Effects of Photo-Voice Approach on Recall Accuracy in 24-Hour Dietary Assessment Procedure among University of Ibadan Undergraduate Students

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ABSTRACT

Background: *Misreporting in 24-hour dietary recall procedure limits establishing diet-disease relationship, thus, innovations to improve recall accuracy is desirable.*

Objective: *This study was designed to assess the effects of photo-voice approach on 24-hour dietary recall accuracy among undergraduate students.*

Method: *This cross-sectional study involved 200 undergraduate students selected using a simple random sampling from a pool of consenting students using WhatsApp-enabled smartphones. Socio-demographic characteristics and dietary intake data were obtained using semi-structured questionnaire. Respondents were prompted to capture and submit daily foods and drinks consumption and randomly sampled for assessment over a 30-day period. Dietary intake was assessed using 24-hour multi-pass recall and photovoice-aided 24-hour multi-pass recall same day. Energy and nutrients intake and percentage difference in the two approaches were calculated and compared using descriptive statistics and Chi-square test ($p \leq 0.05$).*

Results: *Age was 21.0±1.8 years and 57.5% were males. Estimated intakes of energy (1701.2±795.3; 1684.4±774.4)kcal, Protein (50.6±29.1; 50.1±28.1)g, Vitamin A (2712.5±1903.4; 2149.5±1747.4)RE and other nutrients were largely higher with photovoice-aided than conventional 24-hour recall approach, respectively. Large underreporting of phosphorus (-76.7%); thiamin (-72.7%), vitamin A (-26.2%), and vitamin C (-10.1%); and overreporting of vitamins B6 (+33.3%); B2 (+11.1%), and B12 (+17.6%) were observed. Recall accuracy for energy (+15.2%; -8.2%); thiamin (+21.4%; -58.5%); riboflavin (+27.3%; -24.2%), vitamin B6 (+9.1%; -18.6%), folate (+27.8%; -12.2%), calcium (+11.3%; -17.9%), zinc (+10.9%;-2.6%) and iron (+14.1%; -8.2%) differed significantly in female and male respondents, respectively.*

Conclusion: *Application of photo-voice methodology improves recall accuracy in 24-hour dietary recall procedure and reflects gender difference in recall accuracy.*

Keywords: Dietary assessment, Innovation, Nutrient intake; Overreporting; Underreporting

INTRODUCTION

Dietary assessment is essential to investigate relationships between dietary intake and health outcomes; however, correct measurement of dietary exposure remains a challenge in nutritional epidemiology. The reliable and objective dietary assessment methods are expensive, time-consuming and require high respondents' commitment; therefore, many studies adopt the less time-intensive, cost-friendly and easy to use methods including the

24-hour recall, food frequency questionnaire and diet history (1). However, these methods have inherent limitations that restrict the establishment of diet–disease relationships and efficacy of dietary interventions (2).

The 24-hour recall remains one of the most frequently used dietary assessment methods though misreporting and poor recalls are common especially among older children, adolescents and adults (2, 3). The 24-hour dietary recall uses an in-depth interview approach to collect information on foods and drinks intake of respondents from the time of waking up in the morning to the return to bed at night the previous day, approximately a day period or 24-hour cycle. The use of 24-hour dietary recall requires high level of motivation, skilled interviewers, interviewing and probing skills, and understanding of the dietary practices in the study area. Nevertheless, dependence on respondents' memory, misreporting, recall bias, interviewer's bias, time-consuming nature of the method, and requirements for repeated measures to determine usual intake limits the accuracy and establishing diet-disease relationship using 24-hour dietary recall (2, 4, 5, 6).

In recent times, dietary assessment methods harnessing of mobile technology to improve reliability have been proposed (7, 8). Mobile technology reduces costs, researchers' and participants' burden, automates coding and upgrades data quality (9, 10). In a low-income country like Nigeria, the potential to enhance accuracy in dietary assessment using mobile technology is high. Eighty-eight percent of households in Nigeria have mobile phones (11), this presents opportunity to deploy mobile technology in dietary studies. The use of mobile phones with cameras for capturing food images as expressed in photo-voice methodology has been shown to be promising in health promotion (12, 13).

