

A comprehensive review on dietary assessment methods in epidemiological research.

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Abstract

Dietary assessment methods play an important role in making dietary recommendations to different population in with varying health conditions and nutritional status. The main purpose of this review is to provide comprehensive information at a glance as guidance on major dietary assessment methods, their advantages, and limitations. Dietary records (food diaries), 24-hour dietary recall and food frequency questionnaire (FFQ) methods are discussed comprehensively throughout this review.

According to the findings of previous studies, the estimated diet records are widely used to assess the diet than the direct measurements. Selecting an appropriate dietary assessment method depend on the group of participants and their lifestyle. Twenty-four-hour dietary recall is a valid tool to assess the average intake of the groups by applying standardized data collection methods with careful administration and with repeated assessments more than one day. The easiest administrative assessment method is the three-day food diaries although it's having a high respondent burden. FFQ are a widely used method to estimate the specific macro and micronutrients of an individual during a specific period. However, FFQ has many limitations such as a higher respondent burden, difficulty to quantify the portion size, need of population specificity and necessity of validation.

Therefore, every method has an unavoidable error which results in under-reporting, over-reporting, errors in portion size estimation, inability to encounter the day to day variations in the meals and diversity of the biomarkers of the population. Hence selection of the best diet assessment method must be carefully done depending on the population's age gender and profession.

Keywords: Dietary assessment, Dietary records, 24-hour dietary recall, Food frequency questionnaire.

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Introduction

Food is an essential part of human life that provides energy and nutrients to maintain a healthy and protective. A balanced diet which contains carbohydrate, protein, fat, vitamins and minerals with appropriate quantities provide a healthy energy intake to the body. If the daily dietary intake is in excess or too low as required for the daily energy expenditure, such a diet is known as an imbalanced diet [1]. As consequences, an imbalance diet leads to either being underweighted or obese leading to many health problems. Malnutrition has serious long-term effects on the growth of both behaviour and cognition [2]. According to Gorman, 1995, malnutrition harms infants, and children, especially in developing countries. The malnutrition can be treated and reduced through a healthy diet in both quality and quantity [3]. However, an increase in energy intake with decreased physical activity is the primary factors that influence obesity of the children as well as the adults [4]. Hence the diet is an important factor that could lead to many non-communicable diseases such as diabetes, cardiovascular diseases, and cancer. An exposure of an individual to diet is difficult to measure because the

variability of the food intake frequency, type of food, amount of food consumed very largely within the individuals [5]. Therefore, between these two extremes of obsessed and malnourished, people across the world follow vastly different diets with no significant influence concerning their day to day energy intake. The inaccurate dietary assessment has posed a serious obstacle of evaluating and understanding the impact of dietary factors on disease.

Previous studies have shown that specific biochemical markers to be accurate in assessing the dietary intake levels independent from memory, desirability, and ability to describe quantity and type consumed [6]. However, these measures obtained from the markers are affected by homeostatic regulation and the disease condition of an individual making the values obtained inaccurate when correlated to the actual dietary intake [7]. Therefore, dietary assessment methods still play an important role in making more accurate assessments and providing dietary recommendations concerning the use of biomarkers. However, selecting the appropriate dietary assessment method depending on the group of participants and their activities would provide more accurate results (Table 1).

Dietary assessment involves reviewing the intake of food and individual dietary component and comparing the amount consumed with the reference values to evaluate if any deficiency or excess is likely to occur [8]. Therefore, to maximize the accuracy in weighing of all food consumed and analysing its chemical compositions is involved. Biochemistry plays a significant role in establishing how the body uses various nutrients and has also been important in defining certain deficiency states [9]. However, analysing each component in an individual diet biochemically is impractical for clinical purpose. Therefore, several dietary assessment methods such as Diet records or food diaries, Dietary recalls and Food frequency questionnaires (FFQ) are frequently used. These methods differ from each other concerning the time duration utilized to collect dietary intake information and in the methods used to quantify the portion size. Use of food diaries is also a common method especially 3-day food diaries and 7-day food diaries in which weighted or estimated food records are used. Food frequency questionnaires (FFQ) are also used as an essential and commonly used tool to obtain information. However various versions of FFQ are developed since these questioners are greatly influenced by culture and language. Measuring dietary intake accurately is crucial to understand the role of diet in causing and preventing several non-communicable diseases such as cancer, heart disease, and diabetes. The WHO recommends a healthy diet and regular physical activities in preventing and controlling the above diseases [10,11]. Hence providing proper recommendations to people are important facilitating them to follow a healthy dietary pattern that would improve health conditions and reduce disease risks. Therefore, gathering information using a suitable assessment method is important as the accuracy of the information gathered would vary with the lifestyle of the individual and with the assessment method used.

