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CHARACTERISTICS OF STUDENTS EATING HABITS WITH THE SEPARATION OF THE NUTRITIONAL MODELS USING ADVANCED STATISTICAL ANALYSIS METHODS

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A study was conducted in order to identify and characterize the specific nutritional models of the student population. It included 190 male and 454 female students with a mean age of 20.7±1.68. The analyzed student food rations nutrient value was determined by the 24-hour recall method. The calculated energy and nutrient content in the food rations was reduced, and then compared with the nutrition norms for safe levels. For student nutritional model separation, a factor analysis (the main components method) and cluster analysis (objects grouping by the k-means method) was used. The food ration nutrient value differentiation of the students rated among particular clusters was verified on the basis of a single-factor variance analysis. Feature distributions were compared by a chi^2 test.

In the analyzed population, 3 specific nutritional models were separated: "low nutritive" (LN) – 50.6% of the total population, "with vegetable fats domination" (VF) – 25.6% and "dairy-vegetable-fruit" (DVF) – 23.8% of the population. The LN nutritional model was significantly more often stated among female students, the VF and the DVF among male students, and the DVF among urban residents. Students with the DVF habitually consumed a larger number of meals than the LN or the VF. In the variance analysis, a significant differentiation in the food ration nutrient value for students with different nutritional models was confirmed. Among students with LN , consumption below 50% of the norm was found *i.e.* for energy, carbohydrates, fiber, calcium, magnesium, iron, copper, vitamin A, vitamin E, vitamin B_1, vitamin B_2, vitamin PP, vitamin B_6 and vitamin C. For none of the analyzed students with the VF nutritional model was any PUFA intake <50% of the norm revealed, and only 1.2% of this subpopulation was characterized with a vitamin E intake <50% of the norm. The calcium intake <50% of the norm was found among a significantly smaller people percentage with the DVF in comparison to students with the LN and the VF (10.5% of the population *vs.* 70.9% and 73.3%). Analogous differences were found for fiber and vitamin C.

A wide differentiation in the university youth intake was found. There were 3 characteristic nutritional models identified with different nutritive value of food rations. A correlation between the university youth nutritional models and gender and place of residence was found. Most of female students characterized with the "low nutrition" nutritional model, and among male students the nutritional model "with vegetable fats domination" and "dairy-vegetable-fruit" predominated. The "dairy-vegetable-fruit" nutritional model was the best-balanced and best met the dietary guidelines.

INTRODUCTION

Polish students' nutritional habits and their relationships with environment factors represent a relatively well-known area of human nutritional behaviour [Duda *et al.*, 1997; Gacek, 2001; Olędzka *et al.*, 2001; Ostrowska *et al.*, 2001; Stopnicka & Szamrej, 2001; Trafalska & Grzybowski, 2001; Wądołowska, 2000; Wądołowska *et al.*, 1998; Wawrzyniak & Hamułka, 2002; Zielke *et al.*, 2000]. The literature describes typical nutritional habits, food ration nutritive values and determining factors, and also enables a comparison with data on students from other countries [Alvarez-Pineiro *et al.*, 1998; Montana & Lopez, 1996; Quiles *et al.*, 1996; Whybrow & Kirk, 1997]. The accessible works, however, are limited only to presentation of research results in the form of statistical measures designed to describe the typical or most commonly occurring behaviour (*e.g.* mean value, median) with the dispersion measures (*e.g.* standard deviation, standard error of the mean) [Duda *et al.*, 1997; Gacek, 2001; Quiles *et al.*, 1996; Trafalska & Grzybowski, 2001; Wądołowska, 2000; Wawrzyniak & Hamułka, 2002; Whybrow & Kirk, 1997; Zielke *et al.*, 2000]. Only a few authors give more specific information which enables, for example, showing the percentage of the population with specific intake levels [Quiles *et al.*, 1996; Trafalska & Grzybowski, 2001] or specific nutritional quality [Koszewski & Kuo, 1996; Olędzka *et al.*, 2001]. Each analysis is held with reference to the whole population included in the research or after separating subpopulations according to pre-arranged criteria, such as *e.g.* gender, demographical, social and health categories *etc*. In this way, the researcher assumes the existence of a correlation with an earlier characterized, described and often quantified factor, and the conducted research is designed to verify the stated hypothesis. This classic way of conduct is extremely valuable in cases of known factors differentiating human nutritional habits, and moreover, it provides information for making a generalization. Its unquestionable disadvantage is its

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"averaging" effect. Moreover, there are some circumstances which suggest that nutritional habits vary, not only between individuals and groups (*e.g.* groups of culture, age, gender), but also within these groups and the "division line" does not run according to any known demographic-socio-health criteria [Gibson, 1990]. The recognition of this differentiation needs application of non-classical statistical methods.

This task is superbly fulfilled by cluster analysis, worked out almost a hundred years ago by the Polish scientist, anthropologist, statistician and demographist Jan Czekanowski (1882–1965). This analysis enables separation on the basis of a mathematically-defined similarity between the homogeneous groups of objects, similar to each other in many features (multidimensional analysis), while the criteria of this similarity can be earlier unknown [Marek & Noworol, 1987; Mezzich & Solomon, 1980]. This method was successfully applied for identification of the nutritional habits increasing colon tumor risk [Stattery *et al.*, 1998], seniors' nutritional habits [Schroll *et al.*, 1996; Wierzbicka *et al.*, 2001], and youth nutritional characteristics [Wądołowska *et al.*, 2003]. It seems to be a very useful tool which may provide new, valuable information about internal differentiations in the nutritional habits of groups, including students. The obtained results should clarify whether the described Polish students nutrition features such as: small number of meals during the day, incorrect energy intake structure, low female students' food ration nutritive value and insufficiency for male students are really common features of the whole society or are there some subgroups in it with different nutritional profiles [Duda *et al.*, 1997; Gacek, 2001; Olędzka *et al.*, 2001; Ostrowska *et al.*, 2001; Stopnicka & Szamrej, 2001; Trafalska & Grzybowski, 2001; Wądołowska, 2000; Wądołowska *et al.*, 1998; Wawrzyniak & Hamułka, 2002; Zielke *et al.*, 2000].

