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Association between Maternal Dietary Patterns and Anthropometric Parameters of Polish Pregnant Women and Infants: A Cross-sectional Study

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Abstract The role of maternal diet on anthropometry of pregnant women and birth outcomes is ambiguous. The aim of this study was to describe maternal dietary patterns according to individual characteristics and examined associations between them and the anthropometric parameters of mother and infant. Pregnant women enrolled from 2010-2012 of hospitals in the province of Warmia and Mazury. Dietary patterns were identified from a food frequency questionnaire using Principal Components Analysis. Logistic regression analysis was used to evaluate the potential association of each dietary pattern and anthropometry of mother: prepregnancy BMI, gestational weight gain; and infant: birth weight, length, Ponderal Index. Three dietary patterns were identified: "Varied", "Traditional Polish" and "Vegetable-fruit". In the Varied dietary pattern the third tertile was associated with higher risk of excessive gestational weight gain and the second tertile was associated with higher risk of to low birth weight. In tertiles of the Traditional Polish dietary pattern the risk of too high BMI was higher among women in the higher tertiles. The risk of too high Ponderal Index in newborns was lower among women in the higher tertiles of the Vegetable- fruit dietary pattern. Moreover, the risk of too low Ponderal Index in newborns was higher among women in the higher tertiles of this dietary pattern. More research is needed to confirm this finding and the direction of changes induced by maternal diet.

Keywords: *dietary patterns, pregnancy, gestational weight gain, birth weight, birth length*

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1. Introduction

Nowadays pathogenesis of diseases that used to be considered the effects of lifestyle or inheritance is regarded as consequences of the pre- and early postnatal life [1,2]. Dietary habits of women during pregnancy are, besides stress and environmental toxins, the main factor affecting intrauterine conditions [1,3]. Their disturbance may determine the occurrence of metabolic, endocrine and cardiovascular chronic non-infectious diseases in the adult life of a child [4]. An increased risk of developing concerns diet-related diseases, allergy, childhood asthma, autoimmune disorders, mental and behavioral disorders, autism, cognitive disorders, Alzheimer's disease and osteoporosis [1,5]. Moreover, the energy requirements of the body significantly grow during pregnancy and the demand for mineral components and vitamins changes. Deficiencies resulting from eating disorders or improper nutritional habits of the mother may have an unfavorable effect on health conditions and anthropometrical parameters of both the pregnant woman and the child [6,7,8]. These relations are known as metabolic programming and means the quantity and quality of nutrients in a mother's diet during pregnancy affect metabolism, physiology and genomic expression of the fetus, as well as health conditions in adulthood [2,4,6].

With an increase in diet-related diseases in recent years, it seems particularly important to determine dietary habits of pregnant women and their effects on the child's health condition. For many years, the conducted analyses have focused on the effect of the health status of individual diet components during pregnancy [9]. Determination of dietary patterns and defining participants' adherence to one of them permits characterizing the mother's diet in a broader context than using an analysis of selected single nutrients and their effects on the anthropometric birth parameters of a child [10,11]. A comprehensive focused research of dietary impact can provide precious information concerning proper nutrition during pregnancy to a much more significant extent than the research concerning the effect of single nutrients [12,13]. Epidemiological research shows that the health outcomes for both the mother and the offspring have been associated with a maternal dietary pattern. However, the impact of diet on their anthropometric parameters is unclear [7,8,9,13,14,15]. Wherefore the purpose of this study was to identify and describe maternal dietary patterns and examine associations between them and the anthropometric parameters of mother and infant.

2. Materials & Methods

2.1. Study Procedure and Participants

The project has obtained the consent of the Bioethical Committee of the Warmia-Mazury Medical Chamber in Olsztyn, No. 20/2010.

