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REVIEW ARTICLE

REVIEW OF THE STUDIES ON NUTRITION IN POLISH PRESCHOOL CHILDREN. PART 1. PRESCHOOL MENUS

Sylwia Merkiel[*]*, Wojciech Chalcarz*

Eugeniusz Piasecki University School of Physical Education in Poznan,
Department of Food and Nutrition, Poznan, Poland

ABSTRACT

The last review of the literature on nutrition in Polish children covered the years 1980-1995. From that time living conditions in Poland have changed due to political and economic changes. Attitudes toward eating and healthy life-style have also changed. Therefore, it is necessary to summarise current knowledge about what Polish preschool children eat.

The aim of this article was to present the areas of research on nutrition in Polish preschool children based on the review of the literature, and to present and summarise the results of the studies on the assessment of preschool menus. The review of the literature showed two main areas of research on nutrition in Polish preschool children: the assessment of meals planned and served to children at preschools, and the assessment of food behaviour and daily food and nutrient intake in preschool children. Studies on energy and nutrient content of preschool menus should be carried out regularly in order to improve nutrition of children during their stay at preschool and vegetarian menus should be studied to fill the gap in the literature. The methodology of assessing preschool meals should be the same in order to provide the possibility to compare both the results and the conclusions. Preschool menus should be adjusted to the needs of 3-year-old children and 4-6-year-old children separately. The nation-wide education programme for preschool staff should be worked out and implemented in order to teach the preschool staff about the current nutrition recommendations for children, as well as the nutritional needs of 3-year-old children and 4-6-year-old children.

Key words: *preschool children, nutrition, preschool menus, energy content, nutrient content*

STRESZCZENIE

Ostatni przegląd literatury dotyczącej żywienia polskich dzieci obejmował lata 1980-1995. Od tego czasu warunki życia w Polsce uległy zmianie na skutek przemian politycznych i ekonomicznych. Postawy wobec jedzenia i zdrowego stylu życia także się zmieniły. Dlatego konieczne jest podsumowanie współczesnej wiedzy na temat tego co jedzą polskie dzieci w wieku przedszkolnym. Celem pracy było przedstawienie obszarów badań z zakresu żywienia polskich dzieci w wieku przedszkolnym na podstawie przeglądu literatury oraz przedstawienie i podsumowanie wyników badań dotyczących oceny jadłospisów przedszkolnych.

Badania z zakresu żywienia polskich dzieci w wieku przedszkolnym skupiły się na dwóch problemach, a mianowicie: ocenie posiłków planowanych i serwowanych dzieciom w przedszkolach oraz jakościowej i ilościowej ocenie sposobu żywienia dzieci przedszkolnych. Należy regularnie prowadzić badania dotyczące zawartości energii i składników pokarmowych w przedszkolnych jadłospisach, aby skorygować ewentualne błędy żywieniowe. Szczególną uwagę powinno się zwrócić na jadłospisy w przedszkolach wegetariańskich, gdyż brakuje badań na ten temat. Metodologia oceny posiłków przedszkolnych powinna być ujednolicona, aby zapewnić porównywalność zarówno wyników, jak i wniosków. Jadłospisy przedszkolne powinny być dostosowane do potrzeb dzieci 3-letnich oraz 4-6-letnich. Należy opracować i wprowadzić narodowy program edukacyjny dla personelu przedszkolnego, aby personel znał współczesne zasady żywienia dzieci oraz znał potrzeby żywieniowe dzieci 3-letnich oraz 4-6-letnich.

