, 44)

(II) Portion size

Some foods like eggs, slices of bread and apples are available in natural portions, while some others like meat and rice have arbitrary serving sizes. For the latter foods data collection using models or pictures of portion sizes may be necessary.

(III) Frequency and period of ingestions

For most epidemiological purposes, the dietary intake over a number of months to years is the main interest. As diet changes from year to year, (45) FFQ designers may prefer to ask about the subject’s frequency of food ingestion during the preceding months to years, so that day-to-day variability and the effect of seasonal variation in nutrient intake can be diluted.

(IV) FFQ validation

After the creation of a FFQ, validation studies can be conducted to determine whether the FFQ measures what it is intended to measure. This can involve criterion validity in which one compares the results of the FFQ with data obtained by dietary recalls or records, not withstanding the inherent limitations of the latter methods(1) (see Table 1). In addition, predictive validity may be examined, to determine whether the results of the FFQ predict or are related to other results of interest or outcomes, such as survival.(25, 29)

Need for a Dialysis Patient Specific FFQ

There have been very few studies of dialysis patients in which a FFQ was used as an assessment tool. Reid et al (27) developed an FFQ to evaluate folate and zinc intake in (26) dialysis patients. Facchini et al (30) used Block's FFQ in 85 patients undergoing maintenance dialysis and in 50 healthy controls and concluded that patients with ESRD ingested an atherogenic diet. Their reports showed that of 6 dietary constituents associated with cardioprotective effects (folate, vitamin E, vitamin A, total carotenoids, beta carotene, and vitamin C), intake of all but vitamin E were significantly lower in the endstage renal disease (ESRD) diet; significantly lower intakes of potassium, calcium, and phosphorus were also observed (30) Kalantar-Zadeh et al (28) used Block's FFQ in 30 HD patients and 30 healthy controls and concluded that patients receiving dialysis may consume significantly lower amounts of potassium, vitamin C, and dietary fibers as well as lower amounts of some carotenoids.

Dialysis Food Frequency Questionnaire

We have developed a so-called Dialysis-FFQ by examining food intake data derived from a cohort of 154 hemodialysis patients of the "Nutrition and Inflammation in Dialysis Patients" (NIED) Study.(12) A 3-day diet diary with a dietary interview that covered the last hemodialysis treatment day of the week and the 2 subsequent non-dialysis days identified the key contributors to the daily nutrient intake. The resulting Dialysis-FFQ includes approximately 100 food items representing 90% of the patients' total food intake of the NIED Study population. Distinctions were made in several food items based on key nutritional issues in dialysis patients such as protein, phosphorus and potassium. The details of the Dialysis FFQ creation and validation is reported separately.[Kalantar-Zadeh et al. Creation of a Dialysis Food Frequency Questionnaire, submitted to JREN 2010] The earlier Block FFQ was tested in the NIED Study and shown to be associated with survival, in that higher phosphorus or potassium intake are predictors of increased death risk.(25, 29)

Conclusions

Dietary assessment is of paramount importance in providing optimal care to individuals with CKD patients, and in particular to dialysis patients, even though it is not performed routinely in these patients. Reliable methods for assessing dietary intake are also important for outcomes research concerning the relationship between nutrient intake and clinical response. Diverse types of dietary restrictions are imposed on dialysis patients, some of which may cause more harm than benefit, such as restricting protein intake in order to lower the serum phosphorus levels.(46) Among food data collection tools, 24-hr recall, diet records and diaries, food screeners and FFQs have been utilized in dialysis patients. There are both inherent and population specific limitations of the aforementioned dietary assessment methods. Ongoing and future studies will ascertain additional strengths and limitations of these methods.

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Table 1

Overview of dietary assessment methods for CKD patients

	Strengths	**Limitations**	**Studies in CKD patients**
24-hrs recall	• Convenience • Rapidity • No need to provide or prepare records • Possibility to be performed over the phone • Ability to evaluate the validity of other assessment tools	• Reliance on patient's memory, • Lack of ability to represent a longer period esp. in dialysis patients whose food intake pattern on dialysis and non-dialysis days may be significantly different • Reliance on patient's cooperation and communication ability • Reliance on interviewer's skills, comprehensiveness and prompts • Reliance on interviewer's familiarity with background food culture	(37, 47–49)
Diet records and diaries (with or without dietary interviews)	• Expecting real time recording on the ingested food and the extended period of time beyond 24 hrs. • Ability to evaluate the validity of other assessment tools	• Reliance on compliance of the patients with instructions • Possibility of missing or inaccurate recordings of food items • Lack of capturing seasonal or other cycling variations in dietary pattern.	(48, 50–55)
Urea dynamic calculated protein intake (nPCR or nPNA)	• No need for direct dietary assessment	• Lack of ability to assess other nutrients intakes other than protein • Variations due to non-dietary factors related to urea generation such as in catabolic or anabolic states • Inaccurate or misleading if residual renal function is not clear.	(15, 46, 56)
Food screeners and FFQ	• Convenience, esp. if self-administered for use in large populations • Large temporal catchment (months to years) hence less sensitivity to seasonal variations • Relatively high reliability in ranking subjects across each food item • Feasibility and low coast for large scale epidemiologic studies	• Under or even over estimation of nutrient intake at individual level • Lack of accuracy to use to assess the amounts or adequacy of dietary intakes of individuals or small groups of people • Inadequate coverage to include all available food items • Inclusion of diverse varieties of a given food under one single food item question, and hence, failure to capture significant differences among different food subtypes	(26–28, 30–32)

nPNA: normalized protein equivalent of total nitrogen appearance. nPCR: normalized protein catabolic rate FFQ: food frequency questionnaire.