Table 1. Participant socio-demographic, anthropometric, health and lifestyle characteristics

Socio-economic variables	n =487
Age (year) [mean (95% CI)]	28.2 (27.8; 28.6)
Prepregnancy weight (kg) [mean (95% CI)]	61.9 (60.9; 62.9)
Body height (cm) [mean (95% CI)]	166.4 (165.9; 166.9)
Prepregnancy Body Mass Index	
BMI<18,5 (%)	10.8
18,5<BMI<24,9 (%)	71.6
BMI>24,9 (%)	17.6
Body weight before the delivery (kg) [mean (95% CI)]	77.5 (76.1; 78.9)
Gestational weight gain (kg) [mean (95% CI)]	15.5 (14.9; 16.1)
Adequacy of gestational weight gain	
Adequate (%)	38.4
Excessive (%)	44.6
Inadequate (%)	17.0
Physical activity	
Less than once a week (%)	35.9
Once a week (%)	30.0
2-3 times per week (%)	25.5
Every Day (%)	8.6
Subjective evaluation of health	
Very good (%)	24.0
Good (%)	62.0
Pretty good (%)	12.5
Bad (%)	1.5
Place of residence	
Village (%)	27.7
Town less than 50 thous. inhabitants (%)	27.3
Town between 50-100 thous. inhibitants (%)	13.2
Town more than 100 thous. inhibitants (%)	31.8
Economic score	
Low (below the average) (%)	4.1
Medium (average) (%)	78.9
Well (above the average) (%)	17.0
Education	
Primary (%)	18.7
Secondary (%)	36.6
Higher (%)	44.7
Ponderal Index	
< tertile 10 (%)	10.1
> tertile 10 and <tertile 90 (%)	80.9
> tertile 90 (%)	9.0

A cross-sectional study was carried out in 2010-2012. To estimate the variance in anthropometric results and food frequency consumption with a relative error of 10% and 95% confidence interval (CI), a minimum sample size of 348 pregnant women was needed. Further considering a missing data and recording error of 15% this minimum sample size was set about 400 pregnant women. Ultimately in the study participated 487 women in the postpartum period, aged 17-47 (28.2 years 95% CI: 27.8; 28.6), patients of departments of gynecology and obstetrics of hospitals in the province of Warmia and Mazury. Decisions on including patients into research were taken by attending physicians on the basis of inclusion and exclusion criteria.

Inclusion criteria included: absence of gynecological diseases and chronic metabolic diseases (e.g. diabetes), proper course of pregnancy, full-term pregnancy (after 37 weeks' gestation), no-smokers, consent to participate in the study and a declaration of intent to continue the study depending on further research plans, single, live-born infants.

Exclusion criteria included: occurrence of health problems, mental diseases, HIV infection and viral type B hepatitis, impairment or limitation of legal capacity, no consent for anthropometric examinations and data use.

Before commencing the study, all patients were informed about its purpose and its planned course. Women were characterized by a different body weight and height, pre-pregnancy BMI, body weight before the delivery, gestational weight gain (GWG), physical activity, subjective assessment of socio-economical status and educational background [Table 1].

2.2. Dietary Data Collection

Dietary data were collected by in-person interviews using a validated semi-quantitative Food Frequency Questionnaire (FFQ), which have been described elsewhere [16]. An interview concerning a retrospective analysis of dietary habits over the year before. The survey was conducted between the second and tenth day after delivery. That's mean it studied mother's dietary habits during pregnancy and three months before pregnancy. The main part of the questionnaire consisted of questions concerning the usual intake frequency of 165 products and their quantity. The intake of products was determined by the respondents by indicating the typical frequency of consumption per day, week, month and year and the typical size of the portion. The study was based on the "Album of photographs of food products and dishes" [17].

2.3. Anthropometrics

Information on declared prepregnancy body weight was obtained from women through the questionnaire. Other information about anthropometric parameters of mother and child were obtained from the medical records of patients. Before the delivery, the body weight was measured with the use of a Radwag electronic scale, with an accuracy of 0.1kg. The obtained results were adjusted by 0.5kg for light clothes. Body height was measured with a Sieber Henger & Co anthropometer to an accuracy of 0.5 cm. BMI (kg/m2) was calculated on the basis of measurements of weight and height and evaluated pursuant to WHO criteria [18].

Gestational weight gain was calculated as the difference between the prior to delivery and pre-pregnancy body weight and classified into inadequate, adequate, or excessive gestational weight gain according to the guidelines of the Institute of Medicine (IOM), National Academy of Sciences in USA [19].

Deliveries were both natural and by cesarean section. The birth condition of a newborn was evaluated on the basis of measurement of the birth weight (g) and crown-heel length of the body (cm), taken in the hospital at birth. On the basis of obtained measurements, the Ponderal Index was identified. Anthropometric parameters of newborns were classified according to tertile distribution of a given feature. Values below tertile 10 and above tertile 90 were considered improper. The general health condition was determined in the first minute of life using the Apgar scale (8-10 points – good, 4-7 points – medium <4 points – bad).

