

Evaluating the Reproducibility of a Beverage Intake Questionnaire for Caloric Estimation Among Adolescents in Iraq

Abbas Ali Alkinani

abbasalkanani08@gmail.com

Ministry of Health

Rohana A.J.

Universiti Sains Malaysia

Saad Abid AlBadri

University of Wasit

Ruhaya Hasan

Universiti Sains Malaysia

Wan Muhamad Amir W Ahmad

Universiti Sains Malaysia

Article

Keywords: Reproducibility, Beverage Intake Questionnaire, Adolescent

Posted Date: October 16th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10444145/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Evaluating the Reproducibility of a Beverage Intake Questionnaire for Caloric Estimation Among Adolescents in Iraq

Abbas Ali Alkinani¹, A.J. Rohana², Saad Abid Al-badri³, Ruhaya Hasan⁴, Wan Muhamad Amir W Ahmad⁴,

Affiliation: ¹Al-Zahra Teaching Hospital, Wasit Health Directorate, Ministry of Health, Iraq

²Department of Community Medicine, School of Medical Sciences, Health Campus Universiti Sains Malaysia, Malaysia, Kubang Kerian.

³Department of Internal Medicine, College of Medicine, Wasit University, Iraq

⁴School of Dental Sciences, Health Campus, Universiti Sains Malaysia, Kubang Kerian.

Email: abbasalkanani08@gmail.com, rohanajalil@usm.my, salbadri@uowasit.edu.iq, wmamir@usm.my, ruhaya@usm.my,

Corresponding author: abbasalkanani08@gmail.com

Evaluating the Reproducibility of a Beverage Intake Questionnaire for Caloric Estimation Among Adolescents in Iraq

Abstract:

Background: Assessing the relationship between beverage consumption and health outcomes during adolescence is of considerable significance, requiring the use of reliable dietary assessment instruments for this important developmental period. This study aimed to evaluate the test-retest reliability of the 12-item Arabic Beverage Intake Questionnaire (BEVQ-A) in accurately measuring adolescents' average short-term beverage intake.

Methodology: The study used a cross-sectional design, targeting adolescents aged 16 to 18 years. A total of 83 participants participated in the reproducibility assessment, which was conducted twice over a one-month interval. Reproducibility was assessed using paired t-tests, the Intraclass Correlation Coefficient (ICC), Pearson correlation, and Bland-Altman plot analysis to assess consistency and reliability in the data collected.

Results: The intra-class correlation coefficients (ICCs) between BEVQ1 and BEVQ2 for kilocalorie intake demonstrated strong reproducibility across beverage categories, with values of 0.942 for total milk consumption, 0.775 for total sugar-sweetened beverages, and 0.905 for total beverage intake. These high ICCs indicate that participants reported beverage consumption reliably between the two administrations of the BEVQ-A. Most beverage types had no significant intake differences between the two assessments, and Bland-Altman plots indicated minimal bias, confirming the consistency and reliability of participants' dietary reporting.

Conclusion: The results of this study suggest that the BEVQ-A is a reliable and reproducible questionnaire for evaluating beverage consumption among Arabic-speaking adolescents. Applying the BEVQ-A in this population may enhance the evaluation of nutritional status among adolescents.

Keywords: Reproducibility, Beverage Intake Questionnaire, Adolescent

1 **Introduction:**

2 Adolescence is a formative period during which beverage choices leave a lasting imprint on growth
3 trajectories and long-term health [1] . Among dietary exposures in this age group, sugar-sweetened
4 beverages (SSBs) have received particular scrutiny, with a substantial body of work linking their
5 consumption to adverse metabolic and dental outcomes [2–5]. This concern is not merely theoretical for
6 the Arab region: in Iraq, roughly 40% of adolescents report consuming SSBs five to seven times per week
7 [6–8], a pattern consistent with the region-wide rise in obesity, type 2 diabetes, dental caries, and metabolic
8 syndrome attributed to high SSB intake [1]. The World Health Organization recommends limiting free
9 sugars to under 10% of total energy intake, ideally below 5%, yet adolescents in the Eastern Mediterranean
10 Region routinely exceed this threshold [9], and while more than 40 countries have introduced SSB taxation,
11 Iraq has not [10], leaving surveillance and behavioural data as the most immediately available lever for
12 public health action.

13 Turning such surveillance into credible evidence, however, depends entirely on the measurement
14 instrument used, and dietary assessment in adolescents is notoriously difficult to get right (recall burden,
15 portion-size estimation, and reporting bias all threaten validity). Against this backdrop, the Beverage Intake
16 Questionnaire (BEVQ) has emerged as a pragmatic, low-burden alternative to full dietary records, and its
17 psychometric properties have been established across several populations [11,12]. A one-month test–retest
18 interval has been shown to capture typical short-term variation in intake [13], and repeated administration
19 is now considered standard practice for demonstrating that a dietary tool measures consistently rather than
20 capturing a single, possibly atypical, reporting occasion [14]. The 15-item adult version of the BEVQ has
21 itself been validated in Spanish-speaking adults [11,12], underscoring the instrument's adaptability across
22 languages and cultural settings.

23 Yet adaptability across languages is not the same as demonstrated reliability within a specific population,
24 and this is precisely where the evidence trail for Iraqi adolescents runs out. Our group previously produced
25 a culturally adapted, 10-step-translated Arabic version of the questionnaire and established its content and

1 face validity, with strong agreement among four independent experts and 30 adolescent–parent pairs [15].
2 That work answered whether the Arabic BEVQ-A measures the intended construct — it did not answer
3 whether the instrument produces consistent, reproducible estimates when the same adolescents complete it
4 twice. This is not a minor gap: without documented test–retest reliability, any single administration of the
5 BEVQ-A cannot be distinguished from measurement noise, which would undermine its use in the very
6 surveillance and intervention-evaluation studies that the regional SSB burden demands.

7 The present study was therefore designed to close this specific gap. Using the sample-size framework
8 recommended for reliability studies [16,17], we evaluated the test–retest reliability of the 12-item Arabic
9 BEVQ-A in estimating short-term average beverage intake among Iraqi adolescents aged 16–18 years,
10 applying paired t-tests, intraclass correlation coefficients, Cronbach's alpha, Pearson correlation, and Bland-
11 Altman analysis to characterise agreement between two administrations conducted one month apart.

12 **Materials and Methods**

13 **Study design, setting, and participants**

14 This cross-sectional reproducibility study was conducted between June and July 2023 in governmental and
15 private secondary schools under the Wasit Education Directorate, Kut City, Wasit Governorate, Iraq.
16 Eligible participants were adolescents aged 16–18 years, enrolled in the selected schools, with both
17 adolescent and parental consent; those with uncontrolled hyperactivity or inattention, or a diagnosis of
18 diabetes mellitus, were excluded to avoid conditions that could independently distort self-reported beverage
19 intake.

