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AN ANALYSIS OF THE MEAL PATTERN AT THE NUTRIENT LEVEL IN POLISH WOMEN

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ABSTRACT

Background. Before the 1990's, access to a variety of foods in Eastern Europe was limited, which could have influenced the currently analyzed dietary behaviors pertaining to overweight and obesity development. The aim of this study was to describe the daily profile of meal patterns in Polish women aged 50–70 at the nutrient level.

Material and methods. The anthropometrical parameters of four-hundred and fifty Polish women aged 50–70 were assessed. Three 24-hour dietary recalls and validated questionnaires regarding socio-demographic-economic status and meal frequency were applied. Timing in food intake was considered as follow: 6:00–8:59 CET – breakfast, 9:00–11:59 CET – morning snacks, 12:00–14:59 CET – lunch, 15:00–17:59 CET – afternoon snacks, 18:00–21:00 CET – dinner. Statistical analyses were conducted using Tukey's multiple comparison tests and discriminant analysis.

Results. No statistically significant differences were found in socio-demographic-economic and anthropometrical characteristics between women categorized to differentiated meal frequency intakes. However, the subjects from the 5-meal-per-day group were characterized by higher anthropometrical parameters, the statistically lowest percentage of regularity in meal consumption and skipping meals related to shortest breaks between meals. At the nutrient level, potassium, niacin, vitamin E and vitamin D were selected in the discriminant analysis as the nutrients most strongly related to different dietary behaviors.

Conclusion. Our findings did not provide sufficient evidence that diverse nutrient intake could lead to the development of a specific nutritional profile in Polish women.

Key words: meal patterns, obesity, food intake

INTRODUCTION

Differentiated biological and behavioral mechanisms are involved in appetite regulation (Teixeira et al., 2010). In-depth investigations regarding energy intake and meal patterns during the day are still needed, especially in the context of the obesity epidemic (Colles et al., 2007). The timing of energy intake is one of the

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most important factors of energy regulation and the risk of obesity (http://www.who). Therefore, the importance of meal frequency intake, considered in the timeframe over the day has to be emphasised. It has previously been shown that skipping breakfast may be related to the intake of less energy early in the day, leading to weight gain resulting from overcompensation (Keim et al., 1997). Furthermore, consumption of more than 3 meals per day can contribute to being overweight or obese, with the exception of single eating occasion (Howarth et al., 2006). Thus, higher total calorie intake might be the consequence of consuming more often meals and snacks.

The self-assessment of food intake, including the timing of meals, may be reported with insufficient detail. Occasionally, the classification of products being recognized as a snack (ie. fruits, cake) is also not clearly described, due to the bias in the energy density assessment (Poppitt and Prentice, 1996). The single behaviors in populations analyzed may be considered at different levels and may underreport the energy intake between subjects characterized by Body Mass Index (BMI) as normal weight, overweight or obese (Miller and Perez, 2014; Stelmach-Mardas et al., 2014a). Dietary behaviors are highly variable across Europe. However, many of the determinants of diet that could explain their backgrounds seem to be very similar. Nevertheless, it is worth analyzing the meal patterns of Polish adults, in which the process of maturation was connected with limited food accessibility as a consequence of the political transformation in Eastern Europe, and therefore be able to show currently diverse meal patterns and potentially form the basis of overweight development in this age-specific group.

Therefore, the aim of the study was to describe the daily profile of meal patterns in Polish women aged 50–70 at the nutrient level.

MATERIAL AND METHODS

The recruitment of women for the study took place in public health institutions in the Greater Poland region. Women that responded positively to the invitation were screened according to inclusion and exclusion criteria. The following women were eligible for the study: Caucasian, aged 50–70, weight stable in the past 6 months, shift-work, willingness to maintain habitual diet for the duration of the experiment. Exclusion criteria were: history of bariatric surgery, anorexia nervosa and bulimia, history of depression, diagnosed type 1 or type 2 diabetes, hepatic or renal disorder, myocardial infarction or cardiovascular diseases, alcohol abuse and participation in weight-management study or use of medications known to alter food intake or body weight.

