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CULTURAL ADAPTATION AND PRELIMINARY VALIDATION OF THE POLISH VERSION OF THE BEVERAGE INTAKE QUESTIONNAIRE (BEVQ-PL) AMONG ADOLESCENTS

S u m m a r y

Background. The increasing consumption of beverages, particularly sugar-sweetened beverages (SSBs), contributes to excess energy intake and the development of diet-related diseases among adolescents. Reliable tools for assessing beverage intake in this population are therefore essential. The aim of this study was to evaluate the reliability and preliminary psychometric properties of the Polish version of the Beverage Intake Questionnaire (BEVQ-PL).

Results and conclusions. The BEVQ-PL demonstrated moderate to good test–retest reliability for most beverage categories and global indicators. Spearman's correlations ranged from 0.17 to 0.71, with the highest values being observed for total energy intake from beverages. Intraclass correlation coefficients (ICC) indicated moderate agreement for commonly consumed beverages, but lower reproducibility for infrequently consumed categories. Bland–Altman analysis revealed a small systematic bias with wide limits of agreement at the individual level. An exploratory factor analysis supported a three-factor structure (milk/coffee–protein beverages, alcohol, juices/soft drinks) with acceptable temporal stability. Internal consistency was low ($\alpha = 0.393$), reflecting the multidimensional nature of the instrument. Overall, the findings support the use of BEVQ-PL as a preliminarily validated instrument for assessing beverage intake among Polish adolescents at the group level.

Key words: adolescents, beverages, questionnaire, reproducibility, validity

Introduction

Changes in dietary patterns observed over recent decades represent one of the key factors contributing to the global burden of diet-related diseases [48]. Among these

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changes, a notable increase in the contribution of beverages to total energy intake has been observed, particularly those containing added simple sugars [38]. Sugar-sweetened beverages, including carbonated drinks, fruit nectars, sweetened teas and energy drinks, have become a common component of daily diets in many countries, contributing to increased sugar consumption in the general population [50]. Numerous epidemiological studies and meta-analyses indicate that regular consumption of these products is associated with an increased risk of obesity, metabolic disorders and type 2 diabetes, independent of other lifestyle factors [22, 39]. Adolescence represents a critical period for the development of dietary habits that have long-term implications for health and growth; however, adolescents' food choices often deviate from dietary recommendations, which may promote the development of diet-related diseases [17].

A key characteristic of sugar-sweetened beverages is their low capacity to induce satiety compared to solid foods with a similar energy content, which may lead to a positive energy balance without compensatory reductions in energy intake from other sources [2, 10, 12]. This phenomenon is particularly relevant in younger populations, in whom mechanisms of energy intake self-regulation are not yet fully developed. As a consequence, beverages may constitute a "hidden" source of energy, the contribution of which is often underestimated by both participants and researchers [30, 40, 45].

Behaviors acquired during this stage tend to persist into adulthood, exerting a lasting impact on individual health outcomes [6, 41, 47, 49]. At the same time, adolescents are particularly susceptible to environmental influences, such as food marketing, peer norms and the widespread availability of sugar-sweetened beverages in both school and out-of-school settings [18]. Studies conducted across different countries indicate that the consumption of sugar-sweetened and energy drinks among adolescents remains high, despite increasing health awareness [7, 9, 15, 29, 42].

An accurate assessment of beverage intake in this age group therefore represents a significant research challenge [31]. In population-based studies, it is essential to employ tools that capture habitual consumption patterns, while remaining feasible for use in large samples and minimizing respondent burden. In this context, short, standardized self-report questionnaires play a crucial role, enabling a systematic and comparable assessment of selected dietary components [37, 52]. In contrast to instruments designed to assess total dietary intake, questionnaires focused on specific product categories allow for a more precise evaluation of particular dietary behaviors, such as beverage consumption [26].

Beverage intake is commonly assessed using 24-hour dietary recalls, food diaries and food frequency questionnaires (FFQs). Although these methods provide detailed information on dietary intake, their application in large-scale epidemiological studies may be limited by respondent burden, cost and time requirements, particularly among younger populations [46, 48].

In response to these limitations, shorter and more specialized tools have been developed to assess specific dietary components, including beverage consumption. One of the most widely used instruments of this type is the Beverage Intake Questionnaire (BEVQ), designed as a brief tool for the quantitative assessment of habitual beverage intake and energy intake from beverages [19]. The psychometric properties of BEVQ have been confirmed across various populations, including children and adolescents [21, 32], as well as adults [14].

Several studies have also emphasized the need for the cultural adaptation of the instrument, including the modification of beverage lists and the adjustment of categories to reflect local consumption patterns and product availability, while maintaining the core structure of the questionnaire. In Poland, research on beverage consumption among adolescents has primarily relied on general dietary questionnaires or large-scale population studies (e.g. HBSC), which limits the possibility of a detailed assessment of beverage consumption patterns [23, 34].

The short version of the Beverage Intake Questionnaire (BEVQ-15) was developed as a tool for the rapid, quantitative assessment of habitual beverage consumption in epidemiological studies. The questionnaire covers a wide range of beverage categories, including water, sugar-sweetened beverages, juices, milk and energy drinks, allowing for the estimation of both consumption volume and associated energy intake [14, 19].

BEVQ-15 has been developed and validated across different populations. For example, a study conducted in an adult population in Spain demonstrated high reliability and agreement of the instrument, supporting its usefulness in assessing fluid intake [5]. However, it should be noted that most validation studies of BEVQ-15 have been conducted in adult populations, which may limit the direct generalizability of findings to other groups [1, 19, 36].

At the same time, it is increasingly emphasized that research tools developed within one cultural context cannot be directly applied to other populations without prior cultural and linguistic adaptation. Differences in beverage consumption patterns, product availability, terminology and cultural norms may influence how questions are interpreted and, consequently, the quality of the collected data. This issue is particularly relevant in adolescent populations, where subtle linguistic or contextual differences may lead to a systematic measurement bias. Therefore, the adaptation process should include not only translation, but also a comprehensive evaluation of the psychometric properties of the instrument in the target population, in accordance with established methodological standards [13, 20, 51]. Despite the growing interest in beverage consumption among Polish adolescents, the availability of validated, brief tools for a standardized assessment of this dietary component remains limited [11, 23, 52]. In many studies, author-developed questionnaires are used, the reliability and validity of which are not sufficiently documented, limiting comparability across studies and their utility for public health monitoring [8, 27].

Therefore, the aim of the present study was to culturally adapt the BEVQ-15 and to conduct a preliminary evaluation of its psychometric properties, including reliability and construct validity, among Polish adolescents, while maintaining the original structure of the instrument and incorporating culturally relevant beverage categories.

Method

Study design

The study had a cross-sectional and methodological design. Its primary aim was to culturally adapt and evaluate selected psychometric properties of the Polish version of the short Beverage Intake Questionnaire (BEVQ-PL), including internal consistency, test–retest reliability and the preliminary factor structure of the instrument. Prior to data collection, it was assumed that the primary focus of the evaluation would be on internal consistency and temporal stability of the measurements. Analyses of the factor structure were treated as exploratory.

Cross-cultural adaptation of the instrument

The cross-cultural adaptation process of the Beverage Intake Questionnaire (BEVQ-15) was conducted in accordance with widely accepted guidelines for the adaptation of self-report instruments. The study used the Polish version of the Beverage Intake Questionnaire (BEVQ-PL), designed to assess the consumption of various beverage categories.

The questionnaire includes items on both the frequency and volume of beverage intake, enabling the estimation of daily fluid consumption (ml/day) and energy intake from beverages (kcal/day). The Polish version (BEVQ-PL) was developed based on the original BEVQ-15, retaining its core structure, while incorporating additional beverage categories as part of the cultural adaptation process.

The adaptation procedure consisted of the following steps:

(I) contacting the developer of the original instrument, Dr. Valisa Hedrick, and obtaining information about the questionnaire;

(II) two independent forward translations of the questionnaire into Polish, performed by translators fluent in English;

(III) synthesis of the translated versions;

(IV) back-translation into English by an independent translator blinded to the original version of the instrument;

(V) review of the pre-final version by an expert panel in nutrition and research methodology;

(VI) cultural adaptation of selected items to better reflect beverage consumption patterns among Polish adolescents;
(VII) development of the pre-final Polish version;
(VIII) pilot testing involving 20 participants;
(IX) finalization of the BEVQ-PL questionnaire.