Through this review, we compare and discuss three dietary assessment methods Food diaries, 24-hour dietary recall method and FFQ which are commonly used for evaluating dietary intake throughout the world.

Diet Records/Food Diary

In a food diary or diet record, the person records all the food and beverages consumed, including ingredients, preparation method, and quantity of the food consumed at a given period. This method provides all the instruction and description are provided for the individual before assigning the task to record the diet which ensures the accuracy and reliability of the information provided. According to the time, there are "Three-day food diaries" (records two weekdays and one weekend day) and "Seven-day food dairies" to estimate the nutrient intake. The most common methods for portion size are estimated dietary record, weighed diet record, and duplicate portion as it is direct and feasibility is high.

However, the food diaries highly depend on the memory recall and as the study period lengthens, participant compliance decrease making this method disadvantages with the above issues. According to Magkos & Yannakoulia, 2003, this method is also disadvantaged for being relatively expensive and time-consuming [12]. However, with the follow-up interviews, the accuracy could be increased.

In weighted diet- record individual weighs the items on a scale before and after consumption. The Weighted dietary records are a widely used method where precise portion size of consumed food is measured. This method too has its disadvantages such as high respondent burden, miss-reporting, expensive and provides only limited data on food composition.

Through weighted dietary records are more accurate than estimated dietary records, the former is not suitable for the athlete because they lack time for measuring each item with the busy schedules and patience [12].

Therefore, many researchers use duplicate sample methods to measure the selected nutrients intake than for total energy intake [13-15]. Stephany & Schuller, 1980 used the duplicate sample method to evaluate the nitrate, nitrite and volatile N-nitrosamines intake from foods and drinks within 24-hour sampling period and varied and precise data revealing that the mean daily intake of nitrate and N-nitrosodimethylamine was 179 mg and 0.38 µg respectively and the major source of nitrosamine from the intake of beer (71%) [15].

Evaluation of duplicate portions of 24-hour diets also allowed to analyzed aluminum, cadmium, copper, lead, manganese, mercury, zinc, nitrate, nitrite and volatile N-nitrosamines intake in 110 adults and provides precise data revealed the daily intake of copper (1.2 mg) was only 50% of recommended values, while manganese (3.3 mg) and zinc (8.4 mg) was adequate and marginal to recommended amounts [14].

Bro et al., successfully used a 48 h duplicate food portions method to measure average daily intakes of essential and toxic trace elements consumed through diets among 100 men of ages ranging 30-34 years from both urban and rural areas [13]. Hence the duplicate portion method is recommended for the analysis of selected components in the dietary intake [13-15].

An epidemiological assessment of diet which was performed with the comparison of seven-day diary with food frequency questionnaire using urinary markers of nitrogen, potassium and sodium where 179 individuals completed seven day diary and FFQ in two occasions separated in 12 months duration and provide urine sample one six times in 6-9 months duration revealed that the seven-day diary was the better estimate of average intake than FFQ [16]. In contrast Livingstone et al. revealed that seven-day weighted dietary records tend to underestimate and the diet histories are biased towards overestimation in food intake [17]. However, three to four day estimated diet record is the most widely used approach and single or multiple dietary recall method is the most common method used for measuring the energy intake of athlete [18].

Estimation diet record is the most widely used method than any other food records since it exerts lower respondent burden with the comparison to other food diaries. However, misreporting and low accuracy was observed in comparison to weighed diet records as they estimate the portion size [19].

