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DAIRY PRODUCTS FREQUENCY QUESTIONNAIRE (ADOS-CA) CALIBRATION FOR CALCIUM INTAKE EVALUATION

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The aim of the study was to prepare a tool for quantitive evaluation of calcium intake and its calibration. The ADOS-Ca test calibration was carried out by the 24-hour recall method repeated seven times. The study included 90 people (aged 22.6±0.1) who gave complete information, *i.e.* 630 nutrition interviews and 90 ADOS-Ca tests. Calcium intake from dairy products estimated by the test was stated in mg/person/day and was estimated on the basis of the consumed products amount, intake frequency indices and calcium content in 100 g of a product. Calibration included comparing the mean calcium intake (dependant-sample t-test, correlation coefficient) and compatibility of population distribution (chi^2 test) in calcium intake classes (<66.7% of the Polish RDI at the safe level = calcium deficiency risk; 66.6–90% of RDI = no calcium deficiency risk; >90% of RDI = no calcium deficiency risk). Moreover sensitivity, specificity and accuracy indices were calculated for the prepared test.

No differences between mean calcium intake from dairy products estimated by the ADOS-Ca test and the 24-hour recall method repeated seven times (men: 619 mg vs. 661 mg; p=0.263; women: 434 mg vs. 442 mg; p=0.645) were revealed, but calcium intake correlation was noted. No differentiation in the population distribution in three calcium intake classes was noted, and the percentage of people classified accurately into the same class by the ADOS-Ca test and the 24-hour recall method repeated seven times was high (71% of the population). The noted high sensitivity index value (88%), shows high ability of the test to classify people properly to a group under calcium deficiency risk. The prepared ADOS-Ca diagnostic test was proved to be a good tool for quantitive evaluation of calcium intake from dairy products and enabled accurate classification of people with different calcium intake with regards to risk of its deficiencies.

INTRODUCTION

Food intake evaluation methodology includes multiple research methods. In the recent years, however, the need for simple, cheap and reliable research tools, enabling carrying out epidemiological studies, has greatly increased [Drewnowski, 2001]. The food frequency questionnaire (FFQ) is a valuable measure tool used for gathering data to evaluate correlations between nutrition manner and diet-related diseases incidence. That method enables gathering more precise information about habitual food intake than for example the 24-hour recall method. The unquestionable advantage of food frequency questionnaires is the possibility to correlate results with health indicators. Their advantage includes also quite fast data gathering [Gibney *et al.*, 2002; Thomas, 2001]. Food frequency questionnaire method is by all means cheaper than other nutrition interviews methods, does not require high commitment of the respondent, thus is not burdensome [Gibney *et al.*, 2002; Willett, 1998]. That is why this method is suitable for nutrition manner evaluation and can be successfully used in epidemiological studies to identify people with low, medium and high products intake, terciles or quartiles of specified nutrients intake, like calcium, iron, vitamin C.

The review of literature concerning calcium intake by people proved that the most often used was the 24-hour recall method repeated only once, seldom it was repeated three or seven times [Górnicka & Gronowska-Senger, 2003; Szymelfejnik, 2004; Wądołowska *et al.*, 2004]. Laboratory methods were used sporadically [Nabrzyski & Wituszyńska, 1992; Olejnik *et al.*, 1999; Schlegel-Zawadzka *et al.*, 1998]. However, despite common usage of the 24-hour recall method in nutrition manner evaluation for different groups of people, single nutrition interview application for concluding about the organism nutritive state is limited. The individual people have considerable changes in day-by-day intake. Because of this the 24-hour recall method is not an adequate tool for single person's habitual intake description and correct classification [Gibney *et al.*, 2002]. It was noted that the single 24-hour recall method in the case of calcium intake gives higher amounts than the same method but repeated three times, thus more often classifying single persons into higher intake class [Wądołowska *et al.*, 2004].