The research was conducted in order to separate and characterize the specific nutritional models of youth studying at the University of Warmia and Mazury in Olsztyn.

MATERIAL AND METHODS

The research included 644 persons (made up of 29.5% men and 70.5% women) studying in the years 1996–1998 at the Faculty of Food Science at the University of Warmia and Mazury in Olsztyn. The research was conducted after having verified the hypothesis that the eating habits and nutritional status of people studying at different faculties of the university did not differ significantly [Wądołowska, 1992; Wądołowska & Cichon, 1996]. The participation in the research was proposed to all students in the first and the fourth year of studies. In subsequent years the research covered 69% to 95% of the population, including students in the first year of study (from 69% to 74% of the population) and the fourth year students (from 89% to 95% of the population). The average age of the examined population amounted to 20.7±1.68 years (18–26 years old), and the BMI index for women was 21.4±2.73 kg/m^2 and for men it was 22.9±2.58 kg/m^2.

The food ration nutritive value was determined by means of the 24-hour recall method [Charzewska *et al.*, 1997, Gibson, 1990]. The nutrition interviews were carried out with each respondent once, using the "Album of food products with different portion size" [Szczygłowa *et al.*, 1991]. The interviews were carried out on every day of the week, maintaining the proper proportions between the interviews gathered in subsequent days, including weekends and weekdays. In the calculations, the computer program "Dietetyk" v. 2.0 and the products' content and nutritive value tables [Nadolna *et al.*, 1994; Łoś-Kuczera, 1990] were used. The calculated energy and nutrient contents were reduced by 10%, excluding vitamin A, for which a 25% reduction was accepted, vitamin B$_1$ – 20%, vitamin B$_2$ – 15%, and vitamin C – 55%. The energy and nutrient content in the food rations were compared with the daily recommended intake (DRI) for a safe level for women and men aged 19–25 with moderate physical activity [Ziemlański *et al.*, 1994], and in the case of cholesterol and fiber – with the dietary guidelines [WHO, 1990]. The recommendations for fiber evaluation was set at 27 g, and for cholesterol – 300 mg. In order to define a low nutritional-level, connected with a very low nutrient intake, the realization of DRI at the level of 50% of the safe level was arbitrarily agreed to be a cut-off value and the percentage of subjects with an intake under this level was defined.

To separate the characteristic student nutritional models, a factor analysis and cluster analysis was used. In the statistical analysis, the output variables were 20 features which characterized the DRI or dietary guidelines realization percentage (Table 1). The distribution examination of these features in the total population revealed (for most of

TABLE 1. Matrix of the factor loadings of particular factors after rotation Varimax normalized.

Input variables (% of the norm)	Factor 1: Ca, P, vitamin B$_2$, Zn	Factor 2: PUFA, vitamin E	Factor 3: Vitamin C, fiber	Factor 4: Cholesterol
Energy	0.57	0.54	0.33	0.23
Protein	0.61	0.41	0.14	0.43
Fat	0.48	0.65	0.11	0.36
Carbohydrates	0.60	0.35	0.49	-0.04
Cholesterol	0.22	0.19	-0.03	0.76
PUFA	0.09	0.87	0.08	0.10
Fiber	0.42	0.19	0.72	-0.05
Ca	0.83	-0.08	0.14	0.07
P	0.80	0.24	0.27	0.31
Mg	0.66	0.21	0.54	0.11
Fe	0.43	0.33	0.55	0.37
Zn	0.74	0.34	0.26	0.27
Cu	0.51	0.29	0.61	0.14
Vitamin A	0.15	-0.06	0.44	0.49
Vitamin E	0.08	0.83	0.21	0.13
Vitamin B$_1$	0.49	0.38	0.48	0.31
Vitamin B$_2$	0.77	0.10	0.14	0.33
Vitamin PP	0.19	0.36	0.38	0.51
Vitamin B$_6$	0.30	0.40	0.49	0.53
Vitamin C	0.04	0.06	0.75	0.16
Explained variation	5.25	3.38	3.46	2.34
Variance participation (%)	26	17	17	12

them) multi-modality, indicating distribution discordance with the normal distribution. This permitted conducting further statistical analysis into separating homogeneous subpopulations from the total population. On the basis of the factor analysis, 4 main factors were separated. The main components method was used, putting the factors into a Varimax normalized rotation. The main factors were identified by taking as the limit value the factor values (correlation coefficients) between the output variables and the created factors r>0.7 (Table 1) [Stanisz, 1998; Instruction of the STATISTICA PL v.6.0 computer program].

Factor 1 was determined by four output variables, *i.e.* DRI realization percentage for calcium (r=0.83), phosphorus (r=0.80), vitamin B_2 (r=0.77) and zinc (r=0.74); factor 2 – by two variables, *i.e.* DRI realization percentage for the PUFA (r=0.87) and vitamin E (r=0.83); factor 3 – by two variables, *i.e.* DRI realization percentage for vitamin C (r=0.75) and dietary guidelines percentage realization for fiber (r=0.72); factor 4 – by one variable, *i.e.* dietary guidelines percentage realization for cholesterol (r=0.76).

In the cluster analysis, the k-means method [Marek & Noworol, 1987] was used for object grouping. As output variables in the cluster analysis, 4 factors created in the factor analysis were agreed. On the basis of the cluster analysis, 3 internally homogeneous clusters were created in the total population characterizing the subpopulation's nutritional models (Table 2). The solution was found in 7 iterations.

The differentiation of the food rations nutritive value of subjects numbered among individual clusters was verified on the basis of the single-factor variance analysis (ANOVA). The features distribution in the analyzed categories was compared by the chi^2 test. The statistical analysis was carried out with the use of the computer program STATISTICA PL v.6.0, with a p≤0.05 significance level.

RESULTS

The three separated clusters characterizing the students' nutritional models were named using Euclid's clusters with mean values stated for 4 newly created factors (Table 2). While naming the clusters, the nutritive value (cluster 1) or products that stated their main source in the food rations (cluster 2 and 3) were appealed to. The method of data collection made it impossible to present the data on the product intake according to the groups in the tables, yet the data analysis confirmed the correctness of the names given to the separated clusters.

