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Assessing Dietary Intake in Childhood Cancer Survivors: Food Frequency Questionnaire *versus* 24-Hour Diet Recalls

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Abstract

Cancer diagnosis and treatment may influence dietary intake. The validity of using self-reported methods to quantify dietary intake has not been evaluated in childhood cancer survivors. We validated total energy intake (EI) reported from food frequency questionnaire (FFQ) and repeated 24-hour diet recalls (24HRs) against total energy expenditure (TEE) measured using the doubly labeled water method in 16 childhood cancer survivors. Dietary underreporting, assessed by (EI-TEE)/TEE ×100%, was 22% for FFQ and 1% for repeated 24HRs. FFQ significantly underestimates dietary intake and should not be used to assess the absolute intake of foods and nutrients in childhood cancer survivors.

Keywords

dietary intake; dietary assessment; childhood cancer survivors

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INTRODUCTION

Cancer treatment has been associated with long-term chronic health conditions in childhood cancer survivors.[1] Nutrition plays an important role in the etiology of chronic health conditions, and is among the few modifiable behaviors that can prevent or delay the early onset of chronic diseases. Identifying nutritional patterns in young survivors of childhood cancer is clearly a major priority for improving the survival and long-term health of this population. However, the nutritional intake in childhood cancer survivors has not been adequately studied. One obstacle for studying nutritional intake is the lack of a valid method to quantify habitual intake. Two common methods used to assess diet are food frequency questionnaires (FFQs) and repeated 24-hour diet recalls (24HRs).[2] FFQs are designed to measure a person's typical diet over a defined period of time, and 24HRs involve a recall of food intake in the preceding 24 hours.[2] The validity of using FFQs and 24HRs to capture dietary intake against a reference method has not been previously examined in childhood cancer survivors, for whom cancer diagnosis and treatment may present additional influences on dietary intake.

We evaluated the validity of using FFQ and repeated 24HRs to assess dietary intake in childhood cancer survivors by comparing the reported energy intake to the total energy expenditure measured by the doubly labelled water method. Findings from this study are important to determine the valid methods assessing dietary intake in childhood cancer survivors.

MATERIALS AND METHODS

Twenty-two patients who met the inclusion criteria (1) be diagnosed with acute lymphoblastic leukemia (ALL) or lymphoma at age younger than 21 years, (2) be between the ages of 3–25 years at study enrollment, and (3) have completed all cancer treatment within the past 15 years and be in remission, or on-treatment and receiving maintenance therapy were enrolled between October 2011 and June 2012 from the Floating Hospital for Children at Tufts Medical Center, Boston, MA. Among the 22 participants, 16 completed measures of dietary intake using FFQ and repeated 24HRs and measures of total energy expenditure using the doubly labelled water method, and were included in this analysis.

FFQ—Participants <18 years completed a Block Kids 2004 FFQ,[3] and those ≥18 years completed a Block 2005 FFQ.[4] The Block Kids 2004 FFQ queries the frequency intake of 77 food items in the past week. The Block 2005 FFQ asks the frequency intake of 110 food items during the last year. The food list of both FFQs were developed based on dietary recall data from the National Health and Nutrition Examination Survey (NHANES) III.[5] Completed FFQs were sent to NutritionQuest® (Berkeley, CA) for processing. Nutrient intake was estimated using the US Department of Agriculture Food and Nutrient Database for Dietary Studies (FNDDS version 1.0).[6] Both FFQs were previously validated with repeated 24-hour diet recalls or 3-day diet records and showed reasonable correlations for most nutrients (r =0.4–0.7).[3,4,7–9]

24HR—Each participant was scheduled to complete a set of three recalls within a week (two weekdays and one weekend day). The initial recall was administered in person at the study visit and two additional unannounced recalls were conducted by phone within seven days of the first recall. 24HR was collected by trained staff of the Dietary Assessment Unit at the Jean Mayer USDA Human Nutrition Research Center on Aging at Tufts University, using the standardized multiple pass method developed for national dietary surveillance.[10,11] The recall data were analyzed using the Nutrition Data System for Research software (NDSR, version 2011). Repeated recalls at each visit were averaged to improve the validity of estimating habitual nutritional intake.[2]