The review of world literature concerning questionnaires validation showed the possibility of using that method for calcium intake determination in various groups

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of people. High correlation between calcium intake evaluated by the FFQ and its validation methods was noted, while most often those methods were weighed or estimated current records of several days or the 24-hour recall method. The correlation for the validated FFQ ranged from 0.52 to 0.90 [Date *et al.*, 1996; Fornes *et al.*, 2003; Fregapane & Asensio-Garcia, 2000; Heath *et al.*, 2000; Mason, 2001; Marshall *et al.*, 2003; Taylor & Goulding, 1998]. The lowest correlation (r=0.39 and r=0.47) was obtained by Heath *et al.* [2000] and Xu *et al.* [2000]. Despite the fact that the FFQ usually overestimated the mean calcium intake [Fornes *et al.*, 2003; Taylor & Goulding, 1998], the possibility of classifying most people properly into appointed intake percentiles [Lietz *et al.*, 2002] or quartiles [Heath *et al.*, 2000; Taylor & Gouldinga, 1998] was obtained. In the Taylor & Goulding's study [1998] 68% of the children population with actual calcium intake below 800 mg (Australian safe intake level) and 79% of the children population with calcium intake over the Australian safe intake level were properly classified into the same quartile. The food frequency questionnaires validation proved their high reproducibility by comparing calcium intake in two studies (test – re-test) which were made in some period of time [Fornes *et al.*, 2003; Heath *et al.*, 2000]. The national literature has had only a few comparisons of calcium intake estimated by various methods so far. Rutkowska *et al.* [2000] showed a high compatibility of analytical and theoretical results. According to the Central Statistical Office (GUS) data from household budgets studies, mean levels of calcium intake were identical and the theoretical values amounted to 98–103% of the analytical values. Bigger differences between the analytical and theoretical results were obtained by Nabrzyski & Wituszyńska [1992]. In daily diet (DD) of babies below one year the analytical results ranged from 85.8% to 104.5% of values from questionnaire, and analytical method agreed with 91.5% of values from questionnaire on average, giving thus average correlation between results. Significant correlation between results obtained by analytical and theoretical methods was noted by Schlegel-Zawadzka *et al.* [1998] for calcium in children's hospital meals (analytically 155.9%±58.8 of calcium obtained by computational method was found). On the other hand according to Olejnik *et al.* [1999] calcium intake determined by computational method in young boys' diet amounted from 1058 mg to 1178 mg and was higher by 10–11% than the results obtained by analytical method (from 986 mg to 1106 mg). Nadolna *et al.* [1985] in case of calcium proved small differences between analytical and theoretical values in daily diets determined by the Central Statistical Office (GUS) data in 1973 (-2%) and in 1980/81 (-4%), in dormitories (+3%) and special diets (+8%). Big differences were noted between results obtained in dormitories diets (from -46% to +65%) and high compatibility of the Central Statistical Office (GUS) daily diet results (from -7% to +2%).

The aim of the study was to prepare a tool for quantitive calcium intake evaluation – a diagnostic test constructed as a dairy products intake frequency questionnaire and its calibration. A reliable questionnaire should be validated (Latin *validus* – strong, effective) or calibrated by giving it accuracy and checking it with a referential method, *i.e.* with nutritional status assessment method (validation) or food intake assessment method (calibration) [Jędrychowski, 1982; Fraser & Stram, 2001]. The constructed questionnaire calibration was carried out by (i) comparing with another intake evaluation method and (ii) evaluating diagnostic accuracy of the questionnaire.

MATERIALS AND METHODS

In years 2001–2002 a dairy products intake frequency questionnaire was worked out and validated, which was tentatively called the diagnostic questionnaire for intake estimation of calcium (**A**nkieta **D**iagnostyczna do **O**szacowania **S**pożycia wapnia). That name was abbreviated to ADOS-Ca. Finally, the questionnaire was called diagnostic test for calcium intake evaluation, but the abbreviation ADOS-Ca remained. The questionnaire validation was carried out on a group of 123 people aged 22.6±0.1, studying at the University of Warmia and Mazury at the Faculty of Food Sciences and at the Medical Academy in Poznań at the Pharmaceutical Department. The 24-hour recall method repeated seven times was carried out and the dairy products intake frequency was determined on the basis of the ADOS-Ca questionnaire. The group selection for the worked out diagnostic test verification was made taking into consideration education profile. It was counted on bigger interest in the research and knowledge of more laborious 24-hour recall method, which made gathering complete data easier.