Cluster 1 was called the "low nutrition" nutritional model (LN), because the mean values of all 4 main factors were the lowest (factor 1: -0.38±0.59, factor 2: -0.53±0.55, factor 3: -0.39±0.69, factor 4: -0.14±0.78). This means that the nutrition of subjects from this cluster had the lowest intake of all nine nutrients (PUFA, cholesterol, vitamin B_2, vitamin E, vitamin C, fiber, Ca, P, Zn), creating 4 main factors and indicates the lowest food ration nutritive value (Table 2). The cluster size amounted to 326 persons, which represented 50.6% of the population. The membership in this cluster was not connected with the application of slimming diets. Slimming diets were declared by 27 persons in total (4.2% of the total population), including 21 persons which consumed in the manner called "low nutrition". The nutritional habits of the people losing weight had no influence on the mean nutritive value declared by all people included in cluster 1. The mean energy intake by female students losing weight included in cluster 1 (N=18) did not differ significantly from the mean energy intake of female students from this cluster (N=276, 1186±554 kcal *vs.* 1335±413 kcal daily, respectively; p=0.1482). Similarly, mean energy intake by male students losing weight and included in cluster 1 (N=3) did not differ significantly from the mean energy taken in by male students with a "low nutrition" nutritional model (N=50, 1347±191 kcal *vs.* 1790±471 kcal daily, respectively; p=0.1138).

Cluster 2 was called the nutritional model "with vegetable fats domination" (VF). It had the highest value of factor 2 (1.17±0.85), described by DRI realization percentage for PUFA and vitamin E. The values of factor 3 and 4 were average (0.18±0.95 and 0.45±1.26, respectively), and the factor 1 value was the lowest (-0.38±0.70). This indicates that only factor 2 differentiated the separated clusters and was a characteristic feature of cluster 2. The cholesterol intake did not differentiate the separated clusters, despite the separation of this feature in the feature analysis as the feature distinguishing (but not differentiating) the consumption of the student group analyzed. The higher PUFA and vitamin E consumption suggests a higher share of vegetable-originating fats in the food rations. Cluster 2 included 165 people (25.6% of the population).

Cluster 3 was named the "dairy-vegetable-fruit" nutritional model (DVF). It had the highest factor 1 value (1.22±1.00), described by the DRI realization for Ca, P, vitamin B_2 and Zn and also a moderately high factor 3 value (0.64±1.20), described by the DRI realization for vitamin C and dietary guidelines percentage realization for fiber (Table 2). The values of factors 2 and 4 were average (-0.14±0.83 and -0.18±0.96, respectively). The higher content in the food rations of Ca, P, vitamin B_2 and Zn and moderately high vitamin C and fiber suggests a high level of

TABLE 2. Clusters mean values and the characteristics of nutritional models.

Cluster	Euclid's clusters means values (x±SD)				Nutritional model
	Factor 1: Ca, P, vitamin B_2, Zn	Factor 2: PUFA, vitamin E	Factor 3: vitamin C, fiber	Factor 4: cholesterol	
Cluster 1 N=326	-0.38±0.59	-0.53±0.55	-0.39±0.69	-0.14±0.78	low nutrition (LN)
Cluster 2 N=165	-0.38±0.70	1.17±0.85	0.18±0.95	0.45±1.26	with vegetable fats domination (VF)
Cluster 3 N=153	1.22±1.00	-0.14±0.83	0.64±1.20	-0.18±0.96	dairy-vegetable- fruit (DVF)
ANOVA	F=279.0 p<0.0001	F=319.7 p<0.0001	F=72.8 p<0.0001	F=23.9 p<0.0001	

N – sample size, x – mean value, SD – standard deviation, p – significance level consumption of dairy products, vegetables and fruit by subjects from cluster 3 in comparison to subjects from clusters 1 and 2. The size of cluster 3 amounted to 153 subjects, which constituted 23.8% of the population.

The correlation between students' nutritional model and gender and place of residence was also analysed ($p<0.05$; Table 3). The "low nutrition" nutritional model was significantly more often stated among women than men (84.7%

TABLE 3. The characteristics of subpopulations with different nutritional models.

Category	Population percentage (%)				p chi²
		Nutritional model			
	Total N=644	LN N=326	VF N=165	DVF N=153	
Sex					<0.0001
men	29.5	15.3	44.2	43.8	
women	70.5	84.7	55.8	56.2	
Place of residence					0.0254
village	31.8	29.7	37.6	30.1	
town to 50,000 population	30.6	31.9	32.1	26.1	
town 50,000-100,000 population	19.9	23.3	13.9	19.0	
city >100,000 population	17.7	15.0	16.4	24.8	
Place of residence during the study year					NS
at home, by family	10.9	9.5	10.3	14.4	
in students' hostel	57.0	59.8	56.4	51.6	
in a rented room	32.1	30.7	33.3	34.0	
Year of studies					NS
1st year	53.9	50.9	57.0	56.9	
4th year	46.1	49.1	43.0	43.1	
Economic situation					NS
good	16.7	12.5	23.2	23.5	
average	75.6	79.9	66.1	73.5	
bad	7.7	7.6	10.7	2.9	
Father's education					NS
primary	38.7	37.7	41.8	37.2	
secondary	42.5	46.6	38.2	38.6	
university	18.8	15.6	20.0	24.2	
Mother's education					NS
primary	30.4	29.4	32.1	30.7	
secondary	57.9	61.7	55.8	52.3	
university	11.6	8.9	12.1	17.0	

N – sample size, p – significance level, NS – differences statistically not significant

TABLE 4. Students' percentage in the particular clusters consuming different numbers of meals.

Number of meals	Population percentage (%)				p
	Total N=644	Nutritional model			
		LN N=326	VF N=165	DVF N=153	
1 meal	1.2	1.8	0.6	0.6	0.0003*
2 meals	10.4	14.7	6.7	5.2	
3 meals	46.6	43.2	58.2	41.2	
4 meals	31.4	31.0	27.9	36.0	
5 meals	7.9	7.4	5.4	11.8	
≥6 meals	2.5	1.8	1.2	5.2	
In average (x±SD)	3.4±0.91	3.3±0.94	3.3±0.76	3.7±0.96	0.0002**

N – sample size, p – significance level, x – mean value, SD – standard deviation, * chi² test significance level, ** ANOVA significance level

TABLE 5. Daily recommended intake and dietary guidelines* realization by people with different nutritional models.