Słowa kluczowe: *dzieci w wieku przedszkolnym, żywienie, jadłospisy przedszkolne, zawartość energii, zawartość składników pokarmowych*

[*]**Corresponding author:** Sylwia Merkiel, Eugeniusz Piasecki University School of Physical Education in Poznan, Department of Food and Nutrition, Królowej Jadwigi 27/39 Street, 61-871 Poznan, Poland, Tel.: +48 61 835 52 87, Fax: +48 61 851 73 84, e-mail: sylwiamerkiel@awf.poznan.pl

INTRODUCTION

As early as in 1998, in the review of the literature on nutrition in Polish children, *Gronowska-Senger* et al. [22] pointed out the necessity of constant monitoring preschool children's nutrition. In their review [22], the authors stated that the meals served to children at preschools were not in line with the recommendations, both in rural and urban areas, and were characterised by insufficient amounts of vegetables and fruit, milk and dairy products, eggs and grain products, and by excessive amounts of fats, sugar and sweets. In terms of energy and nutrient content, preschool meals did not provide enough energy, protein and vitamin B_1, and in rural preschools also vitamin A, vitamin C and calcium. On the other hand, fat content was too high and sodium content exceeded even the recommendations for adults [22]. The results of the few available at that time studies on individual food intake were similar and included insufficient intake of milk and dairy products, vegetables and fruit, and excessive intake of meat, fats, sugar and sweets, which resulted in inadequate intake of vitamin A, vitamin C and calcium along with excessive intake of fat.

The review by *Gronowska-Senger* et al. [22] covered the years 1980-1995. From that time living conditions in Poland have changed due to political and economic changes. Moreover, in recent years people's attitudes toward eating and healthy life-style have also changed and the significant factors which play an important role in these changes are first of all the increasing access to the Internet and the fact that the issues connected with nutrition, diet and cooking are simply very popular resulting in many television programmes which are broadcast every day, such as reality shows, culinary programmes, culinary journeys, interviews with famous people about their food habits or interviews with dieticians about current dietary recommendations. All those television programmes, although sometimes spreading information not in line with the current nutrition knowledge, have significant influence on people's attitudes and beliefs. Due to these changes, it is necessary to summarise current knowledge about what Polish preschool children eat and what their intake of nutrients is.

The aim of this article was to present the areas of research on nutrition in Polish preschool children based on the review of the literature, and to present and summarise the results of the studies on the assessment of preschool menus.

MATERIAL AND METHODS

We searched Polish database: *Polska Bibliografia Lekarska od 1991 roku* (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. To ensure an exhaustive search, we also browsed through selected journals and the reference lists of the articles included in this review. The review covered the years from 1996, because previous studies were summarised in the review cited above [22].

When summarising the studies on the assessment of energy and nutrient content in preschool menus, we decided to compare the results of all these studies to the same reference values and in the same way. Otherwise, it would be very difficult to summarise the results of these studies due to the methodological differences described in the section *Assessment of preschool menus*. The values used to assess energy and nutrient content in preschool menus are presented in tables 1 and 2 and all the assumptions are explained as follows.

Table 1. The values used to assess energy content in preschool menus

Energy	3-year-olds	4-6-year-olds
Total energy[1]	700 kcal	980 kcal
Energy from protein[2]	10-15%	
Energy from fat[2]	20-30%	
Energy from saturated fatty acids[2]	<10%	
Energy from polyunsaturated fatty acids[2]	6-10%	
Energy from monounsaturated fatty acids[2]	>10% [3]	
Cholesterol[2]	<210 mg	
Energy from carbohydrates[2]	55-70% [4]	

[1] 70% of EER , Jarosz M (ed.) [24]
[2] WHO, 2003 [46]
[3] Calculated by difference as: total fat – (saturated fatty acids + polyunsaturated fatty acids).
[4] Calculated by difference as: the percentage of total energy – energy from total protein – energy from total fat.

Firstly, energy and nutrient content in preschool menus was compared to 70% of the daily requirement. Although the recommended amount of energy and nutrients which should be provided with preschool meals is either 70% of the daily requirement [29] or 70% to 75% of the daily requirement [7], we chose the first recommendation because it was used in most studies. Besides, the presented summary will be more clear if the results will be compared to one value instead of a range of values.