During the adaptation process, several modifications were introduced to improve the suitability of the instrument for the target population. In particular, the categories of 100 % fruit juices and 100 % vegetable juices were separated, protein drinks were added as a distinct category, and selected categories, such as sugar-sweetened beverages, diet beverages and alcoholic drinks-were further refined.

As a result, the number of beverage categories in the Polish version exceeded that of the original BEVQ-15. Therefore, the BEVQ-PL should be considered a culturally adapted and extended version based on the structure of the original instrument, rather than a direct linguistic translation.

Pilot testing (n = 20) was conducted to assess the clarity of the items, the appropriateness of the terminology used and the acceptability of the response format. Feedback obtained during this stage led to minor editorial revisions, resulting in the final version of the questionnaire used in the main study.

Participants and recruitment

A total of 230 secondary school students aged 14 ÷ 18 years from schools located in the Małopolskie Province of Poland were invited to participate in the study. Inclusion criteria were: age within the specified range (14 ÷ 18 years), attendance at a participating school and the provision of written informed consent from both the participant and their parent or legal guardian. Exclusion criteria included the presence of chronic diseases or other health conditions that could significantly affect dietary habits or beverage consumption. The participants were recruited through schools using a school-based sampling approach within a defined geographic context. A total of 189 secondary school students from the Małopolskie Province participated in the study. The sample included 189 adolescents aged 14 ÷ 18 years, comprising 92 boys (48.7 %) and 97 girls (51.3 %). The mean age of the participants was 16.34 ± 1.28 years, indicating a relatively balanced representation of mid- and late adolescence. Students from selected schools that agreed to participate in the study were invited to take part. The participants were informed that the aim of the study was the cross-cultural adaptation and psychometric evaluation of a questionnaire assessing habitual beverage intake. The participation was voluntary, and no financial or material incentives were provided. Of the 230 recruited participants, 189 completed both stages of the study (test and retest) and were included in the test–retest reliability analysis. The remaining participants either did not complete the second assessment or provided incomplete data. The sample size was determined based on previous validation studies of the BEVQ and similar dietary assessment tools and was considered sufficient to obtain stable estimates of reliability coefficients. Additionally, the sample size met general recommendations for psychometric studies.

Study procedure and data collection

Data were collected in school settings during organized research sessions conducted on school premises. The BEVQ-PL questionnaire was self-administered by the participants in the presence of a trained researcher, following a standardized protocol. The researchers provided uniform instructions on how to complete the questionnaire and responded to the participants' technical questions without influencing the content of their responses or suggesting specific answers. Their presence aimed to improve data quality, reduce missing responses and minimize errors resulting from the ambiguous interpretation of the items. The questionnaire included items assessing both the frequency and quantity of consumption across various beverage categories, enabling the estimation of habitual daily intake. Data were collected anonymously, with no possibility of identifying individual participants.

BEVQ-PL scoring procedure

Scoring of the Polish version of the BEVQ-PL was conducted in accordance with the procedure proposed by the developers of the original instrument, while preserving its core assumptions and adapting measurement units to the metric system, as well as accounting for the expanded range of beverage categories [19]. For each beverage category, mean daily intake was calculated based on the reported frequency of consumption and the typical portion size. Frequency response categories were converted into daily equivalents using predefined conversion factors, as presented in Table 1.

Table 1. Conversion of beverage consumption frequency into daily equivalents in the BEVQ-PL

Response category in the questionnaire	Daily equivalent [times/day]	Notes
Never or <1 time per week	0.00	No habitual consumption
1 time per week	0.14	1 ÷ 7
2–3 times per week	0.36	2,5 ÷ 7
4–6 times per week	0.71	5 ÷ 7
1 time per day	1.00	-
≥2 times per day	2.00	Reported value

The mean daily intake of each beverage category (mL/day) was calculated as the product of the converted frequency of consumption and the reported portion size. Based on these values, daily energy intake from beverages (kcal/day) was also estimated using category-specific energy density coefficients. The Polish version of the BEVQ-PL included the following beverage categories: water, 100 % fruit juice, fruit drinks and lemonades, 100 % vegetable juice, whole milk (3.2 % fat), reduced-fat milk (2 %), skim milk, as well as plant-based and flavored milk beverages, diet beverages with sweeteners (e.g. zero-calorie beverages), energy drinks, sweetened tea, black coffee or tea, coffee with milk and/or sugar, smoothies and protein drinks and alcoholic beverages, including non-alcoholic beer, beer, wine (red/white), spirits (hard liquor) and alcoholic mixed drinks (cocktails).

The inclusion of alcoholic beverages reflected actual consumption behaviors in the study population, regardless of legal restrictions. Additionally, summary variables were calculated, including total daily beverage intake, sugar-sweetened beverage (SSB) intake, milk and dairy beverage intake, and alcohol consumption. Portion sizes reported in fluid ounces were converted to milliliters using standardized conversion values.

Test–retest procedure

To assess the temporal stability of the BEVQ-PL questionnaire, a test–retest procedure was applied. The questionnaire was completed twice by the same participants. The second administration (retest) was conducted seven days after the initial assessment. The selected time interval was considered sufficiently short to limit real changes in beverage consumption habits, while being long enough to minimize recall bias. A total of 189 participants who completed both assessments were included in the test–retest reliability analyses.

Statistical analysis

Analyses were conducted for each beverage category and summary variables by comparing results from the first and second assessments. Only the participants who completed both study phases ($n = 189$) were included in the test–retest analyses. Participants with incomplete data (i.e. missing second assessment or incomplete responses) were excluded, consistent with a complete-case approach.

For quantitative variables, results are presented as mean ± standard error (SE) for both test and retest, along with the difference (test − retest). Test–retest reliability was assessed using Spearman's rank correlation coefficient (ρ), as the analyzed variables were not normally distributed and exhibited skewed distributions.

To evaluate potential systematic differences between test and retest measurements at the group level, the Wilcoxon signed-rank test was applied. The primary measure of test–retest reliability was the intraclass correlation coefficient ICC(2), calculated using a two-way random-effects model, assessing absolute agreement between the two measurements.

Statistical analyses (excluding ICC) were performed using TIBCO Statistica version 14.1.0.4 (TIBCO Software Inc., San Ramon, CA, USA). The ICC was calculated in Python 3.12.12 (Python Software Foundation, Wilmington, DE, USA) using the Pandas and Pingouin libraries.

For each variable, paired test–retest observations were analyzed after excluding missing values, reshaping the data into long format (subjects treated as targets and raters) and estimating ICC (2) (two-way random-effects model, absolute agreement), with the reporting of ICC values, 95 % confidence intervals (CI), F-statistics, and p-values. Agreement between test and retest measurements was further assessed using Bland–Altman analysis, by calculating the mean difference (bias) and 95 % limits of agreement (bias ± 1.96 × SD), and by plotting the differences against the means. Statistical analyses were conducted in R (version 4.1.2) using the following packages: readxl (data import), dplyr and stringr (data handling and string operations), psych (KMO, Bartlett's test, correlation smoothing, parallel analysis and exploratory factor analysis), GPArotation (oblimin rotation), clue (Hungarian algorithm for factor matching), and tibble/purrr (structured outputs and iteration). For EFA, item-level "mean daily intake" variables were selected, while energy variables (kcal) and composite measures (e.g. SSB, TBI) were excluded. Values < 0 were treated as missing, complete-case data were retained and variables were log-transformed [log(1+x)] and standardized (z-scores) prior to correlation matrix estimation.