After the gathered material verification 90 people were qualified for the analysis (Olsztyn – 43 people, Poznań – 47 people), including 26 men and 64 women. Interviews and diagnostic tests that had less than 7 full 24-hour recall interviews, interviews without full information of the amount of consumed products and drinks, and tests which had not determined the frequency or amount of all dairy products were rejected (33 people – 26.8% of the initial population). For questionnaire validation only complete information about all drinks and products intake during the week and information of consumed dairy products amount and frequency on the basis of the ADOS-Ca test were used. Finally there were 630 nutrition interviews and 90 ADOS-Ca tests qualified in total.

Multiple 24-hour recall method. The calcium intake evaluation among the university students was carried out using the 24-hour recall method repeated seven times. Proper forms were used for gathering information about intake of all products, dishes and drinks in 7 consecutive days. The amount of consumed dishes, products and drinks was estimated on the basis of the "Album of food products with different portion size" published by the Institute of Food and Nutrition in Warsaw [Szczygłowa *et al.*, 1991]. Calcium intake from dairy products and its content in daily diet (DD) was determined using computer database prepared in the Microsoft Access 7.0 computer program on the basis of the nutritive values tables [Kunachowicz *et al.*, 1998]. Calcium intake from dairy products was calculated for daily diet of seven consecutive days for each studied person. Next mean calcium intake from dairy products and calcium content in daily diet was calculated as a mean of seven days for

each person. Those values were used for mean calcium intake estimation in the population of students. Mean calcium content in daily diets of women and men was compared to nutrition recommendations (RDI) [Ziemlański *et al.*, 1994], agreeing for the evaluation intake the safe level of intake for people aged 19–25, for men – body mass of 75 kg and medium physical activity, for women – body mass of 60 kg and small physical activity. Mean body mass for men and women was determined on the basis of the carried out anthropometrical measures [Szymelfejnik, 2004].

ADOS-Ca diagnostic test for calcium intake evaluation. Filling in of the diagnostic test was preceded by detailed description of research aim and answering ways. During the filling in of the questionnaire the person responsible for the research was always present in the lecture hall. The worked out and applied in the research diagnostic test was anonymous and included three parts. The first part of the test concerned socio-economic characteristics of the analysed people. It included questions about place of residence, place of living during the studies, parents' education and economic situation (self evaluation). The second, major part of the test, was a dairy products intake frequency questionnaire, including questions about habitual amount and frequency of 11 dairy products intake during last 6 months. The questionnaire included such products as: (1) milk; (2) hard cheese; (3) processed cheese; (4) fresh cheese; (5) homogenized cheese; (6) cheese for spreading like "Fromage" or "Surage"; (7) natural yoghurt; (8) fruit yoghurt; (9) kefir, buttermilk or flavoured milk beverage; (10) ice-cream; (11) cream.

For each of the above mentioned products habitual frequency was estimated by choosing one of eight possible answers (closed questions) (Table 1). Next each product was described by habitually consumed amount expressed by home-size, by choosing one of the possible answers (closed questions). Each product had a prepared individual list of answers, taking into consideration available on the market unit packages (*e.g.* small or big package of natural/fruit yoghurt, kefir; slices, triangles or slabs of processed cheese) and/or habitually consumed dairy products portions (*e.g.* slices of hard cheese, glasses of milk *etc.*). Taking into consideration seasonal consumption of ice-cream, respondents were asked about the frequency and amount of their consumption during and out of summer season. Mean ice-cream intake during the whole year was calculated agreeing the summer season duration as 5/12 of year. Because of different forms of milk intake respondents were asked about its intake in the form of drink, *e.g.* milk, cacao, white coffee and in the form of milk soup, *e.g.* with corn flakes, muesli.

TABLE 1. Dairy products intake frequency indices.