2.3. Statistical Analysis

Normality was verified using the Shapiro-Wilk's W test. Continuous data are presented as mean with 95% CIs.

The Kaiser-Meyer-Olkin (KMO) test was used to measure of sampling adequacy greater than 0.5 and Bartlett's sphericity test achieving statistical significance, before deriving dietary patterns. KMO value for dietary data was 0.659 and Bartlett's test had a significance of $p<0.001$. Principal Components Analysis (PCA) was used to identify dietary patterns. With this aim in view, 165 food products included in validated FFQ were reduced to 41 product groups (without alcohol) [Table 2] comparable with validated grouping scheme [16]. The typical size of the portion of each food group was finally computerized and used in the analyses. A factor analysis was carried out using the PCA, subjecting the factor to the normalized varimax rotation. The features used in the factor analysis were reduced to eleven main factors, taking into account their own values (>1) and the Scree Plot. To the analyzing was chosen three most prevalent factors accounting for 24.8% of the total variation in data. Selected main factors (dietary patterns), were identified with the use of factor loads (correlation factor – r) between the initial variable and the newly created main factor. The assumed cut-off was r=0.4. Dietary patterns were named based on subjective assessment of food groups with the highest loadings within each principal component. Three dietary patterns, named Varied, Traditional Polish and Vegetable-fruit, have been identified from these data analyses. Each of the patterns was divided into tertiles.

Kruskal-Wallis ANOVA was used to describe the differences in the anthropometrics of pregnant woman and infants among the tertiles of each dietary patterns. Logistic regression analysis was also applied in order to evaluate the potential association of each independent covariate on the outcome. The strength of the association was measured using an odds ratio (OR) and 95% confidence intervals (CIs). In all analyses, the level of significance was set at $p<0.05$. The statistical analysis was carried out using STATISTICA software (version 10.0 PL; StatSoft Inc., USA, Tulsa; StatSoft Polska, Krakow).

3. Results

Characteristics of nutritional intake of the 487 women are shown in Table 2. The first factor was named the Varied dietary pattern. It comprised a high intake of high-quality charcuterie, whole-grain cereal products, eggs, legumes, leafy vegetables and cruciferous vegetables. The second factor was named the Traditional Polish dietary pattern and was characterized by a high intake of potatoes, French fries, potato pancakes, red meat, mixed dishes (vegetable and meat), sauces, sour cream, refined cereal products, dish of flour, sausages. The third factor was named the Vegetable-fruit dietary pattern and was characterized by fruit juices, orange and yellow vegetables, other vegetables, vegetable- fruit juices, fruit [Table 2].

Table 2. Factor loadings of the food groups on the first two principal components identified

Food group	Varied dietary pattern	Traditional Polish dietary pattern	Vegetable-fruit dietary pattern
Sausages	0.37	0.41	-0.13
High-quality charcuterie	0.62	0.03	-0.00
Organ meat, cold meat	-0.05	0.38	-0.07
Red meat	0.30	0.66	0.22
Poultry meat	0.27	0.11	0.33
Fishes and seafood	0.35	0.10	0.21
Mixed dishes (vegetable and meat)	0.28	0.59	0.12
Dish of flour	0.27	0.49	0.37
Eggs	0.51	0.05	0.00
Refined cereal products	-0.22	0.50	0.09
Whole-grain cereal products	0.55	-0.24	0.12
Ready-to-eat breakfast cereals	0.07	0.07	0.27
Butter	0.25	0.32	0.29
Sour cream	0.15	0.52	0.06
Other animals fats	0.04	0.27	-0.08
Margarine	-0.02	0.21	-0.18
Oil	-0.02	0.08	0.20
Mayonnaises and dressings	0.07	-0.08	0.08
Sauces	0.35	0.53	0.06
Milk and dairy drinks	-0.17	0.29	0.29
Curd cheese	0.06	-0.04	0.27
Cheese	0.18	0.14	-0.16
Potatoes	-0.04	0.70	-0.11
French fries, potato pancakes	0.07	0.66	0.33
Legumes	0.51	0.15	0.05
Soups	0.36	0.15	0.29
Cruciferous vegetables	0.43	0.13	0.32
Orange and yellow vegetables	0.15	0.07	0.59
Leafy vegetables	0.47	-0.06	0.02
Tomatoes	0.13	0.00	0.38
Other vegetables	0.31	0.37	0.52
Fruit	0.20	0.10	0.42
Fruit juices	-0.16	0.07	0.61
Vegetable- fruit juices	-0.28	0.02	0.51
Processed fruit products	-0.21	0.28	0.11
Sweets or confectionery	-0.05	0.25	0.07
Nuts	0.35	-0.08	0.33
Salty snacks	0.15	0.23	0.19
Non-alcoholic beverages	-0.26	0.25	0.22
Tea	-0.13	-0.02	0.14
Coffee	0.01	0.04	-0.11
Percentages of variance explained (%)	13.61	6.21	4.99