Given the zero-inflated and skewed nature of intake variables, Spearman correlation matrices were computed and, where necessary, smoothed using psych::cor.smooth to address non-positive definite matrices. Sampling adequacy was assessed using the Kaiser–Meyer–Olkin (KMO) measure (overall and individual MSA) and Bartlett's test of sphericity (psych::cortest.bartlett). The number of factors was initially explored using a parallel analysis (psych::fa.parallel; MINRES extraction), while the final dimensionality was determined using a combined decision rule, balancing parallel analysis results with model stability (avoiding Heywood cases), interpretability and the minimum item criterion. An exploratory factor analysis was conducted using minimum residual (MINRES) extraction with oblimin rotation (psych::fa). In the cases where Heywood solutions occurred, factor extraction was re-estimated using principal axis factoring (PA) as a robustness check. Structural similarity between test and retest solutions was quantified using Tucker's congruence coefficients based on pattern loadings, with factor matching optimized by maximizing absolute agreement using the Hungarian algorithm (clue:solve_LSAP). Statistical significance was set at $p < 0.05$.

Ethical approval

The study was approved by the Bioethics Committee of the Medical University of Gdańsk, Poland (approval no. KB/432/2025). The participation in the study was voluntary. Written informed consent was obtained from all the participants and their parents or legal guardians. The study was conducted in accordance with the principles of the Declaration of Helsinki.

Results

Relative stability (Spearman's correlations)

The test–retest analysis of the Polish version of the BEVQ-PL questionnaire demonstrated moderate to good reproducibility for most assessed beverage categories in children and adolescents. Total beverage intake was higher in the first assessment (2240.43 ± 89.62 mL/day) compared to the second (2047.99 ± 98.74 mL/day), with a moderate Spearman's rank correlation (r = 0.56). Total energy intake from beverages was 448.24 ± 32.39 kcal/day in the first assessment and 419.80 ± 41.06 kcal/day in the second, showing the highest correlation coefficient among all analyzed indicators (r = 0.71) (Table 2). Correlation coefficients ranged from 0.17 to 0.71. The highest stability was observed for total energy intake from beverages (r = 0.71), energy drinks (r = 0.69), beer (r = 0.69) and 100 % fruit juice (r = 0.67). Moderate stability was also found for total beverage intake (r = 0.56), sugar-sweetened beverages (SSB) (r = 0.55) and unsweetened beverage intake (r = 0.52). The lowest correlation coefficients were observed for sweetened tea (r = 0.17) and mixed alcoholic drinks (r = 0.24). Detailed results are presented in Table 2.

Table 2. Test–retest reliability of the Beverage Intake Questionnaire (BEVQ-PL) in children and adolescents (n = 189)

Beverage category	Unit	BEVQ-PL (test)	BEVQ-PL (retest)	Spearman's ρ
Water				
	mL / day	1086.80 ± 43.48	1066.99 ± 46.41	0.48
	kcal / day	0	0	0
100 % Fruit juice				
	mL / day	181.89 ± 26.27	184.38 ± 24.27	0.67
	kcal / day	81.85 ± 11.82	82.97 ± 10.92	0.67
Sweetened fruit drinks, lemonades				
	mL / day	115.83 ± 20.26	101.69 ± 16.11	0.50
	kcal / day	46.33 ± 8.10	40.67 ± 6.44	0.50
100 % Vegetable juice				
	mL / day	21.91± 6.93	33.13 ± 8.75	0.60
	kcal / day	5.48 ± 1.73	8.28 ± 2.19	0.60
Whole milk (3.2 % fat)				
	mL / day	110.08 ± 17.02	77.69 ± 15.98	0.42
	kcal / day	70.45 ± 10.89	49.72 ± 10.23	0.42

Reduced-fat milk (2 %)				
	mL / day	84.34 ± 15.62	77.37 ± 16.32	0.46
	kcal / day	42.17 ± 7.81	38.68 ± 8.16	0.46
Skim milk, Plant-based drinks, flavored milk				
	mL / day	27.40 ± 6.45	32.74 ± 8.22	0.43
	kcal / day	12.33 ± 2.90	14.73 ± 3.70	0.43
Sugar-sweetened beverages (SSB) e.g., soda, cola)				
	mL / day	119.20 ± 17.57	92.68 ± 18.95	0.41
	kcal / day	50.06 ± 7.38	38.93 ± 7.96	0.41
Energy drinks				
	mL / day	63.11 ± 15.72	58.70 ± 12.23	0.69
	kcal / day	28.40 ± 7.08	26.41 ± 5.50	0.69
Diet beverages with sweeteners e.g., zero-calorie beverages				
	mL / day	71.41 ± 13.52	54.47 ± 12.24	0.37
	kcal / day	0.71 ± 0.14	0.54 ± 0.12	0.37
Sweetened tea				
	mL / day	145.53 ± 18.25	33.93 ± 7.49	0.17
	kcal / day	36.38 ± 4.56	8.48 ± 1.87	0.17
Black coffee, tea				
	mL / day	141.63 ± 18.66	114.57 ± 17.13	0.57
	kcal / day	2.83 ± 0.37	2.29 ± 0.34	0.57
Coffee with milk and sugar				
	mL / day	75.19 ± 13.90	46.28 ± 12.56	0.37
	kcal / day	30.08 ± 5.56	18.51 ± 5.03	0.37
Smoothies, protein drink				
	mL / day	43.85 ± 10.26	27.48 ± 6.45	0.48
	kcal / day	26.31 ± 6.16	16.49 ± 3.87	0.48
Non-alcoholic beer				
	mL / day	13.97 ± 4.30	21.61 ± 6.59	0.58
	kcal / day	3.63 ± 1.12	5.62 ± 1.71	0.58
Beer				
	mL / day	7.76 ± 3.41	16.50 ± 5.88	0.69
	kcal / day	3.34 ± 1.46	7.10 ± 2.53	0.69
Spirits (hard liquor)				
	mL / day	1.39 ± 0.63	8.16 ± 3.57	0.60
	kcal / day	3.21 ± 1.45	18.86 ± 8.24	0.60
Alcoholic Mixed Drinks (cocktails)				
	mL / day	2.81 ± 1.86	7.11 ± 2.86	0.24
	kcal / day	3.37 ± 2.23	8.54 ± 3.43	0.24
Wine (red / white)				
	mL / day	1.53 ± 0.68	38.78 ± 16.77	0.63
	kcal / day	1.30 ± 0.58	32.96 ± 14.26	0.63
Total SSB intake				
	mL / day	518.86 ± 43.73	333.28 ± 36.94	0.55

Total unsweetened beverage intake				
	mL / day	1313.80 ± 52.40	1257.64 ± 52.22	0.52
Total beverage intake				
	mL / day	2240.43 ± 89.62	2047.99 ± 98.74	0.56
	kcal / day	448.24 ± 32.39	419.80 ± 41.06	0.71

Explanatory notes: SSB Sugar-sweetened beverages

Differences between measurements (Wilcoxon signed-rank test)

To assess differences between the first (BEVQ1-PL) and second (BEVQ2-PL) measurements, the Wilcoxon signed-rank test was applied. For most beverage categories, no statistically significant differences were observed between measurements, indicating the absence of systematic bias at the group level. Significant differences were identified in selected categories, including sweetened tea, sugar-sweetened beverages, diet beverages, coffee with milk and sugar and certain alcoholic beverages. Additionally, significant differences were observed for total beverage intake (both ml/day and kcal/day). Detailed results are presented in Table 3.

Table 3. Wilcoxon signed-rank test results for test–retest comparisons of beverage intake (BEVQ-PL)

Variable	Z (Wilcoxon)	*p*-value
Water	0.19	0.85
100 % Fruit juice	0.57	0.57
Sweetened fruit drinks, lemonades	0.63	0.53
100 % Vegetable juice	1.32	0.19
Whole milk (3.2 % fat)	2.67	0.01
Reduced-fat milk (2 %)	1.18	0.24
Skim milk, plant-based drinks, flavored milk	0.15	0.88
Sugar-sweetened beverages (SSB) e.g. soda, cola)	2.07	0.04
Energy dinks	0.51	0.61
Diet beverages with sweeteners e.g. zero-calorie beverages	2.35	0.02
Sweetened tea	6.07	<0.001
Black coffee, tea	1.26	0.21
Coffee with milk and sugar	2.91	< 0.001
Smoothies, protein drinks	1.90	0.06
Non-alcoholic beer	1.21	0.23
Beer	1.86	0.06
Spirits (hard liquor)	2.43	0.02
Alcoholic mixed drinks (cocktails)	1.57	0.12
Wine (red, white)	3.30	0.001
Total Beverage Intake	3.87	<0.001

Explanatory notes: Z – test statistic of the Wilcoxon signed-rank test; SSB – sugar-sweetened beverages; Values for mL/day and kcal/day were identical and are presented once.

