

## REVIEW OF THE STUDIES ON NUTRITION IN POLISH PRESCHOOL CHILDREN. PART 2. MEALS PREPARED AT PRESCHOOL

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### ABSTRACT

This article is the second part of the review of the studies on nutrition in Polish preschool children. In the first part, studies on preschool menus assessment were presented and summarised, whereas this article reviews the studies on the assessment of foods and meals prepared at preschool. The aim of this review was to present and summarise the results of the studies on the assessment of meals prepared for children at preschool based on the reports from the preschool food storeroom, the studies on chemical analysis of sample meals served at preschools and the studies on comparison of the results of chemical analysis to the results obtained by calculations obtained from computer programmes. The results of the studies on the assessment of meals prepared for children at preschool using various methods confirm most of the findings from the studies on the assessment of preschool menus. It is necessary to carry out more studies on energy and nutrient content assessment of preschool meals determined by chemical analysis of sample meals in order to provide more accurate information about the real nutritional value of meals served to children at preschool. It is essential to update the Polish food composition tables to enable more precise calculations of nutritional value of the meals planned for children at preschools which will improve the possibility of adjusting preschool meals to the real needs of both 3-year-old and 4-6-year-old children during their stay at preschool.

**Key words:** *preschool children, nutrition, preschool meals, chemical analysis, energy, nutrients*

### STRESZCZENIE

Niniejsza praca jest drugą częścią przeglądu badań dotyczących żywienia polskich dzieci w wieku przedszkolnym. W pierwszej części przedstawiono i podsumowano wyniki prac poświęconych ocenie jadłospisów przedszkolnych. Niniejsza część dotyczy oceny posiłków przygotowanych w przedszkolu. Celem pracy było przedstawienie i podsumowanie wyników badań dotyczących oceny posiłków przygotowywanych dla dzieci w przedszkolach na podstawie raportów magazynowych, analizy chemicznej posiłków serwowanych w przedszkolach oraz badań, w których porównano wartość odżywczą posiłków ocenioną metodą analizy chemicznej i metodą obliczeniową przy użyciu programów komputerowych. Wyniki badań dotyczących oceny posiłków przygotowanych dla dzieci w przedszkolach przy zastosowaniu różnych metod oceny potwierdzają większość wniosków wynikających z prac dotyczących oceny jadłospisów przedszkolnych. Należy prowadzić więcej badań dotyczących oceny zawartości energii i składników pokarmowych w przedszkolnych posiłkach na podstawie analizy chemicznej, aby uzyskać bardziej dokładne informacje odnośnie rzeczywistej wartości odżywczej posiłków serwowanych dzieciom w przedszkolach. Konieczne jest uaktualnienie polskich tabel wartości odżywczej żywności, aby zapewnić większą dokładność obliczeń wartości odżywczej posiłków planowanych dla dzieci w przedszkolach, co przyczyni się do zwiększenia możliwości dostosowania przedszkolnych posiłków do rzeczywistych potrzeb zarówno dzieci trzyletnich, jak i 4-6-letnich podczas ich pobytu w przedszkolu.

**Słowa kluczowe:** *dzieci w wieku przedszkolnym, żywienie, posiłki przedszkolne, analiza chemiczna, energia, składniki pokarmowe*

### INTRODUCTION

This article is the second part of the review of the studies on nutrition in Polish preschool children. In the first part [19], review of the studies on the assessment of preschool menus was presented. The first part of

the review [19] showed that preschool menus were characterised by low frequency of including pulses or not including them at all, insufficient content of milk and dairy products, and high content of butter, sweets and sugar. Moreover, there was a concern for insufficient content of fruit and vegetables. The

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menus contained excessive amounts of energy and energy from saturated fatty acids, and high amounts of vitamin A. On the other hand, the menus contained inadequate amounts of energy from unsaturated fatty acids and carbohydrates as well as inadequate amounts of vitamin D, calcium and potassium. There was also a concern for inadequate content of vitamin C. Therefore, planning nutrition in preschools should be improved in order to provide the children with balanced meals which would contain all the essential nutrients in amounts adequate for both 3-year-olds and 4-6-year-olds [19].