For both FFQ and repeated 24HRs, parents were used as proxy reporters for participants ≤12 years of age because previous research has documented considerable errors in recalls of food intake and portion size by children 12 years old or under.[12]

Doubly Labeled Water (DLW)—The DLW method was used to measure total energy expenditure (TEE) in childhood cancer survivors during the same one-week window when FFQ and 24 HR were administered. TEE is reflective of actual EI in weight-stable individuals, and the DLW method is the gold standard to assess the validity of self-reported EI in free-living humans.[10] During a one-week period, participants completed two visits for DLW: at the first visit, participants provided a baseline urine sample and then received orally 0.08g of $^{2}H_2O$ at 99.9 atom % and 1.25g/kg of $H_2{}^{18}O$ at 10% per kg of body weight. For all participants, the dose was administered by the study staff and the consumption of isotopic water by participants was directly observed by the study stuff to ensure the complete consumption. Specifically, each participant was asked to drink the entire dose from a dose container to avoid potential spillage. The dose container was then rinsed with 20ml of drinking water, and the participant was asked to drink the entire rinse. The rinse procedure was repeated to ensure the entire amount of the isotopic water was consumed by the participant. All study participants completed the dose with two rinses, with no loss observed by study stuff. Two post-dose urine samples were collected at 4 and 5 hours. One week after dosing, the final post-dose urine sample was collected. All urine samples were shipped on dry ice to the USDA/ARS Children's Nutrition Research Center in Houston, TX for mass spectrometry measures.[13] Carbon dioxide production rate (VCO_2) was calculated from the fractional turnover rates of ^{2}H and ^{18}O using the equation of Schoeller[14] and then converted to TEE based on an energy equivalent of a liter of CO_2 to be 3.815/RQ + 1.2321 according to Ravussin et al.[15] Respiratory quotient (RQ) was assumed to be 0.86.[16] Total energy expenditure measured by the DLW method has been shown to be within 2.5% of the whole-room or whole-body indirect calorimetric values.[15,17–20] We assessed the reliability of the TEE measurements by analyzing two duplicate samples collected from the same participant, and the results were highly reproducible with a correlation of 0.98.

Statistical Analysis

EI misreporting was defined as the difference between reported EI and measured TEE in proportion to TEE, i.e. (EI-TEE)/TEE × 100%. We evaluated whether EI misreporting differed by survivors' demographic, anthropometric, and cancer-related variables using

analysis of variance (ANOVA). BMI z-score was calculated using the 2000 Center for Disease Control and Prevention (CDC) growth charts for children.[21]

RESULTS

The 16 childhood cancer survivors included 14 survivors of pediatric acute lymphoblastic leukemia and 2 survivors of non-Hodgkin's lymphoma. The median age was 11.7 years (range: 4.7–22.3), and the median interval from diagnosis was 6.0 years (range: 2.3–17.0). The majority was males (75%) and non-Hispanic whites (81%). None of the survivors was underweight while 44% were overweight or obese.

The mean EI reported from FFQ and from repeated 24 HRs were 1,405 (95% CI: 1,149–1,662) and 1,933 (95% CI: 1,727–2,138) kcal/day, respectively. The mean TEE measured using the DLW method was 2,073 (95% CI: 1,501–2,475) kcal/day. Although the EI reported from FFQ and repeated 24HRs were both lower than the measured TEE, underreporting was more apparent for FFQ than for repeated 24HRs (Figure 1). The percentage of dietary underreporting, expressed as the difference between reported EI and measured TEE over TEE, i.e. (EI-TEE)/TEE×100%, was −21.8% (95% CI: −42.3%, −1.4%) for FFQ and −0.9% (95%CI: −21.6%, 19.8%) for 24HRs. Adolescent and young adult survivors tended to underreport EI from both FFQ (−32.5%) and 24HRs (−23.2%) although the age difference for FFQ did not reach statistical significance. EI misreporting did not differ by other patient and treatment characteristics.