Absolute agreement (intraclass correlation coefficient, ICC)

Absolute agreement was assessed using the intraclass correlation coefficient ICC (2). ICC values indicated moderate to good reproducibility for the most frequently consumed beverage categories. The highest values were observed for 100 % juices and fruit drinks/lemonades (ICC = 0.66), black coffee or tea (ICC = 0.58) and beer (ICC = 0.56). Moderate agreement was also observed for water, energy drinks, diet beverages and total beverage intake. The lowest reproducibility was found for infrequently consumed categories, particularly alcoholic beverages, for which ICC values were very low. Detailed results are presented in Tables 4 and 5. A similar pattern of results was observed for variables expressed in kcal/day (Table 5).

Table 4. Absolute agreement (ICC) for beverage intake expressed in mL/day (BEVQ-PL)

Beverage Category	ICC (2)	F	*p*-value	95 % CI
Water	0.47	2.76	<0.001	[0.35÷0.57]
100 % Fruit juice	0.66	4.85	<0.001	[0.57÷0.73]
Sweetened fruit drinks, lemonades	0.66	4.94	<0.001	[0.58÷0.74]
100 % Vegetable juice	0.40	2.36	<0.001	[0.28÷0.52]
Whole milk (3.2 % fat)	0.50	3.02	<0.001	[0.38÷0.60]
Reduced-fat milk (2 %)	0.14	1.32	0.028	[0.00÷0.28]
Skim milk, plant-based drinks, flavored milk	0.20	1.50	0.003	[0.06÷0.33]
Sugar-sweetened beverages (SSB) e.g. soda, cola)	0.50	3.04	<0.001	[0.39÷0.60]
Energy dinks	0.42	2.42	<0.001	[0.29÷0.53]
Diet beverages with sweeteners e.g. zero-calorie beverages	0.42	2.47	<0.001	[0.30÷0.53]
Sweetened tea	0.13	1.37	0.016	[0.00÷0.26]
Black coffee, tea	0.58	3.79	<0.001	[0.48÷0.67]
Coffee with milk and sugar	0.30	1.85	<0.001	[0.16÷0.42]
Smoothies, protein drinks	0.33	1.99	<0.001	[0.20÷0.45]
Non-alcoholic beer	0.44	2.56	<0.001	[0.32÷0.55]
Beer	0.56	3.55	<0.001	[0.45÷0.65]
Spirits (hard liquor)	0.10	1.21	0.092	[-0.05÷0.23]
Alcoholic mixed drinks (cocktails)	0.03	1.06	0.344	[-0.11÷0.17]
Wine (red, white)	0.03	1.07	0.320	[-0.11÷0.17]
Total Beverage Intake	0.45	2.65	<0.001	[0.33÷0.56]

Explanatory notes: SSB – sugar-sweetened beverages; ICC – intraclass correlation coefficient; F – F-statistic; CI – confidence interval

Table 5. Absolute agreement (ICC) for energy intake from beverages (kcal/day) (BEVQ-PL)

Beverage Category	ICC (2)	F	*p*-value	95 % CI
Water	0	0	0	0
100 % Fruit juice	0.66	4.85	<0.001	[0.57÷0.73]
Sweetened fruit drinks, lemonades	0.66	4.94	<0.001	[0.58÷0.74]
100 % Vegetable juice	0.40	2.36	<0.001	[0.28÷0.52]
Whole milk (3.2 % fat)	0.50	3.02	<0.001	[0.38÷0.60]
Reduced-fat milk (2 %)	0.14	1.32	0.028	[-0.00÷0.28]
Skim milk, plant-based drinks, flavored milk	0.20	1.50	0.003	[0.06÷0.33]
Sugar-sweetened beverages (SSB) e.g. soda, cola)	0.50	3.04	<0.001	[0.39÷0.60]
Energy dinks	0.42	2.42	<0.001	[0.29÷0.53]
Diet beverages with sweeteners e.g. zero-calorie beverages	0.42	2.47	<0.001	[0.30÷0.53]
Sweetened tea	0.13	1.37	0.016	[0.00÷0.26]
Black coffee, tea	0.58	3.79	<0.001	[0.48÷0.67]
Coffee with milk and sugar	0.30	1.85	<0.001	[0.16÷0.42]
Smoothies, protein drinks	0.33	1.99	<0.001	[0.20÷0.45]
Non-alcoholic beer	0.44	2.56	<0.001	[0.32÷0.55]
Beer	0.56	3.55	<0.001	[0.45÷0.65]
Spirits (hard liquor)	0.10	1.21	0.092	[-0.05÷0.23]
Alcoholic mixed drinks (cocktails)	0.03	1.06	0.344	[-0.11÷0.17]
Wine (red, white)	0.03	1.07	0.320	[-0.11÷0.17]
Total Energy Intake from Beverages	0.44	2.59	<0.001	[0.32÷0.55]

Explanatory notes: SSB – sugar-sweetened beverages; ICC – intraclass correlation coefficient; F – F-statistic; CI – confidence interval

Bland–Altman analysis

For total sugar-sweetened beverage (SSB) intake assessed in the first (T) and second (RT) measurements, Bland–Altman analysis (Figure 1) showed a positive mean difference (systematic bias) of 185.58 mL/day. This indicates that participants reported, on average, higher SSB intake during the first administration of the BEVQ-15 compared to the retest. The variability of differences increased with higher levels of intake, suggesting greater disagreement at the individual level, particularly among participants with higher consumption.

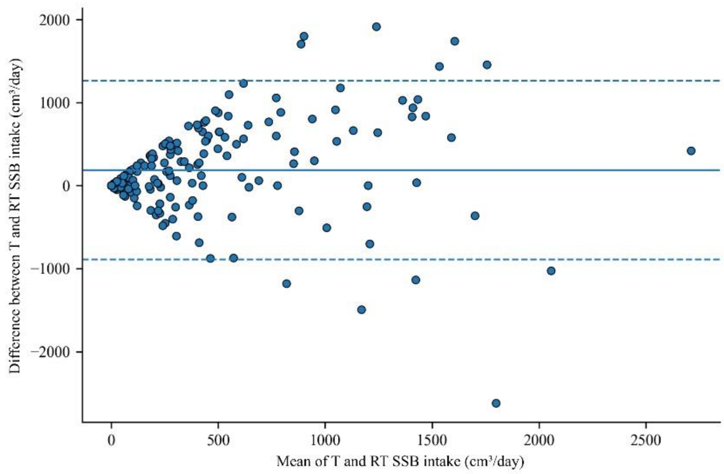

Figure 1. Bland–Altman plot for total sugar-sweetened beverage (SSB) intake in the first (T) and second (RT) measurements

The wide limits of agreement (−891.65 to 1262.81 mL/day), together with the increasing dispersion of differences at higher levels of intake, indicate limited repeatability at the individual level. The standard deviation of the differences was 549.61 mL/day, resulting in very wide 95 % limits of agreement. In practical terms, for an individual participant, test and retest values for total SSB intake may differ by approximately ±1 liter per day, while still remaining within the expected range of measurement error.

The scatterplot further suggests that the variability of differences increases with higher mean SSB intake. Participants with higher consumption exhibited both larger positive and negative discrepancies between test and retest measurements. This pattern is consistent with heteroscedasticity, indicating poorer agreement at higher levels of intake.

Overall, the BEVQ-PL demonstrated a slight systematic overestimation of total sugar-sweetened beverage (SSB) intake during the first administration compared to the retest. However, repeatability at the individual level was limited due to wide limits of agreement, particularly among participants with higher SSB consumption.