However, the other aspect of the assessment of children nutrition during their stay at preschool is to assess the foods and meals which were actually served. This assessment may be performed using various methods which include: using the reports from the preschool food storeroom and chemical analysis of sample meals served at preschools. Another important area of research connected with preschool meals assessment is the comparison of nutritional value determined by chemical analysis to the results obtained by calculations obtained from computer programmes.

The aim of this review was to present and summarise the results of the studies on the assessment of meals prepared for children at preschool based on the reports from the preschool food storeroom, the studies on chemical analysis of sample meals served at preschools and the studies on comparison of nutritional value determined by chemical analysis to the results obtained by calculations obtained from computer programmes.

## MATERIAL AND METHODS

We used the same methodology as in part 1 of this review [19], that is we searched Polish database: *Polska Bibliografia Lekarska* (Polish Medical Bibliography) since 1991, and international databases: ScienceDirect and EBSCOhost with the inclusion of the following databases: Academic Search Complete, SPORTDiscus, MEDLINE, Health Source and Agricola. We also manually searched selected journals and the reference lists of the articles included in this review [19]. Similarly to part 1 [19], this review covered the years from 1996, because previous studies were summarised in the review by *Gronowska-Senger et al.* [12].

Despite the diversity in the methodology of the studies, we aimed to provide the possibility of comparison the observations and conclusions from this article to the observations and conclusions from the previous review [19]. Therefore, when summarising the studies which reported energy and nutrient content in meals prepared at preschool, we made the same methodological assumptions which were described in

detail in the previous review [19]. In short, energy and nutrient content in the meals prepared at preschool was compared to 70% of the daily requirement of 3-year-old children and 4-6-year-old children separately. The World Health Organization recommendations on energy content from macronutrients [23] and the amended dietary reference values (DRVs) by *Jarosz* [14] were used, unless some nutrients or some levels of the DRVs were not included – in these cases we applied the DRVs worked out either by the Scientific Committee on Food [21] or by the Food and Nutrition Board of the Institute of Medicine [5, 6, 7, 8, 9]. All the levels of DRVs were used for comparison: Estimated Average Requirement (EAR), Recommended Dietary Allowance (RDA), Adequate Intake (AI) and Tolerable Upper Intake Level (UL). Energy content from macronutrients was calculated if it was not provided by the authors.

## ASSESSMENT OF PRESCHOOL MEALS BASED ON THE REPORTS FROM THE PRESCHOOL FOOD STOREROOM

We found only three studies [4, 13, 18] in which meals prepared for children at preschool were assessed based on the analysis of foods used to prepare these meals. The information about the foods used to prepare the meals were taken from the reports from the preschool food storeroom. These reports contain the information about the amounts of all foods used to prepare meals at a preschool on a given day per one person. The studies were carried out in various parts of Poland. One study was carried out at 15 preschools in Tarnobrzeg and 79 preschools in the Tarnobrzeg voivodeship [4] situated in south-eastern part of Poland. The other studies were carried out at a preschool in Kielce [18] situated in central-eastern part of Poland, and at a preschool in Poznań [13] situated in the central-western part of Poland.

The studies [4, 13, 18] covered various periods. The study in the Tarnobrzeg voivodeship [4] covered six ten-day periods within two consecutive weeks excluding weekends, that is one ten-day period during winter and one ten-day period during summer over three consecutive years. The study in Kielce [18] covered four ten-day periods, including one period from every season of the year. The study in Poznań [13] covered one ten-day period during winter.

The authors of the study in the Tarnobrzeg voivodeship [4] did not report the number and the kind of meals prepared at preschools. In the remaining two studies [13, 18], the authors reported that three meals were prepared for the children at preschool. The meals prepared at a preschool in Kielce [18] included breakfast, dinner and an afternoon snack, whereas the meals at a preschool in Poznań [13]

included the first breakfast, the second breakfast and dinner. Therefore, the number of meals was in line with the recommendations which is in accordance with the results of preschool menus analysis [19]. The explanation of the kind of meals eaten in Poland is available in the previous review [19].

