

CLINICAL INVESTIGATION

Validation of a food frequency questionnaire designed for children 10-12 years: THE PANACEA-FFQ

RUNNING TITLE: PANACEA FFQ VALIDATION

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Abstract

Background: Food Frequency Questionnaires (FFQ) are commonly used in the nutritional research. The aim of the present work was to evaluate the validity of a food frequency questionnaire that could be used for children aged 10-12 years living in urban areas in Greece.

Methods: The semi-quantitative FFQ included questions regarding the frequency of consumption of the main food groups and beverages typically consumed in Greece, as well as questions regarding eating habits of children. During 2007, 125 children 10-12 years old recruited from randomly selected schools from Athens (overall mean age: 10.9±1.2 yrs, 38% boys) were studied. FFQs were completed by the children's parents and were compared with the 3-day dietary diary (3DD) records recorded also by them. Agreement of the FFQ with 3DD was evaluated using the Bland-Altman method, cross-classification analysis and Kendall's tau-b.

Results: High percentage of agreement (i.e., >91%) between FFQ and 3DD according to the Bland and Altman method was found. Low but still significant agreement for refreshments /juices (tau-b=0.29, p=0.004), dairy products (tau-b=0.26, p<0.001), starchy products (tau-b=0.13, p=0.057), vegetables (tau-b=0.23, p=0.006), fruits (tau-b=0.19, p=0.017), sweets/snacks (tau-b=0.14, p=0.057) and toasts/pizzas (tau-b=0.19, p=0.017) was also observed. Stratified analysis by gender and obesity status confirmed the high agreement of the two methods. Cross classification analysis of the FFQ and 3DD demonstrate moderate to very good percentages of correct classification (range: 49% to 90.2%).

Conclusions: The suggested FFQ seems to be a reasonably valid measure of dietary intake and can be used in children aged 10-12 years living in urban areas in Greece.

Keywords: questionnaire, food, dietary, assessment, children.

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ΚΛΙΝΙΚΗ ΕΡΕΥΝΑ

ΜΕΛΕΤΗ ΕΓΚΥΡΟΤΗΤΑΣ ΕΙΔΙΚΟΥ ΗΜΙ-ΠΟΣΟΤΙΚΟΥ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟΥ ΣΥΧΝΟΤΗΤΑΣ ΚΑΤΑΝΑΛΩΣΗΣ ΤΡΟΦΙΜΩΝ ΠΑΙΔΙΩΝ ΗΛΙΚΙΑΣ 10-12 ΕΤΩΝ: ΤΟ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ PANACEA-FFQ

ΣΥΝΤΟΜΟΣ ΤΙΤΛΟΣ: ΕΓΚΥΡΟΤΗΤΑ ΤΟΥ PANACEA-FFQ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟΥ

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Περίληψη

Σκοπός: Τα Ερωτηματολόγια Συχνότητας Κατανάλωσης Τροφίμων (ΕΣΚΤ) χρησιμοποιούνται συχνά στη διατροφική έρευνα. Ο σκοπός της παρούσας εργασίας είναι η αξιολόγηση της εγκυρότητας ΕΣΚΤ που μπορεί να χρησιμοποιηθεί σε παιδιά ηλικίας 10-12 ετών που ζουν σε αστικές περιοχές στην Ελλάδα.

Μέθοδοι: Το ημι-ποσοτικό ΕΣΚΤ περιλαμβάνει ερωτήσεις σχετικά με τη συχνότητα κατανάλωσης των βασικών ομάδων τροφίμων και ποτών που καταναλώνονται συνήθως στην Ελλάδα, καθώς και ερωτήματα σχετικά με τις διατροφικές συνήθειες των παιδιών. Κατά τη διάρκεια του 2007, μελετήθηκαν 125 παιδιά ηλικίας 10-12 ετών από τυχαία επιλεγμένα σχολεία από την Αθήνα (συνολική μέση ηλικία: $10,9 \pm 1,2$ ετών, το 38% αγόρια). Τα ΕΣΚΤ συμπληρώθηκαν από τους γονείς των παιδιών και συγκρίθηκαν με διατροφικό 3-ημερών ημερολόγιο που καταγράφηκαν επίσης. Ο βαθμός συμφωνίας του ΕΣΚΤ με το ημερολόγιο 3-ημερών αξιολογήθηκε χρησιμοποιώντας την μέθοδο Bland-Altman μέθοδος, την διασταυρούμενη ταξινόμηση και την χρήση του συντελεστή Kendall tau-b.