Table 2. The values used to assess nutrient content in preschool menus

Nutrient	1-3-year-olds				4-6-year-olds			
	70% EAR	70% RDA	70% AI	70% UL	70% EAR	70% RDA	70% AI	70% UL
Dietary fibre (g)			7[1]				9.8[1]	
Total water (g)			875[1]				1120[1]	
Vitamin A (retinol equivalent) (µg)	196[1]	280[1]			210[1]	315[1]		
Retinol (µg)				560[2]				770[2]
Vitamin D (µg)	7[3]	10.5[3]		17.5[2]	7[3]	10.5[3]		17.5[2]
Vitamin E (mg)			4.2[1]	70[2]			4.2[1]	84[2]
Vitamin B_1 (mg)	0.28[1]	0.35[1]			0.35[1]	0.42[1]		
Vitamin B_2 (mg)	0.28[1]	0.35[1]			0.35[1]	0.42[1]		
Vitamin B_6 (mg)	0.28[1]	0.35[1]		3.5[2]	0.35[1]	0.42[1]		4.9[2]
Folate (µg)	84[1]	105[1]		140[2]	112[1]	140[1]		210[2]
Vitamin B_{12} (µg)	0.49[1]	0.63[1]			0.7[1]	0.84[1]		
Niacin (mg)	3.5[1]	4.2[1]		7[4]	4.2[1]	5.6[1]		10.5[4]
Vitamin C (mg)	21[1]	28[1]		280[5]	28[1]	35[1]		455[5]
Calcium (mg)	350[1]	490[1]		1750[3]	560[1]	700[1]		1750[3]
Phosphorus (mg)	266[1]	322[1]		2100[6]	287[1]	350[1]		2100[6]
Magnesium (mg)	45.5[1]	56[1]		45.5[6]*	77[1]	91[1]		77[6]*
Sodium (mg)			525[1]	840[1]			700[1]	1050[1]
Potassium (mg)			1680[1]				2170[1]	
Iron (mg)	2.1[1]	4.9[1]		28[7]	2.8[1]	7[1]		28[7]
Zinc (mg)	1.75[1]	2.1[1]		4.9[2]	2.8[1]	3.5[1]		7[2]
Copper (mg)	0.175[1]	0.21[1]		0.7[2]	0.21[1]	0.28[1]		1.4[2]
Manganese (mg)			0.84[7]	1.4[7]			1.05[7]	2.1[7]
Iodine (µg)	45.5[1]	63[1]		140[2]	45.5[1]	63[1]		175[2]

[1] Jarosz M. (ed.) [24] Normy żywienia dla populacji polskiej – nowelizacja, in Polish. (Dietary reference intakes for the Polish population – amendment). Warszawa: Instytut Żywności i Żywienia; 2012.
[2] EFSA, 2006 [43] ScienfiticCommittee on Food, ScientificPanel of Dietetic Products, Nutrition and Allergies: Tolerable upper intake levels for vitamins and minerals. Brussels: European Food Safety Authority (EFSA); 2006.
[3] FNB, 2011 [14] Food and Nutrition Board of the Institute of Medicine: Dietary Reference Intakes for calcium and vitamin D. Washington DC: the National Academies Press; 2011.
[4] FNB, 1998 [16] Food and Nutrition Board of the Institute of Medicine: Dietary Reference Intakes for thiamin, riboflavin, niacin, vitamin B_6, folate, vitamin B_{12}, panthotenic acid, biotin and choline. Washington DC: the National Academies Press; 1998.
[5] FNB, 2000 [18] Food and Nutrition Board of the Institute of Medicine: Dietary Reference Intakes for vitamin C, vitamin E, selenium and carotenoids. Washington DC: the National Academies Press; 2000.
[6] FNB, 1997 [15] Food and Nutrition Board of the Institute of Medicine: *Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D and fluoride*. Washington DC: the National Academies Press; 1997.
[7] FNB, 2001 [17] Food and Nutrition Board of the Institute of Medicine: *Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium and zinc*. Washington DC: the National Academies Press; 2001.
*from supplements only

Secondly, to assess energy content, estimated energy requirement (EER) was applied [24]. Energy content from macronutrients was compared to the recommendations in the prevention of diet-related diseases worked out by the World Health Organization (WHO) [46]. We did not use either the estimated average requirement (EAR) or the recommended dietary allowance (RDA) to assess protein and carbohydrate content, because we consider assessing energy provided by these macronutrients as sufficient.