20 Four schools were selected by simple random sampling. Coded identifiers preserved anonymity while
21 linking each participant's questionnaire to their consent record. Adolescents completed the BEVQ-A, the
22 Adolescent Food Parenting Questionnaire, and a socio-demographic interview, alongside anthropometric
23 measurement, in a single ~15-minute face-to-face session; the same protocol was repeated one month later.

24 **Sample size**

1 Sample size was calculated for the intraclass correlation coefficient (ICC) using a web-based calculator
 2 [18], based on a minimum acceptable ICC of 0.60, an expected ICC of 0.76 [11], $\alpha = 0.05$, power = 0.80,
 3 and two repetitions per subject, following the framework of Walter et al. [17]. This yielded a base
 4 requirement of 87 participants, inflated to 97 to allow for 10% anticipated dropout (Table 1).

5 **Table 1. Sample size determination for the Arabic Beverage Intake Questionnaire (BEVQ-A)**

Intraclass correlation coefficient (ICC) — hypothesis testing		
Minimum acceptable reliability (ICC), ρ_0	0.60	
Expected reliability (ICC), ρ_1	0.76	[11]
Significance level, α	0.05	Two-tailed
Power, $1 - \beta$	80%	
Repetitions per subject, k	2	
Expected dropout rate	10%	
Sample size, n	87	
Sample size with 10% dropout	97	

6 *Sample size calculated using Walter, Eliasziw and Donner's [17] framework via a web-based calculator [18].*

7 Instruments

8 Socio-economic status (SES) was assessed using the four-domain scale of Tiwari et al. [19] — parental
 9 education, occupation, crowding index, and property ownership — which double-weights parental
 10 education and occupation, consistent with the approach of Omer and Al-Hadithi [20]. Total scores (range
 11 36–150) were categorised as low (<89), moderate (90–120), or high (121–150) using cut-offs established
 12 in prior Iraqi studies [21–26]; SES was analysed as a continuous variable.

13 Beverage intake was measured with the BEVQ-12, a validated instrument estimating past-month habitual
 14 consumption in fluid ounces, kilocalories, and grams across beverage categories, including sugar-
 15 sweetened beverages, milk, and water [11]. The Arabic version (BEVQ-A) had previously undergone a 10-
 16 step translation with independently confirmed content and face validity [15]; the present study addressed
 17 its test–retest reliability, which had not yet been established.

18 Weight (0.1 kg) and height (0.1 cm) were measured with calibrated digital scales and a portable stadiometer,
 19 and BMI-for-age z-scores (BAZ) were derived using WHO AnthroPlus (v1.01), classified per the WHO

1 growth reference [27] as underweight (<-2 SD), normal (-2 to $+1$ SD), overweight ($>+1$ to $+2$ SD), or
2 obese ($>+2$ SD).

3 **Statistical analysis**

4 Data were entered and analysed in Excel and SPSS v26. Following established thresholds [28,29], variables
5 missing more than 5% of values were flagged, and those exceeding 20% missingness were excluded
6 [30,31]; remaining missing values were imputed by the mean/median/regression method.

7 Normality of the score differences between administrations was inspected visually via histogram [29];
8 where normality held, paired t-tests compared BEVQ1 and BEVQ2 means for total milk, total SSBs, and
9 total beverages [32,33], with $P > 0.05$ interpreted as evidence of agreement.

10 Test-retest reliability was quantified using a two-way mixed-effects, single-measures, absolute-agreement
11 ICC [16,34–37], interpreted as poor (<0.50), moderate ($0.51–0.75$), good ($0.76–0.90$), or excellent (>0.91)
12 [37]. Internal consistency was assessed with Cronbach's alpha ($\alpha > 0.70$ considered acceptable), with item-
13 total correlations below 0.1 flagged for exclusion. Pearson correlation coefficients were interpreted per
14 Colton [38] as negligible ($0.00–0.25$), fair ($0.26–0.50$), moderate-to-strong ($0.51–0.75$), or very strong
15 ($0.76–1.00$). Bland-Altman analysis [39–41] was used to visualise mean bias and 95% limits of agreement
16 between the two administrations.

17 **Ethical approval**

18 The study was approved by the Human Research Ethics Committee of Universiti Sains Malaysia
19 (USM/JEPeM/KK/23030276) and the Director General of Wasit Education (Ref: 71654). Parental consent,
20 Arabic-language information sheets, and in-person briefings addressed participant protection; no conflicts
21 of interest were declared, and all costs were met by the researchers.

22 **Results**

23 **Normality and response rate**

1 Histogram inspection confirmed that score differences between administrations were normally distributed
2 for total milk, total SSBs, and total beverages, satisfying the assumption for paired t-testing. Of 160
3 adolescents screened, 98 met eligibility criteria; 83 completed both administrations, giving a completion
4 rate of 84.6% among those who initially agreed, with first- and second-round participation rates of 60.6%
5 and 85.7%, respectively. The realised sample ($n = 83$) fell short of the 87 required before accounting for
6 dropout, a point returned to in the Discussion.

7 **Participant characteristics**

8 The final sample ($n = 83$) had a mean age of 16.72 years ($SD = 0.75$; range 16.0–18.7) and was balanced
9 by sex (54.2% boys, 45.8% girls; Table 2). SES was predominantly moderate (50.6%) or low (31.3%), with
10 only 18.1% classified as high SES (mean score 99.98, $SD = 20.07$; range 57–142); fathers were most often
11 lower professional or skilled workers (47.0%) and mothers predominantly unskilled workers (80.7%).
12 Mean BAZ was 0.59 ($SD = 1.70$; range -3.75 to 4.03), with 51.8% of participants classified as normal
13 weight, 22.9% overweight, 13.3% obese, 7.2% severely obese, and 4.8% underweight (Table 3).

14 **Mean differences between administrations**

15 Across most beverage categories, mean intake did not differ significantly between BEVQ1 and BEVQ2
16 (Table 4). Total beverage intake showed non-significant mean differences of 1.540 fl oz ($P = 0.298$), 47.733
17 g ($P = 0.286$), and 28.567 kcal ($P = 0.058$), and total milk likewise showed no significant change (all $P >$
18 0.39). The single exception was total SSB intake in grams, which increased significantly by a mean of
19 147.432 g (95% CI: 41.887–252.977; $P = 0.007$), whereas the corresponding changes in fluid ounces
20 (-0.183 fl oz; $P = 0.906$) and kilocalories (7.244 kcal; $P = 0.712$) were not significant. Individual beverage
21 sub-categories (water, fruit juice, sweetened local drinks, milk variants, soft drinks, energy/sports drinks,
22 tea and coffee) all showed small, non-significant mean differences (Table 4).