Αποτελέσματα: Υψηλό ποσοστό συμφωνίας (δηλαδή > 91%) μεταξύ ΕΣΚΤ και ημερολογίου διαπιστώθηκε με την μέθοδο Bland και Altman. Χαμηλή αλλά ακόμα σημαντική συμφωνία παρατηρήθηκε επίσης για τις ομάδες των αναψυκτικών / χυμών (tau-b = 0,29, $p = 0,004$), των γαλακτοκομικών προϊόντων (tau-b = 0,26, $p < 0,001$), αμυλούχων προϊόντων (tau-b = 0,13, $p = 0,057$), λαχανικών (tau-b = 0,23, $p = 0,006$), φρούτων (tau-b = 0,19, $p = 0,017$), γλυκών / σνακ (tau-b = 0,14, $p = 0,057$) και τσιστ / πίτσες (tau-b = 0,19, $p = 0,017$). Η ανάλυση ανά φύλο και ανα κατηγορία σωματικού βάρους επιβεβαίωσε την υψηλή συμφωνία των δύο μεθόδων. Η διασταυρούμενη ταξινόμηση του ΕΣΚΤ με το διατροφικό ημερολόγιο ανέδειξαν μέτρια έως πολύ καλά ποσοστά σωστής ταξινόμησης (εύρος: 49% έως 90,2%).

Συμπεράσματα: Το προτεινόμενο ΕΣΚΤ αποτελεί αξιόπιστο εργαλείο αξιολόγησης της διαιτητικής πρόσληψης και δύναται να χρησιμοποιηθεί σε παιδιά ηλικίας 10-12 ετών που ζουν σε αστικές περιοχές στην Ελλάδα.

Keywords: questionnaire, food, dietary, assessment, children.

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Introduction

The association between childhood asthma and body weight has been a matter of particular interest in recent literature. An increasing body of evidence implicates obesity as a major risk factor for asthma, thus linking these two epidemics¹⁻³. In order to study childhood obesity, the need to use valid measurements for the assessment of the usual diet and eating patterns of children is of crucial importance⁴. In epidemiologic studies the food frequency questionnaire (FFQ) method has been proposed as the most appropriate method for dietary assessment as it can easily capture usual food intake. FFQs are used for food intake evaluation over specific time periods like the preceding month or year. A certain food list is presented to respondents which are requested to report how often they consume the specific food item in times per day, week, or month⁵. Although easy in completion, estimates derived from FFQ may suffer from errors in the frequency estimation or in estimation of portion size. In addition, inaccuracies may result due to incomplete listing of all possible foods or seasonal effect. Therefore, it is essential to consider at which level such research instruments can measure true intake⁶. It is, thus, very important for assessment tools to provide accurate and valid results. Usually, validity of an FFQ is tested versus a more accurate method often referred as a "reference" method (i.e., 24-hour recall, dietary diaries, and food weighted records)^{7,8}.

The Physical Activity, Nutrition and Allergies in Children Examined in Athens (PANACEA) study was designed to determine the prevalence of asthma symptoms among Greek schoolchildren and to evaluate these

rates in relation to anthropometric, lifestyle characteristics and dietary habits of the children⁹. For the evaluation of dietary patterns, an FFQ was developed as the assessment dietary method. In order for the validation of the PANACEA FFQ, 3-days dietary records (3DD) were chosen as the reference method for the comparison of the FFQ results. Thus, the aim of this work was to examine the validity of the food intake measured with the FFQ used in the PANACEA study against the 3DD method.

Methods

The PANACEA study

The PANACEA study is an epidemiological cross-sectional survey that has three main research hypotheses, i.e. that the prevalence of asthma and allergies in 10–12 year-old boys and girls from Greece is related to their: (a) sociodemographic characteristics, (b) level of physical activity, and (c) dietary habits⁹. During 2006, 815 schoolchildren aged 10–12 (4th to 6th school grade) years from 18 public schools located in the greater Athens area were recruited to participate in the study. Seven hundred schoolchildren (323 male and 377 female) agreed to enroll into the study (participation rate 83.5%). The schools were randomly selected from a list of schools provided by the regional education offices. In order to achieve a representative sample, the enrolled schools were selected from various regions of Athens. Only pre-menstrual girls were included. Children suffering from chronic diseases that prohibited free running, i.e. cyanotic heart disease or severe motor handicaps, were also excluded.

The parents of every child completed a questionnaire that was developed for the purposes of the study and was designed to retrieve information on: age (in years), sex, school class (i.e., 4th, 5th or 6th,) and asthma and other allergic symptoms (ISAAC questionnaire)¹⁰. The same questionnaire also included information regarding the social status of the family, i.e. educational level of the parents (none, basic education, high school, academic), number of cars within the family, availability of child's own-room and number of siblings as well as information on hospitalizations of the children. A special questionnaire on the children's physical activity was completed at school by children themselves with the help of a researcher.

Standing height and weight were measured at the school setting and overweight and obesity were defined using the international body mass index cut-off points established for children and youth¹¹. Parents were also asked to report the height and weight of their children. Reported height, weight and calculated BMI of both parents also were recorded.