The anthropometrical parameters including body weight and height (RADWAG digital scale with an approximation of 0.1 kg and 0.5 cm respectively) (Radom, Poland), waist and hip circumference were assessed. Participants were measured without shoes while wearing minimal clothing. Body Mass Index and Waist to Hip Ratio (WHR) were calculated. Four-skinfolds were measured to calculate the percentage of body fat mass (% FM) according to Durnin and Womersley formula (Durnin and Womersley, 1974). Females completed three 24-h dietary recalls and a previously validated questionnaire that included questions regarding socio-demographic-economic status and meal patterns (Stelmach-Mardas et al., 2014b). Energy, macro- and micronutrient intake was determined using the Dietetyk software (National Institute of Food and Nutrition, Warsaw, Poland). Snacks were described as a food of high energy density (>2 kcal/g). All data that were recognized as over- and underreported (<1000 kcal and >3000 kcal) were excluded from the analysis. The timing of food intake was considered as follow: 6:00–8:59 CET – breakfast, 9:00–11:59 CET – morning snacks, 11:00–14:59 CET – lunch, 15:00–17:59 CET – evening snacks, 18:00–21:00 CET – dinner. The meal patterns were reported as meal type and the time for each intake episode through a day.

All subjects gave their written consent for participation. The study was performed in accordance with the Helsinki Declaration. The protocol was approved by the Bioethical Committee at Poznan University of Medical Sciences in Poland.

Statistical approach

We applied analysis of variance (ANOVA) with Tukey's multiple comparison test for differences between groups. Additionally, discriminant analysis was applied to discriminate analyzed variables between the groups. From a set of independent variables discriminant analysis found combinations of those that best discriminated the groups consuming 3-, 4- and 5-meals

per day. We have built a model that used fourteen variables that have been selected by Wilk's Lambda method through the use of a discriminant analysis. Wilk's Lambda assumed values in the range of 0 (perfect discrimination) to 1 (no discrimination) in the model. The significance of the variables analyzed through the discrimination process was assessed by the *F*-value. Partial Lambda was used to show the unique contribution of the variable being analyzed to the discriminatory power of the model. *F* to remove showed the *F*-value related to the respective Partial Lambda. The tolerance value of a variable was analyzed as 1-Tolerance (R^2) of the variable with all other variables in the model. The analysis was performed using the STATISTICA Software (StatSoft Inc., Tulsa, US).

RESULTS

Taking into account the meal frequency intake during the day, there were no statistically significant differences in socio-demographic-economic characteristics of the women studied (Table 1). The majority

Table 1. Characteristics of the women studied (n = 450), %

Analyzed factor	Frequency of meal intake per day			*p*-value
	3	4	5	
Education				
Primary school	20.00	21.00	13.00	
High school	52.00	55.00	57.00	0.55
University degree	28.00	24.00	30.00	
Place of living				
Countryside	3.00	3.00	0.00	
City of <20 000 inhabitants	8.00	13.00	3.00	0.14
City of 20–500 000 inhibitants	84.00	79.00	84.00	
City of >500 000 inhabitants	5.00	5.00	3.00	
Marital status				
Single	9.00	7.00	10.00	
Married	74.00	80.00	80.00	0.61
Widowed	17.00	13.00	10.00	
Socio-economic status				
Poor	16.00	19.00	10.00	
Good	59.00	57.00	70.00	0.29
Very good	25.00	24.00	20.00	
Employment statut				
Pension	35.00	31.00	41.00	
Pension + work	6.00	3.00	3.00	0.43
Work	59.00	66.00	56.00	

$p < 0.05$ for all values is considered as statistically significant.

of the women lived in cities of 20,000–50,000 inhabitants, were married and work either full-time or were already retired. No statistically significant association was found between the anthropometrical parameters and the frequency of meal consumption (Table 2 and Table 3). Nevertheless, subjects from the 5-meal group had a higher median value of WHR, % FM and BMI. The greatest percent of subjects with a BMI > 30 kg/m^2 were also present in the 5-meal group (Table 3). Women from the 5-meal group had