For total unsweetened beverage intake, Bland–Altman analysis (Figure 2) showed a small positive mean difference (a systematic bias) of 56.16 mL/day, indicating slightly higher reported intake during the first measurement compared to the retest (including water, coffee, tea and diet Beverages with Sweeteners e.g. zero-calorie beverages). The limits of agreement were wide (−1361.99 to 1474.31 mL/day), reflecting substantial inter-individual variability. The standard deviation of the differences was 723.54

mL/day, resulting in very wide 95 % limits of agreement. In practical terms, for an individual participant, test and retest values for total unsweetened beverage intake may differ by approximately ±1.4 liters per day, while still remaining within the expected range of measurement error.

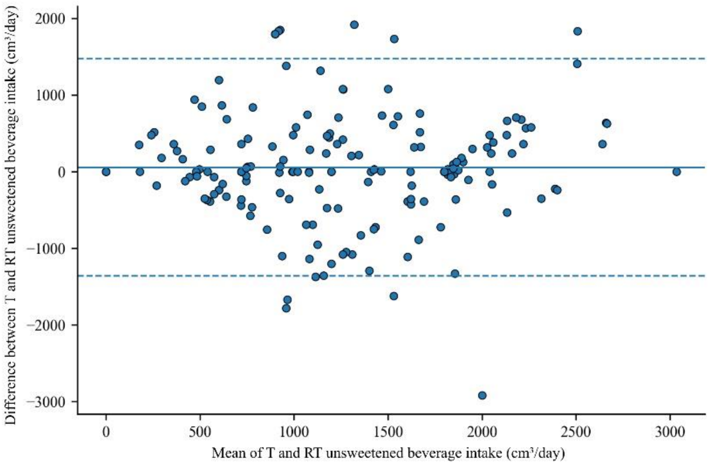

Figure 2. Bland–Altman plot for total unsweetened beverage intake in the first (T) and second (RT) measurements

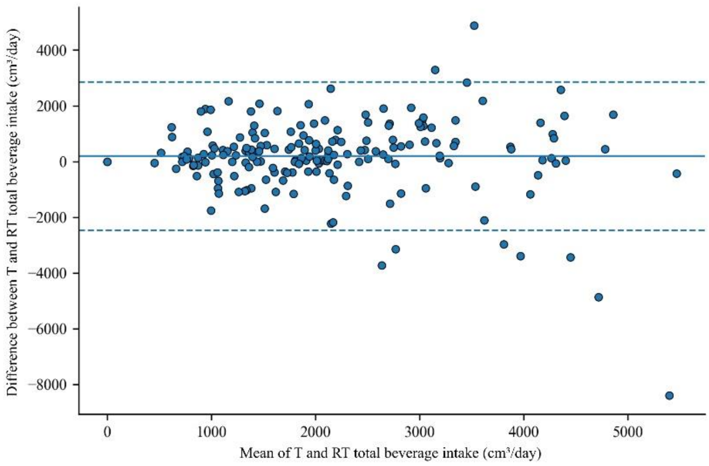

Figure 3. Bland–Altman plot for Total Beverage Intake in the first (T) and second (RT) measurements.

The scatterplot indicated considerable dispersion of differences across the entire range of mean intake, with some suggestion of greater discrepancies at higher levels of consumption. This pattern reflects substantial within-subject variability and measurement error between the two administrations. Overall, the BEVQ-PL showed a minimal systematic bias for total unsweetened beverage intake; however, individual-level repeatability was limited due to very wide limits of agreement.

For Total Beverage Intake, Bland–Altman analysis (Figure 3) showed a positive mean difference (a systematic bias) of 192.44 mL/day. The participants reported, on average, approximately 190 mL/day higher total beverage intake (including alcoholic beverages) during the first administration of the BEVQ-15 compared to the retest, indicating a slight systematic overestimation. The standard deviation of the differences was 1356.85 mL/day, resulting in extremely wide 95 % limits of agreement (−2466.97 to 2851.86 mL/day). This indicates that, for an individual participant, Total Beverage Intake reported in the test and retest may differ by approximately ±2.7 liters per day, while still remaining within the expected range of measurement error.

The scatterplot showed substantial dispersion of differences across the full range of mean intake, with particularly large discrepancies among participants with higher total fluid consumption, suggesting considerable within-subject variability and potential heteroscedasticity. Overall, while the mean difference between test and retest for Total Beverage Intake was small, individual-level repeatability was poor due to extremely wide limits of agreement.

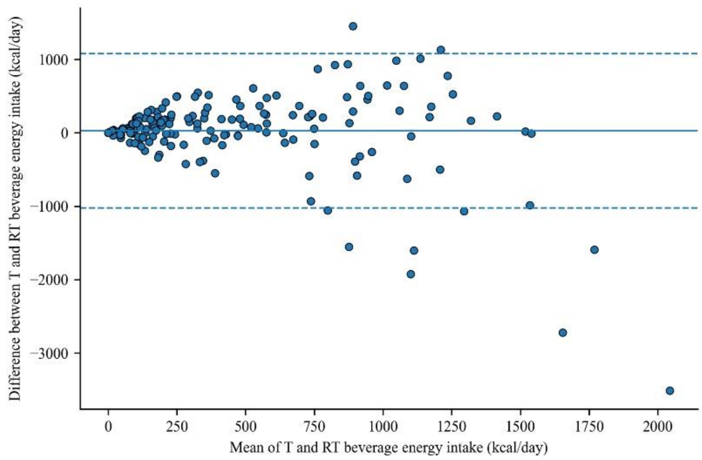

Figure 4. Bland–Altman plot for total energy intake from beverages (kcal/day) in the first (T) and second (RT) measurements

For total energy intake from beverages (kcal/day), Bland–Altman analysis (Figure 4) based on 189 participants showed a small positive mean difference (a systematic bias) of 28.45 kcal/day. On average, total daily energy intake from beverages reported during the first administration of the BEVQ-15 was approximately 28 kcal/day higher than during the retest, indicating a minimal systematic bias. The standard deviation of the differences was 536.61 kcal/day, resulting in wide 95 % limits of agreement (−1023.31 to 1080.20 kcal/day). This indicates that, for an individual participant, estimates of energy intake from beverages may differ by approximately ±1000 kcal/day between test and retest, while still remaining within the expected range of measurement error.

The Bland–Altman plot showed increasing dispersion of differences with higher mean energy intake, with some very large positive and negative discrepancies among participants with higher consumption. This pattern suggests substantial within-subject variability and heteroscedasticity, indicating poorer agreement at higher levels of intake. Overall, while the mean difference between test and retest was minimal, individual-level repeatability was poor due to wide limits of agreement, particularly at higher levels of energy intake from beverages.

Exploratory factor analysis (EFA)

The factor structure of the questionnaire was assessed using exploratory factor analysis (EFA). The analysis was conducted based on items representing mean daily beverage intake from the BEVQ-PL (excluding kcal variables and composite scores; n = 189 for both administrations). The data were suitable for factor analysis at both time points. In the test administration (T), sampling adequacy was moderate (overall KMO = 0.647), while in the retest (RT) it improved to an acceptable level (KMO = 0.738). Bartlett's test of sphericity was highly significant for both matrices (T: $\chi^2 = 533.40$, $p = 1.41 \times 10^{-43}$; RT: $\chi^2 = 937.74$, $p = 6.00 \times 10^{-113}$), indicating the correlation matrices were not identity matrices and were appropriate for factor extraction. Item-level measures of sampling adequacy (MSA) identified a small subset of weaker items (lowest MSA values approximately 0.55–0.61 in T and 0.61 ÷ 0.66 in RT), suggesting that some beverage categories shared limited common variance with the remaining items and may reflect more specific consumption patterns (Table 6).

A parallel analysis of the test correlation matrix suggested up to seven factors; however, this solution was not psychometrically tenable. Specifically, (i) higher-order models (k = 7) exhibited Heywood cases, and (ii) solutions exceeding four factors rapidly produced factors supported by too few salient indicators (min_salient = 1 for k = 5 ÷ 7 at a loading threshold of ≥ 0.30).