Photo-voice is a specific visual methodology used to engage participants through photo-taking and is based on theoretical approaches that focus on equity and inclusion to enable reflection, promote dialogue, and reach decision makers (12, 13, 14). It is an innovative qualitative method of participatory action research based on health promotion principles; however, its application in nutrition studies is presently limited (15). The use of photo-voice is not restricted by age, health conditions, financial situations, or literacy levels and could improve reliability of 24-hour recall by acting as a prompt to minimize food omissions and assists food description (15, 16). Addressing omissions and poor description using the photo-voice approach could reflect on dietary recall accuracy and enhance the reliability of 24-hour dietary recall and its application in understanding the diet-disease relationship. This study was therefore designed to assess the effects of photo-voice approach on recall accuracy in 24-hour dietary assessment procedure among University of Ibadan undergraduate students.

METHODOLOGY

Study design

This study was descriptive cross-sectional in design.

Study Area

This study was conducted in the University of Ibadan, Ibadan, Oyo State, Nigeria. University of Ibadan covers 2,550 acres of land and is located in Ibadan North Local Government Area of Oyo State, southwest Nigeria. The University is made up of 92 academic departments organized into 17 faculties and has 15 halls of residence which provide accommodation for about 30% of the population of students in the regular studies mode. The University has a total staff strength of 5,339 and student population of 41,743.

Study population

This study involved undergraduate students across all the halls of residence in the University. An undergraduate is considered eligible for the study if he/she is aged 16- 24 years, resident in any of the undergraduate halls of residence, runs a full-time undergraduate programme in the University, owned a *WhatsApp*-enabled smartphone with good camera and agreed to participate in the study. An undergraduate student was considered non-eligible if he/she was a student of the Department of Human Nutrition and Dietetics or offered a course from the Department, had challenge with verbal communication, fasting during the period of study or failed to sign the informed consent form. In all, a total of 200 undergraduate students were selected from the pool of eligible respondents using a simple random sampling technique.

Data Collection

A semi-structured, interviewer-administered questionnaire was used to obtain information on socio-demographic characteristics, anthropometric characteristics, and dietary intake of the respondents. Height and weight

were assessed using stadiometer calibrated in centimeters (cm) and SECA digital weighing scale, respectively. The anthropometric data were analyzed using age appropriate procedures. World Health Organization Anthro Plus software was used to derive the Body Mass Index for age Z-scores for respondents aged 19 years and below (WHO, 2009). Respondents aged 16-19 years with z-score below -2SD were categorized to be thin, those between -2SD and +2SD had normal nutritional status while those with z-score more than +2SD were categorized to be overweight (WHO 2020). Body mass index of respondents aged 20-24 years was defined according to WHO BMI cut-offs; underweight (≤18.4 kg/m^2), normal weight (18.5-24.9 kg/m^2), overweight (25.0-29.9 kg/m^2), and obese as BMI of ≥30.0 kg/m^2 (17).
Respondents were engaged and trained on the use smartphone in capturing, storing, tagging, and sharing of photos/images of high quality using *WhatsApp*-enabled smartphone. A 30-day of photo capturing of all foods and drinks including snacks and beverages intake was agreed and foods and drinks consumed were taken prior to and after consumption, labelled and shared immediately to an agreed platform. Each picture was archived and saved by name of respondent, date and eating occasion defined by time. Eight respondents were randomly selected per day for 24-hour dietary recall interview from the pool of respondents that submitted food and drinks pictures/images from the previous day. Interviews were conducted in the morning using two sessions; the first session adopted the conventional multi-pass 24 hour dietary recall procedure and the second adopted multi-pass 24-hour recall procedure aided with photo images submitted the previous day (color printed on A3 paper). Daily broadcast messages were sent to participants on WhatsApp to remind them to take pictures of foods and drinks intake. Dietary intake data from the two procedures were analysed to derive the energy and nutrients intake using the West African Food Composition Table (18).

Statistical analysis
Data were analysed using IBM-SPSS version 20.0. Descriptive statistics were presented in frequency counts, percentages, mean and standard deviation. Percentage difference in the mean nutrient intake of the two approaches was calculated as mean of conventional 24 hour recall minus mean of photo-voice aided 24 hour recall divided by mean of 24 hour recall multiplied by 100. Data were analysed descriptive statistics and Chi-square test at p≤0.05.