Gustafsson & Sidenvall, 2002 used a three-day food diary to study about food-related health perceptions and food habits among older women in age 64 to 88 years who living alone or cohabiting and independently manage shopping and cooking in central Sweden. The results revealed that cohabiting women

had proper meals (1872 ± 627 kcal) than women who living alone (1350 ± 443 kcal) [20].

Evaluating the reproducibility of a three day dietary record used for a study of 26 adults and 35 children of both sex who completed two records with the 7 day interval stated that children reported more stable intake (9478 ± 2566 KJ, 9234 ± 2552 KJ, Interclass Correlation=0.86, $P \leq 0.01$) than adults (9740 ± 2713 KJ, 8919 ± 1988 KJ, Interclass Correlation=0.72, $P \leq 0.01$) indicating the adults tend to alter the records when documenting the diary [21].

A study of randomized controlled trial of primary school-based intervention to reduce risk factors for obesity based on 634 children aged 7-11 years in 10 primary schools revealed that the consumption of high sugar foods was higher (Weighted mean difference=0.8, 0.1-1.6, CI=95%) in overweight children in intervention group than control group. However, the 24-hour recall and three-day diary methods which used in this study did not provide accurate data to be assessed [22]. Hence the researchers found that performing an accurate dietary assessment was difficult in children.

24-hour Dietary Recall

Twenty-four-hour dietary recall method describes food and beverages in detailed that an individual consumed in the past 24 hours. The interview is conducted in two ways of "starting to recall from the beginning of the recalling day" or "starting with the current day and works backward" and in general requires approximately 15 to 20 minutes by depending on the types and variety of the food that is consumed [23]. According to Thompson & Byers, 1994 a standard diet recall would usually require an interview of at least 20 minutes [24].

The 24-hour dietary recall method is suitable for large scale surveys [25] which has the lower respondent burden [12] and could be administered as a face to face interview or telephone interview. A 24-hour dietary recall method is advantages as it is to administer and fast completion with the major disadvantage being the needs of an experienced interviewer [12]. The errors of measurement are small when the interviewers are well trained and provided with written protocols. Therefore, this tool is considered to be an accurate and well-established method [26].

The validity of the 24-hour recall method was tested with the comparison of recalled and observed food nutrient intake of 140 individuals (84 of males & 56 females) 15 to 57 years. The results revealed that -6% & 11% of the difference of mean recalled and observed nutrient intake can be seen, except in sucrose (-20%) and vitamin C(-16%). The accuracy of women's recall was higher than males and the age group 35 to 44 years provides more valid data in comparison to others. Hence the validity of the 24-hour dietary intake method was satisfactory in group-level while it was unsatisfactory in individual level [25].

The validity of the self-reported food items about the time interval between eating and reporting of the children in fourth grades (age between 9 to 10 years) was tested with the comparison of recalled and observed food items. The results revealed that the accuracy of recalled was decreased with the time interval between eating and reporting was increased. The food items reported but not observed was increased 5% to 13%

and food items reported but observed was increased 6% to 32% from same day to following morning respectively [27]. Frank et al., proposed an improved 24-hour recall method by including the careful observation of school lunch operation, graduated food models, and standardized probing to increase the reliability of the collected data by school children [26].

Personality characteristics such as body image, adiposity and relative weight of the adults in have shown to be affecting the records of the 24-hour dietary recall method. Hence the body image and fatness are key features considered as predictors of underreporting of energy intake on 24-hour dietary recall interviews [28]. In a study of 98 individuals with a 24-hour dietary recall for the energy intake, doubly labeled water for energy expenditure and Physical and psychological characteristics also revealed that the people who dissatisfied with their body image underreported a 398 kcal/ day. Gender also affected the reporting concerning the body fat percentage where the women underreported relative body weight ~ 21 kcal/day/kg as compared to that of 16 kcal/day/percent body fat of men [28].