Intake frequency	Intake frequency index
Never	0
More seldom than once a week	1/30
Once-twice a week	1/7
3–4 times a week	3/7
5–6 times a week	5/7
Once daily	1
Twice daily	2
3 times daily	3

The third part of the diagnostic test included questions concerning nutrition habits, *i.e.* dishes habitually consumed during the day, type of the applied diet. That part included also questions enabling determination of lifestyle elements, having influence on consumed calcium usage and included to osteoporosis risk factors (level of physical activity, exposition to sun light, habit of milk and dairy products consumption in the past, incidence of fractures and bones pains among the respondent and osteoporosis among respondent's family, consumption of such drinks as coca-cola and stimulants - tea, coffee, drinks with various alcohol content, smoking currently and in the past). Diagnostic test included also questions concerning intake of products enriched in calcium (*e.g.* juices, corn flakes) and calcium supplementation. It included also additional questions referring to women, concerning age of first menstruation, length of possible break in menstruating and used hormonal contraception.

Calculating calcium intake from dairy products on the basis of the dairy products intake frequency questionnaire. The defined possible answers about the amount and frequency of consumed dairy products had numerical values attributed. The amount of products described by home-size and unit packages was calculated into grams. Intake frequency indices were ascribed to categories of products intake frequency (Table 1). Calcium content in 100 g of dairy products was agreed on the basis of the nutritive values tables [Kunachowicz *et al.*, 1998]. Calcium intake from particular products was calculated on the basis of the formula (1) and was presented in mg/person/day, *e.g.* calcium intake from milk:

$$Ca_{milk} = a_{milk} \times (b_{milk} \times c_{milk}/100) \quad (1)$$

where: Ca_{milk} – calcium intake from milk (mg/person/day); a_{milk} – product intake frequency index, *e.g.* milk; b_{milk} – the amount of product in single consumption, *e.g.* milk (g); and c_{milk} – calcium content in 100 g of product, *e.g.* milk (mg/100 g).

Total calcium intake from dairy products was calculated according to formula (2), adding calcium intake from all 11 groups of dairy products:

$$Ca_{from\ dairy\ products} = Ca_{drank\ milk} + Ca_{milk\ from\ milk\ soup} + Ca_{hard\ cheese} + Ca_{processed\ cheese} + Ca_{fruit\ yoghurt} + Ca_{natural\ yoghurt} + \ldots + Ca_{cream} \quad (2)$$

Results usage and statistical verification of the ADOS-Ca test. The statistical analysis was carried out using the StatSoft's STATISTICA PL v. 6.0 computer program. Compatibility of the analysed features distribution with normal distribution was checked using the Kołmogorow-Smirnow test. Calcium content in daily diet on the basis of the 24-hour recall method repeated seven times (mg/person/day) and total calcium intake from dairy products according to the ADOS-Ca test (mg/person/day) was presented calculating mean values ($\bar{x}$) and standard error of mean (*SEM*).

The worked out ADOS-Ca test validation included comparing of calcium intake determined by the ADOS-Ca test with calcium intake determined by the 24-hour recall

method repeated seven times on the basis of dependant-sample t-test and the t-Kendall correlation coefficient. On the basis of the results it was found [Szymelfejnik, 2004] that dairy products amounted to 74% of the calcium intake in daily diet. Calcium intake from dairy products determined by the ADOS-Ca test was presented in separated three intake classes (Table 2). The calcium intake classes were created agreeing 66.7% and 90% of the Polish RDI on the safe level as cut off points. The compatibility of the population distribution in the calcium intake classes was verified by the chi^2 test.

In order to evaluate the ADOS-Ca diagnostic test accuracy people were divided into two diagnostic classes: under risk (insufficient consumption) and without risk (sufficient and low consumption) of calcium deficiency (Table 2). Next sensitivity, specificity, precision and accuracy indices, precision errors and prediction indices were calculated [Jędrychowski, 1982].

RESULTS

The comparison of calcium intake from dairy products in the students' diets estimated by the ADOS-Ca diagnostic test and by the 24-hour recall method repeated seven times did not reveal any differences between mean calcium intake from dairy products estimated by two above-mentioned methods both for men and for women (men: 619 mg *vs*. 661 mg; p=0.263; women: 434 mg *vs*. 442 mg; p=0.645) (Table 3). Calcium intake from dairy products estimated by the ADOS-Ca test was lower by about 8% in men's diets and lower by about 4% for women in comparison to calcium amount from dairy products on the basis of the 24-hour recall method repeated seven times (Table 3).