Ethical Consideration
Participation was entirely voluntary, informed consent was obtained from respondents. Strict confidentiality was ensured throughout the study. The ethical principles guiding research among human subjects as contained in the Helsinki Declaration were adhered to. Respondents were free to withdraw from the study whenever they deemed fit without any fear of victimization. The study was approved by the University of Ibadan/University College Hospital, Ibadan Ethics Committee (UI/UCH EC Registration Number NHREC/05/01/2008a-UI/EC/16/0401).

RESULTS
Basic characteristics of respondents
The basic characteristics of the 200 undergraduate students that completed the study are presented in Table 1. Age was 21.01±1.8 years, 80.5% were aged 20-24 years and 19.5% were aged 16-19 years. Male respondents accounted for 57.5% and females were 42.5%. Respondents cut across four geopolitical zones in Nigeria with majority (79.0%) from the South-West while South-East, South-South and North-Central zone constituted 8.0%, 8.0% and 5.0%, respectively. Respondents also cut across six Colleges/faculties including Arts, Social Science and Law (33.5%), Science and Technology (21.5%), Education (14.0%), Agriculture, Forestry and Veterinary Medicine (11.5%), College of Medicine (6.0%), and Pharmacy (3.5%). Anthropometric characteristics of the respondents reflects higher prevalence of overweight among respondents aged 16-19 years (10.3%) compared to older respondents (9.3%). Prevalence of thinness was 5.1% among respondents aged 16-19 years while underweight affected 11.8% of the respondents aged 20-24 years. Other characteristics are as indicated in Table 1.

Recall Accuracy as measured by Nutrient Intake
The recall accuracy of the respondents as indicated by differences in mean nutrient intake between the standard 24-hour recall and photo-voice assisted 24-hour recall is presented in Table 2, There was no statistically significant difference (p>0.05) in mean nutrient intake between the two procedures. About one percent

Table 1: **Socio-Demographic Characteristics of Respondents**

Variable	N	Percentage (%)
Age		
16 – 19 years	39	19.5
20 – 24 years	161	80.5
Mean±SD	21.01±1.8	
Sex		
Male	115	57.5
Female	85	42.5
Religion		
Christianity	187	93.5
Islam	13	6.5
Geopolitical zone of Origin		
North Central (Benue, Kogi, Kwara & Plateau)	10	5.0
South East (Abia, Anambra, Enugu & Imo)	16	8.0
South South (Akwa Ibom, Delta & Edo)	16	8.0
South West (Ekiti, Lagos, Ogun, Ondo, Osun & Oyo)	158	79.0
Colleges		
Agriculture, Forestry and Veterinary Medicine	23	11.5
Arts, Social Science and Law	67	33.5
College of Medicine	32	6.0
Education	28	14.0
Pharmacy	7	3.5
Science and Technology	43	21.5
Anthropometric Characteristics		
Undergraduates aged 16-19 years (BMI for age)		
Thinness	2	5.1
Normal	33	84.6
Overweight	4	10.3
Undergraduates aged > 19 years (Body Mass Index) 161		
Underweight	19	11.8
Normal	127	78.9
Overweight	15	9.3

underestimation was noted in energy (1684.4±774.4kcal; 1701.2±795.3kcal), protein (50.1±28.1g; 50.6±29.1g), total fat (41.6±27.2g; 42.1±31.4g), dietary fiber (10.9±9.8g; 11.0±11.0g), potassium (896.9±724.3mg; 906.2±684.9mg); zinc (7.4±3.6mg; 7.5±3.9mg) and iron (13.9±7.1mg; 14.1±7.4mg) while saturated fat (9.2±6.8g; 9.1±6.6g) and poly saturated fatty acids (7.7±6.0g; 7.6±6.0g) were overestimated by 1% using 24-hour recall procedure compared to photo-voice assisted approach, respectively. Large underestimation of nutrients intake was observed for phosphorus (512.7±336.9mg; 906.2±684.9mg); thiamin (1.1±1.0mg; 1.9±1.0mg), vitamin A (2149.5±1747.4RE; 2712.5±1903.4RE), and vitamin C (9.9±9.5mg; 10.9±9.7mg) while vitamin B6 (0.9±0.7mg; 0.6±0.5mg); riboflavin (0.9±0.8mg;

0.8±0.6mg), and vitamin B12 (1.7±1.1μg; 1.4±0.8μg) were largely overestimated in 24-hour recall procedure compared to photo-voice assisted approach, respectively.