Nutrient	Norm percentage (%)				p in ANOVA
	Total N=644	Nutritional model			
		LN N=326	VF N=165	DVF N=153	
Energy					
x±SD	77.0±31.03	56.9±17.23	94.7±25.96	100.5±30.87	<0.0001
P 10	41.8	34.9	66.8	66.2	
P 90	118.2	78.5	130.4	138.0	
Protein					
x±SD	122.7±60.35	89.3±40.69	148.9±56.26	165.4±59.00	<0.0001
P 10	57.5	48.6	81.8	107.6	
P 90	192.6	133.4	217.7	226.4	
Fat					
x±SD	87.6±44.00	62.4±28.47	119.6±37.31	106.7±45.98	<0.0001
P 10	39.4	30.5	78.7	61.0	
P 90	142.0	94.2	176.3	154.0	
Carbohydrates					
x±SD	62.9±26.49	47.9±15.55	68.7±21.02	88.4±28.35	<0.0001
P 10	33.5	29.0	45.6	60.3	
P 90	97.3	68.2	97.8	129.3	
Cholesterol*					
x±SD	79.5±61.87	61.4±52.33	109.4±74.54	85.8±51.34	<0.0001
P 10	19.7	14.5	35.6	32.9	
P 90	155.7	133.0	222.1	139.9	
PUFA					
x±SD	143.7±96.48	89.3±47.25	244.0±104.99	151.7±73.26	<0.0001
P 10	43.2	33.8	149.4	67.7	
P 90	254.5	149.3	338.6	237.8	
Fiber*					
x±SD	62.1±30.32	45.8±19.99	67.5±22.60	91.1±32.18	<0.0001
P 10	28.5	23.7	36.7	57.3	
P 90	99.5	70.8	91.7	129.9	
Ca					
x±SD	53.1±36.98	39.4±20.58	40.9±19.67	95.5±45.69	<0.0001
P 10	18.0	13.1	20.4	49.8	
P 90	98.2	67.9	67.9	143.2	
P					
x±SD	129.7±67.06	90.0±33.73	141.6±50.31	201.4±71.80	<0.0001
P 10	58.7	50.2	89.6	129.6	
P 90	220.5	129.4	209.3	293.6	
Mg					
x±SD	76.5±33.20	56.6±18.23	81.0±23.77	114.3±32.14	<0.0001
P 10	39.7	35.9	54.5	78.4	
P 90	118.8	80.6	109.1	155.7	
Fe					
x±SD	87.9±50.82	57.7±26.73	112.5±48.53	125.9±52.82	<0.0001
P 10	37.5	31.3	57.1	71.9	
P 90	157.5	87.5	170.2	194.3	

Continuation of table 5

Nutrient	Norm percentage (%)				p in ANOVA
	Total N=644	Nutritional model			
		LN N=326	VF N=165	DVF N=153	
Zn					
x±SD	82.3±37.55	60.1±21.03	93.9±29.33	117.1±40.80	<0.0001
P 10	42.3	32.9	59.0	77.2	
P 90	127.1	85.0	131.8	156.5	
Cu					
x±SD	47.7±23.82	32.7±11.80	55.4±18.52	71.2±25.16	<0.0001
P 10	22.5	19.4	34.6	47.5	
P 90	80.1	47.3	81.0	104.4	
Vitamin A					
x±SD	102.2±91.23	78.0±82.69	118.7±87.91	136.1±97.64	<0.0001
P 10	25.4	20.4	38.9	49.3	
P 90	228.0	183.8	230.0	256.3	
Vitamin E					
x±SD	110.2±67.99	68.5±34.98	184.3±65.13	119.4±50.86	<0.0001
P 10	34.7	25.8	111.5	59.7	
P 90	204.6	115.5	280.3	191.0	
Vitamin B_1					
x±SD	56.6±30.92	37.9±17.13	71.6±27.13	80.2±32.63	<0.0001
P 10	23.8	17.3	37.6	46.4	
P 90	98.8	61.6	110.2	129.8	
Vitamin B2					
x±SD	64.3±28.57	50.7±21.29	64.9±21.11	92.6±28.27	<0.0001
P 10	31.9	27.6	41.2	59.5	
P 90	100.9	75.0	93.0	132.8	
Vitamin PP					
x±SD	74.6±57.86	47.2±26.09	110.2±80.91	94.7±47.47	<0.0001
P 10	24.8	19.8	50.3	44.9	
P 90	135.6	78.8	169.8	163.1	
Vitamin B6					
x±SD	68.2±37.01	45.5±20.35	94.4±37.22	88.4±34.01	<0.0001
P 10	28.0	19.5	50.0	49.4	
P 90	115.5	70.5	144.8	129.5	
Vitamin C					
x±SD	46.8±45.72	29.9±28.30	59.0±44.36	69.8±60.80	<0.0001
P 10	6.7	4.1	15.8	13.0	
P 90	101.1	64.6	111.6	137.1	

N – sample size, p – significance level, x – mean value, SD – standard deviation, P10 and P90 – percentile values, * – compared with dietary guidelines

vs. 15.3%) in comparison to the participation of that gender category stated in the total population (70.5% *vs.* 29.5%, respectively). Further, men more often had the "with vegetable fats domination" or "dairy-vegetable-fruit" nutritional model (44.2% and 43.8% *vs.* 29.5% of the total population, respectively). Students coming from towns with >100 000 inhabitants significantly more often represented the "dairy-vegetable-fruit" nutritional model. They had a characteristically higher subpopulation percentage of this nutritional model (24.8%) than in the total population (17.7%).