The PANACEA study Food Frequency Questionnaire (FFQ)

A semi-quantitative Food Frequency Questionnaire (FFQ) that gathers information on daily or weekly basis was applied to all children. Various foods and beverages commonly consumed in Greece and habits pertaining to mealtime behaviours were recorded by using 63 detailed descriptive questions. Common foods usually consumed by children and adolescents, plus traditional foods, and some specific foods related to

asthma symptoms (i.e., types of fish and fisheries, fruits with antioxidants etc.) were used for the construction of the questionnaire. In particular, the FFQ included the frequency of consumption of various foods such as: fish, poultry, red meat, eggs, white bread, whole grain bread, potatoes, rice, fruits, vegetables, fruit juices, soda drinks, low-calorie soft drinks, beverages, and of traditional Greek cooked meals. Also, there were questions assessing the weekly or daily intake of dairy products, the frequency of breakfast consumption per day, the frequency of consumption of cereals with breakfast, the daily consumption of meals including snacks (toasts, hotdogs, cheese pie, spinach pie), the weekly or daily frequency of consumption of foods outside the home (including school canteens and non home-made meals), the cooking method usually employed by the family, the type of oils/fat used in cooking (butter, margarine, olive oil, vegetable oil) and the frequency of snacks consumed per week and per day.

Typical serving sizes were employed as units for measurements and for every food/drink item in the questionnaire, a clearly described measure was used (e.g. a can of soft drink, one hamburger (including meat and ban), one portion of chicken approximately 150 g, a bag of crisps, etc). Information regarding frequency of intake based on: daily or more (> 2 times per day), weekly (i.e., 1time per week, 2-6 times per week), monthly basis (i.e., 1-3 times per month), rare, or never was collected (Appendix table). The FFQ was completed by the children's parents, according to detailed guidelines that were accompanied the FFQ.

Validation sample

During 2007, a sample of 125 children (4th to 6th school grade, 10-12 years) were enrolled for the validation of the FFQ questionnaire, from 3 schools out of the 18 originally selected for the PANACEA study. The validation sample represents the 17.9% of the original sample size included in the PANACEA study. The selection of the schools was on a random basis from the list of the participating schools of the study. Participation of subjects was on a voluntary basis and prior to acceptance, children's guardians were fully informed on the objectives and methods of the study and signed an informed consent. The PANACEA eligibility criteria were applied to the sample collection (pre-menstrual girls and children without chronic diseases that prohibited running were included). In all participating children height and weight was measured by the researchers (after shoes and heavy clothes removal) and body mass index (BMI) was calculated in order to be classified as normal weight or overweight and/or obese according to the age and gender specific BMI cut-off values, as established by the IOTF organization¹¹. The obesity status of children, together with their gender was used in the stratified analyses followed on to test the validity of the FFQ separately in boys and girls, and in normal weight or overweight/obese children. The basic characteristics of the sample are presented in Table 1. The size of the study sample is sufficient enough to detect a significant relationship between the independent and the depended variables with minimal standardized difference of 0.3 with 90% power.

Administration of the 3-days Dietary Diary (3DD)

The parents of the participating children

were also asked to fill in a 3-day dietary diary (3DD) as the reference method for assessing true dietary habits of their children. The recording period included two weekdays and one weekend day, over the same time span as for the FFQ. Detailed guidelines were given to participants' parents in order to fill in the 3DD, using standard household measures (i.e., cups, teaspoons, tablespoons) to describe food quantity, and were trained to record each food item or beverage consumption, at real time (i.e., meal-by-meal). The participating children were also asked to track their food intake and to report it to their parents, in order to include all the meals and snacks consumed per day. Starting days for data collection were allocated in such way to cover all days within a week in the overall sample, in order to ensure the representativeness of all week days.

Table 1. Basic characteristics of the validation sample of the PANACEA FFQ study.

Characteristic	Validation Sample
Sex (boys- n %)	46 (37.1)
Overweight/obese (n %)	31 (26.9)
Age (years- n %)	
	10 60 (48.4)
	11 35 (28.2)
	12 29 (23.6)

Food intake calculations

Daily consumption in grams (g) or milliliters (mL) of the listed foods was calculated from the reported frequency of consumption of the FFQ items which were converted to intake in g/mL per day by multiplying the serving size of each one defined in the questionnaire by the value corresponding to each consumption frequency: never-1 times/month=0.02; 1-3

times/month=0.07; 1 times per week= 0.13; 2-6 times/week= 0.53; 3-6 times/week=0.64; 1 times/day=1; >2 times/day=3. Based on the participants' responses the information was then aggregated into food groups. Twelve main food groups (dairy products, starchy products, meat, fish, legumes, vegetables, fruits, sweets and snacks, refreshments and juices, toasts and pizzas) were formed reflecting a dietary scheme usually followed by the reference population. Data from 3DD were categorized in the same food groups as in the FFQ questionnaire. Mean food consumption reported in the 3DD was also calculated in g or mL per day.

Statistical methods

In order to estimate the level of agreement between the children's reports from the FFQ and the 3DD the Kendall's tau-b coefficients were calculated for all food groups (absolute values of Kendall's tau-b<0.30 suggest "low" agreement, values between 0.31-0.60 suggest "moderate" and values >0.61 suggest "good" agreement)¹². To confirm the results for the

agreement between the FFQ and the 3DD the Bland & Altman method¹³ for measuring agreement in comparative methods was applied. With respect to the Bland & Altman method the limits of agreement (i.e., $\text{mean}_{(\text{difference})} \pm 1.96 \cdot \text{standard deviation}_{(\text{difference})}$) were used to quantify the degree of agreement for the validation process. In addition, the correct cross-classification percentages between the tertiles of the food groups distribution were calculated for the two methods. SPSS version 14 software was used for all the statistical analysis (SPSS Inc., Chicago, IL, USA).