Dietary intake of the children in home setting measured by interviewing parents with 24-hour dietary recall method found difficulties in estimating actual portion sizes eaten. Hence the accuracy of the recalls was poor in both under-reporting and over-reporting. But many studies that used the 24-hour recall method to estimate dietary intake of children was found that parents were well-educated [29]. The other disadvantage of this method is the inability of the parents to recall the food intake when children are out of the home especially when in preschool.

Estimation of portion sizes and memory dependent are two limitations of the 24-hour dietary recall method and also it needed a well-trained interviewer to obtain accurate measurements. The improved version of the 24-hour recall is multiple-pass 24-hour dietary recall method which included three passes to get information from the participants. The passes termed as the quick list of food items, the detailed description of food and beverage items consumed and the review of using food models. The accuracy of the multiple-pass 24-hour dietary recall method was tested by estimating the energy expenditure measured using the doubly labeled water method of 24 children in the age between 4 to 7 years. The results revealed that multiple-pass 24-hour dietary recall method gives a precise estimation of dietary intake of the children as there was not any significant correlation between individual measures of energy intake and expenditure ($r=0.25$, $P=0.24$) [30]. Multiple-pass 24-hour dietary recall method was suitable for large scale surveys and could be administered by telephone. In a study of 78 individuals age ranging from 22 to 67 years tested the accuracy of the multiple-pass 24-hour dietary recall method in randomly selected days on a self-selected diet (all meals were prepared their meals) and controlled diet period (meals were provided by the study). The results revealed that both men and women underestimated energy intake by 11% and 13%, respectively in self-selected diet period while men underestimation increased in 13% whereas women overestimated the energy intake by 1.3% in controlled diet period. The recalled energy intake measured with the multiple-pass 24-hours dietary recall the women were influenced by the situation and men underestimate the energy intake regardless of the circumstance [31].

Table 1. Dietary Assessment methods in epidemiological studies.