DISCUSSIONS

Our study represents the first study to evaluate the validity of using FFQ and 24HRs to assess dietary intake in childhood cancer survivors. The results revealed substantial underreporting of dietary intake from FFQ whereas repeated 24HRs overall yielded reasonable estimates.

Cancer treatment may adversely affect children's dietary intake through complex pathways, and biases associated with self-reported dietary intake may be correlated with cancer-related variables. Although we did not find dietary misreporting differed by cancer-related variables, it may reflect a lack of statistical power rather than a lack of impact. We found adolescents and young adult survivors are susceptible to dietary underreporting. This is not surprising given adolescents and young adults are known to have less structured eating patterns with meals eaten at unusual times or outside. They also lack sufficient knowledge of food preparation method in addition to having the difficulties of recalling food items eaten and estimating food portion size. Social desirability may also play an important role in reporting dietary intake. For young children, parents often serve as proxy reporters, which may help overcome some of the limitations associated with self-reported diet in children. In addition, a close parent-child relationship is often expected in families with childhood cancer survivors,[22] and parents are likely to play important roles in facilitating children's dietary intake. Thus, in young survivors of childhood cancer, the use of parents as proxy reporters may yield reasonable estimates for children's dietary intake. Future studies should evaluate whether reporting by parents yields better estimates than reporting by adolescent

and young adult survivors themselves. Alternative methods of collecting dietary data such as food records may also be included to assess the validity of dietary assessment methods in childhood cancer survivors.

The limitations of our study include small sample size that limits small differences in dietary misreporting to be detected by patient or treatment characteristics. Our study included only survivors of childhood leukemia or lymphoma and may not be applicable to all survivors of childhood cancer. Participants ages 18 years or older completed the Block FFQ that asks typical dietary intake in the past 12 months whereas DLW measures TEE in the past week, which may lead to an attenuation of correlations between the two measures. However, study participants were weight stable during the one-year study period (the change in BMI z-score within 12 months = −0.09, p=0.14). The TEE measured in the past week is likely to represent the usual levels of energy expenditure within 12 months. Despite these limitations, our study provided the first line of evidence on the validity of self-reported method in assessing dietary intake in childhood cancer survivors using the DLW method. The DLW method is highly accurate, does not depend on subjects' cooperation or memory, and requires no restrictions on subjects' daily activities, and is used as the gold standard to validate self-reported dietary intake.

In summary, this pilot study provides evidence that FFQ tends to underestimate dietary intake in childhood cancer survivors and should not be used to assess the absolute intake of foods and nutrients in this population. Repeated 24HRs overall provide a reasonable estimation. Future large-scale studies are required to further evaluate whether parental inputs may help improve the accuracy of dietary reporting in adolescent and young adult survivors.

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References

1. Hudson MM, Ness KK, Gurney JG, et al. Clinical ascertainment of health outcomes among adults treated for childhood cancer. JAMA. Jun 12; 2013 309(22):2371–2381. [PubMed: 23757085]
2. Willett, WC., editor. Nutritional Epidemiology. New York, NY: Oxford University Press; 1998.
3. Cullen KW, Watson K, Zakeri I. Relative reliability and validity of the Block Kids Questionnaire among youth aged 10 to 17 years. J Am Diet Assoc. May; 2008 108(5):862–866. [PubMed: 18442512]
4. Subar AF, Thompson FE, Kipnis V, et al. Comparative validation of the Block, Willett, and National Cancer Institute food frequency questionnaires: the Eating at America's Table Study. Am J Epidemiol. Dec 15; 2001 154(12):1089–1099. [PubMed: 11744511]
5. Block G, Hartman AM, Dresser CM, Carroll MD, Gannon J, Gardner L. A data-based approach to diet questionnaire design and testing. Am J Epidemiol. Sep; 1986 124(3):453–469. [PubMed: 3740045]
6. Composition of Foods Raw, Processed, Prepared USDA National Nutrient Database for Standard Reference U.S. Department of Agriculture. [Accessed October 2014] 2013. http://www.ars.usda.gov/SP2UserFiles/Place/80400525/Data/SR26/sr26_doc.pdf