If content of macronutrients was given by the authors only in grams, and energy content was also reported, we calculated energy from macronutrients to assess it in comparison to the recommendations of the WHO [46]. Content of dietary fibre, water and micronutrients was compared to Polish dietary reference values (DRVs) [24], that is to EAR and RDA, to the adequate intake (AI) if EAR and RDA were not available, and to the tolerable upper intake level (UL). Polish DRVs include only AI for vitamin D, therefore, in the case of this micronutrient, we used EAR and RDA worked out by the Food and Nutrition Board of the Institute of Medicine [14]. Polish DRVs do not also include manganese, thus we used AI for this micronutrient worked out by the Food and Nutrition Board of the Institute of Medicine [17]. If Polish DRVs did not include UL for a nutrient, we used the ULs worked out by the Scientific Committee on Food (SCF) [43]. If also the ULs by SCF did not include a nutrient, we used the ULs worked out by the Food and Nutrition Board of the Institute of Medicine [14, 15, 16, 18]. Magnesium content was not compared to UL because this level of DRVs was worked out for intake from supplements only and preschool menus do not include any supplements.

Thirdly, because preschool menus should be assessed using EAR, but also RDA is acceptable as explained in the section *Assessment of preschool menus*, we used both EAR and RDA. Therefore, taking into account the application and the interpretation of the DRVs [13], we assessed and assumed as follows: (1) menus which contained less nutrients than 70% of EARs – in this case there is a considerable risk that the menus do not provide adequate amount of nutrients to preschool children; (2) menus which contained more nutrients than 70% of EARs but less than 70% of RDAs; (3) menus which contained less nutrients than 70% of AIs – in the case when EARs and RDAs were not available; (4) menus which contained more nutrients than 70% of RDAs and 70% of AIs but less than 70% of ULs – the risk of inadequate content is low; and finally (5) menus which contained more nutrients than 70% of ULs – in this case the risk of adverse health effects resulting from excessive content is high.

Fourthly, we performed the assessment using DRVs for both 3-year-olds and 4-6-year-olds because this is the age range of children who attend preschool in Poland.

AREAS OF RESEARCH ON NUTRITION OF POLISH PRESCHOOL CHILDREN

The review of the literature showed two main areas of research on nutrition in Polish preschool children, showed in figure 1. These areas are: the assessment of meals planned and served to children at preschools, and the assessment of food behaviour and daily food and nutrient intake in preschool children. The first area of research includes: assessment of preschool menus, assessment of meals prepared for children at preschool based on the reports from the preschool food storeroom, chemical analysis of sample meals served at preschools and comparison of nutritional value determined by chemical analysis to the results obtained by calculations. The other area of research includes: preschoolers' food behavior, preschoolers' daily dietary intake and using supplements by preschool children.

In this article, which is the first out of the three parts of the review, the literature on the assessment of preschool menus is presented and summarised.