Method	Description	Study, Year, Sample		Advantages	Disadvantages
Three-day food dairies	Collection of diet record by Self-administered dairy, provided with all instructions and descriptions	Gustafsson & Sidenvall, 2002	Women 64-88 years	<ul style="list-style-type: none"> Lower respondent burden than other food dairies Good for the studies about food related health perception & habits <ul style="list-style-type: none"> Could Self-administered Essay to administered Fast completion than other food dairies 	<ul style="list-style-type: none"> Depend on memory recall Adults tend to alter the records Difficult to take accurate data from children Literacy affect for the completion of the record
		Tremblay et al., 1983	26 adults & 35 children		
		Posner et al., 1992	73 females and 77 males		
		Sahota et al., 2001	634 children aged 7-11 years		
Seven-day food dairies	Collection of diet record by Self-administered dairy	Day et al., 2001	179 individuals	<ul style="list-style-type: none"> Better estimation on average food intake <ul style="list-style-type: none"> Could Self-administered 	<ul style="list-style-type: none"> High respondent burden Depend on memory recall Participant compliance decrease Literacy affect for the completion of the record <ul style="list-style-type: none"> Time-consuming Cannot use for long term dietary status of group of people <ul style="list-style-type: none"> Mis-reporting
		Hoidrup et al., 2002	175 men and 173 women aged 30-60 years		
		Mahalko, et al. 1985	18 men 36 female aged 55-99 years		
Weighted diet record	Collection of diet record by weighing food on the scale and recorded by participants	Bingham et al., 1994	160 women aged 50-65 years	<ul style="list-style-type: none"> Gives precise portion size Could Self-administered 	<ul style="list-style-type: none"> High respondent burden <ul style="list-style-type: none"> Mis-reporting Limited data on food composition <ul style="list-style-type: none"> Not suitable for athlete <ul style="list-style-type: none"> Expensive Time-consuming
		Livingstone et al., 1992	41 male & 37 female aged 3-18 years		
Duplicate diet method	Collection of duplicate diet sample and direct analysis	Stephany & Schuller, 1980	141 men and 60 women	<ul style="list-style-type: none"> Good to measure selected nutrients Gives precise data on food composition 	<ul style="list-style-type: none"> High respondent burden <ul style="list-style-type: none"> Expensive Time-consuming
		Ellen et al., 1990,	110 adults		
		Bro et al., 1990.	100 men 30-34 years		
24-hour Dietary recall	Subjective measure using open-ended questionnaires administered by a trained interviewer	Schoeller, 1995	-	<ul style="list-style-type: none"> Suitable to measure dietary intake of athlete Suitable for large scale survey <ul style="list-style-type: none"> Lower respondent burden Could be administered through telephone <ul style="list-style-type: none"> Fast completion Great validity in group level surveys Reliability increase with the use of food models, standardized probing <ul style="list-style-type: none"> Good assessment for low socioeconomic status women 	<ul style="list-style-type: none"> Need an experienced interviewer <ul style="list-style-type: none"> Highly depend on memory Should equipped with well written protocols and food models Less validity in individual level Personality characteristics and gender affect for the mis-reporting <ul style="list-style-type: none"> Not suitable for children Recalling from parents not suitable for the children not in home setting
		Karveti & Knuts, 1985	140 individuals 15 to 57 years		
		Bingham et al., 1994	160 women aged 50-65 years		
		Briefel et al., 1995	14801 individuals		
		DeBiasse et al., 2018	36 participants		
		Posner et al., 1992	73 females and 77 males		
Food frequency questionnaires	Used to estimate specific macro and micronutrients in a specific period on time (1 day to several months)	Bingham et al., 1994	160 women aged 50-65 years	<ul style="list-style-type: none"> Ability to self-administered <ul style="list-style-type: none"> Inexpensive Suitable for large scale survey Suitable for food consumed in large quantities <ul style="list-style-type: none"> Good assessment for low socioeconomic status women Could use for the ranking individuals according to the usual intake 	<ul style="list-style-type: none"> Highly memory dependent Difficult to quantify the portion size <ul style="list-style-type: none"> Higher mis-reporting Higher respondent burden with the rises of food list Need of population specificity Not suitable for the accessory foods <ul style="list-style-type: none"> Necessity of validation Not precise estimation for usual food intake & not informative
		Willett et al., 1985	173 women		
		Mullen et al., 1984	31 college students		
		Day et al., 2001	179 individuals		
	DeBiasse et al., 2018	36 participants			
Subjective measure using a predefined, self- or interviewer-administered format					

Food Frequency Questionnaires

Food frequency questionnaires are used to estimate the specific macro and micronutrient of an individual consumes during a specific period on time usually one day to several months. FFQs are largely depended on the individual's ability to memorize and quantifying the particular food or food group consumed. Hence it increases the burden of respondents with the rises of the food list, difficult to quantify the portion sizes, need of population specificity and necessity of validation to use are some disadvantages [12]. However, the ability to self-administered, inexpensiveness, suitability for large scale surveys, could be self-completed by the respondents and could post to the respondents are the advantages in FFQs.

To evaluate the reproducibility and validity of a 61-item Semi-quantitative FFQ Willett et al., used the dietary intake records collected four times in one year period by 7-day weighted food diary and FFQ records twice in one year period

among 173 women [32]. The results revealed that the difference between the methods of diet records, FFQ 1 & FFQ 2 was generally small (1620 kcal +/- 323 kcal, 1418 kcal +/- 496 kcal and 13711 kcal +/- 482 kcal respectively). According to Willett et al., simple self-administrated dietary questionnaire was a useful measure to evaluate usual nutrient intake over a period of one year [32].

A food-based validation of a dietary questionnaire by Salvini et al., used weighted dietary records and self-administered food frequency questionnaire to evaluate reproducibility and validity of responses for 55 specific foods and beverages and found that foods that often considered as healthy such as fruits and vegetables were over-reported while less desirable foods were underestimated by FFQ [33].