A statistically substantial gender difference in recall accuracy was observed for intakes of energy, thiamin, riboflavin, niacin, folate and vitamin B12. There was 8.2% underreporting of energy intake in male respondents (1642.9±617.7kcal; 1776.9±663.2kcal) while 15.2% overestimation was observed among

Table 2: Recall Accuracy as measured by Nutrient Intake

	24 hr recall only	**Photovoice + 24 hr recall**	Difference as % of 24 hr Recall	**T**	**P-value**
Nutrients	Mean± S.D	Mean± S.D			
Energy (Kcal)	1684.4±774.4	1701.2±795.3	-1.0%	0.51	0.61
Protein (g)	50.1±28.1	50.6±29.1	-1.0%	0.21	0.84
Carbohydrate (g)	266.4±117.7	274.6±134.1	-3.1%	0.35	0.73
Dietary fiber (g)	10.9±9.8	11.0±11.0	-0.9%	-0.54	0.59
Fat-Total (g)	41.6±27.2	42.1±31.4	-1.2%	0.24	0.81
Saturated Fat (g)	9.2±6.8	9.1±6.6	+1.1%	0.69	0.49
Mono fat (g)	13.1±11.3	12.8±10.4	+2.3%	0.38	0.71
Poly fat (g)	7.7±6.0	7.6±6.0	+1.3%	-0.14	0.89
Cholesterol (g)	188.4±172.0	198.8±174.0	-5.5%	0.44	0.66
Water (g)	403.9±265.6	422.5±257.8	-4.6%	0.64	0.52
Vitamin A (RE)	2149.5±1747.4	2712.5±1903.4	-26.2%	0.53	0.59
Vitamin C (mg)	9.9±9.5	10.9±9.7	-10.1%	0.83	0.41
Thiamin (mg)	1.1±1.0	1.9±1.0	-72.7%	0.17	0.87
Riboflavin (mg)	0.9±0.8	0.8±0.6	+11.1%	0.21	0.84
Niacin (mg)	12.0±9.7	12.4±10.4	-3.3%	0.36	0.72
Vitamin B_6 (mg)	0.9±0.7	0.6±0.5	+33.3%	-0.44	0.66
Folate (mcg)	234.2±227.7	245.7±232.9	-4.9%	0.36	0.72
Vitamin B_{12} (mcg)	1.7±1.1	1.4±0.8	+17.6%	0.14	0.89
Calcium (mg)	195.7±134.8	186.3±121.7	+4.8	0.02	0.98
Phosphorus (mg)	512.7±336.9	906.2±684.9	-76.7%	0.00	0.99
Sodium (mg)	1106.5±852.3	1076.4±812.8812.8	+2.7%	0.21	0.84
Potassium (mg)	896.9±724.3	906.2±684.9	-1.0%	0.14	0.89
Zinc (mg)	7.4±3.6	7.5±3.9	-1.4%	0.58	0.56
Iron (mg)	13.9±7.1	14.1±7.4	-1.4%	0.36	0.72
Magnesium (mg)	147.2±79.3	150.8±85.0	-2.4%	0.45	0.65

female respondents (1780.2±984.7kcal; 1509.7±692.3kcal). Underestimation of intakes of thiamin (58.5%), riboflavin (24.2%), niacin (12.3%), vitamin B6 (18.6%) and folate (12.2%) was observed in male respondents while overestimation of thiamin (21.4%), riboflavin (27.3%), niacin (17.6%), vitamin B6 (9.1%) and folate (27.8%) was noted in female respondents. Mineral intake underreporting of calcium (17.9%), phosphorus (9.3%), sodium (10.9%), potassium (17.3%), zinc (2.6%), iron (8.2%) and magnesium (8.2%) was found among male respondents. Among females, calcium (11.3%), phosphorus (11.9%), potassium (20.4%), zinc (10.9%), iron (14.1%) and magnesium (16.9%) were overestimated while sodium (8.2%) was underreported. Overestimation of vitamin A was three-times higher in female (13.7%) than male