Loadings for variables whose contribution to the variance of component is superior to 0.4 are shown in bold.

Analysis of the associations between maternal and infant anthropometry (pre-pregnancy BMI, weight gain during pregnancy, birth weight, fetal length, Ponderal Index) and tertiles of dietary patterns showed statistically significant differences between tertiles of the Varied dietary pattern. Prepregnancy BMI was significantly different in the first and the third tertiles and GWG significantly decreased in subsequent tertiles of this pattern. Birth length was significantly higher in the first tertile compared to the third tertile, and lower in the second tertile compared to the third tertile of the Varied dietary pattern. Ponderal Index was significantly lower in the second tertile compared to the first tertile. The analysis didn't show statistically significant differences between tertiles of the Traditional Polish dietary pattern and the Vegetable-fruit dietary pattern [Table 3].

Analysis of associations between tertiles of dietary patterns and anthropometric parameters of mother showed the risk of BMI <18,5 was lower among women in the third tertile of the Traditional Polish dietary pattern (OR 0.40, 95% CI 0.17; 0.94), and in the third tertile of the Vegetable- fruit dietary pattern (OR 0.38, 95% CI 0.18; 0.83) than among women in the first tertile. The risk of BMI >24,9 was higher among women in the higher tertiles of Traditional Polish dietary pattern. The odds ratio among women in the second tertile was 2.12 (95% CI 1.04; 4.33) and in the third tertile, 2.38 (95% CI 1.15; 4.92) compared to those in the first tertile. Women in the third tertile of the Varied dietary pattern had greater odds of excessive GWG (OR 2.78, 95% CI 1.32; 5.88) compared to those in the first tertile. In the Traditional Polish dietary pattern women in the second tertile had significantly lower odds of excessive GWG (OR 0.48, 95% CI 0.23; 0.98) compared to the women in the first tertile. No such relations were observed in the Vegetable-fruit dietary pattern [Table 4].

Significant associations were observed also between tertiles of dietary patterns and birth outcomes.

Among women in the second tertile of the Varied dietary pattern risk of too low infant's birth weight was higher (OR 3.88, 95% CI 1.47; 10.27) compared to the first tertile. Women in the second tertile of the Vegetable-fruit dietary pattern had greater odds of too high infant's birth weight (OR 2.21, 95% CI 1.10; 4.45). No relations were observed between tertiles of dietary patterns and the risk of incorrect birth length. The risk of too high Ponderal Index in newborns was lower among women in the higher tertiles of the Vegetable- fruit dietary pattern. The odds ratio among women in the second tertile was 0.44 (95% CI 0.23; 0.87) and in the third tertile, 0.24 (95% CI 0.11; 0.53) compared to those in the first tertile. Moreover, the risk of too low Ponderal Index in newborns was higher among women in the higher tertiles of this dietary pattern. The odds ratio among women in the second tertile was 2.26 (95% CI 1.16; 4.40) and in the third tertile, 4.09 (95% CI 1.87; 8.95) compared to those in the first tertile. Women in the second tertile of Traditional Polish dietary pattern had higher risk of too low Ponderal Index (OR 6.45, 95% CI 2.44; 17.02) and lower risk of too high Ponderal Index (OR 0.16, 95% CI 0.06; 0.41) [Table 5].