Statistical analysis of correlations between calcium intake from dairy products according to the ADOS-Ca test and the 24-hour recall method proved very high and significant correlation in men's diet (r=0.79 p<0.001) and high and significant correlation in women's diets (r=0.64 p<0.001; Table 3).

The comparison of calcium amount from particular dairy products in men's and women's diets according to the ADOS-Ca diagnostic test and 24-hour recall method repeated seven times is displayed in Table 4. In men's diets 4 out of 11 analysed products were revealed to correlate significantly with the amount of calcium estimated by the ADOS-Ca diagnostic test and the 24-hour recall method:

TABLE 2. Calcium intake classes.

Ca intake form dairy products	Ca intake class in daily diet	Description: intake – risk level	Diagnostic classes
Ca<543mg	Ca<66.7% of RDI*	insufficient – high risk of deficiencies	Under risk
543mg≤Ca<733mg	66.7%≤Ca<90% of RDI	low – medium risk of deficiencies	Without risk
Ca≥733mg	Ca≥90% of RDI	proper – no risk of deficiencies	

* Polish recommended daily intake at the safe level

TABLE 3. Comparison of total calcium intake from dairy products (mg/person/day) according to the ADOS-Ca test and the 24-h recall method repeated seven times.

Population	Calcium amount from dairy products		p	Ca from ADOS-Ca *vs*. Ca from 7x 24h interview (interview=100%)	
	ADOS-Ca	7x 24h			
	$\bar{x}$ ± SEM	$\bar{x}$ ± SEM		Me ± QD	r, p_{tau}
Total	492 ± 29.6	510 ± 28.2	0.323	94.4 ± 46.3	
Men	619 ± 54.6	661 ± 55.2	0.263	92.5 ± 32.4	r=0.79 p_{tau} <0.001
Women	434 ± 33.0	442 ± 28.7	0.645	96.4 ± 49.3	r=0.64 p_{tau} <0.001

p – the dependant-sample t-test significance level, r – the tau-Kendall correlation coefficient, p_{tau} – the tau Kendall correlation significance level

TABLE 4. Comparison of calcium intake from particular dairy products (mg/person/day) according to the ADOS-Ca test and the 24-h recall method repeated seven times.

Products	Men (N=28)		r	Women (N=62)		
	ADOS-Ca	7x 24h		ADOS-Ca	7x 24h	
	Me ± QD	Me ± QD		Me ± QD	Me ± QD	
Milk	95.4 ± 315.6	149 ± 274	0.42*	103 ± 197	143 ± 181	0.46*
Hard cheese	80.7 ± 92.2	161 ± 187	0.15	46.1 ± 99.1	78.1 ± 123.3	0.55*
Fruit yoghurt	85.5 ± 61.3	9.57 ± 57.4	0.36*	28.5 ± 65.6	28.7 ± 86.1	0.35*
Natural yoghurt	36.4 ± 100.8	0.00 ± 36.4	0.17	8.50 ± 32.2	1.82 ± 55.9	0.40*
Buttermilk, kefir	30.6 ± 65.7	0.00 ± 117.7	0.58*	7.13 ± 27.0	0.00 ± 23.6	0.38*
Fresh cheese	12.9 ± 22.7	19.7 ± 23.1	0.33*	6.43 ± 16.3	14.8 ± 22.4	0.38*
Processed cheese	12.7 ± 20.1	9.18 ± 53.7	0.22	6.12 ± 10.0	0.00 ± 15.7	0.45*
Ice-cream	3.22 ± 6.13	0.00 ± 0.00	0.10	4.46 ± 7.40	0.00 ± 0.00	-0.07
Cream	0.00 ± 0.75	5.86 ± 7.95	0.16	0.26 ± 1.50	3.47 ± 8.49	0.19*
Homogenized cheese	4.25 ± 4.25	0.00 ± 0.00	0.25	4.25 ± 3.49	0.00 ± 0.00	0.39*
Cheese for spreading	1.10 ± 2.28	0.00 ± 0.00	0.24	0.55 ± 1.10	0.00 ± 0.00	-0.05

Me – median, QD – quartile deviation, r – tau-Kendall correlation coefficient, * – correlation significant

milk (r=0.42), fruit yoghurt (r=0.36), buttermilk and kefir (r=0.58), fresh cheese (r=0.33, Table 4). Milk, fruit yoghurt, buttermilk/kefir and fresh cheese, *i.e.* products with the noted above correlations, were situated on the 1st, 3rd, 5th and 6th position as regards dairy products intake by men.