Table 3: **Recall Accuracy by Gender as shown by Nutrient Intake**

	Male			**Female**			M/F
	24 hr recall	**Photovoice assisted**	Diff.	**24 hr recall**	**Photovoice assisted**	Diff	**P-value**
Nutrients	Mean± S.D	Mean± S.D		Mean± S.D	Mean± S.D		
Energy (Kcal)	1642.9±617.7	1776.9±663.2	-8.2%	1780.2±984.7	1509.7±692.3	+15.2%	0.04*
Protein (g)	48.6±21.9	52.6±29.5	-8.2%	53.2±36.6	46.3±25.6	+12.9%	0.30
Carbohydrate g	263.9±107.8	282.7±131.8	-7.1%	289±162.6	252.5±129.1	+12.6%	0.22
Dietary fiber g	8.7±9.1	9.9±10.2	-13.8%	11.9±12.9	9.8±11.8	+17.6%	0.25
Fat-Total (g)	40.3±20.7	45.9±30.2	-13.9%	44.6±41.7	35.3±21.2	+20.9%	0.06
Saturated Fat g	9.1±5.8	9.9±7.6	-8.8%	9.2±7.5	8.1±5.4	+11.9%	0.28
Mono fat (g)	12.5±8.3	14.3±12.6	-14.4%	13.3±12.7	11.5±9.2	+13.5	0.32
Poly fat (g)	7.2±5.6	8.4±6.4	-16.6%	8.2±6.5	6.7±5.4	+18.3%	0.13
Cholesterol (g)	202.8±176.4	425.4±258.5	-109.8%	193.4±171.6	184±164.9	+4.9%	0.90
Water (g)	423.6±247.7	425.4±258.5	-0.4%	421.1±272.4	379.6±252.8	+9.9%	0.58
Vitamin A (RE)	1822.8±2284.9	1754.9±1891.2	+3.7%	2012.7±3218.63	1737.2±2468	+13.7	0.87
Vitamin C (mg)	10.7±9.5	9.8±11.5	+8.4%	11.1±10.1	9±7.2	+18.9%	0.50
Thiamin (mg)	.82±.86	1.3±1.1	-58.5%	1.4±1.6	1.1±1.2	+21.4	0.01*
Riboflavin (mg)	.66±.69	.82±.83	-24.2%	1.1±1.3	.8±1.1	+27.3%	0.04*
Niacin (mg)	10.6±6.9	11.9±9.1	-12.3%	14.8±13.4	12.2±10.4	+17.6%	0.04*
Vitamin B_6 (mg)	0.49±.52	0.58±.62	-18.4%	0.66±.83	0.6±.79	+9.1%	0.35
Folate (mcg)	202.2±176.5	226.8±203.9	-12.2%	303.9±319.2	219.5±213.6	+27.8%	0.02*
Vitamin B_{12} (mcg)	1.5±.87	1.3±.94	+13.3%	1.2±.74	1.9±5.8	-58.3%	0.00*
Calcium (mg)	180.8±121.8	213.3±146.7	-17.9%	193.8±121.9	171.9±113.3	+11.3%	0.00*
Phosphorus (mg)	485.7±274.8	531.1±331.3	-9.3%	553.4±393.9	487.8±344.7	+11.9%	0.00*
Sodium (mg)	1066.3±728.8	1182.9±933.5	-10.9%	1090.2±918.7	10052±725.5	-8.2%	0.00*
Potassium (mg)	811.9±528.6	952.1±740.2	-17.3%	1033.9±838.6	823.1±705.6	+20.4%	0.00*
Zinc (mg)	7.7±3.6	7.9±3.8	-2.6%	7.3±4.2	6.5±2.9	+10.9%	0.00*
Iron (mg)	13.4±5.6	14.5±7.1	-8.2%	14.9±9.3	12.8±7.2	+14.1%	0.00*
Magnesium (mg)	141.1±65	155.1±78.2	-8.2%	163.9±105.2	136.2±81.9	+16.9%	0.00*