Table 3. Anthropometric characteristics stratified into adherence categories of dietary patterns

Anthropometric parameters	Adherence of dietary patterns			
	Tertile 1	Tertile 2	Tertile 3	p[1]
Varied dietary pattern				
	n=161	n=168	n=158	
Prepregnancy BMI	21.9 (21.3; 22.5)[a]	23.0 (22.4; 23.7)	22.0 (21.5; 22.5)[a]	*
GWG	17.1 (16.0; 18.3)[ab]	14.7 (13.6; 15.9)[a]	14.6 (13.7; 15.4)[b]	*
Birth weight	3463.8 (3349.9; 3577.7)	3361.7 (3267.7; 3455.8)	3306.7 (3196.9; 3416.6)	ns
Birth length	53.1 (51.4; 54.7)[a]	37.9 (33.9; 41.8)[b]	48.2 (45.4; 51.0)[ab]	***
Ponderal Index	21.5 (21.0; 21.9)[a]	21.0 (20.5; 21.4)[a]	20.6 (20.2; 21.0)	**
Traditional Polish dietary pattern				
	n=162	n=168	n=157	
Prepregnancy BMI	22.5 (21.8; 23.1)	22.3 (21.8; 22.8)	22.2 (21.6; 22.9)	ns
GWG	15.4 (14.4; 16.4)	15.7 (14.6; 16.7)	15.4 (14.3; 16.5)	ns
Birth weight	3258.2 (3138.7; 3377.8)	3421.5 (3327.6; 3515.4)	3439.3 (3333.6; 3544.9)	ns
Birth length	47.5 (44.6; 50.3)	43.7 (40.2; 47.2)	48.0 (45.0; 50.9)	ns
Ponderal Index	21.5 (20.9; 22.0)	20.7 (20.3; 21.1)	20.9 (20.6; 21.2)	ns
Vegetable- fruit dietary pattern				
	n=160	n=164	n=163	
Prepregnancy BMI	22.4 (21.9; 23.0)	22.3 (21.7; 22.8)	22.2 (21.5; 22.9)	ns
GWG	15.3 (14.1; 16.4)	15.2 (14.4; 16.1)	16.1 (15.0; 17.2	ns
Birth weight	3467.2 (3355.5; 3578.8)	3361.1 (3274.0; 3448.2)	3296.6 (3179.8; 3413.4)	ns
Birth length	44.4 (40.9; 47.9)	46.6 (43.5; 49.7)	48.1 (45.3; 50.9)	ns
Ponderal Index	20.8 (20.5; 21.2)	20.7 (20.3; 21.1)	21.5 (21.0; 22.0)	ns

Values represent means with 95% CIs
[1]To test the significant differences, Kruskal-Wallis ANOVA, $p<0.05$.

Table 4. Associations between tertiles of dietary patterns and anthropometric parameters of pregnant women

Dietary patterns		Anthropometric parameters					
		Prepregnancy BMI			Adequacy of gestational weight gain		
		>= 18,5 and <=24,9	<18,5	>24,9	Adequate	Inadequate	Excessive
Varied	Tertile 1	ref.	ref.	ref.	ref.	ref.	ref.
	Tertile 2	ref.	0.69 (0.32; 1.47)	0.74 (0.38; 1.43)	ref.	1.29 (0.54; 3.04)	0.90 (0.46; 1.74)
	Tertile 3	ref.	0.84 (0.40; 1.75)	1.44 (0.79; 2.63)	ref.	-	2.78** (1.32; 5.88)
Traditional Polish	Tertile 1	ref.	ref.	ref.	ref.	ref.	ref.
	Tertile 2	ref.	0.63 (0.30; 1.31)	2.12* (1.04; 4.33)	ref.	1.04 (0.38; 2.85)	0.48* (0.23; 0.98)
	Tertile 3	ref.	0.40* (0.17; 0.94)	2.38* (1.15; 4.92)	ref.	0.73 (0.19; 2.70)	1.12 (0.49; 2.57)
Vegetable- fruit	Tertile 1	ref.	ref.	ref.	ref.	ref.	ref.
	Tertile 2	ref.	0.48 (0.23; 1.02)	1.49 (0.81; 2.76)	ref.	0.55 (0.19; 1.64)	0.52 (0.26; 1.04)
	Tertile 3	ref.	0.38* (0.18; 0.83)	1.19 (0.61; 2.29)	ref.	1.47 (0.43; 4.96)	-

Odds ratio adjusted for age (years), mother's education, place of residence, economic score. Values refer to principal components analysis *p≤0.05; **<0.01; OR- odds ratio; CI – confidence interval.