In the three cited studies [4, 13, 18], various nutrients were analysed. At preschools in the Tarnobrzeg voivodeship [4], content of fat and fatty acids was analysed. However, the authors analysed content of these nutrients only in fats added to dishes and fats spread on sandwiches. These fats were: butter, lard, pork fat, margarine and plant oils. In the meals at a preschool in Kielce [18], the authors analysed content of energy, macronutrients, vitamins and minerals. In the meals at a preschool in Poznań [13], only content of vitamins was analysed.

The authors of these studies [4, 13, 18] used the DRVs which were in use at the time of doing the research. Fat and fatty acid content in the fats used to prepare meals at preschools in the Tarnobrzeg voivodeship [4], as well as energy and nutrient content in the meals prepared for children at a preschool in Kielce [18] were compared to the DRVs by *Ziemlański* [24]<sup>1</sup>. Vitamin content in meals prepared at a preschool in Poznań [13] was compared to the DRVs by *Jarosz* [15] published in 2008.

In the study in Poznań [13], the results were compared to 75% of daily requirement of 4-6-year-olds. It was the authors' assumption to assess if the meals cover the needs of 4-6-year-old children, whereas 3-year-old children were not taken into account. In the study in Kielce [18], the authors assumed that children should receive 55-60% of their daily requirement with preschool meals. In the study in the Tarnobrzeg voivodeship [4], only fats used to prepare meals were analysed, as mentioned above, and the authors assumed that fats added to dishes and fats spread on sandwiches should provide 50% of total fat eaten by preschool children.

The results of the study in preschools in the Tarnobrzeg voivodeship [4] are in accordance with the results of preschool menus assessment presented in the first part of the review [19]. High content of saturated fatty acids along with insufficient content of mono- and polyunsaturated fatty acids was reported. It was the result of using mainly animal fat which accounted for 65% of all fats used at preschools.

Content of vitamins reported in preschool meals in Poznań [13] confirm most of the observations from the analysis of vitamin content in preschool menus [19]. Vitamin A content was very high, however,

neither retinol content nor  $\beta$ -carotene content was reported, therefore, it is not known whether the UL was exceeded. Vitamin D content was much lower than 70% of EAR for 3-year-olds. Content of vitamin B<sub>1</sub>, B<sub>2</sub>, B<sub>6</sub> and B<sub>12</sub> was adequate. Niacin content was adequate for 4-6-year-old children but was too high for 3-year-olds because it exceeded 70% of UL for this age group. However, vitamin E content did not reach 70% of AI for children of both age groups. Folate content did not reach 70% of RDA for 3-year-old children, thus it was lower than 70% of EAR for 4-6-year-old children. Vitamin C content was adequate for 3-year-old children, exceeded 70% of EAR for 4-6-year-old children but was lower than RDA for 4-6-year-old children.

Content of energy and nutrients in preschool meals in Kielce [18] may not be analysed according to the assumptions described in the previous article [19] because the tables with the results were not provided in the publication. However, the discussion of the results and some cited figures [18] show tendencies similar to those concluded from preschool menus analysis [19], that is content of energy and sodium was too high, content of energy from protein and carbohydrates, as well as content of dietary fibre and phosphorus was adequate, whereas content of vitamin C and calcium was too low.

## CHEMICAL ANALYSIS OF SAMPLE MEALS SERVED AT PRESCHOOLS

Assessing the nutritional value of meals served at preschool by chemical analysis of sample meals was the aim of eight studies [1, 2, 3, 10, 11, 16, 17, 20]. Three of those studies were carried out in Lublin [2, 3, 17] which is situated in eastern part of Poland, two studies were carried out in Warsaw [1, 16], the capital city situated in central-eastern part of Poland, two studies were carried out in Wrocław [10, 11] situated in south-western part of Poland, and one study was carried out in towns and villages of north-eastern part of Poland [20]. In three studies [2, 3, 17], sample meals were taken from one preschool. In two studies [1, 16], sample meals from three preschools were analysed. In two studies [10, 11], sample meals were taken from four preschools and in one study [20], sample meals were taken from 15 preschools.