23

24

1 **Table 2. Sociodemographic and socioeconomic characteristics of ICC study participants (n = 83)**

Domain	Category	Father, n (%)	Mother, n (%)
Age, sex, and school			
Adolescent	Age, years — mean ± SD (range)	16.72 ± 0.75 (16.0–18.7)	
	Sex — boy	45 (54.2)	
	Sex — girl	38 (45.8)	
School	Al-Mustafaa (governmental)	26 (31.3)	
	Al-Ghasaq (governmental)	21 (25.3)	
	Al-Zahraa (private)	20 (24.1)	
	Nur Almuftabaa (private)	16 (19.3)	
Socioeconomic status (SES) — WHO scale			
Parental occupation	High professional / managerial	15 (18.1)	–
	Lower professional / skilled / semiskilled	39 (47.0)	16 (19.3)
	Unskilled	29 (34.9)	67 (80.7)
Parental education	Illiterate	3 (3.6)	10 (12.0)
	Read and write	3 (3.6)	3 (3.6)
	Primary graduate	23 (27.7)	21 (25.3)
	Intermediate graduate	22 (26.5)	16 (19.3)
	Secondary graduate	8 (9.6)	15 (18.1)
	College graduate	24 (28.9)	18 (21.7)
Household-level indicators (not parent-specific)			
Crowding index	≤2 persons/room	59 (71.1)	
	>2–4 persons/room	21 (25.3)	
	>4 persons/room	3 (3.6)	
	Mean ± SD (range)	1.77 ± 1.07 (0.44–7.50)	
Property ownership	Owns house, car, and all household assets	47 (56.6)	
	Rents house, with/without car and most assets	27 (32.5)	
	Shares house with another family, no car, some assets	9 (10.8)	
Overall SES category	High (121–150)	15 (18.1)	
	Moderate (90–120)	42 (50.6)	
	Low (≤89)	26 (31.3)	
	Mean ± SD (range)	99.98 ± 20.07 (57–142)	

2 SES was scored using the four-domain scale of Tiwari et al. [19], which double-weights parental education and occupation, consistent with Omer
3 and Al-Hadithi [20]; cut-offs follow prior Iraqi studies [21–26]. Missing data: 11.9% for fathers and 9.4% for mothers on occupation/education
4 items. Crowding index, property ownership, and overall SES category are household-level measures and are therefore reported in a single column
5 rather than separately by parent.

6 **Reliability: ICC, Cronbach's alpha, and Pearson correlation**

7 Reliability was good to excellent for the composite beverage categories most relevant to this study's
8 objective (Table 5). Total milk intake showed excellent reliability (ICC = 0.942, 95% CI: 0.911–0.962, for

1 kcal; 0.929 for fl oz; 0.963 for g), as did total beverage intake (ICC = 0.905, 95% CI: 0.856–0.937, for kcal;
2 0.903 for fl oz and g). Total SSB intake showed good reliability for kilocalories (ICC = 0.775, 95% CI:
3 0.673–0.849) and fluid ounces (ICC = 0.799), and moderate reliability for grams (ICC = 0.698, 95% CI:
4 0.558–0.797). Corresponding Pearson correlations were strong for total milk ($r = 0.933$ – 0.944), total
5 beverages ($r = 0.905$ – 0.907), and total SSBs ($r = 0.740$ – 0.800). Reliability across individual beverage sub-
6 categories ranged from moderate (e.g., regular energy and sports drinks, ICC = 0.549) to excellent (e.g.,
7 fresh fruit juice, ICC = 0.851; sweet tea, ICC = 0.843), with the lowest values observed for black tea/coffee
8 in kilocalories (ICC = 0.506) (Table 5). Cronbach's alpha exceeded 0.70 for nearly all categories, reaching
9 0.971 for total milk (kcal).

10 **Table 3. Distribution of ICC study participants by BMI-for-age z-score (n = 83)**

Measure	Category	n (%)
Adolescent BMI-for-age z-score (BAZ)	Underweight: BAZ < -2 SD	4 (4.8)
	Normal weight: -2 SD ≤ BAZ ≤ +1 SD	43 (51.8)
	Overweight: +1 SD < BAZ ≤ +2 SD	19 (22.9)
	Obese: +2 SD < BAZ ≤ +3 SD	11 (13.3)
	Severely obese: BAZ > +3 SD	6 (7.2)
	Mean ± SD (range)	0.59 ± 1.70 (-3.75 to 4.03)

11 *BAZ = BMI-for-age z-score; SD = standard deviation.*

12 **Bland-Altman analysis**

13 Bland-Altman plots showed negligible systematic bias in kilocalorie estimates for total milk ($\beta = -0.049$, t
14 $= -0.982$, $P = 0.329$), total SSBs ($\beta = -0.054$, $t = -0.132$, $P = 0.235$), and total beverages ($\beta = -0.007$, $t =$
15 -0.214 , $P = 0.831$) (Figure 1), consistent with the ICC and paired t-test findings above.

16
17
18
19

1

Table 4. Mean differences in beverage intake between the first and second BEVQ-A administrations (n = 83)