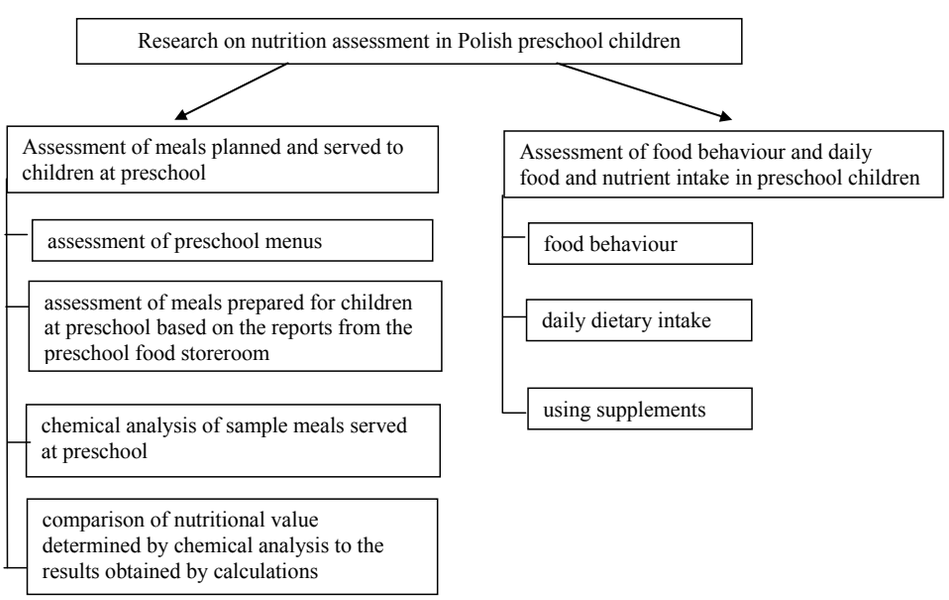

Figure 1. Areas of research on nutrition assessment in Polish preschool children

ASSESSMENT OF PRESCHOOL MENUS

We found 17 studies on the assessment of menus from various preschools all over Poland: from Warsaw [26, 40], from Warsaw, Dziekanów, Łomianki, Nowa Iwiczna and Żyrardów [19, 20], from Warsaw and the vicinity [1] and from Warsaw and Zbuczyn near Siedlce [30] which are all situated in the central-eastern part of Poland; from Białystok [12, 32] situated in the north-eastern part of Poland; from Kraków and the vicinity [28], and Wieluń [42] situated in the southern part of Poland; from Drawsko Pomorskie [27] and Koszalin [9, 10, 11] situated in the north-western part of Poland; from Legnica [41] situated in the south-western part of Poland; and from Poznań [6, 39] situated in the central-western part of Poland. In seven studies [6, 9, 10, 26, 27, 39, 41], menus from one preschool were analysed. In two studies, menus from two preschools were analysed for comparison: one urban preschool compared to one rural preschool [30], and one preschool with its own kitchen and kitchen staff compared to one preschool with catering [40]. In one study menus from three preschools [11], from four preschools [32] or from seven preschools [28] were analysed, in three studies – from five preschools [12, 19, 20], and in one study – from six preschools [1], including three public preschools and three private preschools for comparison. Only one of the mentioned studies [26] focused on the analysis of vegetarian preschool menus.

All of these studies varied in terms of the season of the year and the number of menus analysed. In five studies [6, 28, 39, 41, 42], the analysed menus covered either the whole year or represented each of the four seasons of the year. We need to explain that since children attend preschools only on working days, that is from Monday to Friday, the menus at preschools in Poland are usually planned for two weeks, that is for ten days. And so, in two studies [41, 42] four ten-day menus were analysed, one for each season. In one study [28] five-day menus over one month were analysed, including the first month of each quarter of four consecutive years. In two studies [6, 39] 48 five-day menus from the whole year were analysed. In the remaining studies, menus from selected periods of the year were analysed: four consecutive five-day menus from early autumn [11], however, only dinner meals were included; four ten-day menus from autumn-winter period [9]; the unspecified by the authors number of ten-day menus from winter [1]; five-day menus from a three-month period from January to April [26]; five ten-day menus from spring [19, 20]; the unspecified by the authors number of ten-day menus from May [40] and from spring-summer period [10, 32]; and four ten-day menus from the unspecified by the authors time of the year [27]. In one study [12], the authors provided only the information that ten-day menus were analysed but neither the season of the year nor the number of the menus were specified.