7. Block G, Thompson FE, Hartman AM, Larkin FA, Guire KE. Comparison of two dietary questionnaires validated against multiple dietary records collected during a 1-year period. J Am Diet Assoc. Jun; 1992 92(6):686–693. [PubMed: 1607564]
8. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. J Clin Epidemiol. 1990; 43(12):1327–1335. [PubMed: 2254769]
9. Marshall TA, Eichenberger Gilmore JM, Broffitt B, Stumbo PJ, Levy SM. Relative validity of the Iowa Fluoride Study targeted nutrient semi-quantitative questionnaire and the block kids' food questionnaire for estimating beverage, calcium, and vitamin D intakes by children. J Am Diet Assoc. Mar; 2008 108(3):465–472. [PubMed: 18313429]
10. Conway JM, Ingwersen LA, Moshfegh AJ. Accuracy of dietary recall using the USDA five-step multiple-pass method in men: an observational validation study. J Am Diet Assoc. Apr; 2004 104(4):595–603. [PubMed: 15054345]
11. Jonnalagadda SS, Mitchell DC, Smiciklas-Wright H, et al. Accuracy of energy intake data estimated by a multiple-pass, 24-hour dietary recall technique. J Am Diet Assoc. Mar; 2000 100(3):303–308. quiz 309–311. [PubMed: 10719403]
12. Livingstone MB, Robson PJ, Wallace JM. Issues in dietary intake assessment of children and adolescents. Br J Nutr. Oct; 2004 92 (Suppl 2):S213–222. [PubMed: 15522159]
13. Wong WW, Clarke LL, Llaurador M, Klein PD. A new zinc product for the reduction of water in physiological fluids to hydrogen gas for 2H/1H isotope ratio measurements. Eur J Clin Nutr. Jan; 1992 46(1):69–71. [PubMed: 1313759]
14. Schoeller DA. Measurement of energy expenditure in free-living humans by using doubly labeled water. J Nutr. Nov; 1988 118(11):1278–1289. [PubMed: 3142975]
15. Ravussin E, Harper IT, Rising R, Bogardus C. Energy expenditure by doubly labeled water: validation in lean and obese subjects. Am J Physiol. Sep; 1991 261(3 Pt 1):E402–409. [PubMed: 1909495]
16. Black AE, Prentice AM, Coward WA. Use of food quotients to predict respiratory quotients for the doubly-labelled water method of measuring energy expenditure. Human Nutrition: Clinical Nutrition. 1986; 40C:381–391. [PubMed: 3771290]
17. Klein PD, James WP, Wong WW, et al. Calorimetric validation of the doubly-labelled water method for determination of energy expenditure in man. Human nutrition Clinical nutrition. Mar; 1984 38(2):95–106. [PubMed: 6423577]
18. Schoeller DA, Webb P. Five-day comparison of the doubly labeled water method with respiratory gas exchange. Am J Clin Nutr. Jul; 1984 40(1):153–158. [PubMed: 6741848]
19. Seale JL, Conway JM, Canary JJ. Seven-day validation of doubly labeled water method using indirect room calorimetry. Journal of applied physiology (Bethesda, Md: 1985). Jan; 1993 74(1): 402–409.
20. Seale JL, Rumpler WV. Comparison of energy expenditure measurements by diet records, energy intake balance, doubly labeled water and room calorimetry. Eur J Clin Nutr. Dec; 1997 51(12): 856–863. [PubMed: 9426361]
21. Centers for Disease Control and Prevention. CDC growth charts. 2000
22. Badr H, Paxton RJ, Ater JL, Urbauer D, Demark-Wahnefried W. Health behaviors and weight status of childhood cancer survivors and their parents: similarities and opportunities for joint interventions. J Am Diet Assoc. Dec; 2011 111(12):1917–1923. [PubMed: 22117669]

What is known about this subject?

- Patterns of poor nutritional intake may significantly exacerbate comorbid conditions in children who have survived cancer while healthy dietary patterns may serve as a protective function.
- One obstacle for studying nutritional intake in childhood cancer survivors is the lack of a valid method to quantify habitual intake.