Results

Results of Kendall's tau-b correlation coefficients indicated low agreement with respect to all food groups' intake of the FFQ as compared with the 3DD records. Specifically, Kendall's tau-b ranged from 0.12 for "meat" to 0.29 for "refreshments/juices" (p<0.05). However, the Bland & Altman method showed high agreement of food groups' intake, estimated from both tools. The

Table 2. Validation of the FFQ Questionnaire of the PANACEA study

Food Group (g-mL/day)	Kendall's tau-b	FFQ Median(Q1-Q3)	3-DD Median(Q1-Q3)	Bland & Altman's method	
				Limits of agreement	% of agreement Mean of difference
Dairy products	0.26*	0.90(0.58-1.23)	1.67(1.25-2.00)	(-0.97,2.45)	94.3 0.74
Starchy products (cereals, pasta, potato)	0.13*	0.78(0.51-1.18)	1.67(1.33-2.67)	(-0.97,3.33)	92.5 1.18
Meat (red, poultry, products)	0.12	0.26(0.20-0.49)	1.00(0.67-1.33)	(-0.48,1.78)	94.1 0.65
Fish	0.13	0.05(0.04-0.20)	0.33(0.33-0.33)	(-0.232,0.722)	97.8 0.25
Legumes	0.13	0.16(0.11-0.20)	0.33(0.33-0.67)	(-0.16,0.79)	93.8 0.32
Vegetables	0.23*	1.05(0.71-1.68)	1.00(0.67-1.33)	(-3.86,2.62)	94.9 -0.62
Fruits	0.19*	1.60(1.18-2.49)	1.00(0.67-1.33)	(-3.97,1.97)	96.5 -1.01
Sweets - Snacks	0.14*	0.31(0.18-0.59)	1.00(0.67-1.33)	(-1.34,2.73)	95.4 0.70
Refreshments/Juices	0.29*	0.19(0.08-0.27)	1.00(0.67-1.67)	(-0.98,1.58)	91.8 0.30
Toasts/pizzas	0.19*	0.36(0.20-0.39)	0.67(0.33-1.00)	(-0.35,1.33)	93.1 0.49

*p<0.0

lower agreement was found for "refreshments/juices" (91.8%) and "starchy products" (92.5%) and the higher for "fish" (97.8%) and "fruits" (96.5%) (Table 2). Cross classification analysis of the FFQ and 3DD food groups' consumption distribution tertiles classified correctly from 49% up to 90.2% of the participated children (Table 3).

The validity of the FFQ as compared with the 3DD was similar in both genders as

regards to "dairy products", "legumes" and "fruits" food groups, according to Kendall's tau-b; whereas, it was higher among boys as compared with girls as regards "meat", "fish", "sweets and snacks" and "toasts and pizzas". However, the validity of the FFQ, according to the Bland & Altman method, was high (i.e., > 90%) for all food groups in both genders (Table 4).

To further examine whether the BMI status

Table 3 . Correct cross-classification percentages between the PANACEA FFQ and 3DD using the tertiles of food groups distributions.

Food group (g/d or ml/d)	Percentage of correct cross-classification (%)		
	1 st tertile	2 nd tertile (median)	3 rd tertile
Dairy	72.1	66.4	68.0
Starchy	70.0	49.2	65.0
Meat	64.7	48.8	60.0
Fish	84.4	75.5	37.8
Legume	80.0	56.8	72.8
Vegetables	61.5	58.9	73.1
Fruits	54.7	54.7	66.3
Sweets and Snacks	61.5	54.1	66.1
Toasts	80.0	53.5	70.3
Refreshments/Juices	90.2	65.6	72.1

Table 4. Validation of the FFQ Questionnaire of the PANACEA study according to children's gender.

Food Group (g - mL/day)	Bland & Altman's method							
	Kendall's tau-b		Limits of agreement		% of agreement		Mean of difference	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Dairy products	0.23*	0.28*	-1.31,2.43	-0.76,5.43	93.2	94.8	0.57	0.84
Starchy products (cereals, pasta, potato)	0.05	0.16*	-0.68,2.83	-1.11,3.59	97.6	89.6	1.07	1.24
Meat (red, poultry, products)	0.21	0.05	-0.35,1.67	-0.55,1.86	95.5	93.2	0.67	0.65
Fish	0.27	0.12	-0.11,0.48	-0.29,0.84	100	96.3	0.19	0.28
Legumes	0.09	0.11	-0.09,0.72	-0.17,0.82	96.2	92.6	0.32	0.33
Vegetables	0.13	0.31*	-2.94,2.02	-4.27,2.90	96.0	94.2	-0.46	-0.68
Fruits	0.21	0.15	-0.61,2.38	-0.85,3.04	100	94.3	-0.92	-1.08
Sweets - Snacks	0.27*	0.04	-0.55,2.16	-1.72,2.96	100	92.8	0.81	0.62
Refreshments/Juices	0.14	0.40*	-0.67,1.59	-1.08,1.46	95.0	92.5	0.46	0.19
Toasts/pizzas	0.32*	0.11	-0.36,1.44	-0.35,1.27	89.5	95.2	0.54	0.46