A factor sweep (k = 2 ÷ 7) confirmed a monotonic improvement in global fit indices with increasing k, but also demonstrated that the most complex model (k = 7) was unstable (Heywood), while k = 5 ÷ 6 resulted in underidentified or weakly defined factors (Table 7).

Table 6. Factorability diagnostics (T and RT; N = 189, k = 18)

	KMO (overall)	Bartlett χ^2	*p*-value	Lowest item MSA (examples; ascending)
Test (T)	0.647	533.40	1.41×10^{-43}	Energy drinks (0.551), 100 % Fruit juice (0.561), Beer (0.600), Spirits (hard liquor) (0.601), Smoothies, protein drinks (0.602), Wine (white/red) (0.604), 100 % Vegetable juice (0.608), Diet Beverages with Sweeteners (e.g. zero-calorie beverages) (0.608)
Retest (RT)	0.738	937.74	6.00×10^{-113}	Sugar-sweetened beverages (SSB) (0.607), Diet beverages with sweeteners (e.g. zero-calorie beverages) (0.645), Alcoholic mixed drinks (cocktails) (0.663), Reduced-fat milk (2 %) (0.666), Spirits (Hard Liquor) (0.670), Skim milk, plant-based, flavored milk (0.717), Coffee with milk and sugar (0.771), Whole milk (3.2 % fat) (0.774)

Explanatory notes: KMO – Kaiser–Meyer–Olkin measure of sampling adequacy; Bartlett's χ^2 – Bartlett's test of sphericity; MSA – measure of sampling adequacy; Lower MSA values indicate weaker shared variance with other items

Table 7. Factor-number sweep (test data; extraction MINRES with oblimin rotation; salient loading cutoff = 0.30).

k	TLI	RMSEA	RMSR	Heywood	Minimum salient indicators per factor	Total salient loadings
2	0.630	0.0692	0.0722	No	4	16
3	0.670	0.0652	0.0615	No	4	15
4	0.743	0.0573	0.0518	No	3	17
5	0.790	0.0516	0.0438	No	1	14
6	0.843	0.0444	0.0368	No	1	17
7	0.958	0.0226	0.0285	Yes	1	14

Explanatory notes: TLI – Tucker–Lewis Index; RMSEA – root mean square error of approximation; RMSR – root mean square residual; MINRES – minimum residual method; oblimin – oblique rotation method; salient loadings – factor loadings ≥ 0.30; Heywood – inadmissible solution (e.g. negative variances); k – number of factors

To ensure construct validity and comparability across time points, a three-factor solution was therefore selected a priori (FORCE_K = 3). This solution avoided Heywood issues in the baseline model, retained interpretability and ensured that each factor was supported by multiple salient indicators in both T and RT.

In the initial three-factor EFA solution, factor interpretability was generally consistent across administrations; however, the third factor showed only moderate replication between time points (Tucker's congruence coefficient = 0.717 after factor matching). To improve construct stability, a controlled refinement procedure was applied. Items were initially screened using T-only criteria (maximum loading < 0.30 or uniqueness > 0.85), suggesting the removal of five items (Energy Drinks, 100 % Vegetable Juice, Diet Beverages with Sweeteners (e.g. zero-calorie beverages), Non-Alcoholic Beer and Wine (white/red). However, removing 100 % Vegetable Juice reduced factor adequacy for the juice/beverage factor in the RT solution. Therefore, the algorithm retained 100 % Vegetable Juice, as it contributed meaningful loadings in RT and improved factor replication, while preserving the minimum indicator rule (≥3 salient loadings per factor) and avoiding Heywood cases in the final model.

Table 8. Final EFA pattern loadings (oblimin; salient loadings ≥0.30). Test (T), k=3 (final after pruning + rescue; cumulative variance = 0.276)

Item	F1	F2	F3
Black coffee, tea	0.524		
Reduced-fat milk (2 %)	0.559		
Whole milk (3.2 % fat)	0.484		
Coffee with milk and sugar	0.368		
Smoothies, protein drinks	0.459		
Skim milk, plant-based drinks, flavored milk	0.393		
Alcoholic mixed drinks (cocktails)		0.654	
Spirits (hard liquor)		0.800	
Beer		0.498	
100 % Fruit juice			0.744
Sweetened fruit drinks, lemonades			0.379
Sugar-sweetened beverages (SSB) e.g. soda, cola)			0.385

Explanatory notes: F1–F3 – extracted factors; SSB – sugar-sweetened beverages

The resulting solution included 14 items, with each factor being supported by at least three salient indicators in both T and RT (T: 6/3/3; RT: 6/3/3), with factor labels aligned using the Hungarian algorithm. The final three-factor model explained 27.6 % of the common variance in T (cumulative proportion = 0.276) and 34.3 % in RT (0.343). Although these proportions are modest, this is typical for heterogeneous intake data characterized by zero inflation and substantial within-subject variability. Importantly, the retained factors were interpretable and demonstrated good temporal congruence. The three factors can be described as follows (based on salient loadings ≥ 0.30; Tables 8 and 9). Factor 1 (milk/coffee–protein beverages) was defined by dairy products and milk-based/hot beverages (e.g. Reduced-Fat Milk (2 %), Whole Milk (3.2 % fat), Black Coffee or Tea, Coffee with Milk and Sugar, Skim Milk / Plant-Based / Flavored Milk, and Smoothies / Protein Drinks). Factor 2 (alcoholic beverages) reflected alcohol consumption, including primarily Alcoholic Mixed Drinks (Cocktails), Spirits (Hard Liquor) and Beer. Factor 3 (juices/soft drinks) captured non-alcoholic beverage intake, mainly 100 % Fruit Juice and Fruit Drinks / Lemonades, with Sugar-Sweetened Beverages (SSB) contributing in T and 100 % Vegetable Juice strengthening the factor in RT.

Finally, structural similarity between T and RT was quantified using Tucker's congruence coefficients with factor matching based on an assignment algorithm. In the baseline model, congruence indicated very good replication for two factors (≈ 0.89–0.92) and moderate replication for the third one (≈ 0.72). Following targeted trimming with selective item retention, congruence improved, and all factors reached at least good similarity: 0.931, 0.943 and 0.827 for the matched factors (Table 10). In practice, values above approximately 0.85 are commonly interpreted as indicating high similarity, whereas values in the range of ~ 0.70 ÷ 0.85 suggest moderate similarity. Therefore, the refined solution supports stable measurement of three beverage consumption dimensions across test and retest, although the "juices/soft drinks" factor remained the least stable, while still improving to an acceptable level.

Table 9. Final EFA pattern loadings (oblimin; salient loadings ≥0.30). Retest (RT), k=3 (final after pruning + rescue; cumulative variance = 0.343)

Item	F1	F2	F3
Reduced-fat milk (2 %)	0.696		
Whole milk (3.2 % fat)	0.510		
Coffee with milk and sugar	0.402		
Smoothies, protein drinks	0.340		
Skim milk, plant-based drinks, flavored milk	0.467		
Sweetened tea	0.378		
Alcoholic mixed drinks (cocktails)		0.999	
Spirits (hard liquor)		0.794	
Beer		0.613	
Sweetened fruit drinks, lemonades			0.580
100 % Fruit juice			0.563
100 % Vegetable juice			0.439

Explanatory notes: F1–F3 – extracted factors; SSB – sugar-sweetened beverages

In summary, the EFA results indicate that the instrument captures three interpretable latent dimensions of beverage intake (milk/coffee–protein beverages; alcohol; juices/soft drinks). Despite a moderate overall KMO in the test phase and the expected modest proportion of explained variance, the final structure demonstrated adequate factorability, clear indicator support (≥ 3 salient items per factor at both time points) and good temporal stability based on Tucker's congruence following refinement. This pattern provides evidence for the construct validity of the scale at the latent structure level, with the highest stability observed for the alcohol and milk/coffee factors, and to a certain degree lower – yet acceptable – stability for the juices/soft drinks factor.