**Significant variation in recall accuracy*

Table 4: **Recall accuracy by age group**

	16-19 years			20-24 years			M/F
	24 hr recall	**Photovoice assisted**	Diff.	**24 hr recall**	**Photovoice assisted**	Diff	**p-value**
Nutrients	Mean± S.D	Mean± S.D		Mean± S.D	Mean ± S.D		
Calories (Kcal)	1850.3±1103.4	1776.1±866.2	+4.1%	1665.1±700.5	1636±636.2	+1.7%	0.18
Protein (g)	52.8±35.9	50.3±30.4	+4.7%	50±27.4	49.9±27.5	+0.2%	0.14
Carbohydrate (g)	299.5±182.3	293.1±150.4	+2.1%	268.5±119.4	264.3±125.9	+1.6%	0.12
Dietary fiber (g)	12.1±11.3	11±10.2	+9.1%	9.5±6.9	9.5±6.9	0	0.51
Fat-Total (g)	45.4±35.2	40.1±26.2	+11.7%	41.3±30.5	41.7±27.4	-0.9%	0.32
Saturated Fat (g)	10.2±9.4	9.2±8.1	+9.8%	8.9±5.7	9.1±6.4	-2.2%	0.02*
Mono fat (g)	13.9±13.3	12.4±11	+10.8%	12.6±9.3	13.2±11.4	-4.8%	0.65
Poly fat (g)	7.4±7.1	7.2±5.5	+2.7%	7.7±5.7	7.8±6.2	-1.3%	0.58
Cholesterol (g)	202.6±166.4	172.6±167.9	+14.8%	197.9±176.2	195.6±174.8	+1.2%	0.45
Water (g)	425.3±266.3	390.6±291.2	+8.2%	421.8±256.6	409.6±248.2	+2.9%	0.45
Vitamin A (RE)	1993.7±2185.2	1406.1±1795.3	+29.5%	1881.2±2834.8	1830.1±2223.9	+2.7%	0.23
Vitamin C (mg)	12.3±12.3	8.5±7.8	+30.9%	10.5±8.9	9.7±10.3	+7.6%	0.69
Thiamin (mg)	.9±1.3	1.1±1.3	-22.2%	1.1±1.2	1±1.1	+9.1%	0.43
Riboflavin (mg)	.77±1.1	.77±.99	0	.84±.99	.82±.9	+2.4%	0.42
Niacin (mg)	11.1±10.8	11.4±9.4	-2.7%	12.7±10.2	12.17±9.8	+4.2%	0.17
Vitamin B_6 (mg)	.51±.6	.51±.51	0	.57±.69	.61±.74	-7.0%	0.51
Folate (mcg)	229.7±264.7	201.7±188.7	+12.2%	249.2±249.2	229±212.1	+8.1%	0.16
Vitamin B_{12} (mcg)	1.5±1.1	1.2±.95	+20%	1.3±.77	1.7±4.3	-30.8%	0.43
Calcium (mg)	193.7±144.4	202.3±140.4	-4.4%	184.5±116	194.1±133.8	-5.2%	0.51
Phosphorus (mg)	523.1±384.9	541.8±366.3	-3.6%	512.4±318.5	505.6±330.2	+1.3%	0.42
Sodium (mg)	1123.7±1159.1	1073.5±922.7	+4.5%	1064.9±708.5	1115.6±839.2	-4.8%	0.18
Potassium (mg)	977.3±880.4	773.6±505.6	+20.8%	888.9±630.7	927.8±769.5	-4.4%	0.24
Zinc (mg)	8.1±4.4	7.6±4.2	+6.2%	7.4±3.8	7.2±3.4	+2.7%	0.54
Iron (mg)	14.9±8.9	14.6±7.9	+2.0%	13.9±7.1	13.6±7.1	+2.2%	0.15
Magnesium (mg)	151.3±93.2	157.8±87.6	-4.3%	150.7±83.2	144.5±78.2	+4.1%	0.19

respondents (3.7%) and overestimation of vitamin C was twice higher in females (18.9%) than males (8.4%). Gender variation in the recall accuracy was observed for energy, thiamin, riboflavin, niacin, folate, vitamin B12, calcium, phosphorus, sodium, potassium, zinc, iron and magnesium.