*p < 0.05

may affect the validity of the FFQ as compared with the "reference" method (3DD), the procedure of the FFQ was assessed for the participating children according to their obesity status (normal weight vs overweight and/or obese). The validity was similar and moderate in both BMI categories as regards to "dairy products", "starchy products" and "refreshments /juices". Increased validity was observed among children with normal BMI with respect to "fish", "legumes" and "vegetables" intake; whereas, for "meat", "fruits", "sweet and snacks " and "toasts and pizzas " intake better validity was found among overweight/obese children as compared to those with normal BMI. However, the degree of agreement exceeded 86% in all food groups (according to the Bland & Altman method) in both obesity status groups (Table 5).

Discussion

In the present work the validity of a semi-

quantitative FFQ (i.e., the PANACEA-FFQ) used in children aged 10-12 years was evaluated. Data analysis revealed the validity of the questionnaire as regards food and beverages groups consumed and was confirmed irrespective of the gender and the obesity status of the participants.

The higher agreement percentages observed for fish and fruits food groups among the FFQ and the 3DD questionnaire. It is well known that Greek traditional diet primarily consists of fish food and fruits ¹⁴. Fruits are a typical food group consumed several times per day in a Greek diet and fish traditionally is consumed on Saturdays. Based on these findings, the higher agreement percentages could be attributed to the daily frequent consumption and the traditional weekly nutrition routine of Greeks. The poorest agreement was observed for the refreshments and juices food group. Parents tended to underestimate the consumption of

Table 5. Validation of the FFQ Questionnaire of the PANACEA study according to children's obesity status.

Food Group (g-mL/day)	Bland & Altman's method							
	Kendall's tau-b		Limits of agreement		% of agreement		Mean of difference	
	normal weight	overweight/obese	normal weight	overweight/obese	normal weight	overweight/obese	normal weight	overweight/obese
Dairy products	0.26*	0.34*	0.48,0.88	0.53,1.00	92.8	100	0.68	0.78
Starchy products (cereals, pasta, potato)	0.22*	0.16	0.33,3.24	0.80,1.35	93.8	86.2	1.24	1.07
Meat (red, poultry, products)	0.10	0.22	0.57,0.82	0.27,0.74	93.8	92.9	0.70	0.50
Fish	0.25	-0.14	0.14,0.32	0.11,0.47	96.9	100	0.23	0.29
Legumes	0.20	-0.08	0.27,0.39	0.16,0.43	92.3	94.4	0.33	0.30
Vegetables	0.39*	-0.05	-0.94,-0.11	-1.90,0.14	96.0	90.0	-0.53	-0.88
Fruits	0.18	0.31	-1.43,-0.60	-1.53,-0.46	95.2	100	-1.02	-0.99
Sweets - Snacks	-0.05	0.41*	0.52,96	0.01,0.94	95.8	96.4	0.74	0.47
Refreshments/Juices	0.32*	0.23	0.13,0.50	-0.24,0.54	96.7	93.8	0.31	0.15
Toasts/pizzas	-0.05	-0.41	0.39,0.61	0.39,0.63	91.2	100	0.50	0.51

* p < 0.05

this food group in FFQ, as seen by the median differences in the two diet assessment methods. Refreshments and juices are types of food that are offered in various places (home, school, social events etc.) and on several occasions per day, so this food group is more prone to recall bias than the others included in the PANACEA FFQ.

Several validation studies of FFQs have demonstrated a satisfactory correlation between FFQ results and gold standard methods in both adults¹⁵⁻¹⁷ and children for different age periods¹⁸⁻²⁰. The range for crude correlations in our study was from 0.12 to 0.29 and it is similar with other ones reported in literature^{21, 22}. Furthermore, our FFQ has been designed to assess daily dietary intake in a healthy children population and the validation results are in coherence also with relevant studies. Ambrosini et al¹⁸, evaluated an FFQ in comparison with a 3-day food record, in 785 14-years-old adolescents in the context of a population-based cohort study in Western Australia. They reported Bland & Altman limits of mean agreement (LOA) ranging from 73% for starchy products to 161% for vitamin C, with most of the nutrient being overestimated by the FFQ. Bertoli et al.²³ in their study of the validation of an 136-itemed FFQ comparing with a 7-day weighed record method in 18 children 6-10 years also reported overestimation of the nutrient intake but high correlation for all the nutrients considered. Moreover, Khole et al.²⁴, evaluated a 191 food-items FFQ in 57 children aged 1 to 3 years coming from low-income mothers, reported an average validity correlation of 0.41 and concluded an acceptable validity for their questionnaire.

However, there are reports regarding the

use of an FFQ for dietary assessment that argue against its validity for nutrient intake estimation, especially in specific populations. Di Noia et al.²⁵ examined the validity of a 5-day FFQ in a sample of 156 African-American adolescents for juice, fruit and vegetable intake in comparison with direct observation and concluded that youth had difficulties in reporting their monthly and daily food intake, thus producing overestimations, especially in vegetables, more than fruits and juices. This study expands previous finding that supports the overestimation not only in the three aforementioned food groups, but in all of them²⁶.