The presented studies vary also in terms of the method of assessment. In five studies [1, 9, 27, 28, 40], qualitative assessment was performed using the points method by *Starzyńska* [1, 9, 27, 28] and/or test by *Bielińska* modified by *Kulesza* et al. [1, 27, 28, 40]. These qualitative methods of menus assessment had practical value due to their easy application. However, in our opinion these methods are of historical value now because the science of nutrition has been evolving rapidly from the time when these methods were worked out. Knowledge on the role of animal protein in the diet has changed causing that vegetarian diets, including also a vegan diet, became approved even for the youngest children and pregnant women [8]. The nutritional recommendations for children have changed, both in terms of the foods which should be included in the daily diet and in terms of nutrients intake. One of the results of these changes are the recommendations for children in the form of a plate on which the recommended food groups are placed in the recommended proportions. These recommendations are called MyPlate [44] and include vegetarian choices as equivalent to the traditional ones. MyPlate contains Protein Group which includes sources of animal protein and sources of plant protein of high nutritional value addressed especially to vegetarians, including vegans. Moreover, from the time when these qualitative methods of menu assessment were worked out, the DRVs changed several times: first the DRVs by *Ziemlański* [47] were introduced and seven years later the DRVs by *Jarosz* [25] which were amended four years later [24]. Therefore, in our opinion, using this method currently may not lead to correct conclusions.

In her points method, *Starzyńska* chose six items which are to decide whether the menu is planned correctly. These items are: the number of meals, the number of meals containing animal protein, the frequency of serving milk or cheese, the frequency of serving vegetables or fruit, serving raw vegetables and fruit every day, and the frequency of serving wholemeal bread, groats and pulses [21]. The item 'number of meals containing animal protein' is scored highest if animal protein is in every meal. This means that every vegan menu and many vegetarian menus, even the best ones, will not score the highest. Moreover, it is in line with the current recommendations to include vegetarian meals in the daily menu, even if the whole diet is not vegetarian. Such plant foods as pulses and nuts contain protein of high nutritional value and therefore a meal containing these foods but no animal protein should not be disqualified. Moreover, it is considered a good habit if in a preschool, vegetables and fruit are served as a snack between breakfast and dinner. Another item,

'frequency of serving vegetables or fruit', is scored highest if these foods are every day in at least three meals. This means that if three meals contain one fruit but no vegetables, the menu will be scored highest. However, it is not in line with the recommendations to eat only fruit. And finally, the item 'frequency of serving wholemeal bread, groats and pulses' is scored highest if at least one of these foods is planned in the menu every day. This means the highest score also for a menu in which wholemeal bread or groats or pulses are served in only one meal and no other foods rich in starch are planned, for example wholemeal pasta, brown rice or cereals. Moreover, if for example the meals contain wholemeal pasta, brown rice and cereals every day, but contain no wholemeal bread or groats and contain pulses every second day, the menu will be scored zero. Bread and groats together with pasta, rice and cereals are the basis of all types of food pyramids providing the main source of energy from complex carbohydrates, therefore choosing only some of these foods as a criterion of the assessment may lead to false conclusions.