What is the impact on clinical practice?

- Food frequency questionnaire tends to underestimate dietary intake while repeated 24-hour diet recalls overall provide a reasonable estimation.
- Clinicians and dietitians may use diet recalls to assess dietary intake but parental inputs may be needed to improve reporting accuracy in adolescent and young adult survivors.

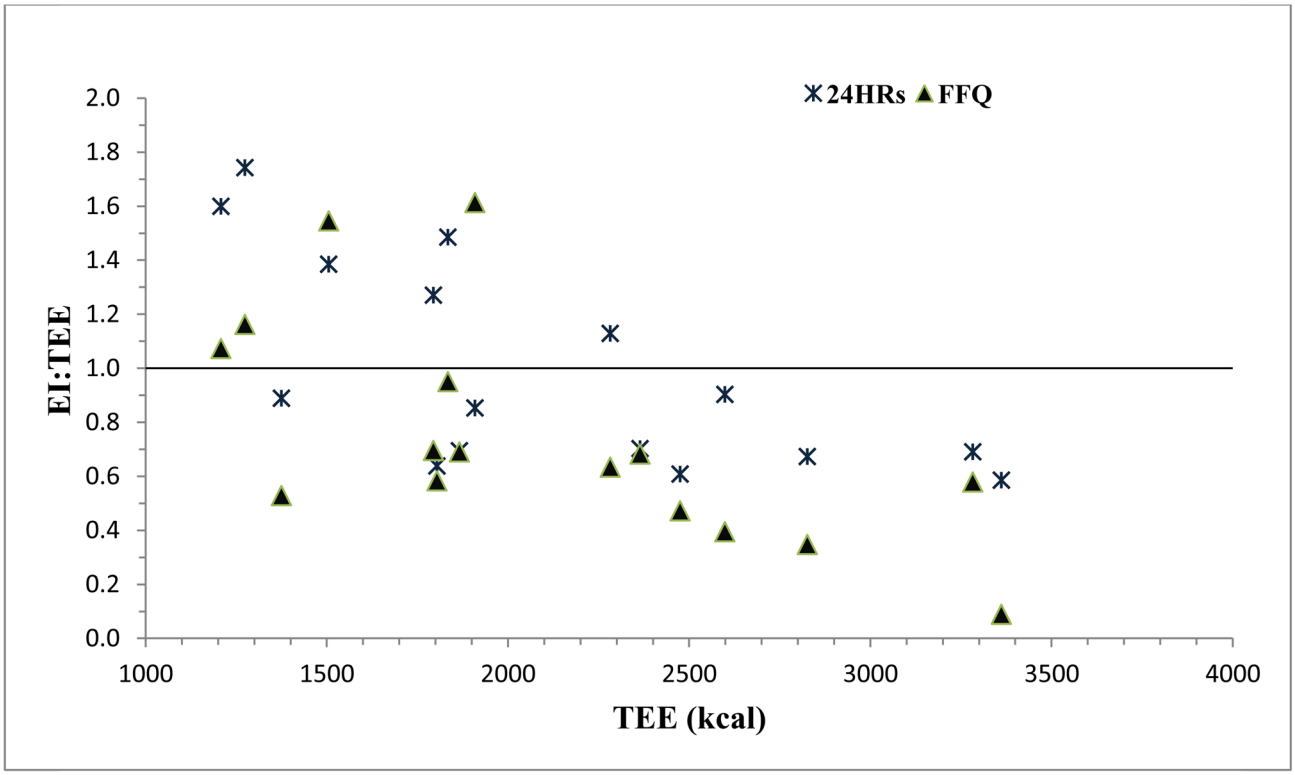

Figure 1.

Reported energy intake (EI) from food frequency questionnaire (FFQ) and repeated 24-hour diet recalls (24HRs) against total energy expenditure (TEE) measured by the doubly labeled water (DLW) in 16 childhood cancer survivors. The crosses are data from 24HRs and the triangles are data from FFQs. Solid line represents the expected ratio for valid reporting. Points above the line correspond to over-reporters and points below the line correspond to under-reporters.