In women's diets significant statistical correlations were noted for 9 out of 11 dairy products in the calcium level estimated by the ADOS-Ca diagnostic test and the 24-hour recall method: milk (r=0.46), hard cheese (r=0.55), fruit yoghurt (r=0.35), natural yoghurt (r=0.40), buttermilk and/or kefir (r=0.38), fresh cheese (r=0.38), processed cheese (r=0.45), cream (r=0.19), homogenised cheese (r=0.39, Table 4).

The men's and women's population distributions in three classes: insufficient, low and sufficient according to the RDI calcium intake, estimated by the ADOS-Ca test and the 24-hour recall method, did not differ significantly (Table 5). No differentiation related with sex was found in the accuracy of calcium intake classification by the ADOS-Ca test and the 24-hour recall method (p_{chi}^2=0.090, Table 6). Percentage of people classified properly into the same class by the test as in the referential method was high and amounted for the analysed population to 71%. On the other hand percentage of people classified by the test into lower or higher class was similar and amounted to 13% and 16% of the population, respectively.

The number of people classified into two diagnostic groups: under risk of calcium deficiencies and without risk of calcium deficiencies is presented in Table 7. The calculated diagnostic accuracy of the ADOS-Ca test are displayed in Table 8. Sensitivity index of the worked out ADOS-Ca diagnostic test amounted in men's and women's groups to 78% and 90%, respectively (total population 88%), and specificity index 74% and 62%, respectively

TABLE 5. Comparison of studied sample distribution (%) of calcium intake classes according to the ADOS-Ca test and the 24-h recall method repeated seven times.

Calcium intake	Total (N=90)		p chi^2	Men (N=28)		p chi^2	Women (N=62)		p chi^2
	7x 24 h	ADOS-Ca		7x 24 h	ADOS-Ca		7x 24 h	ADOS-Ca	
Ca≤ 90% of RDI	14	19	>0.1	36	36	>0.1	3	11	>0.1
66.7%≤Ca< 90% of RDI	22	13	>0.1	32	21	>0.1	18	10	>0.1
Ca<66.7% of RDI	64	68	>0.1	32	43	>0.1	79	79	>0.1

p – chi^2 test significance level, % of RDI – percentage of the Polish recommended daily intake at the safe level

TABLE 6. Comparison of accuracy of studied sample distribution in calcium intake classes according to the ADOS-Ca test and the 24-h recall method repeated seven times.

Accurate/inaccurate classification	Total(N=90)		Men(N=28)		Women(N=62)		chi^2 test
	N	%	N	%	N	%	
ADOS-Ca classifies higher than 7x 24h	14	16	4	14	10	16	
Classification accurate	64	71	17	61	47	76	0.090
ADOS-Ca classifies lower than 7x 24h	12	13	7	25	5	8	

N – sample size, % – population percentage

TABLE 7. Number of people in groups under or without risk of calcium deficiencies according to the ADOS-Ca test and the 24-h recall method repeated seven times.

Referential method - the 7 times 24-h recall method	The results of the ADOS-Ca diagnostic test								
	Total (N=90)			Men (N=28)			Women (N=62)		
	Under risk	Without risk	Σ	Under risk	Without risk	Σ	Under risk	Without risk	Σ
Under risk	51	7	58	7	2	9	44	5	49
Without risk	10	22	32	5	14	19	5	8	13
Σ	61	29	90	12	16	28	49	13	62

N – sample size, Σ – sum

TABLE 8. Values of diagnostic indices of the ADOS-Ca test.