Table 10. Tucker congruence coefficients between test and retest factor solutions

	RT F2	RT F1	RT F3
T F1	0.073	**0.931**	0.384
T F2	**0.943**	0.085	0.074
T F3	-0.001	0.169	**0.827**

Explanatory notes: T – test; RT – retest; F1–F3 – factors extracted in EFA;
Matched (maximize congruence):

T factor	RT factor	Tucker congruence
F1	F1	0.931
F2	F2	0.943
F3	F3	0.827

Explanatory notes: T factor – test; RT retest; Tucker congruence – coefficient of factor similarity; values closer to 1 indicate higher similarity

Internal consistency

Internal consistency of the BEVQ-PL was assessed using Cronbach's alpha. The alpha coefficient for the overall scale was 0.393 in both the test and retest measurements, indicating low internal consistency of the instrument as a whole. The identical values across time points suggest stability of the internal structure despite the overall low level of item homogeneity. An item-level analysis revealed variability in the contribution of individual items to the overall alpha coefficient. In both measurements, the removal of the water intake item resulted in the largest increase in alpha (to 0.531 in the test and 0.672 in the retest), indicating that this item contributed most to reducing internal consistency.

For the remaining items, alpha values in the test ranged from approximately 0.32 to 0.39, with the lowest values observed for black coffee/tea (0.320), sweetened tea (0.328) and 2 % milk (0.343), and the highest (excluding water) for energy drinks (0.416) and beer (0.395). In the retest, values were generally higher (0.47 ÷ 0.51), suggesting slightly improved internal consistency. The highest values (excluding water) were observed for protein drinks (0.509), spirits (0.509) and mixed alcoholic beverages (0.508). However, these differences were relatively small and did not indicate any clearly dominant item within the scale.

Overall, the observed pattern reflects the heterogeneous nature of the construct, with BEVQ-PL capturing diverse beverage categories, rather than a single latent dimension. Therefore, the low Cronbach's alpha should not be interpreted as the evidence of poor instrument quality, but rather as a consequence of its multidimensional structure. For behavioral tools assessing distinct categories of intake, high internal consistency is not expected, and reliability should be interpreted primarily in terms of temporal stability (e.g. test–retest correlations and ICC).

Discussion

The aim of this study was to conduct a preliminary psychometric evaluation of the BEVQ-PL questionnaire among children and adolescents. Reliability was assessed using complementary measures, including relative stability (Spearman correlations), absolute agreement (intraclass correlation coefficient, ICC), systematic differences (Wilcoxon test) and an agreement analysis (Bland–Altman). This approach enables a more comprehensive evaluation of the measurement properties of the instrument compared to analyses based on a single indicator, which is supported by methodological guidelines [28].

The inclusion of alcohol does not constitute a recommendation or normalization of its consumption among minors, but rather reflects the need for a comprehensive assessment of beverage-related behaviors in a sample that also includes individuals of legal age. A similar multi-indicator approach was applied by Fausnacht et al. [14], who assessed the reproducibility of the BEVQ-15 using Spearman correlations, non-parametric tests and agreement analyses. The authors demonstrated significant test–retest correlations for all beverage categories and summary indicators, while emphasizing that statistical significance of differences between measurements does not necessarily imply practical relevance.

The validity of the BEVQ-15 questionnaire has also been confirmed in studies involving adult populations, in which the results obtained using this tool were compared with 24-hour dietary recalls. No significant differences between methods were observed, and the mean difference was small, indicating good agreement and supporting the usefulness of BEVQ-15 as a rapid tool for assessing beverage intake [36]. The validity and reliability of the BEVQ questionnaire have been confirmed in studies conducted in various populations. In a study among adults in Turkey, significant correlations were observed between questionnaire results and three-day dietary records (ρ = $0.26 \div 0.96$), with most beverage categories achieving values ≥ 0.50. Additionally, high test–retest reliability was reported (ICC up to 0.94), indicating good reliability of the instrument [16]. Although this study was conducted in an adult population, it provides important methodological support for the assessment of the psychometric properties of BEVQ-PL in younger populations. The findings of the present study are partially consistent with previous observations regarding beverage intake in pediatric populations. In a longitudinal study among children with obesity, higher energy intake from beverages, particularly sugar-sweetened beverages (SSBs) and juices, was associated with increases in BMI. At the same time, reductions in beverage intake during intervention did not always translate into significant improvements in body weight parameters. Similarly, in the present study, differences between measurements were observed; however, their impact on total energy intake and potential health consequences may be limited by other behavioral and environmental factors. It should also be noted that differences in study populations limit direct comparability [35].

The results indicate that the BEVQ-PL questionnaire demonstrates moderate to good relative stability for the most commonly consumed beverage categories and global indicators. The highest stability was observed for global indicators and selected beverage categories, suggesting the preservation of participants' relative ranking across measurements. In nutritional epidemiology, test–retest correlation coefficients above 0.40 are generally considered acceptable, while higher values indicate good stability [48]. For self-reported tools, this range is considered satisfactory due to the presence of both a recall bias and true variability in intake over time, particularly pronounced in children and adolescents.

The results obtained are consistent with previous studies using the BEVQ questionnaire in adolescent populations, similar to findings reported in the Turkish adaptation study of the BEVQ, which demonstrated moderate correlations and acceptable reproducibility [4]. In a study conducted among adolescents, a significant association was found between the consumption of sugar-sweetened beverages and metabolic risk indicators, confirming the usefulness of the tool in assessing dietary behaviors [3]. Additionally, validation studies conducted in various youth populations have confirmed the high validity and reliability of the questionnaire, while emphasizing the necessity of cultural adaptation [1].

The present findings are also consistent with the previous validations of BEVQ in pediatric populations, in which moderate to high reproducibility was observed for most beverage categories and global indicators [21, 32]. Despite some variability in absolute values, the tool enables the stable classification of participants according to their level of beverage intake. The values obtained in this study fall within the range reported in the literature, supporting the comparable level of relative stability of the instrument. Lower reliability values observed for infrequently consumed beverages, including some alcoholic beverages, can be interpreted in the context of the statistical properties of the ICC coefficient, which depends on between-subject variability. Limited variability in consumption leads to lower estimated test–retest reliability, as described in methodological references [30]. An absolute agreement analysis using ICC (2) confirmed moderate to good reproducibility for commonly consumed beverages, and lower reproducibility for less frequently consumed categories. The values obtained fall within the range considered acceptable in population-based studies [28]. The lowest reproducibility was observed for categories such as sweetened tea, 2 % milk and alcoholic beverages. In the case of alcohol, confidence intervals for ICC included negative values, indicating a lack of agreement between measurements, which is consistent with the episodic nature of consumption and zero-inflated distributions. This finding may be explained by the irregular and episodic nature of consumption of these beverages, particularly among adolescents. Furthermore, ICC estimates are sensitive to low between-subject variability and a high proportion of zero responses, both of which may artificially reduce reliability coefficients despite acceptable agreement at the group level. The Wilcoxon test indicated no significant differences between measurements for most beverage categories, suggesting the absence of a systematic measurement error. In the cases where significant differences were observed, they were accompanied by moderate correlations, indicating small shifts in absolute values, while preserving relative classification. These differences may result from learning effects, increased awareness or actual changes in behavior between measurements.