The overestimation observed in several food groups in our study is in consistence with the literature on dietary assessments in children and it is acceptable for the use of our FFQ in dietary assessment. Domel et al.²⁷, observed over reporting of fruits and vegetables among a sample of fourth and fifth grade lower-middle socioeconomic students. Same results are reported also by Cullen et al. for the validation of a FFQ in 40 inner city African American boys²⁸. This could be attribute to that children may ate commonly consumed foods more often that they thought of or that they tend to report a more standard number of servings rather than the actual number of servings consumed²⁹. Another possible explanation about the difficulty that younger children had in reporting their intake is that they had not progressed to the developmental stage characterized by the ability to think abstractly and were not familiar with the concept of averaging or reporting 'usual' patterns³⁰. Moreover, day-to-day variability and within-person variability might be responsible for the large differences observed between the FFQ

and 3-day dietary diary results. This discrepancy between food groups servings among the two assessment methods has been also found in other studies^{31, 32}. Other limitations of our study include the narrow age range of the sample, the food categories and portions that may be unique to your population and that the results may not generalize well to other populations. Furthermore, our food categories may not capture all possible foods consumed by the participating children, however, effort was

made to be the most representative of the typical Greek diet.

Despite the limitations regarding the overestimation of food intake and the generability of the results, the good level of agreement between the dietary tools evaluated in this project suggest that the PANACEA-FFQ is valid and can provide an acceptable assessment of dietary intakes in children aged 10-12 years living in urban areas in Greece.

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Appendix

Appendix Table. The PANACEA FFQ: food items and beverages, portion sizes and classes of consumption

Food or beverage	Portion size that used as a reference	Frequency of consumption measured
DAIRY		
Full fat milk	1 cup (240mL)	never/1t/mo, 1 t/wk, 2-6 t/wk, 1 t/d, 2-3 t/d, ≥4 t/d
Low fat milk (2%)	1 cup (240mL)	never/1t/mo, 1 t/wk, 2-6 t/wk, 1 t/d, 2-3 t/d, ≥4 t/d
Chocolate milk (4% fat)	1 cup (240mL)	never/1t/mo, 1 t/wk, 2-6 t/wk, 1 t/d, 2-3 t/d, ≥4 t/d
Yogurt	1 cup (240 ml)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥2t/d
Low fat yogurt (2%)	1 cup (240mL)	never/1t/mo, 1 t/wk, 2-6 t/wk, 1 t/d, 2-3 t/d, ≥4 t/d
Yellow cheese/ cream cheese	30 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥2t/d
White cheese (e.g. feta cheese)	30 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥2t/d
Low fat cheese (light/ cottage)	30 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥2t/d
Egg (boiled, fried, omelet)	50 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥2t/d
CEREALS, STARCHY FOODS		

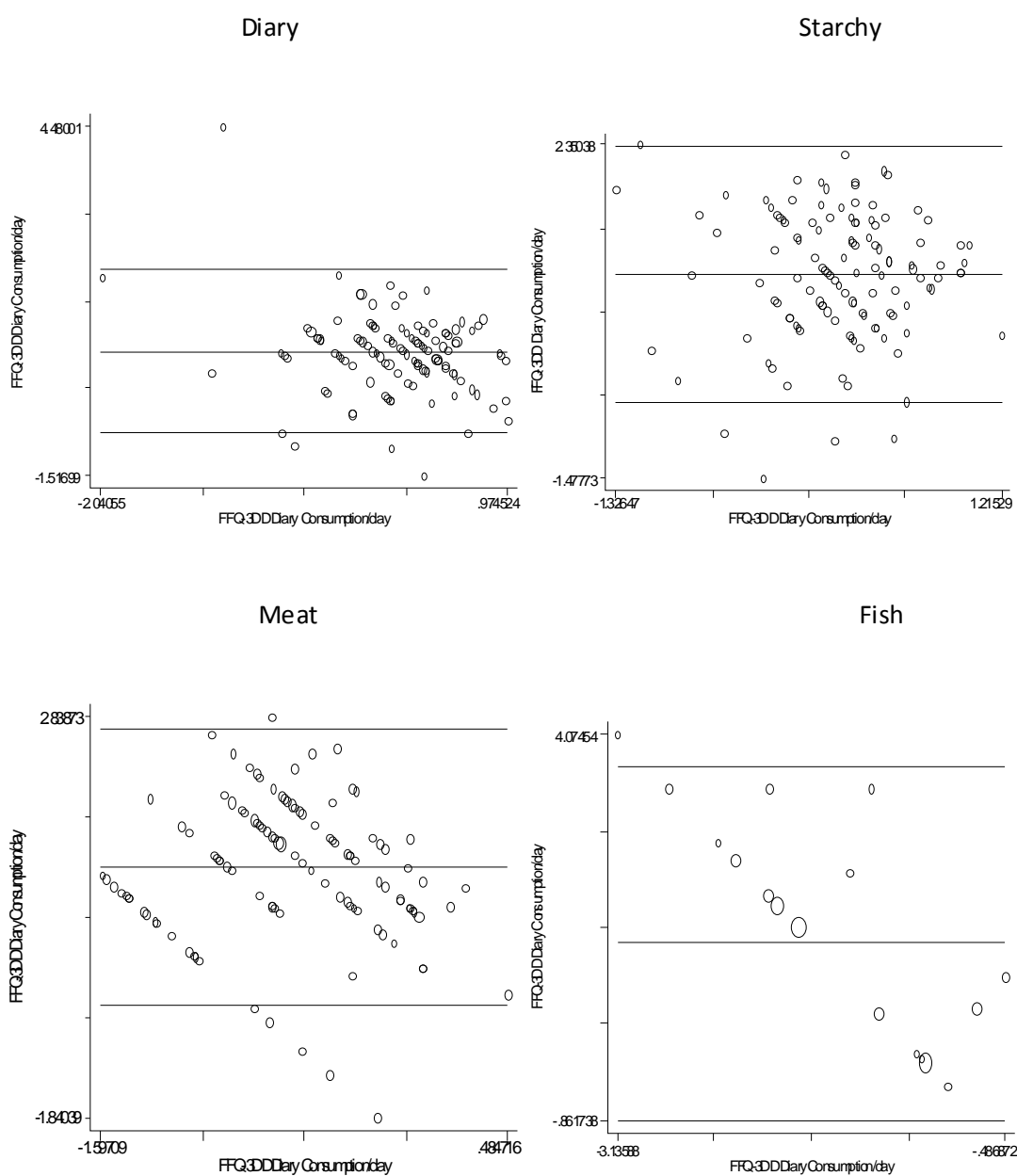
Appendix Table. The PANACEA FFQ: food items and beverages, portion sizes and classes of consumption