The significant differentiation in the number of meals consumed habitually by people with different nutritional models was found (Table 4). Students with the "diary--vegetable-fruit" nutritional model consumed on average more meals than students with the "low nutrition" or "with vegetable fats domination" model (3.7±0.96 meals *vs.* 3.3±0.94 or 3.3±0.76 meals, respectively, p=0.0002). On the other hand, students with the "low nutrition" nutritional model consumed 2 meals daily twice as often as students with the "with vegetable fats domination" nutritional model, and three times more often than students with the “dairy-vegetable-fruit” nutritional model.

In the variance analysis, the significant differentiation (p<0.0001) of the DRI and the dietary guidelines realization percentage between people with different nutritional models (Table 5) was confirmed. This differentiation was also revealed in the variance analysis carried out separately within gender groups, during the comparison of the nutrient intake and DRI realization degree by female and male students with different nutritional models (Tables 6 and 7). Only the protein contribution energy percentage did not show any correlation with the female students' nutritional model (p=0.8467; Table 6) and with the male students' nutritional model (p=0.1244; Table 7).

In groups with different nutritional models, some different occurrence frequency of extremely low intakes, *i.e.* below 50% of the norm was found (Table 8). Among people with the “low nutrition” nutritional model, an intake below 50% of the norm was found, *i.e.* for energy among 33.7% of the population, carbohydrates – 57.7%, fiber – 64.1%, calcium – 70.9%, magnesium – 39.3%, iron - 45.1%, copper – 93.6%, vitamin A – 47.8% vitamin E – 33.4%, vitamin B_1 – 77.3%, vitamin B_2 – 55.8%, vitamin PP – 59.8%, vitamin B_6 – 62.0%, and vitamin C – 82.8% of the population (Table 8). For no subjects of the “with vegetable fats domination” nutritional model was a PUFA intake <50% of the norm found, and only 1.2% of this subpopulation was characterized with a vitamin E intake <50% of the norm. The calcium intake <50% of he norm was found among the significantly lower people percentage with the “dairy--vegetable-fruit” nutritional model in comparison to the students with the “low nutrition” nutritional model and the “with vegetable fats domination” nutritional model (10.5% of the population *vs.* 70.9% and 73.3%). Analogous differences were revealed for fiber (6.5% *vs.* 64.1% and 21.8% of the population, respectively) and vitamin C (40.5% *vs.* 82.8% and 52.1% of the population, respectively, Table 8).

DISCUSSION

The mean nutrient intakes by male and female students from Olsztyn were similar to the intakes of other student groups in Poland [Duda *et al.*, 1997; Olędzka *et al.*, 2001; Ostrowska *et al.*, 2001; Stopnicka & Szamrej, 2001;

TABLE 6. Mean consumption of nutrients by female-students with different nutritional models.

Nutrient	Total N=454		Nutritional model						p in ANOVA
			LN N=276		VF N=92		DVF N=86		
	x	SD	x	SD	x	SD	x	SD	
Energy (kcal)	1676	669	1335	413	2172	653	2241	638	<0.0001
Protein (g)	53.3	25.5	42.8	20.1	66.6	26.5	72.5	21.9	<0.0001
Animal protein (g)	36.2	20.8	26.8	14.4	49.1	24.5	46.3	19.0	<0.0001
Fat (g)	62.6	31.0	48.5	22.8	90.7	29.1	77.8	28.3	<0.0001
Carbohydrates (g)	216	93	174	57	245	80	318	108	<0.0001
Cholesterol (mg)	202	156	178	157	246	153	232	141	0.0002
Saturated fatty acids (g)	21.3	12.3	16.0	8.6	25.9	10.2	29.5	15.1	<0.0001
Monounsaturated fatty acids (g)	26.6	14.6	19.2	10.0	41.3	14.1	30.5	12.6	<0.0001
Polyunsaturated fatty acids (g)	10.6	7.6	7.0	3.9	20.4	9.1	11.5	4.9	<0.0001
Fiber (g)	15.05	7.22	12.1	5.4	17.0	6.0	22.5	7.5	<0.0001
Ca (mg)	511	312	417	218	410	172	924	348	<0.0001
P (mg)	877	396	691	254	964	327	1379	373	<0.0001
Mg (mg)	202	88	159	53	219	66	320	83	<0.0001
Fe (mg)	9.4	4.4	7.4	3.3	11.4	3.7	13.6	4.1	<0.0001
Zn (mg)	7.8	3.6	6.0	2.1	9.1	3.1	11.8	3.8	<0.0001
Cu (mg)	0.81	0.38	0.63	0.22	0.95	0.33	1.26	0.38	<0.0001
Vitamin A (ug)	547	531	463	506	613	458	744	618	<0.0001
Vitamin E (mg)	7.7	4.9	5.3	2.8	14.3	4.9	8.4	3.4	<0.0001
Vitamin B_1 (mg)	0.81	0.43	0.61	0.27	1.05	0.41	1.20	0.47	<0.0001
Vitamin B_2 (mg)	1.01	0.46	0.83	0.35	1.03	0.36	1.56	0.44	<0.0001
Vitamin PP (mg)	11.5	7.3	8.6	5.0	16.8	8.5	15.4	7.3	<0.0001
Vitamin B_6 (mg)	1.08	0.61	0.80	0.37	1.58	0.69	1.47	0.60	<0.0001
Vitamin C (mg)	23.8	22.2	17.5	17.2	31.8	22.7	35.6	28.1	<0.0001
Carbohydrates (% of the energy)	53.2	10.4	54.2	11.0	47.4	8.7	56.0	7.5	<0.0001
Fats (% of the energy)	33.7	9.1	32.6	9.5	39.7	7.1	30.7	6.0	<0.0001
Protein (% of the energy)	13.1	4.3	13.1	4.6	12.9	4.2	13.2	3.2	0.8467

N – sample size, x – mean value, SD – standard deviation, p – significance level

TABLE 7. Mean consumption of nutrients by male-students with different nutritional models.