The period of collecting sample meals, most often applied in these studies, were ten consecutive weekdays, that is two weeks excluding weekends. At a preschool in Lublin, sample meals were taken over a ten-day period during spring and autumn [2] and during winter (in February) and summer (in June) [3]. At Warsaw preschools [1, 16], also the ten-day period was analysed but the authors did not specify during which month or season of the year. At preschools in

<sup>1</sup> These DRVs were published many times in the 1990s and the authors of the cited studies used various references, however, we cited the DRVs from 2001 because this publication is the last one, contains all the DRVs with detailed description and is the most easily available.

towns and villages of north-eastern part of Poland [20], sample meals were collected over ten-day period during the first and the second quarter of the year. At preschools in Wrocław [10, 11], sample meals were taken over ten-day periods in March, June, September and December of two consecutive years. Only in one study [17], sample meals were collected over the period of five consecutive days. These were meals prepared in December [17].

Almost in all of the studies, all preschool meals served during the day were analysed, that is breakfast, dinner and afternoon snack [1, 2, 3, 11, 16, 17]. The only exception were preschools in towns and villages of north-eastern part of Poland [20] where only dinners were analysed, however, the authors provided the information that in those preschools, breakfast, dinner and afternoon snack were served, therefore we know that the number of meals was in line with the recommendations. Only in one study [10], the authors did not include the information about what meals were served at preschools but it can be concluded from the article that all meals served at preschools were analysed.

Content of the most nutrients in sample meals were determined at a preschool in Lublin [17]. These nutrients included: protein, fat, carbohydrates, dietary fibre, sodium, potassium, calcium, magnesium, zinc, copper, iron and manganese. At the other preschool in Lublin [2, 3], only content of protein and fat was determined. Also, dietary fibre content was determined but the authors did not report its content and used it only to calculate carbohydrate content 'by difference'. At preschools in Wrocław [11], content of protein, fat, cholesterol, water, calcium, magnesium and iron was determined and carbohydrate content was calculated 'by difference'. In the other study carried out at preschools in Wrocław [10], content of fatty acids was determined. At preschools in Warsaw, content of protein, fat, carbohydrates [16] and magnesium was determined [1].

In two studies [11, 16], energy content was calculated based on macronutrient content. In three studies [2, 3, 17], energy content was not calculated from the measured content of macronutrients but was calculated using dietetic computer programmes. In sample meals at preschools in towns and villages of north-eastern part of Poland [20], protein and fat content was determined, whereas carbohydrate content was calculated 'by difference'. Moreover, the authors [20] calculated content of these nutrients, and also some other nutrients, using a dietetic computer programme but when presenting the results, no information was provided whether the results are those chemically determined or those calculated. Therefore, this study was not used in the summary below.

Among the studies on preschool meals assessment by chemical analysis, only in one [17] the new DRVs were applied [15] because most of these studies were carried out and published before the new DRVs were introduced. In the remaining studies [1, 2, 3, 10, 11, 16], the DRVs by Ziemiański [24]<sup>2</sup> were used, except for one study [20] in which the DRVs by Szponar and Turlejska [22] were applied.

The results of the studies on energy and nutrient content in meals served at preschool determined by chemical analysis [1, 2, 3, 10, 11, 16, 17] show many similar tendencies as those described in the summary of the studies on preschool menus assessment [19]. Energy content in preschool meals was too high in almost all studies [2, 3, 11, 16] exceeding 70% of EER for both 3-year-olds and 4-6-year-olds. Moreover, energy content in meals served at preschools in Wrocław [11] and at a preschool in Lublin during winter and summer [3] was higher than the daily EER for 3-year-old children, while energy content in meals served at preschools in Warsaw [16] and at a preschool in Lublin during spring and autumn [2] either almost reached or exceeded the daily EER for 4-6-year-old children. The only exception was a preschool in Lublin [17] where energy content was almost adequate for 3-year-olds but too low for 4-6-year-olds.