Test accuracy index			Total (N=90)	Men (N=28)	Women (N=62)	p
Sensitivity index	Cz	%	88	78	90	0.132
Specificity index	S	%	69	74	62	0.263
Accuracy error (+) = alfa	Bt(T)	%	12	22	10	0.132
Accuracy error (-) = beta	Bt(N)	%	31	26	38	0.263
Prediction index (+)	D(T)	%	84	58	90	0.001
Prediction index (-)	D(N)	%	76	88	62	0.015
Precision error (T)	Bd(T)	%	16	42	10	0.001
Precision error (N)	Bd(N)	%	24	12	38	0.015
Jouden's index (wages agreed α=1, β=0.5)		J	72.2	64.6	70.6	0.574

N – sample size, p – chi^2 test significance level

(total population 69%). Low positive (alfa: men 22%, women 10%) and negative (beta: men 26%, women 38%) accuracy errors were noted. For women higher prediction index was noted for positive cases, *i.e.* under calcium deficiencies risk, than for men (90% *vs*. 58%; p=0.001) and than for lower negative prediction index (62% *vs*. 88%; p=0.015). It means that the positive precision error, *i.e.* classifying people into group under risk, was lower for women than for men (10% vs. 42%; p=0.001), and the negative precision error, *i.e.* classifying people into group without risk, was lower for men (12% *vs*. 38%; p=0.015).

DISCUSSION

The worked out ADOS-Ca diagnostic test calibration carried out by the 24-hour recall method repeated seven times proved its usefulness for calcium intake estimation. Intake estimated by the test was on average lower by about 5% than in the case of the multiple 24-hour recall method. However no significant differences between the calculated values were noted, like by Date's *et al.* [1996]. The noted high correlation coefficients of calcium intake from dairy products (over 0.5), obtained by the 24-hour recall method calibrating, indicate proper test's ability to estimate calcium intake for single persons [Frgeapane & Asensio-Garcia, 2000].

The percentage of people properly classified into the determined intake classes using the ADOS-Ca test and the 24-hour recall method amounted to 76% for women and 61% for men. This result should be concerned as satisfactory and better than that obtained by Heat *et al.* [2000], Lietz *et al.* [2002], Mason *et al.* [2001] and Taylor & Goulding [1998]. They received from 41% to 63% of proper classifications. The calcium intake evaluation on the basis of the ADOS-Ca test showed also more accurate classification of people into the same class than the single 24-hour recall method in comparison to the 24-hour recall method repeated three times [Wądołowska *et al.*, 2004]. On the basis of the ADOS-Ca test a similar percentage of people was classified into lower and higher intake class, while in the quoted study the single 24-hour recall method more often classified people into higher intake class, showing thus a higher calcium intake.

The very high sensitivity index value noted in the studied population (88%) indicated high ability of the test to proper classifying people into group under risk of calcium deficiencies. Next the specificity index value (69%) means good ability of the test classify people properly into group without risk of calcium deficiencies. The noted higher sensitivity index than the specificity index in the analysed population (88% *vs*. 69%; p=0.002) signifies that the test more accurately classifies people under risk of calcium deficiencies. Bigger beta error, *i.e.* false positive classification (recognising a person without risk as a person under risk) seems to have lower diagnostic value than false negative classification, *i.e.* recognising person with low calcium intake as a person without calcium deficiency risk. In the studied population frequency of insufficient calcium intake incidence for women was higher (79% of women) than for men (32% of men). Higher positive prediction index for women indicates that the ADOS-Ca test is more efficient in recognising cases that are highly frequent in the population.

Calcium content from dairy products in the students' daily diet estimated by the 24-hour recall method repeated seven times and the ADOS-Ca diagnostic test indicates a high correlation between the determined values. High correlation coefficients, accuracy of classification in intake ranges and values of the sensitivity, specificity and accuracy indices enable positive evaluation of the worked out test. The calculated indices' values show that the test may be used for calcium intake estimation in epidemiological studies. As no differentiation related with sex in the test's classification accuracy in comparison to the 24-hour recall method was revealed, it means that the test classified the studied people accurately regardless of sex. Simple test construction needs only short explanation of the research aim and answers choosing, which enables unattended filling in of the questionnaire by adults. The dairy products intake frequency method is simpler than the referential method applied in the research– the 24-hour recall method, which requires remembering of all products and drinks consumed in the last 24 hours, including their amount [Gibney *et al.*, 2002].