Table 5. Associations between tertiles of dietary patterns and anthropometric parameters of child

Dietary patterns		Anthropometric parameters								
		Birth weight (g)			Birth length(cm)			Ponderal Index		
		>= 2500g and <= 4000g	< 2500 g	> 4000 g	>=47 and <=55	< 47	> 55	>=pct 10 and <=pct 90	< pct 10	> pct 90
Varied	Tertile 1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
	Tertile 2	ref.	3.88** (1.47; 10.27)	0.70 (0.35; 1.42)	ref.	1.30 (0.64; 2.62)	1.00 (0.50; 2.01)	ref.	1.34 (0.71; 2.54)	0.75 (0.39; 1.41)
	Tertile 3	ref.	0.96 (0.30; 3.09)	0.69 (0.35; 1.36)	ref.	1.06 (0.54; 2.08)	0.61 (0.36; 1.03)	ref.	1.29 (0.74; 2.23)	0.78 (0.45; 1.35)
Traditional Polish	Tertile 1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
	Tertile 2	ref.	1.45 (0.60; 3.52)	0.67 (0.32; 1.40)	ref.	1.49 (0.73; 3.04)	0.77 (0.46; 1.30)	ref.	6.45** (2.44; 17.02)	0.16** (0.06; 0.41)
	Tertile 3	ref.	1.22 (0.46; 3.26)	1.08 (0.56; 2.11)	ref.	1.82 (0.89; 3.74)	0.72 (0.41; 1.25)	ref.	1.77 (0.91; 3.44)	0.56 (0.29; 1.09)
Vegetable-fruit	Tertile 1	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
	Tertile 2	ref.	1.26 (0.56; 2.83)	2.21* (1.10; 4.45)	ref.	0.91 (0.47; 1.77)	0.71 (0.42; 1.22)	ref.	2.26* (1.16; 4.40)	0.44* (0.23; 0.87)
	Tertile 3	ref.	0.37 (0.13; 1.08)	0.94 (0.43; 2.08)	ref.	0.66 (0.33; 1.33)	0.74 (0.43; 1.26)	ref.	4.09** (1.87; 8.95)	0.24** (0.11; 0.53)

Odds ratio adjusted for age (years) and prepregnancy BMI. Values refer to principal components analysis *p≤0.05; **<0.01; OR- odds ratio; CI – confidence interval.

4. Discussion

This study examined the potential association between maternal dietary patterns during pregnancy and outcomes of mother and child. Three major dietary patterns, namely Varied, Traditional Polish and Vegetable-fruit were identified among polish pregnant women. The first factor, also called "healthy" or "prudent" in other researches, has various vegetables, whole-grain cereal products and sources of protein such as eggs, high-quality charcuterie. It's characterized by a varied diet, rich in foods from different food groups [15,20]. The Traditional Polish pattern was characterized by food typical for Country's eating habits and similar with other identified in studies that used the same analysis procedures [21]. The Vegetable-fruit pattern was based only on vegetables, fruit, and juices and in other studies was also named "vegetarian-type". This dietary pattern doesn't include cereal products, dairy products and animal products [15].

However, neither dietary pattern was characterized by dairy products, fish or seafood, groups of product significant from the point of view of the health of the mother and the child [3,22-27]. The positive correlation between the frequency of presence of dairy products in the mother's diet and the birth weight, length, and head circumference has been confirmed in other studies [22]. Moreover, previous research results prove the existence of a correlation between the consumption of dairy products in pregnancy, a weight gain and a reduction in the number of premature births [28]. The examined patterns were not characterized also by fish or seafood, which can disturb the proper growth of the child in the metabolic programming aspect. On the other hand, the analyses carried out by Oliveira et al. in 2012 demonstrated that LC-PUFAs are extremely important for proper child development. A positive correlation was demonstrated between the DHA content in the diet and the normal head circumference, which proves the effect of this acid on the proper development of the child's brain [23].

The conducted analyses revealed higher risk of too high prepregnancy BMI in the higher tertiles of the Traditional Polish dietary pattern and the lower risk of too low prepregnancy BMI in the third tertile of the Vegetable-fruit dietary pattern. The results suggest that the highest