Table 2. Anthropometrical characteristic of the women studied (n = 450)

Analyzed factor	Frequency of meals intake per day									p-value
	3			4			5			
	Median	Min	Max	Median	Min	Max	Median	Min	Max	
Age	60.50	50.00	70.00	59.50	50.00	70.00	60.50	50.00	70.00	0.80
Body weight, kg	72.00	45.00	120.00	72.00	47.00	125.00	71.00	55.00	100.00	0.66
Body height, m	1.63	1.50	1.75	1.63	1.47	1.75	1.64	1.50	1.68	0.70
BMI, kg/m^2	26.80	17.60	47.60	27.10	17.90	48.80	28.30	20.90	37.60	0.56
Waist circumference, m	0.90	0.62	1.44	0.90	0.60	1.29	0.90	0.70	1.24	0.49
Hip circumference, m	1.04	0.26	1.46	1.04	0.80	1.40	1.07	0.85	1.30	0.50
WHR	0.85	0.57	3.75	0.84	0.70	0.97	0.85	0.74	1.06	0.54
Biceps, mm	10.90	2.00	23.00	10.20	5.00	22.00	11.50	5.00	20.20	0.60
Triceps, mm	17.90	7.60	29.00	17.90	7.00	31.20	19.90	6.00	28.20	0.56
Subscapula	17.40	7.80	30.00	17.20	6.20	35.00	17.30	8.00	27.40	0.46
Supraliac, mm	20.10	8.00	40.00	20.00	7.00	34.20	19.90	9.60	30.20	0.53
FM, %	37.40	27.70	43.50	37.10	24.90	42.90	37.70	27.40	42.70	0.54

Group median, minimum (Min), maximum (Max) for all variables used in this study.
BMI – body mass index, WHR – waist to hip ratio, FM – fat mass.
$p < 0.05$ for all values is considered as statistically significant.

Table 3. Body Mass Index in relation to frequency of meal intake (n = 450), %

Analyzed factor	Frequency of meal intake per day			p-value
	3	4	5	
BMI, kg/m^2				0.38
<18.5	1.00	1.00	0.00	
18.5–25	34.00	38.00	37.00	
25–30	37.00	34.00	26.00	
>30	28.00	27.00	37.00	

$p < 0.05$ for all values is considered as statistically significant.

Table 4. Self-estimated frequency of meal intake (n = 450)

Analyzed factors	Frequency of meal intake per day			p-value
	3	4	5	
Regular consumption, %	83.00	72.00	63.00	0.01
I breakfast	99.00	99.00	100.00	0.60
II breakfast	7.00	82.00	100.00	0.00
Lunch	99.00	99.00	100.00	0.60
Snacks	5.00	24.00	100.00	0.00
Dinner	93.00	95.00	100.00	0.03
Warm meal	90.00	94.00	100.00	0.01
Beverages, %				
No	25.00	36.00	37.00	0.20
1 time	30.00	33.00	30.00	
2–3 times	42.00	31.00	30.00	
More than 3 times	3.00	0.00	3.00	
Breaks between meals, h	4.10	3.90	2.90	0.00

$p < 0.05$ for all values is considered as statistically significant.

the lowest percentage of regularity, while the highest regularity was observed in the 3-meal group. Statistically significant differences between analyzed groups were related to the lowest skipping of 2nd breakfast, snacks, dinner and warm meals in the 5-meal group (Table 4). This is consistent with the significantly shortest breaks between meals within this group. Energy intake was estimated at lower levels than recommended (1750 kcal) and the percentage of fat intake exceeded 30%, although differences were not significant (Table 5).

Discriminant analyses selected the following 14 nutrients as the most strongly related to different dietary behaviors: potassium, niacin, vitamin E, vitamin D, nonessential fatty acids, phosphor, cholesterol, sodium, thiamin, calcium, vitamin B6, vitamin C, selenium, and dietary fiber. Within this group, potassium, niacin, vitamin E and vitamin D were characterized as having the greatest discriminating power according to the frequency of meals consumed during the day (Table 6) and were found to be statistically significant ($p < 0.05$) with nonessential fatty acids and phosphor showing a trend towards significance ($p = 0.07$ and $p = 0.07$, respectively). The classification matrix is shown in Table 7.