Nutrient	Total N=190		Nutritional model						p in ANOVA
			LN N=50		VF N=73		DVF N=67		
	x	SD	x	SD	x	SD	x	SD	
Energy (kcal)	2804	1017	1790	471	3028	723	3317	1060	<0.0001
Protein (g)	90.4	40.4	53.9	20.3	97.0	33.3	110.3	41.3	<0.0001
Animal protein (g)	65.8	39.8	32.9	15.7	73.4	34.4	75.0	44.7	<0.0001
Fat (g)	108.3	50.0	65.6	24.8	127.5	38.2	119.3	56.6	<0.0001
Carbohydrates (g)	345	129	232	69	341	96	433	129	<0.0001
Cholesterol (mg)	326	219	221	153	431	255	290	165	<0.0001
Saturated fatty acids (g)	39.5	21.9	21.5	10.5	42.7	17.8	45.5	25.0	<0.0001
Monounsaturated fatty acids (g)	47.5	23.1	27.6	12.9	57.7	19.3	47.8	24.1	<0.0001
Polyunsaturated fatty acids (g)	17.0	9.5	9.6	4.2	23.0	9.2	16.2	8.5	<0.0001
Fiber (g)	20.9	8.9	14.0	4.9	19.7	6.0	27.3	9.4	<0.0001
Ca (mg)	758	535	523	253	502	253	1213	615	<0.0001
P (mg)	1421	627	878	300	1344	391	1909	649	<0.0001
Mg (mg)	306	123	197	53	296	84	399	124	<0.0001
Fe (mg)	15.2	5.9	9.4	2.9	16.6	4.6	17.9	5.9	<0.0001
Zn (mg)	13.1	5.6	8.1	2.8	13.6	3.7	16.2	6.3	<0.0001
Cu (mg)	1.29	0.52	0.80	0.27	1.31	0.31	1.63	0.56	<0.0001
Vitamin A (ug)	772	555	492	442	837	584	910	531	<0.0001
Vitamin E (mg)	11.4	5.8	6.2	3.0	15.3	5.6	11.0	4.4	<0.0001
Vitamin B_1 (mg)	1.40	0.59	0.88	0.35	1.52	0.46	1.66	0.63	<0.0001
Vitamin B_2 (mg)	1.61	0.66	1.05	0.36	1.58	0.47	2.07	0.68	<0.0001
Vitamin PP (mg)	22.6	16.7	12.1	4.9	28.9	22.0	23.6	11.0	<0.0001
Vitamin B_6 (mg)	1.92	0.82	1.14	0.42	2.26	0.75	2.13	0.73	<0.0001
Vitamin C (mg)	38.3	35.0	20.2	15.9	40.0	30.4	50.0	43.9	<0.0001
Carbohydrates (% of the energy)	51.4	8.9	53.9	8.7	47.0	7.8	54.2	8.4	<0.0001
Fats (% of the energy)	35.3	8.2	33.7	8.6	39.5	7.2	32.0	7.1	<0.0001
Protein (% of the energy)	13.3	3.7	12.4	3.7	13.4	3.8	13.8	3.5	0.1244

N – sample size, x – mean value, SD – standard deviation, p – significance level

Trafalska & Grzybowski, 2001; Wawrzyniak & Hamułka, 2002; Zielke *et al.*, 2000]. The higher intake was noted only among students from the Physical Education Academy in Kraków [Gacek, 2001], which seems to be justified by their different life styles and greater physical activity in comparison to other students. In the analysed total female student group, a low energy intake was found (on the level of 70% of the norm for people with moderate physical activity), resulting from low carbohydrate intake and low food ration nutrient value (<80% of the DRI or the dietary guidelines) with reference to most nutrients, including calcium, magnesium, iron, zinc, copper, vitamins B_1, B_2, PP, B_6, C, and fiber. The application of slimming diets by the female students had no influence on the mean energy intake. Among 454 female students, 22 of them declared applying low--energy diets and on average consumed 1333±619 kcal/day. After excluding this group, the evaluated mean energy intake amounted to 1694±649 kcal/day and did not differ significantly from the intake defined in the total female student population (1676±669 kcal/day). This is why the analysis was held for the whole population, without excluding the female students losing weight.

The total male students food rations had higher nutrient value in comparison to female students. The energy intake by male students was sufficient (on the level of 90% of the DRI), and low nutrients intake (<80% of the norm) was found for six of them: calcium, copper, vitamins B_1, B_2, C, and fiber. In both gender groups an incorrect energy intake structure was revealed – too high in fats (33–35% of the total energy), and too low in carbohydrates (51–53% of the total energy). The average number of habitually consumed meals may be considered as satisfying (on average 3.4 meals/day). At the same time, about 12% of the total population consumed ≤2 meals/day, which is an unacceptably low food intake frequency [Podstawowe Zalecenia Żywieniowe, 1998].

The nutritional characteristics of the investigated groups presented above shows the typical nutritional behaviour of this community. However, the method of description relying on the mean values and the feature dispersion measures (x±SD) in the total population and the gender groups enabled only the creation of a very general view. The completed factor and cluster analysis revealed the existence in the total population of homogenous groups with

TABLE 8. Students' percentage with consumption below 50% of the norm in clusters with different nutritional models.

Nutrient	Population percentage with consumption < 50% of the norm (%)				p chi^2
		Nutritional model			
	Total N=644	LN N=326	VF N=165	DVF N=153	
Energy	17.7	33.7	1.2	1.3	<0.0001
Protein	6.7	10.7	3.6	1.3	0.0001
Fat	19.1	34.0	1.8	5.9	<0.0001
Carbohydrates	34.0	57.7	17.0	2.0	<0.0001
Cholesterol*	37.7	54.3	17.9	24.2	<0.0001
NNKT	12.3	22.7	0.0	3.3	<0.0001
Fiber*	39.6	64.1	21.8	6.5	<0.0001
Ca	57.1	70.9	73.3	10.5	<0.0001
P	5.9	9.8	3.0	0.6	0.0001
Mg	21.6	39.3	6.7	0.0	<0.0001
Fe	24.4	45.1	5.4	0.6	<0.0001
Zn	16.6	29.1	6.7	0.6	<0.0001
Cu	62.4	93.6	46.1	13.7	<0.0001
Vitamin A	30.9	47.8	15.8	11.1	<0.0001
Vitamin E	18.6	33.4	1.2	5.9	<0.0001
Vitamin B_1	48.1	77.3	21.2	15.0	<0.0001
Vitamin B_2	35.7	55.8	26.1	3.3	<0.0001
Vitamin PP	36.3	59.8	9.7	15.0	<0.0001
Vitamin B_6	36.5	62.0	9.1	11.8	<0.0001
Vitamin C	64.9	82.8	52.1	40.5	<0.0001

N – sample size, p – significance level, * – compared with dietary guidelines

different nutritional profiles. The regularity of this occurrence was confirmed by the variance analysis and by the feature dispersion comparison. The separated nutritional models, which were called: "low nutrition", "with vegetable fats domination" and "dairy-vegetable-fruit" provided a background to the renewed, more detailed university youth eating habits analysis.