intensity of dietary pattern characterized by vegetables and fruit decreased the risk of low body weight before pregnancy, contrary to popular opinion, according to which the vegetarian diet may promote the occurrence of underweight [29,30,31,32]. The highest tertile of the Varied dietary pattern was associated with higher risk of excessive gestational weight gain. In the second tertile of the Traditional Polish dietary pattern was observed the lower risk of excessive GWG. The results suggest that a diet high in meat, refined products, potatoes, and fats during pregnancy might be associated with increased risk of excessive GWG. The inverse associations between dietary pattern and GWG were also found by Tielemans et al. (2015) and Shin et al. (2016). In the researches dietary pattern characterized by margarine, sugar, and snacks was related with the higher incidence of excessive gestational weight gain and dietary pattern named mixed was associated with reducing excessive GWG [14,33]. Pre-pregnancy BMI and the gestational weight gain are important for the proper development of a fetus in the aspect of the child's and the adult's health. The research proves that an excessive body weight in pregnancy is related to an increase in the birth weight of a child, and a low increase in body weight in pregnancy is related to a risk of the child's body weight deficiency [34]. A similar relation was observed for the prepregnancy BMI of the mother. The results of the research indicate the existence of a positive relationship between obesity of the mother in pregnancy and the risk of obesity of the child in childhood and in adulthood. Epidemiological data proved a constantly growing number of obese women, which involves an increased risk to children in the period of their development of being exposed to the “obese intrauterine environment” [4]. Unfortunately, the weight gain guidelines not offering dietary recommendations on how to properly gain weight but only focused on ranges of weight.

In the analysis, the birth parameters of newborn infants, an increased risk of too low birth weight was found in the second tertile of the Varied dietary pattern. And the second tertile of the Vegetable- fruit dietary pattern was related to increased risk of too high birth weight. The confirmation of these results could be the research conducted by Murphy et al. (2014) which did not affirm that an increased consumption of vegetables and fruit had a protective effect on the risk of improper body weight at birth [3]. Associations between birth weight and dietary patterns were observed also in other studies. Coelho et al. (2015) reported positive associations between birth weight and snack dietary pattern [20]. Research of Knudsen et al. (2012) showed that Western diet led to lower birth weight [35]. Birth weight is one of the factors the most significant determining development of noncommunicable diseases, including obesity [2]. Low birth weight is very often related to the so-called “thrifty phenotype”. Those newborns are characterized by an increased appetite, which results in consuming large amounts of food, high metabolism performance and reduced metabolic expenditure [4]. Consequently, the phenomenon of catch-up growth is observed among the newborns with low birth weight, consisting of an accelerated growth of the body weight. This process is conducive to the development of the central and peripheral obesity, as well as insulin resistance, type 2 diabetes, allergy, asthma and cardiovascular diseases [2]. On the basis of own research conducted, a decreasing risk of the too high value of the Ponderal Index was observed in subsequent tertiles of the Vegetable-fruit dietary pattern while increasing risk of too low Ponderal Index was observed in the same tertiles. Ponderal Index as a tool used to identify infants whose soft tissue mass is below normal for the stage of skeletal development, is a very important parameter of children. The research showed that incorrect Ponderal Index in infants can be associated with greater fat-mass, obesity or increased risk of cardiovascular diseases [36,37]. In recent years the relationship between PI and dietary patterns wasn't analyzed. Meanwhile, our data suggest it could be very important to consider factors beyond birth weight and length alone in the assessment of fetal growth.

4.1. Limitation and Strengths

This study has several limitations. First, the cross-sectional design prevented the establishment of causal relationships between dietary patterns and anthropometry of mother and child. Second, nutrient intake through dietary supplement consumption before pregnancy was not considered. Despite the limitation, the research has its value due to the fact that the effect of the overall dietary pattern and the food quality on parameters of mother and child was examined. It covered further than the effect of a single nutrient or food on outcomes of anthropometry.

5. Conclusions

In conclusion, results suggest that the Varied, Traditional Polish or Vegetable- fruit pattern could be associated with anthropometrics parameters of mother and infant, but not provide sufficient evidence of determines positive or negative outcomes. The issues broached in above study emphasize the important role of nutrition during pregnancy in maternal health and thereby impact on metabolic programming and development of the child. However, the relationship between dietary pattern and anthropometric parameters of mother and infant may be multidimensional and need explanation by conducting more research.

Statement of Competing Interests

The authors have no competing interests.

List of Abbreviations

BMI: body mass index
CI: confidence interval
DHA: Docosahexaenoic acid
FFQ: Food Frequency Questionnaire
GWG: gestational weight gain
IOM: Institute of Medicine
KMO: Kaiser-Meyer-Olkin
LC-PUFA: long chain polyunsaturated fatty acids
OR: odds ratio
PCA: principal component analysis
WHO: World Health Organization

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