The recall accuracy of the respondents by age group is presented in Table 4, There is no significant difference in the recall accuracy by age group of all the nutrients except for saturated fat intake. Over-reporting of energy intake was twice higher among respondents aged 16-19 years (4.1%) compared to 20-24 years group (1.7%). Protein intake overestimation was about 20 times higher among young respondents (4.7%) compared to older respondents (0.2%). Overestimation was similar in both age groups while dietary fiber overestimation occurred only among younger age group. Saturated fat intake was overestimated by 16-19 years (9.8%) and

under-reported by respondents aged 20-24 years (2.2%). Similar trend was observed for mono unsaturated fat (+10.8%; -4.8%) and poly unsaturated fats (+2.7%; -1.3%) for respondents aged 16-19 and 20-24 years respectively. Over-reporting of cholesterol occurred in both groups, 12 times higher in younger (14.8%) than older (1.2%) groups.

DISCUSSION

Improving the reliability of 24-hour dietary recall in establishing diet-disease relationship is important for low-income settings like Nigeria since 24-hour dietary recall remains the major form of dietary assessment. Though earlier studies have documented misreporting of dietary intake as a common limitation in 24-hour recall (5, 6, 19), the extent and magnitude of this limitation in Nigeria remain unclear. In this study, the adoption of photo-voice methodology reflects no significant variation in macronutrients intake but unmasks more than 10 percent underreporting of intakes of phosphorus, thiamin, vitamins A and C; and overreporting of vitamins B2, B6 and B12 among undergraduate students. Earlier studies have reported up to 30 percent underreporting in energy intake among adolescents and young adults largely due to recall of smaller portion sizes and omission of food eaten in the recall (7, 20). The observed closeness of the energy intake in the present study could be due to early timing of the dietary recall. A study has found that the time interval between eating and reporting, impact on dietary recall accuracy (21). The underestimation of selected micronutrients in this study may be related to the low appreciation of certain food groups including fruits and vegetables, known to be the major sources of these micronutrients (22). Underreporting of selected micronutrients in this study could also be attributed to respondent memory lapses, misrepresentation of portion sizes, and failure to recall foods actually consumed (errors of omission) (23). The higher frequency of underestimation than overestimation of energy and nutrients intake is in agreement with earlier finding of a higher tendency to underestimate and underreport food portions (24, 25).

In this study, gender and age difference in recall accuracy impacts on the estimated energy and nutrients intake. Large underestimation of intakes of dietary fiber, cholesterol, thiamin, riboflavin, niacin, folate, vitamin B6, calcium, sodium and potassium is predominant among male undergraduates while marked overestimation of key nutrients except vitamin B12 was found among female undergraduates. Recall accuracy appears to improve with age as only vitamin B12 has marked difference among undergraduates age 20-24 compared to eight nutrients among adolescent undergraduates, though the variation is not statistically significant. Earlier studies have shown similar variation in recall accuracy with gender and age groups especially with respect to energy intake, intake frequencies and portion sizes (20, 26). The better recall accuracy among the young adults compared to adolescents in this study agrees with the report of an earlier study (7) and confirms that 24-hour dietary recall methodology is better applicable to adults than the younger age categories including adolescents and children. The predominance of underestimation in males and overestimation in females in an earlier study has been associated with gender roles as females are known to be deeply involved in food preparation (23). Nevertheless, this is not expected to be a dominant factor in this study since all the respondents are students and self-catering is largely observed in Nigerian universities. Underreporting of sodium intake as shown in this study could contribute to the burden of high blood pressure in Nigeria. Underestimation of sodium intake among hypertensive patients has been shown to lead to severe consequences including poor treatment outcomes (27). In addition, underreporting of energy could contribute to the burden of overweight and obesity, and complicates assessment of health correlates of food consumption (28, 29). The roles of the vitamins in the biological metabolism is well known, thus, over estimation of vitamins B2, B6 and B12 could influence dietary intake and limit optimization of the macronutrients metabolism and utilization, among other biological dysfunctions.

CONCLUSION

The application of photo-voice approach improves recall accuracy in 24-hour dietary recall procedure, unmasks misreporting in energy and nutrients intakes, and reflects gender and age differences in recall accuracy. It is hereby recommended that efforts to improve the recall accuracy and reliability of 24-hour dietary recall procedure among educated adolescents and young adults should consider the use photo-voice methodology among other innovations.

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CONFLICT OF INTEREST
The authors declare no conflict of interest.

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