Mullen et al., tested the validity of FFQ among 31 college students who lived and dined in a dormitory and used 278 common food components in United State [34]. The results

revealed that the foods considered as major components of a meal had greater accuracy than accessory foods which used in small quantities like nuts or seeds while actual intake of all individuals was significant ($r=0.66$, $P<0.002$). However according to Mullen et al., food frequency technique used for this study could not be recommended as a precise estimation method for the usual intake of general individuals because of the unrepresentativeness of the general populations [34]. Furthermore, an assessment of diet which compared 7-day food diary with food frequency questionnaire using urinary markers found that the correlation between errors in different nutrients was higher in FFQ (0.77-0.80) than for the 7-day food diary (0.52-0.70) [16].

Comparison of Dietary Intake Methods

Records of dietary assessment methods are verified with the reference methods like total energy expenditure, resting metabolic rate and physical activity, doubly-labeled water, and total water loss. The doubly-labeled water method which widely used to validate the measurement of total energy expenditure in free-living subjects also serves as a reference for validating the accuracy of self-reported energy intake [35].

The habitual energy intake tends to be underestimated by the self-reported dietary intake records methods than the actual energy expenditure because of the increase of underreporting [35]. Hence none of the self-reported intake instruments demonstrates greater accuracy against doubly-labeled water method. According to Trabulsi & Schoeller, 2001, the physical and psychological characteristics of the study participants significantly affect for the underreporting of the energy intake [36].

Feasibility of the 24-hour dietary recall method and self-administrated FFQ was tested with 24-hour recalls conducted by two interviewers and a 110-item FFQ with use of 36 participants [37]. Feasibility was determined by the contacts and retentions of the methods and acceptability of the responses to open- and closed-ended questions. Dietary assessments with the 24-hour dietary recall and FFQ were acceptable among low socioeconomic status women with 89% and 91% responses respectively [37].

The comparison of three nutritional intake estimation methods of 24-hour recall, 3-day food record and food frequency questionnaire by Posner et al., used 73 females and 77 males from Framingham in the United States [38]. The results revealed that 24-hour recall and 3-day records were similar in both women (1646.1 +/- 823.5 kcal and 1625.7 +/- 483.2 kcal) and men (2228.2 +/- 767.8 kcal and 2273.6 +/- 723.1 kcal). Mean intake calculated from FFQ of women was higher (1782.5 +/- 586.7 kcal) while men's intake was lower (2035.1 +/- 635.3 kcal) respect to the other two methods. According to the results, FFQ is usable for the ranking individual according to the usual intake but not informative compared to the other two methods of 24-hour recall and 3-day records.

The dietary calcium intake in postmenopausal Malaysian Women compared with the three-day food records and FFQ with 230 Chinese postmenopausal women aged 50- 65 years in Kala Lumpur by Chee et al., [39]. The results revealed that there was no significant difference between dietary records and

FFQ record (447.4 ± 168 mg/day and 498.7 ± 211 mg/day, $0.563(P<0.001)$). According to the results obtained FFQ was found mostly to overestimate the calcium intakes than 3-day food diary method.

A comparison of dietary histories and seven day food records in a nutritional assessment of older adults by Mahalko et al., found that there was a significant difference for energy consumption (1634 ± 477 Kcal, 1745 ± 455 Kcal, $P=0.06$), fat (65 ± 29 g, 74 ± 26 g, $P<0.01$), saturated fatty acids (25 ± 11 g, 27 ± 10 g, $P<0.01$), Oleate (23 ± 11 g, 27 ± 10 g, $P<0.01$), Linoleate (10 ± 6 g, 11 ± 5 g, $P<0.05$), cholesterol (260 ± 101 mg, 315 ± 118 g, $P<0.01$), ascorbic acid (106 ± 50 mg, 90 ± 37 mg, $P<0.01$) and Potassium (2.8 ± 0.7 g, 2.6 ± 0.7 g, $P<0.05$) between dietary histories and 7-day food records [40]. According to the results, both methods are not precisely equivalent and not a useful measure of the long-term dietary status of a group of people. Nutritional components like vitamin A and cholesterol which having day to day variations did not provide representative intake and difficult to determine the usual intake by these methods. Based on the findings of Mahalko et al., neither dietary histories nor 7-day food records was superior to each other [40].