Beverage	Unit	BEVQ1, mean (SD)	BEVQ2, mean (SD)	Mean difference (95% CI) ^a	t ^b (df=82)	P
Water	fl oz	24.53 (8.11)	25.11 (7.40)	-0.578 (-1.895,0.738)	-0.874	0.385
	gm	726.82 (240.46)	748.24 (207.711)	-21.419 (-58.713,15.875)	-1.143	0.257
Fresh fruit juice 100%	fl oz	4.77 (5.67)	4.33 (5.67)	0.444 (-0.201,1.089)	1.369	0.175
	kcal	84.36 (100.21)	76.51 (91.83)	7.846 (-3.556,19.250)	1.369	0.175
	gm	147.19 (174.84)	133.50 (160.22)	13.690 (-6.206,33.586)	1.369	0.175
Sweetened Juice Beverage/ local Drink	fl oz	6.46 (6.61)	6.92 (7.63)	-0.465 (-1.387,0.457)	-1.003	0.319
	kcal	92.44 (94.63)	99.09 (109.22)	-6.651 (-19.846,6.540)	-1.003	0.319
	gm	198.33 (203.02)	212.60 (234.34)	-14.270 (-42.573,14.033)	-1.003	0.319
Whole Milk: red cap, Reduced Fat Milk 2%: purple cap, or Chocolate Milk	fl oz	3.31 (3.98)	3.30 (3.77)	0.003 (-0.578,0.585)	0.012	0.991
	kcal	65.50 (78.85)	65.43 (74.74)	0.068 (-11.454,11.590)	0.012	0.991
	gm	100.89 (121.46)	100.37 (120.22)	0.104 (-17.644,17.854)	0.012	0.991
Low Fat 1%: green cap, Fat- Free/Skim Milk: light blue cap, Buttermilk or Soy Milk	fl oz	4.71 (6.41)	4.69 (6.01)	0.344 (-0.508,1.197)	0.803	0.424
	kcal	57.06 (77.58)	52.89 (62.76)	4.165 (-6.155,14.485)	0.803	0.424
	gm	143.74 (195.42)	133.25 (17.35)	10.492 (-15.505,36.490)	0.803	0.424
Nut milk	fl oz	1.16 (4.51)	1.12 (2.49)	0.041 (-0.622,0.704)	0.123	0.902
	kcal	11.40 (44.20)	10.99 (24.45)	0.404 (-6.098,6.907)	0.123	0.902
	gm	35.46 (137.49)	34.20 (76.07)	1.259 (-18.966, 21.484)	0.123	0.902
Regular Soft Drinks	fl oz	9.88 (10.15)	9.08 (8.49)	0.801 (-0.622,2.225)	1.119	0.266
	kcal	131.53 (135.12)	119.96 (113.59)	11.569 (-7.254,30.393)	1.223	0.225
	gm	296.69 (304.79)	272.66 (254.70)	24.030 (-18.688,66.75)	1.119	0.266
Regular Energy & Sports Drinks	fl oz	1.39 (5.63)	1.17 (2.65)	0.220 (-0.696,1.136)	0.478	0.634
	kcal	19.47 (78.95)	16.38 (37.16)	3.084 (-9.746,15.914)	0.478	0.634
	gm	43.18 (175.11)	36.34 (82.41)	6.840 (-21.615,35.296)	0.478	0.634
Diet or Artificially Sweetened Carbonated Drinks, Energy and Sports Drinks	fl oz	2.27 (6.38)	1.99 (4.34)	0.282 (-0.586,1.150)	0.647	0.520
	kcal	0.68 (0.21)	0.59 (1.30)	0.084 (-0.175,0.345)	0.647	0.520
	gm	67.90 (190.35)	59.49 (129.34)	8.411 (-17.462,34.286)	0.647	0.520
Sweet Tea	fl oz	9.66 (9.21)	9.03 (7.05)	0.633 (-0.365,1.632)	1.261	0.211
	kcal	96.70 (92.0.8)	90.36 (70.54)	6.333 (-3.656,16.324)	1.261	0.211
	gm	302.17 (287.74)	282.37 (220.46)	19.793 (-11.427,51.013)	1.261	0.211
Black Tea or Coffee (no creamer or milk)	fl oz	3.07 (5.64)	2.90 (3.57)	0.165 (-0.773, 1.103)	0.350	0.727
	kcal	10.80 (23.98)	9.71 (16.06)	1.084 (-3.355,5.525)	0.486	0.628
	gm	90.99 (70.54)	86.09 (105.77)	4.890 (-22.890,32.672)	0.350	0.727
Tea or Coffee (with milk &/ or creamer)	fl oz	2.41 (3.88)	2.37 (3.53)	0.034 (-0.475,0.544)	0.134	0.894
	kcal	22.09 (33.87)	22.22 (35.99)	-0.127 (-5.296,5.042)	-0.049	0.961
	gm	71.18 (114.32)	70.17 (104.27)	1.015 (-14.028,16.059)	0.134	0.894
Total Milk	fl oz	9.19 (9.90)	8.78 (8.94)	0.388 (-0.519,1.297)	0.852	0.397
	kcal	133.97 (134.29)	129.32 (128.20)	4.638 (-7.919,17.195)	0.735	0.465
	gm	280.10 (301.75)	268.24 (272.60)	11.856 (-15.836,39.549)	0.852	0.397
Total sugar-sweetened beverages	fl oz	30.29 (23.25)	30.49 (21.23)	-0.183 (-3.281,2.913)	-0.118	0.906
	kcal	364.48 (276.25)	357.47 (253.91)	7.244 (-31.722,46.211)	0.370	0.712
	gm	951.42 (717.81)	803.99 (549.00)	147.432 (41.887,252.977)	2.779	0.007
Total beverages	fl oz	73.48 (36.75)	71.93 (33.82)	1.540 (-1.388,4.469)	1.046	0.298
	kcal	593.43 (411.14)	564.86 (396.80)	28.567 (-1.036,58.170)	1.920	0.058
	gm	2218.99 (1128.32)	2171.25 (1027.68)	47.733 (-40.726,136.193)	1.073	0.286

^a Mean difference from a paired-samples t-test (BEVQ1 minus BEVQ2). ^b t statistic. CI = confidence interval; kcal = kilocalories; fl oz = fluid ounces; gm = grams.

2
3

Table 5. Intraclass correlation coefficients (ICC), Cronbach's alpha, and Pearson correlations between two BEVQ-A administrations