Similarly to the observations from preschool menus analysis [19], also in the meals served at preschools protein content was adequate [2, 3, 11, 16, 17]. Content of fat was either adequate, as in the case of the meals served at a preschool in Lublin [17], another preschool in Lublin during spring and autumn [2], and two out of the three preschools in Warsaw [16], or excessive, as in the case of meals served at a preschool in Lublin during winter and summer [3], at one out of the three preschools in Warsaw [16] and at preschools in Wrocław [11]. Content of fatty acids, determined only in meals served at preschools in Wrocław [10], was reported to favour atherogenesis due to the high content of saturated fatty acids and too low content of unsaturated fatty acids, especially polyunsaturated ones. The only study in which cholesterol content was analysed [11] reported excessive content of this nutrient. Content of carbohydrates was adequate in meals served at almost all preschools [2, 3, 16, 17], except for a preschool in Lublin during winter [3], one out of the three preschools in Warsaw [16] and preschools in Wrocław [11] in which content of carbohydrates was too low. Content of dietary fibre reported in meals served at a preschool in Lublin [17] was adequate for 3-year-old children but too low for 4-6-year-old children.

2 These DRVs were published many times in the 1990s and the authors of the cited studies used various references, however, we cited the DRVs from 2001 because this publication is the last one, contains all the DRVs with detailed description and is the most easily available.

Calcium content, determined in meals served at a preschool in Lublin [17], was far too low and did not reach even the 70% of EAR for 3-year-olds, whereas in preschool meals in Wrocław [11], content of this mineral was adequate for children of both age groups. Magnesium content was adequate in meals served at preschools in Warsaw [1] and Wrocław [11]. At a preschool in Lublin [17], magnesium content was adequate for 3-year-old children and exceeded 70% of EAR for 4-6-year-old children but was lower than 70% of RDA for this age group.

Similarly to the studies on the analysis of preschool menus [19], content of sodium at a preschool in Lublin [17] was higher than 70% of UL for both age groups. Content of potassium [17] did not reach 70% of AI for 3-year-olds and therefore was too low for all preschool children.

Iron content in meals served at preschools in Wrocław [11] was adequate for 3-year-old children. Although it was higher than 70% of EAR for 4-6-year-olds, it did not reach 70% of RDA for this age group. In meals served at a preschool in Lublin [17], content of iron was higher than 70% of EAR for 3-year-olds but lower than 70% of RDA for this age group and lower than 70% of EAR for 4-6-year-old children.

Zinc content in meals served at a preschool in Lublin [17] was adequate for 3-year-olds and exceeded 70% of EAR for 4-6-year-old children. However, it was lower than 70% of RDA for 4-6-year-olds. Copper content [17] may be considered adequate for 3-year-olds but it was lower than 70% of RDA for 4-6-year-olds. Manganese content in meals served at this preschool [17] was adequate for children of both age groups.

### **COMPARISON OF CALCULATED NUTRITIONAL VALUE OF MEALS SERVED AT PRESCHOOLS TO THE RESULTS OF CHEMICAL ANALYSIS**

Three of the studies described in the previous section, that is two studies carried out at three preschools in Warsaw [1, 16] and one study carried out at preschools in Wrocław [11], aimed to compare the results of chemical analysis of sample meals to the results of calculations obtained from dietetic computer programmes. In two studies [1, 16], the authors used FOOD computer programme worked out by the National Food and Nutrition Institute in Warsaw in 1990 and in one study [11] the Nutritionist IV computer programme with Polish database.