An assessment of habitual energy and macronutrient intake in adults by Høidrup et al., used comparison of a 7-day food record with dietary history interview with 175 men and 173 women aged 30-60 years in Denmark. The results found that macronutrients and energy intake was slightly higher in the 7-day food records (7.4 MJ for women, 10.5 MJ for men) than diet history interview (7.1 MJ for women and 10.4 MJ for men). Although total energy intake was stable over the range of age and BMI was underestimated by approximately 20% compared to the estimated energy expenditure in both diet methods [41].

Drawbacks in Dietary Methods

When selecting a dietary assessment method, the attention should be provided to the validity, reliability, reproducibility, specificity, sensitivity, quantifiably and variability within and between the individuals and minimize the errors like systemic errors, random errors and measurement errors. According to Westertep & Goris, there is no method for the accurate determination of dietary intake [42].

Dietary intake methods that under or overestimate the diet lead to biased estimation and do not provide valid data. The measurement errors occur by the subject, interviewer or with the measurement aids. These errors affect the reliability and reproducibility of the dietary assessment method. The Random errors are occurred by the mood status of the respondent or interviewer at the time of assessment, excessive noise during the assessment, respondent's memory capacity, person's inability of quantifying the food intake and results lowering the reliability of the assessment method. However random errors always exist with any measurement and could be minimized by careful administration.

Both 24-dietary recall and FFQ are subjected to the under-reporting and over-reporting which leads to systemic errors [28, 29, 35, 36]. According to the literature, there is a relationship between the underreporting and the bodyweight of the people indicating it is not only that the socio-economical state,

education, literacy level affected to the underreporting [28]. According to Serdula et al., preschool children underestimated and overestimated their diet [43]. Comparison of either weighted or estimated dietary records with the measured energy expenditure indicates that obese individuals, female endurance athletes, and adolescents underestimate the habitual and actual energy intake [42]. Children in age between 5 to 18 years underestimate their food records and overestimate total energy intake in FFQ compared with the DLW [44]. It is recorded that people over-reported the food considered as healthy foods such as fruits and vegetables [33].

Except for weighted dietary food records, other food records and recalling methods are subjected to the respondent's error when estimating the portion size. But one of the limitations in the weighted dietary method is that it consumes additional time to weigh the food before and after consumption and lead to an increase in the respondent's burden. This error could be minimized with the use of food models, measuring cups and utensils when estimating the portion size in 24-hour recalling method [45]. According to Smith, 1991, estimation of portion size depending on the cognition process of the individual and they are poor at reporting the portion size in the form of Small, Medium and Large scale which is common in FFQs [46]. According to Wirfalt, 1998 food portion size is accurate in 24-hour interviews [45].

One of another systemic error was interviewer's bias which usually eliminates by training the interviewers. Systemic errors have occurred with unstructured questioning, leading probes, cultural practices, interruptions, distraction and less experienced interviewers [30]. Day to day variations in the diet in both interpersonal and intrapersonal aspects. Hence repeated collection of dietary recalls and food records are required to take reliable intake of the individuals. According to Briefel et al., the mean energy intake of the weekday and weekend days varied in both male and females in all ages and even in intrapersonal [47].

Conclusion

Dietary recalls and FFQs could be used to examine the changes and effectiveness of the nutrition interventions over time by replicating the assessment. 24 hour dietary recall would be a valid tool to assess the average intake of groups by applying standardized data collection method, improving the interviewer's skill, using tools to memorize the intake and taking an adequate sample. Underreporting, over-reporting, errors in portion size estimation, day to day variation in the diet are the major limitations in the dietary assessment methods. FFQ would be useful to take the usual energy intake of the individual although it possesses several limitations like highly dependent on the memory of the food eaten and deviate from the actual energy intake. Food records or diaries were easy to administer but having high respondent burden when repeating the collection. The 24-hour dietary recall was more reliable when carefully administered and repeated the collection for more than one day.

Conflict of Interest

All authors declare that they have no conflicts of interest with the contents of this article.

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