According to the test by *Bielińska* modified by *Kulesza* et al., the meals should be qualified to nine types of meals: 1 – carbohydrates or carbohydrates and fat; 2 – the same as 1 + foods providing animal protein; 3 – the same as 1 + milk or dairy products; 4 – the same as 1 + foods providing animal protein + milk or dairy products; 5 – the same as 2 + vegetable or fruit; 6 – the same as 3 + vegetable or fruit; 7 – the same as 4 + vegetable or fruit; 8 – the same as 1 + vegetable or fruit; 9 – vegetable or fruit. Only the meals number 5, 6 and 7 are considered correct by the authors. The first question arises whether the word 'carbohydrates' in the characteristics of meal number 1 really means carbohydrates only or rather the authors meant foods rich in carbohydrates. If so, this method qualifies as incorrect such meals as for example: oats with milk and pumpkin seeds or nuts (neither seeds nor nuts are included among the attributes of a balanced menu), rice cakes with tofu, sunflower seeds and fruit, and vegetable and/or fruit salads with nuts or seeds and plant oil, all of which are in line with current recommendations and should be assessed as healthy snack between breakfast and dinner and between dinner and supper. The other serious weak point of this method is not taking into account either the type of carbohydrates or the type of fat. Therefore, according to this method, a meal consisting of a neck of pork (which contains animal protein) with potatoes (which is the source of carbohydrates and is also a vegetable) poured with thick sauce based on butter and cream (which is fat and dairy product, respectively) would be correct because it meets all the criterion of the meal type 4. Thus, in our opinion, the qualitative methods of preschool menus assessment by *Starzyńska* and by *Bielińska* modified by *Kulesza* et al. should either be modified or no longer used.

It is favourable that from among the four studies [9, 27, 28, 40], in which the abovementioned qualitative methods of assessment were used, three studies included also the assessment of energy and nutrient content [9, 27, 40]. In the remaining studies, the content of energy and/or various nutrients in preschool menus was assessed [1, 6, 10, 11, 12, 19, 20, 26, 30, 32, 39, 41, 42] and in two studies [26, 30] also the content of selected foods. In eight studies [6, 9, 10, 12, 19, 30, 32, 39], the energy and/or nutrient content of the preschool menus was compared to 70% of the daily requirement for preschool children and in five studies – to 75% [20, 26, 27, 41, 42]. This is because the recommendations for energy and nutrient intakes during stay at preschool are not the same: in one source it is set as 70% of the daily requirement [29] and in the other – it is 70% to 75% of the daily requirement [7]. In one study [40] the reference value was not specified in the methodological section, however, it seems that the authors compared their results to 70% of the daily requirement and they also mentioned this recommendation in the introduction to their article.

The analysis of the preschool menus in the above mentioned studies showed that in most preschools the recommended number of meals was planned, that is three [6, 10, 19, 20, 26, 28, 32, 39, 41, 42] or four [9, 27]. We need to explain that in Poland the main meals are breakfast, dinner and supper. If more meals are eaten, the first meal during the day is called the first breakfast. The second meal, which is a snack eaten between the first breakfast and dinner, is called the second breakfast. The next and the biggest meal during the day is dinner. The fourth meal is a snack which is usually composed of foods of sweet taste, in Polish called 'podwieczorek'. The only English term for this meal is the British meaning of tea: *a light meal eaten in the afternoon or early evening , usually with sandwiches and/or biscuits and cakes and with tea to drink* [23]. However, Polish 'podwieczorek' is more similar to Spanish 'merienda', a light meal known also in other countries in Southern Europe. Therefore, we will use the term 'afternoon snack' to describe Polish 'podwieczorek' in this review. The last meal in Poland is supper which is eaten in the evening and so it is not served at preschools. Preschool menus were most often composed of breakfast, dinner and afternoon snack [19, 20, 28, 42]. In two studies, the menus were reported to consist of the first breakfast, the second breakfast and dinner [10, 41]. In two other studies, the menus were reported to consist of four meals: the first breakfast, the second breakfast, dinner and afternoon snack [9, 27]. However, not all preschools followed

the recommendations on the number of meals. In one preschool located in the vicinity of Kraków, only two meals were planned, that is breakfast and dinner [28], and in another preschool, also located in the vicinity of Kraków, dinner was the only meal planned for the children [28]. In four studies, the authors did not provide the information on the kind of meals planned at preschool [6, 26, 32, 39] and in one study no information about the number of meals was provided [12].