Content of protein, carbohydrate and fat determined by chemical analysis in preschool meals in Wrocław [16] was lower compared to the results obtained by calculations. Quite the opposite, in meals at all of the three preschools in Warsaw [16], content of protein and

carbohydrates determined by chemical analysis was higher in comparison to the results of the calculations. Content of fat determined by chemical analysis in meals at two out of the three preschools in Warsaw [16] was lower than the results of the calculations and at one preschool the results were higher. Cholesterol content determined by chemical analysis in preschool meals in Wrocław [16] was higher than the results of calculations. It indicates that in fact the recommendations were far more exceeded. Energy content calculated from macronutrient content determined by chemical analysis in comparison to the energy content obtained from dietetic computer programmes was higher in meals at all of the three preschools in Warsaw [16] but lower at preschools in Wrocław [11]. However, both at preschools in Warsaw [16] and Wrocław [11], the meals provided excessive energy for both 3-year-olds and 4-6-year-olds.

The differences in macronutrient content obtained by either chemical analysis or by calculations, along with the differences in the results of energy content, caused that energy content from protein was still within the recommendations in the meals at all preschools [11, 16]. Energy content from fat determined by chemical analysis turned out to be much lower than the content assessed by calculations at two out of the three preschools in Warsaw [16], but it was still in line with the recommendations. However, it remained almost the same at the third preschool in Warsaw [16] and turned out to be much higher at preschools in Wrocław [11] showing that in fact the content of fat exceeded the recommendations much more than it was showed by calculations. Content of energy from carbohydrates was higher at two out of the three preschools in Warsaw [16] and was still within the recommendations, but was much lower in preschools in Wrocław [11] showing that in fact the content of energy from carbohydrates was much lower than it was showed by calculations. Generally, the results obtained from chemical analysis, that is those which show the real content of energy and macronutrients, revealed the same nutritional inadequacies, however, at some preschools energy content from macronutrients was better and closer to the recommendations while it was worse in others.

Magnesium content in the meals determined by chemical analysis was lower than content of this mineral assessed by calculations at one of the three preschools in Warsaw [1], similarly to the results obtained in preschools in Wrocław [11]. However, at two other preschools in Warsaw [1], the results of chemical analysis were higher than those obtained by calculations. These differences did not have any influence on the assessment of magnesium content, that is content of this mineral still exceeded the 70% of RDAs for both age groups and did not pose the risk of excessive content, since the UL is set only for magnesium from supplements.

Content of iron determined by chemical analysis in preschool meals in Wrocław [11] was lower than content of this mineral obtained by calculations. This means that the real content of iron was adequate only for 3-year-old children, exceeded the 70% of EAR for 4-6-year-old children, but was lower than 70% of RDA for 4-6-year-olds. In the case of calcium, the situation was opposite, that is calcium content determined by chemical analysis was much higher than the one obtained by calculations [11]. This means that in fact calcium content was adequate for children of both age groups.

Comparison of the results obtained by chemical analysis and those obtained by calculations showed that content of energy and nutrients planned and calculated in a dietetic computer programme may be either slightly different and insignificant in relation to the dietary recommendations, as it was in the case of magnesium, or may differ either slightly or quite strongly causing significant differences in relation to the dietary recommendations, as it was in the case of iron and calcium. However, the studies are sparse and it is not possible to draw any major conclusions. Nevertheless, it is obvious that it is necessary to carry out more studies on energy and nutrient content in preschool meals and in particular, it is important to do chemical analysis of foods currently available in food stores in order to improve the accuracy of calculations which are the only way to plan nutrient content in preschool meals in every day practice of a nutritionist or a dietician. The best solution would be to impose legal obligation on food producers to provide detailed nutrient content of the foods which they sell determined by chemical analysis.

## CONCLUSIONS

1. The results of the studies on the assessment of meals prepared for children at preschool using various methods confirm most of the previously reported findings from the review of the studies on preschool menus assessment.

2. It is necessary to carry out more studies on the assessment of energy and nutrient content of preschool meals determined by chemical analysis in order to provide more accurate information about the real nutritional value of meals served to children at preschool.

3. It is necessary to update the Polish food composition tables to enable more precise calculations of nutritional value of the meals planned for children at preschools which will improve the possibility of adjusting preschool meals to the real needs of both 3-year-old and 4-6-year-old children during their stay at preschool.

## Conflict of interest

*The authors declare no conflict of interest.*

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