Beverage	Unit	ICC (95% CI) ^a	α^b	r^{pc}
Water	fl oz	0.699 (0.571,0.794)	0.823	0.702
	gm	0.710 (0.586,0.802)	0.831	0.719
Fresh fruit juice 100%	fl oz	0.851 (0.779,0.901)	0.920	0.856
	kcal	0.851 (0.779,0.901)	0.920	0.856
	gm	0.851 (0.779,0.901)	0.920	0.856
Sweetened Juice Beverage/ local Drink	fl oz	0.825 (0.742,0.883)	0.902	0.834
	kcal	0.825 (0.742,0.883)	0.902	0.834
	gm	0.825 (0.742,0.883)	0.902	0.834
Whole Milk: red cap, Reduced Fat Milk 2%: purple cap, or Chocolate Milk	fl oz	0.766 (0.660,0.842)	0.866	0.765
	kcal	0.766 (0.660,0.842)	0.866	0.765
	gm	0.766 (0.660,0.842)	0.866	0.765
Low Fat 1%: green cap, Fat-Free/Skim Milk: light blue cap, Buttermilk or Soy Milk	fl oz	0.776 (0.674,0.849)	0.874	0.793
	kcal	0.776 (0.674,0.849)	0.874	0.793
	gm	0.776 (0.674,0.849)	0.874	0.793
Nut milk	fl oz	0.655 (0.512,0.763)	0.790	0.770
	kcal	0.655 (0.512,0.763)	0.790	0.770
	gm	0.655 (0.512,0.763)	0.790	0.770
Regular Soft Drinks	fl oz	0.757 (0.648,0.836)	0.862	0.770
	kcal	0.760 (0.653,0.838)	0.865	0.773
	gm	0.757 (0.648,0.836)	0.862	0.770
Regular Energy & Sports Drinks	fl oz	0.549 (0.379,0.683)	0.709	0.707
	kcal	0.549 (0.379,0.683)	0.709	0.707
	gm	0.549 (0.379,0.683)	0.709	0.707
Diet or Artificially Sweetened Carbonated Drinks, Energy and Sports Drinks	fl oz	0.736 (0.620,0.821)	0.847	0.790
	kcal	0.736 (0.620,0.821)	0.847	0.790
	gm	0.736 (0.620,0.821)	0.847	0.790
Sweet Tea (with sugar)	fl oz	0.843 (0.768,0.896)	0.916	0.875
	kcal	0.843 (0.768,0.896)	0.916	0.875
	gm	0.843 (0.768,0.896)	0.916	0.875
Black Tea or Coffee (no creamer or milk)	fl oz	0.588 (0.427,0.713)	0.739	0.648
	kcal	0.506 (0.326,0.650)	0.670	0.545
	gm	0.588 (0.427,0.713)	0.739	0.643
Tea or Coffee (with milk &/ or creamer)	fl oz	0.804 (0.712,0.869)	0.890	0.805
	kcal	0.773 (0.669,0.847)	0.870	0.772
	gm	0.804 (0.712,0.869)	0.890	0.805
Total Milk	fl oz	0.929 (0.892,0.953)	0.963	0.933
	kcal	0.942 (0.911,0.962)	0.971	0.944
	gm	0.929 (0.893,0.954)	0.963	0.934
Total sugar-sweetened beverages	fl oz	0.799 (0.685, 0.705)	0.887	0.800
	kcal	0.775 (0.673,0.849)	0.872	0.776
	gm	0.698 (0.558,0.797)	0.833	0.740
Total beverages	fl oz	0.903 (0.854,0.936)	0.949	0.907
	kcal	0.905 (0.856,0.937)	0.950	0.905
	gm	0.903 (0.854,0.936)	0.949	0.907

^a Intraclass correlation coefficient from a two-way mixed-effects, single-measures model. ^b Cronbach's alpha (internal consistency). ^c Pearson correlation coefficient. ICC interpreted per Koo and Li [37]: <0.50 poor, 0.51–0.75 moderate, 0.76–0.90 good, >0.91 excellent.

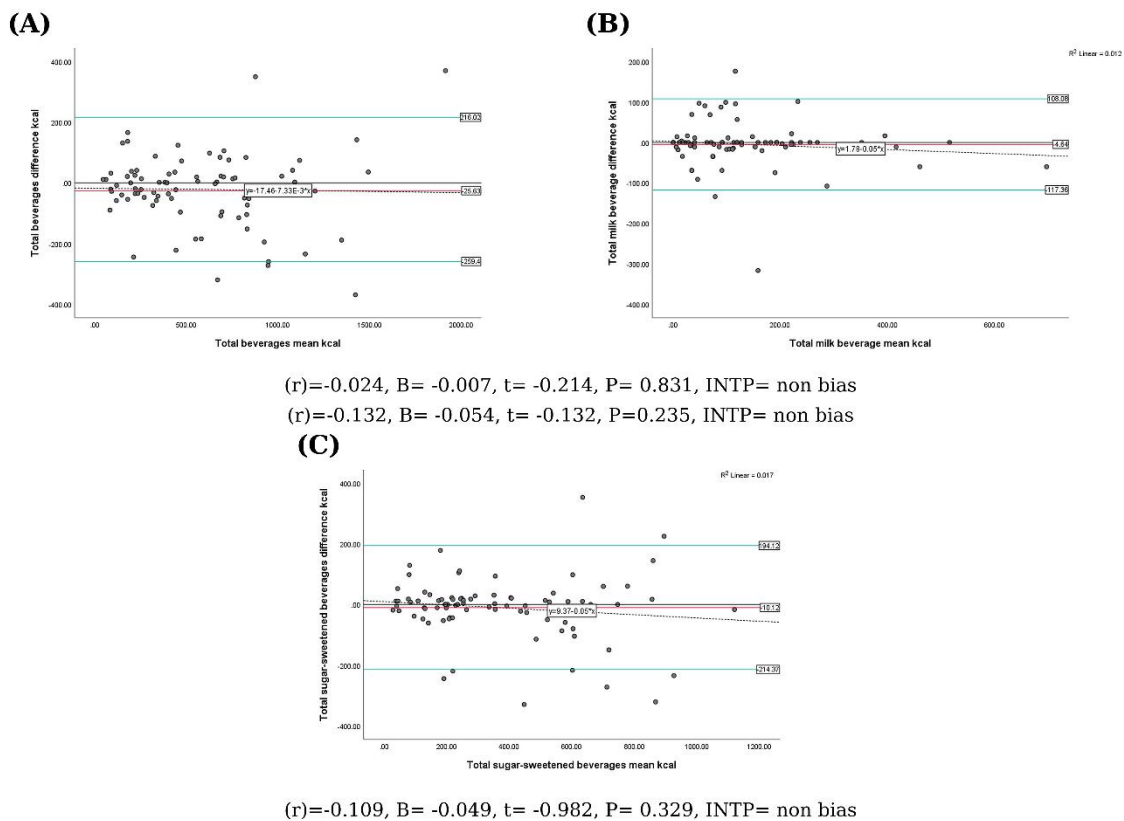


Figure 1. Bland-Altman plots of test–retest kilocalorie estimates for milk, sugar-sweetened beverages, and total beverage

Bland-Altman plots comparing kilocalorie estimates from two administrations of the BEVQ-A, one month apart, in 83 Iraqi adolescents. (A) Total milk; (B) total sugar-sweetened beverages; (C) total beverages. Each point represents one participant; the x-axis shows the mean of the two administrations and the y-axis shows their difference (administration 1 minus administration 2), in kilocalories. Horizontal reference lines denote the mean bias and 95% limits of agreement. r = Pearson correlation between mean and difference; β = unstandardized regression coefficient; t = t statistic; P = two-tailed probability value for β .

Discussion

This study evaluated the test–retest reliability of the Arabic-adapted BEVQ-A among Iraqi adolescents and found that it performs well: total milk and total beverage intake showed excellent reproducibility (ICC $\geq$ 0.90), total SSB intake showed good-to-moderate reproducibility (ICC 0.70–0.80), and Bland-Altman analysis detected no meaningful systematic bias in any of the three composite outcomes. These results support the central hypothesis motivating this work — that a properly translated and content-validated BEVQ can also be reproducible in a new linguistic and cultural setting — and, together with our earlier validation of the instrument's content and face validity[15], complete the evidence base needed before the BEVQ-A can be used with confidence in future Iraqi adolescent research.