DISCUSSION

Here we describe the daily meal pattern of Polish women at nutrient level. Our results failed to show statistically significant differences in the anthropometrical parameters and socio-demographic-economic characteristics in comparison to the differentiated frequency of meal consumption. However, the women from the 5-meal group were characterized by a higher median value of anthropometrical parameters, the statistically lowest percentage of regularity in their meal consumption and also by skipping meals related to the shortest breaks between meals. At the nutrient levels observed, potassium, niacin, vitamin E and vitamin D were selected in discriminant analysis as the nutrients most strongly related to different dietary behaviors.

It should be taken under consideration that food is the source of energy for adipose tissue, and as such,

Table 5. Energy and percentage of energy derivative from selected nutrients in relation to frequency of meals intake

Factor analyzed	Frequency of meal intake per day									*p*-value
	3			4			5			
	Median	Min	Max	Median	Min	Max	Median	Min	Max	
Energy, kcal	1 569.00	1 011.00	2 962.00	1 530.00	1 001.00	2 939.00	1 623.00	1 039.00	2 774.00	0.56
from protein, %	14.08	7.06	30.51	14.12	6.93	27.29	13.23	8.38	21.38	0.77
from fat, %	35.38	10.06	55.81	34.45	9.52	53.83	31.33	15.39	48.35	0.65
from carbohydrates, %	51.19	22.06	80.56	52.83	28.07	81.91	54.70	37.93	69.87	0.58
from SFA, %	13.80	2.48	25.92	14.16	3.60	28.44	12.54	4.81	21.70	0.70
from MFA, %	12.55	3.05	26.20	12.24	2.74	25.39	11.27	4.85	20.02	0.65
from PFA, %	3.95	0.89	23.12	3.632	1.23	18.21	3.381	1.46	21.08	0.75
Cholesterol, mg	268.20	35.60	1284.00	250.20	33.31	1 412.00	205.70	58.02	1 226.00	0.77

Group median, minimum (Min), maximum (Max) for all variables used in this study.
SFA – saturated fatty acids, MFA – momounsaturated fatty acids, PFA – polyunsaturated fatty acids.
$p < 0.05$ for all values is considered as statistically significant.

Table 6. Discriminant function analysis summary of nutrient intake under different frequency of meal consumption (3 meals, 4 meals, 5 meals per day)

Factor analyzed ($n = 450$)	Discriminant function analysis summary no. of variables in model: 14. Wilk's Lambda 88.749 approx. F (28.856) = 1.8801, $p < 0.0040$					
	Wilk's Lambda	Partial Lambda	F-remove (2.428)	p-value	Tolerance	1-Tolerance (R^2)
Potassium, mg	0.909	0.97	5.33	0.00	0.29	0.71
Niacin, mg	0.905	0.98	4.40	0.01	0.29	0.71
Vitamin E, mg	0.904	0.98	3.94	0.02	0.12	0.88
Vitamin D, µg	0.901	0.98	3.28	0.03	0.51	0.49
Nonessential fatty acids, g	0.898	0.99	2.62	0.07	0.12	0.88
Phosphor	0.898	0.99	2.61	0.07	0.27	0.72
Sodium, mg	0.896	0.99	2.11	0.12	0.48	0.52
Cholesterol, mg	0.896	0.99	2.07	0.12	0.73	0.27
Thiamin, mg	0.896	0.99	2.01	0.13	0.47	0.52
Calcium, mg	0.895	0.99	1.722	0.18	0.41	0.59
Vitamin B6, mg	0.893	0.99	1.46	0.23	0.32	0.68
Selenium, µg	0.893	0.99	1.45	0.23	0.68	0.31
Fibre, g	0.893	0.99	1.23	0.29	0.50	0.49
Vitamin C, mg	0.891	0.99	0.91	0.40	0.53	0.47

In the first column, variables were sorted according to their discriminate power in the model.
$p < 0.05$ for all values is considered as statistically significant.