In epidemiological research, the ability of a tool to correctly rank individuals is more important than perfect agreement in absolute values [47]. From this perspective, the results obtained can be considered satisfactory. Additional support for the stability of the BEVQ construct is provided by cross-cultural validation studies. Adaptations conducted in different populations, including Turkish, Arabic and Pakistani samples, have demonstrated high test–retest reliability despite structural modifications, suggesting the robustness of the construct across cultural contexts. Similar conclusions were drawn from validation studies conducted in a Spanish population, where very high agreement was reported (ICC = 0.962). However, it should be noted that this study involved adults, which limits direct comparison with adolescent populations due to developmental differences and distinct reporting patterns [25]. A particularly important finding is the moderate to good stability of global indicators, such as Total Beverage Intake and total energy from beverages. This is highly relevant from a public health perspective, as it enables an accurate classification of individuals according to beverage consumption, particularly sugar-sweetened beverages, which are a major risk factor for obesity and metabolic disorders in pediatric populations [33]. The results suggest that BEVQ is capable of such classification also in adolescent populations. In the present study, the internal consistency of the Polish version of BEVQ-15, assessed using Cronbach’s alpha, was low ($\alpha = 0.393$ in both measurements). The low Cronbach's alpha ($\alpha = 0.393$) observed for the overall BEVQ-PL scale requires cautious contextual interpretation. Cronbach's alpha is an accurate measure of reliability only when the assumption of tau-equivalence is met, meaning that all items reflect a single latent construct with comparable factor loadings. This assumption is substantially violated in the BEVQ-PL, as the EFA results indicate that the instrument captures three statistically independent dimensions of beverage consumption: dairy/coffee-protein beverages, alcohol and juices/non-alcoholic beverages. When a scale is genuinely multidimensional, Cronbach's alpha necessarily underestimates reliability because variance between factors increases item heterogeneity. This limitation of alpha, when applied to multidimensional instruments, is well documented [24, 44]. This interpretation is further supported by an item-level analysis. The item concerning water consumption was the main factor lowering alpha; removing it increased the coefficient to 0.531 (test) and 0.672 (retest), bringing it closer to conventional thresholds. From a nutritional perspective, this is expected because water consumption is physiologically driven and largely independent of the behavioral patterns captured by the remaining beverage categories. Including this item in the overall alpha calculation inevitably reduces the apparent homogeneity of the scale. Importantly, identical alpha values in the test (α = 0.393) and retest (α = 0.393) demonstrate that the internal structure of the instrument is stable over time despite the low item homogeneity.

Despite the low alpha coefficient, a temporal stability analysis demonstrated moderate to good test–retest reliability, particularly for global indicators. This suggests that, although heterogeneous, the instrument provides acceptable measurement stability. Therefore, Cronbach’s alpha should be treated as a supplementary indicator, while BEVQ-15 should be considered a multidimensional tool intended primarily for group-level analyses, rather than as a classical summative scale.

Future research should include the assessment of criterion validity against established reference methods, such as repeated 24-hour dietary recalls or food records, to determine the measurement accuracy of the BEVQ-PL questionnaire. In addition, further studies should evaluate the instrument sensitivity to detect changes in beverage intake in intervention settings and assess its performance in more diverse populations. Future studies should also include a confirmatory factor analysis (CFA) conducted on larger and independent samples to verify the stability and generalizability of the factor structure identified in the present study.

The study has several important strengths that enhance its methodological and practical value. First, a comprehensive cross-cultural adaptation and psychometric evaluation of the BEVQ-15 questionnaire was conducted in an adolescent population, which represents a particularly challenging group due to high variability in dietary behaviors. An important strength is the use of an expanded and culturally adapted structure of beverage categories reflecting current consumption patterns in Poland. This increased the content validity of the instrument and allowed for the more precise capture of diverse consumption behaviors that might be overlooked in more aggregated classifications.

Another strength is the use of a standardized data collection procedure conducted in the presence of trained interviewers, which reduced the risk of misunderstanding and improved data quality. It is also worth noting that the application of a complementary approach to reliability assessment, including relative stability, absolute agreement and an agreement analysis using the Bland–Altman method. This approach allows for a more comprehensive evaluation of measurement properties. Finally, the relatively large and diverse sample, including participants with varying demographic and anthropometric characteristics, enhances the credibility of the findings and allows the assessment of the instrument stability under the conditions similar to population-based studies.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the expanded structure of beverage categories, while improving sensitivity and content validity, may limit direct comparability with studies using the original BEVQ-15 version. Second, the use of self-reported data is associated with the risk of a recall bias and a reporting bias, particularly in adolescent populations. Although the presence of a trained interviewer may have reduced some of these errors, it does not eliminate them entirely.

Another important limitation is the lack of a criterion validity assessment against an external reference method, such as repeated 24-hour dietary recalls or food records. Consequently, although the present study provides preliminary evidence regarding the reliability and construct validity of the BEVQ-PL questionnaire, its measurement accuracy could not be directly evaluated. Future studies should therefore compare BEVQ-PL results with established dietary assessment methods to further validate the instrument. Another limitation is the use of averaged energy density coefficients, which do not fully reflect the variability of products within individual beverage categories. Therefore, the estimates of energy intake should be considered approximate. The sample selection, limited to a specific school and geographic context, may affect the generalizability of the findings to the broader Polish population. Additionally, the low value of Cronbach's alpha reflects the multidimensional nature of the instrument and the variability in consumption frequency across beverage categories, including a high proportion of zero responses. Finally, the seven-day interval between the test and retest measurements may have partially contributed to recall effects, although it simultaneously minimized the influence of actual changes in dietary behavior.

Conclusions

1. The present findings provide preliminary evidence supporting the reliability and construct validity of the BEVQ-PL questionnaire in a population of adolescents in Poland. The instrument demonstrated acceptable to moderate reproducibility. The highest measurement stability was observed for the most frequently consumed beverage categories and global indicators, such as Total Beverage Intake and energy from beverages. The obtained Spearman correlation and ICC values indicate that the instrument allows for a reliable classification of participants according to their level of beverage consumption, which is crucial in epidemiological research. Lower reproducibility was observed for infrequently consumed beverages and categories with more complex structures, most likely due to their irregular consumption patterns and difficulties in accurate reporting. The absence of significant differences between measurements for most beverage categories suggests a lack of a systematic measurement error.

2. In the context of the increasing consumption of sugar-sweetened beverages among adolescents in Poland and the growing burden of overweight, obesity and metabolic disorders, the availability of a validated tool for assessing beverage intake is of significant public health importance.
3. BEVQ-PL may serve as a useful tool for monitoring beverage consumption patterns at the population level, identifying high-risk groups and evaluating the effectiveness of interventions aimed at reducing sugar-sweetened beverage intake. Its application in epidemiological studies enables not only the estimation of total energy intake from beverages, but also the analysis of consumption patterns across different beverage categories, which may support the design of targeted educational and preventive programs. In the long term, this tool may contribute to the systematic monitoring of dietary behavior changes among adolescents and serve as a component of national strategies for the prevention of diet-related diseases.

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ADAPTACJA KULTUROWA I WSTĘPNA WALIDACJA POLSKIEJ WERSJI KWESTIONARIUSZA SPOŻYCIA NAPOJÓW (BEVQ-PL) WŚRÓD MŁODZIEŻY

S t r e s z c z e n i e

Wprowadzenie. Rosnące spożycie napojów, zwłaszcza napojów słodzonych cukrem (SSB), przyczynia się do nadmiernego spożycia energii i rozwoju chorób dietozależnych wśród młodzieży. Dlatego niezbędne są wiarygodne narzędzia do oceny spożycia napojów w tej populacji. Celem niniejszego badania była ocena rzetelności i wstępnych właściwości psychometrycznych polskiej wersji Kwestionariusza Spożycia Napojów (BEVQ-PL).

Wyniki i wnioski. BEVQ-PL wykazał umiarkowaną do dobrej rzetelność testu-retestu dla większości kategorii napojów i wskaźników globalnych. Korelacje Spearmana wahały się od 0,17 do 0,71, przy czym najwyższe wartości zaobserwowano dla całkowitego spożycia energii z napojów. Współczynniki korelacji wewnątrzklasowej (ICC) wskazywały na umiarkowaną zgodność dla napojów często spożywanych, ale niższą powtarzalność dla kategorii rzadko spożywanych. Analiza Blanda-Altmana ujawniła niewielkie systematyczne odchylenie z szerokimi granicami zgodności na poziomie indywidualnym. Eksploracyjna analiza czynnikowa potwierdziła trójczynnikową strukturę (mleko/kawa – napoje proteinowe, alkohol, soki/napoje bezalkoholowe) z akceptowalną stabilnością czasową. Spójność wewnętrzna była niska (α = 0,393), co odzwierciedla wielowymiarowy charakter narzędzia. Ogólnie rzecz biorąc, wyniki potwierdzają zasadność stosowania BEVQ-PL jako wstępnie walidowanego narzędzia do oceny spożycia napojów wśród polskiej młodzieży na poziomie grupy.

Słowa kluczowe: młodzież; napoje; kwestionariusz; powtarzalność; trafność