The received results indicate that the test enables proper characteristics of calcium intake in the population, *i.e.* separating people with insufficient, low and proper according to the recommended level of calcium intake. The worked out test enables showing people under risk of calcium deficiencies, which is extremely important for studying connections between nutrition and health/illness. It enables using the ADOS-Ca diagnostic test as an accurate tool for quantitive evaluation of calcium intake. Moreover additional information gathered in the test, concerning physical activity, habitual milk intake in the past, osteoporosis incidence in the family and lifestyle may better characterise the population under study with regard to the osteoporosis incidence risk.

CONCLUSIONS

High correlation between calcium intake from dairy products estimated by the ADOS-Ca test and the 24-hour recall method repeated seven times and no differences between mean values determined by both methods were revealed. High values of the sensitivity and specificity indices of the worked out test and proper people classification into determined calcium intake classes were noted, which enables positive evaluation of the elaborated diagnostic test as a tool precise enough for calcium intake evaluation and differentiation of its intake level.

The worked out ADOS-Ca diagnostic test was proved to be a good tool for quantitive evaluation of calcium intake from dairy products and enabled accurate classification of people with different calcium intake with regards to risk of its deficiencies.

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KALIBRACJA KWESTIONARIUSZA CZĘSTOTLIWOŚCI SPOŻYCIA PRODUKTÓW MLECZNYCH (ADOS-CA) DO OCENY SPOŻYCIA WAPNIA

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Celem pracy było opracowanie narzędzia do ilościowej oceny spożycia wapnia oraz jego kalibracja. Kalibrację testu ADOS-Ca przeprowadzono metodą wywiadu 24-godzinnego z 7 kolejnych dni. Badaniami objęto 90 osób (w wieku 22,6±0,1 lat), od których uzyskano kompletne informacje, tj. 630 wywiadów żywieniowych i 90 testów ADOS-Ca. Spożycie wapnia z produktów mlecznych określone testem wyrażono w mg/osobę/dobę i określono na podstawie spożywanej ilości produktów, wskaźników częstości spożycia (tab. 1) i zawartości wapnia w 100 g produktów. Kalibracja obejmowała porównanie średniego spożycia wapnia (test t dla prób zależnych, współczynnik korelacji) i ocenę zgodności rozkładów populacji (test chi^2) w klasach spożycia wapnia (<66,7% normy = ryzyko niedoborów wapnia; 66,6–90% normy = brak ryzyka niedoborów wapnia, >90% normy na poziomie bezpiecznym = brak ryzyka niedoborów wapnia, tab. 2). Ponadto wyznaczono wskaźniki czułości, swoistości i trafności opracowanego testu.

Nie wykazano różnic pomiędzy średnim spożyciem wapnia z produktów mlecznych określonym testem ADOS-Ca i 7-krotnym wywiadem 24-h (mężczyźni: 619 mg *vs*. 661 mg; p=0,263; kobiety: 434 mg *vs*. 442 mg; p=0,645), jednocześnie odnotowano wysoką korelację podaży wapnia (tab. 3, 4). Nie odnotowano zróżnicowania rozkładów populacji w 3 klasach spożycia wapnia (tab. 5), a odsetek osób prawidłowo klasyfikowanych testem ADOS-Ca i 7-krotnym wywiadem 24-godzinnym do tej samej klasy był wysoki (71% populacji, tab. 6). Odnotowano wysoką wartość wskaźnika czułości (88%, tab. 8), wskazującą na wysoką zdolność testu do prawidłowego klasyfikowania osób do grupy z ryzykiem niedoborów wapnia. Opracowany test diagnostyczny ADOS-Ca okazał się dobrym narzędziem do ilościowej oceny spożycia wapnia z produktów mlecznych i umożliwił poprawną klasyfikację osób o różnym poziomie spożycia wapnia pod kątem ryzyka jego niedoborów w organizmie.