Food or beverage	Portion size that used as a reference	Frequency of consumption measured
White bread / toast	1 slice (30 g)	never/1t/mo, 1 t/wk, 2-6 t/wk, 1 t/d, 2-3 t/d, ≥ 4 t/d
Wholemeal bread/ rusk	1 slice (30 g), 2 pieces	never/1t/mo, 1 t/wk, 2-6 t/wk, 1 t/d, 2-3 t/d, ≥ 4 t/d
Cereal/ cereal bars	1/2 cup (20 g), 1 piece	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Rice	1 cup (160 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Pasta/ pearl barley	1 cup (140 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Potatoes boiled/ baked/ mashed	1 medium (90 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
French fried potatoes	1 portion (70 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
MEAT		
Veal (steak, filet)	150 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Burger/ meat balls/ minced-meat	120 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Chicken/ turkey (all kind)	150 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Pork (steak, filet)	150 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Liver	150 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
FISH		
Small fish	150 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Large fish	150 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Sea-food (octopus, sleeve-fish, prawns)	150 g	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
LEGUMES, TRADITIONAL DISHES		
Pulses (lentils, beans, chickpeas)	1 portion (300 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Spinach-rice/ cabbage-rice	1 portion (250 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Pastitsio/ mousakas/ papoutsakia	1 portion (150 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Spaghetti with minced meat and grated cheese/	1 portion (150 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
/spaghetti with tomato sauce and grated cheese	1 portion (150 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Stuffed tomatoes/peppers	1 portion (150 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
VEGETABLES		
Petit pois (peas) , green beans, okra, artichoke	½-1 cup	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Tomato, cucumber, carrot, pepper	½-1 cup	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Lettuce, cabbage, spinach, rocket	½-1 cup	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Broccoli, cauliflower, courgette	½-1 cup	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Greens, celery, spinach	½-1 cup	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
FRUIT, NUTS		
Orange	1 medium (170 g)	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Apple, pear	1 medium (140 g)	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Other winter-fruits	1 piece, 1/2 cup (150 g)	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Banana	1 medium (100 g)	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
Other summer – fruits	1 piece, 1/2 cup (150 g)	never/1t/mo, 2-3 t/wk, 1 t/wk, 2-5 t/wk, 1 t/d, ≥ 2 t/d
SWEETS, SAVORY SNACKS AND SNACKS		
Home made pies (e.g. Cheese-pie, spinach-pie)	1 piece (150 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Croissant, gofer, cake , biscuits	1 item, 1 slice, 3-4 pieces	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Chocolate	1 medium (60 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Ice-cream, milk-shake, cream, rice pudding	1 cup	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Chips, pop-corn	1 portion (1 bag -70 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
REFRESHMENTS-JUICES		
Soft drinks	1 can (330 mL)*	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Light soft drinks	1 can (330 mL)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Athletics drinks	1 can (330 mL)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Tea, other teas	1 cup (240 mL)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
Fruit juice	1glass (240 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d
TOASTS/PIZZAS		
Toasted sandwich, sandwich	1 piece (200 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, ≥ 2 t/d