1 The stability of total beverage and milk intake across the one-month interval is consistent with, and extends,
2 prior test–retest work on beverage questionnaires [11,42–44]. Two features of this study's context plausibly
3 contributed to that stability. First, data collection spanned the summer months, when hot-climate hydration
4 patterns tend to be relatively fixed and repetitive [45]; second, the one-month gap between administrations
5 was short enough that broader shifts in diet or lifestyle were unlikely, in line with Xiaoyu et al. [46], who
6 attributed most between-survey variation in adolescent beverage recall to methodological factors rather
7 than to the length of the interval itself.

8 The one notable exception — a significant increase in SSB intake measured in grams, without a
9 corresponding change in fluid ounces or kilocalories — is harder to explain from stability alone, and is
10 more consistent with a shift toward denser or differently formulated SSB products between administrations
11 than with a true change in reported volume or energy intake. Fausnacht et al. [12] and Aldhirgham et al.
12 [13] similarly linked SSB reporting variability to seasonal availability and shifting product preferences, and
13 Stelmach-Mardas et al. [45] documented broader seasonal dietary variation that could plausibly extend to
14 sugar content specifically. Because this discrepancy appeared only in the gram-based metric and not in the
15 energy or volume metrics that are typically used to judge clinical or public-health relevance, it should be
16 interpreted as a reporting-granularity artefact rather than as evidence against the instrument's overall
17 reliability — a distinction this study's multi-metric design was able to make, but which single-metric
18 reliability studies could not.

19 The comparatively lower reliability observed for some individual sub-categories — regular energy and
20 sports drinks ($ICC = 0.549$) and black tea/coffee without milk ($ICC = 0.506$ for kcal) — is a pattern also
21 reported for infrequently or irregularly consumed beverages in other test–retest studies of dietary
22 instruments [47,48], and probably reflects genuine day-to-day variability in intake of these items rather
23 than a flaw specific to the BEVQ-A. This matters practically: researchers using the BEVQ-A to rank or
24 intervene on individual, sporadically consumed beverage types should interpret single-item estimates more

1 cautiously than the composite (total milk, total SSB, total beverage) outcomes that this study found to be
2 highly reproducible.

3 Taken together with the Bland-Altman findings of negligible bias in the three composite outcomes, these
4 results position the BEVQ-A alongside other regionally adapted beverage instruments — such as the
5 Workplace Beverage Intake Questionnaire [47] and the Lebanese food-frequency questionnaire of Zalaket
6 et al. [14] — that report minor category-specific bias without compromising overall instrument validity.
7 This reinforces the practical conclusion that the BEVQ-A can support the surveillance and intervention-
8 evaluation work that the region's SSB burden requires [1,6], provided analyses focus on the composite
9 categories for which reliability was strongest.

10 This study has several strengths, including a purpose-built, previously content-validated Arabic instrument,
11 a multi-method reliability assessment (paired t-tests, ICC, Cronbach's alpha, Pearson correlation, and
12 Bland-Altman analysis), and a school-based sampling frame reasonably representative of Kut City
13 adolescents. Its main limitations are the reliance on self-report, which remains vulnerable to recall and
14 social desirability bias; a completed sample (n = 83) that fell short of the pre-specified target of 87 after
15 accounting for dropout, which may have modestly widened the confidence intervals reported in Table 5;
16 and a single-city, one-month design that limits generalisability to other seasons, regions, or age groups
17 [47,48]. Future work should test the BEVQ-A's reproducibility across seasons and regions of Iraq, and in
18 younger adolescents, to establish the boundaries of its current reliability profile. Within these limits, the
19 present findings indicate that the BEVQ-A is a reproducible tool for estimating habitual beverage intake,
20 and total beverage/milk/SSB consumption in particular, among Iraqi adolescents.

21 **Conclusions**

22 In conclusion, the BEVQ-A showed an acceptable reproducibility instrument to estimate beverage intake
23 in Iraqi adolescents. Because the questionnaire is shorter and includes calculations of total calorie intake
24 and quantities in grams and portions, the quality of responses is enhanced. This format helps minimize
25 potential limitations related to misunderstandings or neglect common in this age group, thereby improving

1 data accuracy. Therefore, this tool is valuable for the performance of epidemiological studies in the Arabic
2 adolescent population because it allows the identification of different risky consumption eating behaviours
3 and their relationships with health markers.

4 **List of Abbreviations:**

5 The following abbreviations are used throughout this manuscript: BAZ, Body Mass Index-for-Age Z-score;
6 BEVQ, Beverage Intake Questionnaire; BEVQ-A, Arabic Beverage Intake Questionnaire; BEVQ1, first
7 administration of the Beverage Intake Questionnaire; BEVQ2, second administration of the Beverage
8 Intake Questionnaire; BMI, Body Mass Index; CI, Confidence Interval; ICC, Intraclass Correlation
9 Coefficient; kcal, kilocalorie; SES, Socioeconomic Status; SPSS, Statistical Package for the Social
10 Sciences; SSBs, Sugar-Sweetened Beverages; USM, Universiti Sains Malaysia; and WHO, World Health
11 Organization.

12 **Declarations**

13 **Ethics approval and consent to participate:** This study was approved by the Human Research Ethics
14 Committee of Universiti Sains Malaysia (USM/JEPeM/KK/23030276) and the Director General of Wasit
15 Education, Iraq (Ref: 71654). Written informed consent was obtained from parents/legal guardians, with
16 assent from adolescent participants. All methods involving human participants were performed in
17 accordance with the relevant institutional guidelines and regulations and the principles of the Declaration
18 of Helsinki.

19 **Clinical trial number:** Not applicable.

20 **Consent for publication:** Not applicable.

21 **Availability of data and materials:** The datasets generated and/or analysed during the current study are
22 available from the corresponding author on reasonable request.

23 **Competing interests:** The authors declare no competing interests.

24 **Funding:** The study obtained no outside funding.

1 **Authors' contributions:** AAA (Abbas Ali Alkinani): Conceptualization, Data Curation, Formal Analysis,
2 Investigation, Methodology, Writing – Original Draft. AJR (A.J. Rohana): Conceptualization, Data
3 Curation, Formal Analysis, Investigation, Methodology, Writing – Original Draft. SAB (Saad Abid Al-
4 Badri): Validation, Writing – Review & Editing. RH (Ruhaya Hasan): Validation, Supervision, Writing –
5 Review & Editing. WMAW (Wan Muhamad Amir W Ahmad): Project Administration, Supervision,
6 Writing – Review & Editing. All authors read and approved the final manuscript.