Table 7. Classification matrix after the discriminant analysis of nutrients intake after different frequency of meals consumption per day (3 meals, 4 meals, 5 meals)

Group	Classification matrix rows: observed classifications, columns: predicted classifications			
	percent correct	3 meals $p = 0.58$	4 meals $p = 0.35$	5 meals $p = 0.06$
3 meals	91.10	235.00	18.00	5.00
4 meals	32.20	136.00	19.00	1.00
5 meals	33.30	23.00	3.00	4.00
Total	68.10	394.00	40.00	10.00

$p < 0.05$ for all values is considered as statistically significant.

the time of eating, particularly of high energy content meals, may be decisive and changes in this timing could have metabolic consequences for the development of obesity (Garaulet et al., 2013). Our findings suggest that all consumers have elevated BMI, WHR and % FM, which could describe one of the possible links between weight gain and changes in energy intake (Ma et al., 2003). Forslund et al. (2002) also found that obese women had a higher meal frequency compared with the normal-weight population. Furthermore, if we analyze which meals are more often skipped or the time period during the day showing the highest frequency of meal intake, we can produce an additional description of the characteristics of the study population. Previously, it was shown by Garaulet et al. (2013) that late eaters had a significantly lower percentage of their total daily energy intake during breakfast, and skipped breakfast more frequently than early eaters. Moreover, Wang et al. (2014) concluded that increased intake of the day's total energy at midday is associated with a lower risk of being overweight or obese, whereas consuming more in the evening is associated with a higher risk. However, in our study, the most frequently skipped meals were '2nd breakfast' and snacks, which suggest that the main meals were eaten regularly. It was surprising to note that the women in the study did not indicate "night eating", which was anticipated, especially in those characterized by higher values of BMI. It was also surprising that we did not find either fat or carbohydrates to be the main discriminant factors between the groups analyzed. Nevertheless, low energy intake could be related to the underreporting of self-estimated food intake, which is very commonly observed in populations suffering from being overweight or obesity (Poppitt et al., 1998).

Currently, the wider variety of food available on the market may change the dietary habits across the day; however, the eating habits that were developed in childhood and during the process of maturation can strongly influence food selection processes observed in adulthood. Therefore, taking into account limited Polish women's food intake before the 1990's, it was suspected that this investigation of meal patterns in specific age groups still cannot be diversified (Kowrygo et al., 1999). At the nutrient level reported, we were able to select vitamin E and vitamin D intake as fat-soluble vitamins discriminating the different food group's consumers. This observation might suggest indirectly the importance of verified fat content in the diet and products rich in fat (Jarosz and Buhak-Jachymczyk, 2008). This is consistent with the assessment of a high percentage of fat intake in the women studied. The increased discriminatory power of niacin could be attributed to the amount of meat consumption (i.e. pork, chicken), rich in niacin, in the Polish population (Verbeke et al., 2013). Furthermore, the greater discriminatory power of potassium was probably related to the different frequency of potatoes consumed across the groups analyzed (Kowrygo et al., 1999). Although statistical significances between those nutrients were observed, the Partial Lambdas did not fall below 0.9. Thus, the visible discrimination power of the factors analyzed cannot be recognized as strong.

The strength of this study was its large sample size and homogenous population. Although self-reported

data was used, all data points recognized as over- and underreported were excluded from the analysis. Unfortunately, we did not assess the metabolic biomarkers that could be included in the discriminant analysis and contribute to higher statistical discriminant power. The observational character of the study supports the necessity of more complex interventional studies.

Our findings did not provide sufficient evidence that diverse nutrient intake could lead to the development of a specific nutritional profile in Polish women aged 50–70. Nevertheless, the 5-meal consumers can be recognized as a group of special interest in the context of being overweight and developing obesity. Future broadened investigations are needed to better discriminate food groups and nutrients that might be associated with healthy and unhealthy meal patterns in Polish women being applied in the strategy of obesity prevention in this age-specific group of women.

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