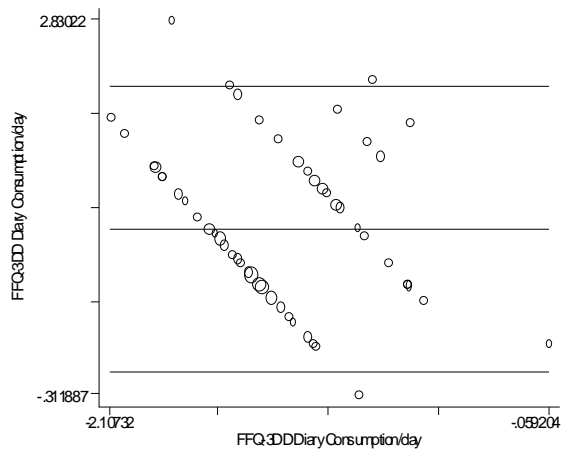
Appendix Table. The PANACEA FFQ: food items and beverages, portion sizes and classes of consumption

Food or beverage	Portion size that used as a reference	Frequency of consumption measured
Pizzas	2 pieces (200 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, $\geq 2t/d$
Hot dog (meat and bun)	1 piece (200 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, $\geq 2t/d$
Hamburger (burger and bun)	1 piece (200 g)	never/1t/mo, 1-3 t/wk, 1 t/wk, 2-6 t/wk1 t/d, $\geq 2t/d$

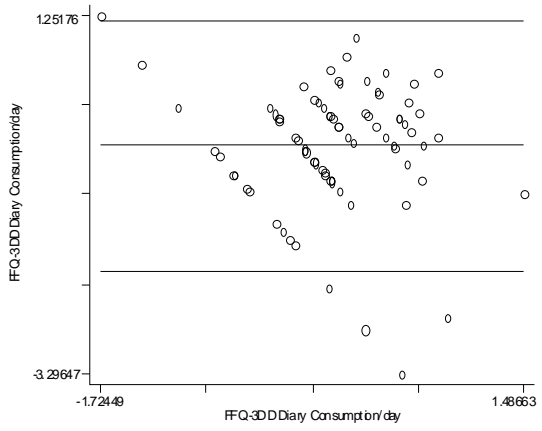
Figure 1. Bland and Altman for the percentage of agreement between dairy consumption per day among PANACEA FFQ and 3-DD (log-scale).



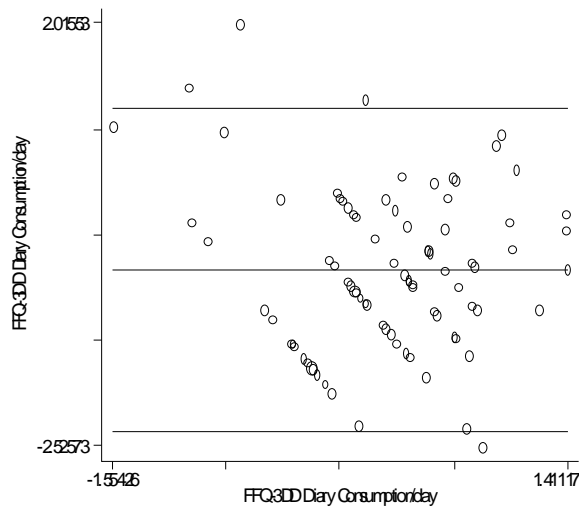
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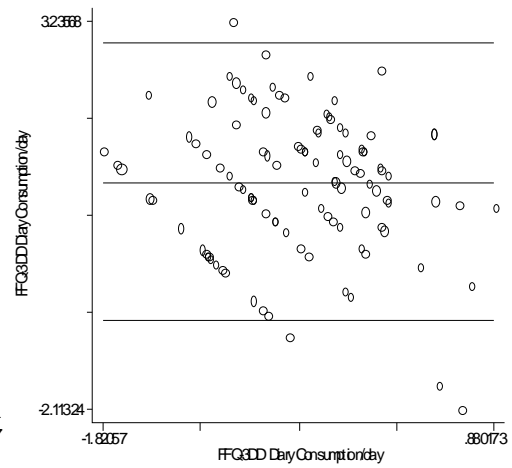
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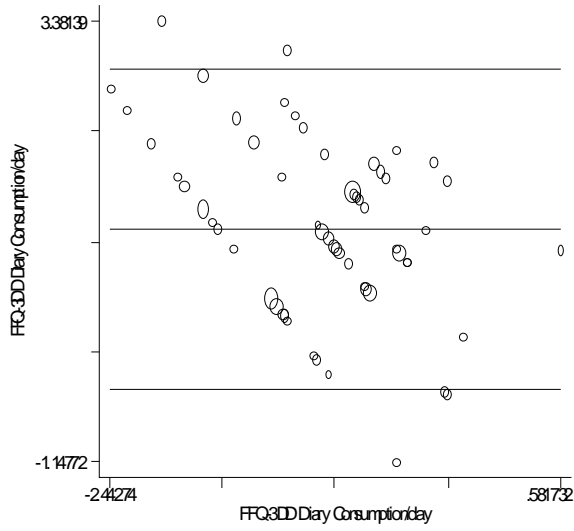
Fruits



Sweets and Snacks



Refreshments and Juices



Toasts/Pizzas