7 **Use of Artificial Intelligence (AI):** Artificial intelligence tools were used in the preparation of this research
8 only for language correction, grammar refinement, and code review. All intellectual content, analysis,
9 interpretations, and conclusions are entirely the authors' own. The authors take full responsibility for the
10 integrity and accuracy of the work presented.

11 **Acknowledgements:** The authors would like to thank Universiti Sains Malaysia (USM) for providing
12 institutional support for this study. Additional gratitude is extended to the Iraqi Ministry of Education for
13 authorizing the study's execution. The authors also thank all of the participating secondary schools in Kut
14 City for their cooperation and support during data collection.

15 **References**

- 16 1. Neelakantan N, Park SH, Chen GC, Van Dam RM. Sugar-sweetened beverage consumption, weight
17 gain, and risk of type 2 diabetes and cardiovascular diseases in Asia: A systematic review. *Nutr Rev.*
18 2022;80(1):50–67. doi:10.1093/nutrit/nuab010 PubMed PMID: 33855443.
- 19 2. Amin S. Obesity Prevalence in Primary School Children in Baghdad City. *Res J Pharm Technol.*
20 2019;12(1):339–41. doi:10.5958/0974-360X.2019.00061.1
- 21 3. Alkinani A, Rohana AJ, Hasan R, Muhamad W, Ahmad AW, Al-badri SA. The relationship between
22 Sugar-Sweetened Beverages and obesity between children and adolescents in Eastern Mediterranean
23 Region : systematic review. In: the 1st international & 14 national conference on innovations in
24 health sciences, Shahid Beheshti University of medical sciences, school of public health & safety
25 [Internet]. 2022. p. 3. Available from: <https://en.ihsc.bsbmu.ir/index.php/posters/>

4. Bleich SN, Vercammen KA. The negative impact of sugar-sweetened beverages on children's health: An update of the literature. *BMC Obes.* 2018;5(1). doi:10.1186/s40608-017-0178-9 PubMed PMID: 29484192.
5. Jakobsen DD, Brader L, Bruun JM. Association between Food, Beverages and Overweight/Obesity in Children and Adolescents—A Systematic Review and Meta-Analysis of Observational Studies. *Nutrients.* 2023;15(3). doi:10.3390/nu15030764 PubMed PMID: 36771470.
6. Alasqah I, Mahmud I, East L, Usher K. Patterns of physical activity and dietary habits among adolescents in Saudi Arabia: A systematic review. *Int J Health Sci (Qassim).* 2021;15(2):39–48. PubMed PMID: 33708043.
7. Boulhannaa A, Anarghoub H, Ihbourc S, Najimid M, Chigr F. Prevalence Of Physical Activity, Sedentary Behaviour And Unhealthy Dietary Habits Among Moroccan Adolescents. *Turkish J Comput Math Educ.* 2021;12(5):937–43. doi:10.17762/turcomat.v12i5.1736
8. Selman NA, Hussain AMA, Mera NAA. The prevalence of nutritional status and obesity in adolescents in Babylon Province, Iraq. *Med J Babylon.* 2024;21(1):174–8. doi:10.4103/MJBL.MJBL_1360_23
9. WHO. World Health Organization [Internet]. 2024 [cited 2024 Aug 10]. Reducing consumption of sugar-sweetened beverages to reduce the risk of childhood overweight and obesity. Available from: <https://www.who.int/tools/elena/bbc/ssbs-childhood-obesity#:~:text=Recent systematic reviews of the,gain in children%2C particularly in>
10. WHO. Global report on the use of sugar-sweetened beverage taxes 2023 [Internet]. 2023. 1–70 p. Available from: <https://www.who.int/publications/i/item/9789240084995>
11. Hill CE, MacDougall CR, Riebl SK, Savla J, Hedrick VE, Davy BM. Evaluation of the Relative Validity and Test–Retest Reliability of a 15-Item Beverage Intake Questionnaire in Children and Adolescents. *J Acad Nutr Diet.* 2017;117(11):1757-1766.e5. doi:10.1016/j.jand.2017.05.011 PubMed PMID: 28673606.

12. Fausnacht AG, Myers EA, Hess EL, Davy BM, Hedrick VE. Update of the BEVQ-15, a beverage intake questionnaire for habitual beverage intake for adults: determining comparative validity and reproducibility. *J Hum Nutr Diet.* 2020;33(5):729–37. doi:10.1111/jhn.12749 PubMed PMID: 32283572.
13. Aldhirgham TM, Almutairi LA, Alraqea AS, Alqahtani AS. Online Arabic Beverage Frequency Questionnaire (ABFQ): evaluation of validity and reliability. *Nutr J.* 2023;22(1):1–10. doi:10.1186/s12937-022-00830-9 PubMed PMID: 36944984.
14. Zalaket J, Matta J, Hanna-Wakim L. Development, validity, and reproducibility of a semiquantitative food frequency questionnaire for the assessment of antioxidant vitamins intake in Lebanon. *Nutrition.* 2019;58:11–7. doi:10.1016/j.nut.2018.06.014 PubMed PMID: 30273820.
15. Alkinani A, Rohana AJ, Hasan R, Muhamad W, Ahmad AW, Al-badri SA. Translation and Validation of a Culturally Adapted Arabic Version of the Beverage Intake Questionnaire (BEVQ). 2024;16(10). doi:10.7759/cureus.71710
16. Amir WM, Khamis MFG, Mohamad FM, Nawawi MAA. *Advanced Statistical Analysis Made Easy Using SPSS.* Penerbit Universiti Sains Malaysia; 2021. 1–93 p.
17. Walter SD, Eliasziw M, Donner A. Sample size and optimal designs for reliability studies. *Stat Med.* 1998;17(1):101–10. doi:10.1002/(SICI)1097-0258(19980115)17:1<101::AID-SIM727>3.0.CO;2-E PubMed PMID: 9463853.
18. Arifin WN. Sample size calculator (web). 2023.
19. Tiwari SC, Kumar A, Kumar A. Development & standardization of a scale to measure socioeconomic status in urban & rural communities in India. *Indian J Med Res.* 2005;122(4):309–14.
20. Omer W, Al-Hadithi T. Developing a socioeconomic index for health research in Iraq. *East Mediterr Heal J.* 2017;23(10):670–7. doi:10.26719/2017.23.10.670 PubMed PMID: 29270967.
21. Alkinani AA, Abbas MF, Faraj SA, Jumaa RM. An Epidemiological Study of Thalassaemia Patients Attending Thalassaemic Center in Wassit Governorate. *World J Pharm Res.* 2017;6(10):1–12.