The female-students' general nutritional characteristics indicated the low nutritive value of their food rations. It was confirmed in the advanced statistical analysis, because the "low nutrition" nutritional model was found for about 61% of this population. After separating this subgroup from female students, it was found that female students with the "low nutrition" nutritional model had a more unprofitable intake profile in comparison to the total female student population. The mean total nutrient intake of this subgroup was lower than 90% of the DRI or the dietary guidelines, including a mean intake <50% of the DRI for 8 of them: carbohydrates, calcium, copper, vitamins B_1, PP, B_6, C and fiber. For about 19% of the female student subpopulation, a profitable nutrition profile was found, and their nutritional model was called "dairy-vegetable-fruit". A mean intake below the DRI (<90%) was found in this cluster for 8 nutrients, but for all it was higher than 50% of the DRI. Female students with the "dairy-vegetable-fruit" nutritional model also had the most profitable energy intake structure – 56.0% of the energy from carbohydrates, and 30.7% of the energy – from fats. A highly fatty character of food rations was found for about 20% of the female student population (the model "with vegetable fats domination"). In their nutritional model, the participation of fat-originating energy amounted to 39.7%, with a PUFA intake 2.5 times higher than the DRI, and a vitamin E intake almost 2-times higher. The cholesterol intake amounted on average to 246 mg, confirming the fact that the source of the overwhelming part of fats in their food rations were fats of vegetable origin. Female students with the "with vegetable fats domination" and "dairy-vegetable-fruit" nutritional models had relatively well-balanced food rations. The lowest mean intake among female students with the nutritional model "with vegetable fats domination" was found for calcium (*ca*. 37% of the DRI), showing the biggest osteoporosis threat of this subgroup in the later decades of their lives [Sawicki *et al.*, 1997; Stracke *et al.*, 1993].

In both female students clusters with the nutritional models "with vegetable fats domination" and "dairy-vegetable-fruit", the mean energy intake was consistent with the recommendations for women with the moderate physical activity (on the level of 2200 kcal), showing a probable intake balance with energy expenditures. An insufficient energy intake (1335 kcal) was found among female students with the "low nutrition" nutritional model. The large size of this group (61% of the female students population) suggests the possibility of the occurrence of energy deficiencies among over half of female students, even in the case of their reduced physical activity [WHO, 1995; Ziemlański *et al.*, 1994]. The confirmation of this thesis may be given by the research results in the field of nutrition status, in which a low body mass (BMI<20kg/m^2) was revealed for over 30% of the female students from Olsztyn [Wądołowska, 2000], and under-nutrition according to the WHO criteria [1995] (BMI<18.5kg/m^2) – for about 15% of the female students from Białystok [Ostrowska *et al.*, 2000].

The general male students nutritional characteristics found a satisfactory nutrient value of their food rations. It was confirmed with reference to most vitamins and minerals for students with the nutritional model "with vegetable fats domination" and "dairy-vegetable-fruit", which together amounted to about 74% of the total male student population. The intake of some nutrients by male students from both subgroups was too high, *i.e.* of protein, fats, the PUFA, phosphorus, iron, vitamins A and E, showing an incorrect balancing of their food rations. The lowest calcium intake (45.6% of the norm), similar to female students, was revealed for male students with the nutritional model "with vegetable fats domination". On the other hand, the calcium intake according to the norm (about 110% of the norm) was noted among students with the "dairy-vegetable-fruit" nutritional model, which characterized the nutrition of about 35% of the male students population. It suggests that the inadequate calcium intake revealed in most studies concerns only a part of the population, but the deficiency threat is greater than that shown by the mean values presented for the total population [Duda *et al.*, 1997; Gacek, 2001; Olędzka *et al.*, 2001; Ostrowska *et al.*, 2001; Stopnicka & Szamrej, 2001; Trafalska & Grzybowski, 2001; Wądołowska, 2000; Wądołowska *et al.*, 1998; Wawrzyniak & Hamułka, 2002; Zielke *et al.*, 2000].

Among male students, the subgroup with the "low nutritive" nutritional model was separated. It found a smaller percentage in the male (26%) than in the female student population (61%), but it revealed the possibility of deficiencies also occurring among male students, despite the satisfying intake determined for students in general. The intake profile of male and female students with the "low nutrition" nutritional model was very similar. The separation of the "low nutrition" nutritional model among female students confirmed the earlier data on the occurrence of a low intake in this subpopulation, although it was documented differently. The separation of this nutritional model among male students was also conducted, among a quite reasonable population percentage (over L' of the population). Regardless of gender, the nutrient deficiency threat among people with a "low nutritive" nutritional model was high. An extremely low nutrient intake (<50% of the norm) was revealed for the overwhelming percentage of this cluster, and with reference to vitamins and mineral nutrients (excluding phosphorus) among 30–94% of this subpopulation.

Regardless of gender, the smallest deficiency threat degree was found among people with the "dairy-vegetable-fruit" nutritional model. This is shown by the mean values and the small percentage of students with an intake <50% of the DRI. Both female and male students subgroups with the "dairy-vegetable-fruit" nutritional model were characterized, moreover, according to the norm energy intake (95% and 107% of the DRI, respectively) and the most profitable participation of energy originating from carbohydrates (56.0% and 54.2%, respectively) and fats (30.7% and 32.0%, respectively) in comparison to subjects with different nutritional models. Students with the "dairy-vegetable-fruit" nutritional model also consumed a characteristically larger number of meals during day (on average 3.7). The obtained results indicate that the part of the female and male student populations had desirable nutrition features, however, it concerned a relatively small population percentage – over 1/3 of male students and below 20% of female students.