doi:10.20959/wjpr201710-8949

22. Ghalib AA. Evaluation of Prostate Cancer Health-Related Quality of Life (Specific Scale) Among A Sample In Baghdad City. *World J Pharm Res.* 2017;6(8):61–75. doi:10.20959/wjpr20178-8846
23. Haider A, Ahmed JT, Ali FH, AL-Kinani AA. Prevalence of nutritional iron deficiency anemia among children under six years in Al Madinah, Basra, Iraq. *Ann Trop Med Public Heal.* 2021;24(4):40–7.
24. Abdalhasan AM, Zedian MA, Al-naqeeb AA, Technology M. Collision of Polycystic Ovarian Syndrome Scenarios on Specific Health Related-Quality of Life among a sample at Maternity and Children Teaching Hospital" in Diwaniyah city –Iraq. *Univ Kufa, Fac Nurs.* 2022;12(1):23–32.
25. Al-azzawi KGR, Al-naqeeb AAAG, Zeidan MAK. Impact of Chronic Liver Diseases on Specific Health-Related Quality of Life among a Sample in Babylon Governorate. *J Tech.* 2022;4:86–90.
26. Al Kaabi SZ, Al-Saad DS, Al-Rubaye AK, Alkinani AAA. The association between the severity of anemia and socio-demographic factors among children under five years of age in Kut City. *J Public Health Africa.* 2023;14(8):64–9. doi:10.4081/jphia.2023.2676
27. Onis M De, Onyango AW, Borghi E, Siyam A, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ.* 2007;85(9):660–7. doi:10.2471/BLT.
28. Hair, Jr. JF, M. Hult GT, M. Ringle C, Sarstedt, Marko. *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)* [3 ed]. *Angewandte Chemie International Edition*, 6(11), 951–952. [Internet]. 2022. 386 p. Available from: <https://medium.com/@arifwicaksanaa/pengertian-use-case-a7e576e1b6bf>
29. Kline RB. *Principles and Practice of Structural Equation Modeling*. 5th Edi. Little TD, editor. New York London: THE GUILFORD PRESS; 2023. 1–516 p.
30. Peng J, Harwell M, Liou SM, Ehman LH. Advances in missing data methods and implications for educational research. In: Sawilowsky S, editor. *Real data analysis*. Greenwich, CT:Information Age

Publishing; 2006. p. 31–78.

31. Pampaka M, Hutcheson G, Williams J. Handling missing data: analysis of a challenging data set using multiple imputation. *Int J Res Method Educ.* 2016;39(1):19–37. doi:10.1080/1743727X.2014.979146

32. Reidpath DD, Cheah JCH, Lam FC, Yasin S, Soyiri I, Allotey P. Validity of self-measured waist and hip circumferences: Results from a community study in Malaysia. *Nutr J.* 2013;12(1):1–5. doi:10.1186/1475-2891-12-135 PubMed PMID: 24093886.

33. Plichta SB, Kelvin EA. MUNRO’S Statistical Methods for Health Care Research. 6th editio. Surrena H, editor. Lippincott Williams & Wilkins; 2013.

34. McGraw KO, Wong SP. Forming Inferences about Some Intraclass Correlation Coefficients. *Psychol Methods.* 1996;1(1):30–46. doi:10.1037/1082-989X.1.1.30

35. Weir JP. Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *J Strength Cond Res.* 2005;19(1):231–40. doi:10.1519/15184.1 PubMed PMID: 15705040.

36. Arifin WN. Test-retest Reliability Interpretation [Internet]. 2023. Available from: <https://wnarifin.github.io/workshop.html>

37. Koo TK, Li MY. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. *J Chiropr Med.* 2016;15(2):155–63. doi:10.1016/j.jcm.2016.02.012 PubMed PMID: 27330520.

38. Colton T. Statistics in Medicine. American Journal of Obstetrics and Gynecology. Boston; 1974. 1–372 p. doi:10.1016/s0002-9378(33)90208-2

39. Myles PS, Cui J. I. Using the Bland-Altman method to measure agreement with repeated measures. *Br J Anaesth.* 2007;99(3):309–11. doi:10.1093/bja/aem214 PubMed PMID: 17702826.

40. Giavarina D. Understanding Bland Altman analysis. *Biochem Medica.* 2015;25(2):141–51. doi:10.11613/BM.2015.015 PubMed PMID: 26110027.

41. Altman D, Bland J. Measurement in Medicine : The Analysis of Method Comparison Studies. *J R*

Stat Soc Ser D (The Stat. 1983;32(3):307–17.

42. Hedrick VE, Comber DL, Ferguson KE, Estabrooks PA, Savla J, Dietrich AM, et al. A rapid beverage intake questionnaire can detect changes in beverage intake. *Eat Behav.* 2013;14(1):90–4. doi:10.1016/j.eatbeh.2012.10.011 PubMed PMID: 23265410.

43. Vanderlee L, Reid JL, White CM, Hobin EP, Acton RB, Jones AC, et al. Evaluation of the online Beverage Frequency Questionnaire (BFQ). *Nutr J.* 2018;17(1):1–10. doi:10.1186/s12937-018-0380-8 PubMed PMID: 30068342.

44. Abutbul Vered S, Shani Levi C, Rozen GA, Solt I, Rozen GS. Development and validation of a computerized web-based quantitative food frequency questionnaire. *Clin Nutr ESPEN.* 2022;52:169–77. doi:10.1016/j.clnesp.2022.10.012 PubMed PMID: 36513450.

45. Stelmach-Mardas M, Kleiser C, Uzhova I, Penalvo JL, La Torre G, Palys W, et al. Seasonality of food groups and total energy intake: A systematic review and meta-analysis. *Eur J Clin Nutr.* 2017;70(6):700–8. doi:10.1038/ejcn.2015.224 PubMed PMID: 26757837.

46. Xiaoyu B, Davis BJK, Barraj LM, Srinivasan D, Mahadev P, Mathew P, et al. Beverage Consumption Patterns among U.S. Adolescents and Adults from a New 24-h Beverage Recall Survey Compared to the National Health and Nutrition Examination Survey (NHANES) 2017–2018. *Nutrients.* 2023;15(16):1–21. doi:10.3390/nu15163561 PubMed PMID: 37630751.

47. Rogerson G, Xu Y, Whelan M, Gibson R. Development and assessment of relative validity and reliability of the Workplace Beverage Intake Questionnaire in UK office workers. *J Hum Nutr Diet.* 2023;36(5):2036–49. doi:10.1111/jhn.13205 PubMed PMID: 37459173.

48. De Cock N, Van Camp J, Kolsteren P, Lachat C, Huybregts L, Maes L, et al. Development and validation of a quantitative snack and beverage food frequency questionnaire for adolescents. *J Hum Nutr Diet.* 2017;30(2):141–50. doi:10.1111/jhn.12411 PubMed PMID: 27611606.