A relatively large group – almost 40% of male students and 20% of female students – included individuals with high fat intake, on the level of 40% of the total energy. The main source of the fats in their food rations were products of vegetable origin (the model "with vegetable fats domination"). Regarding to what extent this nutritional model was stipulated on preferences and economic factors, and to what extent on the conviction of vegetable fat health properties, it would be advisable to investigate the causes of such a nutritional model and to undertake wide scale nutritional education, to highlight the preventive aspects that vegetable fat intake has in the case of overall moderate fat intake [Schaefer, 1997; The International Task Force…, 1998]. However, it should not be expected to be so in highly-fatty food rations, even with a moderate cholesterol intake.

A comparison of the Olsztyn students' nutritional models to the nutritional models of elderly people from the Warsaw region is difficult [Wierzbicka *et al.*, 2001]. In the cited work, the cluster analysis was not preceded by a factor analysis, which makes it difficult to describe the characteristic nutritional features and model naming. There is, however, some similarity between these populations. Among elderly people, similar to students, the cluster (V) characterizing with the lowest of all nutrient intake (on average 50% of the DRI) was separated, which included about 20% of the population. On the other hand, in two clusters (I and II) the highest dairy product intake was found, with 11% and 10% of the population respectively. Elderly people from the cluster III (30% of the population) and IV (29% of the population) had the highest vegetable and fruit intake. A highly-fatty food ration character was found among people from cluster I [Wierzbicka *et al.*, 2001]. In the SENECA research among elderly people from Europe, the most numerous groups were: among women – "modest eaters" (68% of the subpopulation) and "lean and green eaters" (20% of the subpopulation), and among men – "small eaters" (60% of the subpopulation), "gourmands" (17% of the subpopulation) and "milk drinkers" (16% of the subpopulation) [Schroll *et al.*, 1996]. It was revealed that "lean and green eaters" predominated among southern Europeans, and "gourmets" and "milk drinkers" in Northern Europe. The socio-demographic conditions of the nutritional model were also studied for Americans at advanced ages. Higher milk, fruit and grainy products intake and higher calcium and vitamins A, C, B_2, B_6, folacin was connected with higher education level [Tucker *et al.*, 1992].

SUMMARY

A wide differentiation in the university youth intake was found. There were 3 characteristic nutritional models identified with different nutritive value of food rations.

A correlation between the university youth nutritional models and gender and place of residence was found. Most of female students characterized with the "low nutrition" nutritional model, and among male students the nutritional model "with vegetable fats domination" and "dairy-vegetable-fruit" predominated. The "dairy-vegetable-fruit" nutritional model was the best-balanced and best met the dietary guidelines.

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CHARAKTERYSTYKA SPOSOBU ŻYWIENIA STUDENTÓW Z WYODRĘBNIENIEM MODELI ŻYWIENIA ZA POMOCĄ METOD ZAAWANSOWANEJ ANALIZY STATYSTYCZNEJ

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Badania podjęto w celu wyłonienia i scharakteryzowania specyficznych modeli żywienia studiującej młodzieży. Objęto nimi 190 studentów i 454 studentek o średnim wieku 20,7±1,68 lat. Wartość odżywczą racji pokarmowych badanych osób określono metodą wywiadu 24-godzinnego. Obliczoną zawartość energii i składników odżywczych w racjach pokarmowych zredukowano, a następnie porównano z normami żywienia na poziomie bezpiecznym. Do wyodrębnienia modeli żywienia studentów wykorzystano analizę czynnikową (metoda głównych składowych) i analizę skupień (grupowanie obiektów metodą k-średnich). Zróżnicowanie wartości odżywczej racji pokarmowych osób zaliczonych do poszczególnych skupień zweryfikowano w oparciu o jednoczynnikową analizę wariancji. Rozkłady cech porównano testem chi^2.

W badanej populacji wyłoniono 3 specyficzne modele żywienia: "mało odżywczy" (LN) – 50,6% populacji ogółem, "z przewagą tłuszczów roślinnych" (VF) – 25,6% i "mleczno-warzywno-owocowy" (DVF) – 23,8% populacji (tab. 1, 2). Model żywienia LN istotnie częściej stwierdzono u studentek, VF i DVF u studentów, a DVF u mieszkańców dużych miast (tab. 3). Osoby DVF zwyczajowo spożywały większą liczbę posiłków niż LN lub VF (tab. 4). W analizie wariancji potwierdzono istotne zróżnicowanie wartości odżywczej racji pokarmowych osób o różnych modelach żywienia (tab. 5, 6, 7). Wśród osób LN spożycie poniżej 50% normy stwierdzono m.in. dla energii, węglowodanów, błonnika, wapnia, magnezu, żelaza, miedzi, wit. A, wit. E, wit. B_1, wit. B_2, wit. PP, wit. B_6 i wit. C. U żadnej z osób o modelu żywienia VF nie wykazano spożycia NNKT <50% normy, zaś tylko 1,2% tej subpopulacji charakteryzowało spożycie wit. E<50% normy. Spożycie wapnia <50% normy stwierdzono u istotnie mniejszego odsetka osób DVF w porównaniu ze studentami LN i VF (10,5% populacji *vs.* 70,9% i 73,3%; tab. 8). Analogiczne różnice wykazano dla błonnika oraz wit. C.

Stwierdzono duże zróżnicowanie w spożyciu wśród młodzieży akademickiej. Wyłoniono 3 charakterystyczne modele żywienia o różnej wartości odżywczej racji pokarmowych. Wykazano współzależność modelu żywienia młodzieży akademickiej z płcią i miejscem zamieszkania. Większość studentek charakteryzowała się "mało odżywczym" modelem żywienia, natomiast wśród studentów przeważał model żywienia "z przewagą tłuszczów roślinnych" i "mleczno-warzywno-owocowy". Model żywienia "mleczno-warzywno-owocowy" był najlepiej zbilansowany i dostosowany do zaleceń żywieniowych.