In five studies [27, 28, 30, 41, 42], the information about the content of selected foods or food groups in preschool menus was included, and was expressed as amount in grams [26, 41, 42], as percent of the reference values [30] or was mentioned by the authors in the discussion [27, 28]. In the preschool menus, the authors reported low frequency of including cereal products [30], wholemeal bread, groats and pulses [27, 28] or not including pulses at all [41, 42]. The only exception were the menus in a vegetarian preschool in Warsaw [26] in which pulses and soy products were used as meat alternative. Some studies reported low frequency of including vegetables and fruit [28] and raw vegetables and fruit [27], while other study reported their adequate content [30]. One study [30] showed insufficient content of foods from the group 'meat, meat products and fish' and milk and dairy products along with excessive content of butter, other fats, and cream. Two studies reported content of butter in preschool menus [41, 42] which was particularly high in a preschool in Wieluń [42] and ranged from 13.5 g in spring to as much as 27.7 g in winter. Assuming that Polish butter contains usually 54.72 g of saturated fatty acids [31] and that preschool menu for 4-6-year-olds should provide 70% of their daily energy requirement, that is 980 kcal [24], such content of butter provides 6.8% and 13.9% of energy from saturated fatty acids, respectively. It should be emphasised that butter was not the only source of saturated fatty acids in these menus [41, 42]. The authors of two studies [41, 42] stated in the discussion that content of salt was limited to the minimum, however, no values were reported of either salt or sodium content. All of the studies reported excessive content of sweets [27, 28, 30] or sugar [41, 42] in the preschool menus.

In sixteen studies, the analysis of energy and/or nutrient content in preschool menus [1, 6, 9, 10, 12, 19, 20, 26, 27, 30, 32, 39, 40, 41, 42] and in preschool dinners [11] was included. However, the number of the analysed indices was diverse and ranged from four indices [12, 27] to 25 indices [1]. Content of energy and the main macronutrients was most often analysed: content of fat in twelve studies [1, 9, 11, 12, 19, 26, 27, 30, 39, 40, 41, 42] and content of energy, protein and carbohydrates in eleven studies [1, 9, 11, 19, 26, 27, 30, 39, 40, 41, 42]. Content of vitamin A and C in preschool menus was assessed in ten studies [1, 6, 10, 20, 26, 30, 32, 40, 41, 42], content of calcium and iron was assessed in eight studies [1, 6, 10, 26, 30, 40, 41, 42] and content of vitamin B_1 and B_2 – in seven studies [1, 6, 10, 20, 26, 30, 40]. In five studies, content of dietary fibre [1, 11, 19, 30, 39], vitamin E [1, 6, 20, 26, 32], vitamin B_{12} [6, 10, 20, 26, 41], niacin [1, 6, 20, 26, 30], magnesium [1, 6, 10, 26, 30] zinc and copper [1, 6, 26, 30, 32] was analysed. In four studies, content of polyunsaturated fatty acids [1, 12, 19, 39], cholesterol [1, 11, 19, 39], vitamin D [6, 10, 20, 26], vitamin B_6 [1, 6, 20, 26] and phosphorus [1, 6, 26, 30] was analysed. In three studies, content of saturated and monounsaturated fatty acids [12, 19, 39], folate [6, 20, 26], sodium and potassium [1, 6, 26] was analysed. Content of sucrose was analysed only in two studies [19, 39] and content of manganese – in only one study [6]. No study included iodine content and only one study included water content, however, only in dinners [11].

In the studies cited above, various DRVs were used, that is the DRVs by *Ziemlański* [47], the DRVs by *Jarosz* [25] published in 2008, amendment to the DRVs by Jarosz [24] published in 2012 and the DRVs by the Institute of Mother and Child [45]. The DRVs by *Ziemlański* [47] were used in eight studies: in three studies [12, 26, 32] because these values were in use at the time of the publication, in three studies [6, 27, 39] because the articles had already been in press at the time of the publication of the new DRVs by Jarosz [25], in one study [1] because it was the authors' assumption described in the methodological section and in one study [9] although the authors analysed the menus collected in 2009 when the new DRVs by *Jarosz* [25] had already been in use. The DRVs by *Jarosz* [25] were used in two studies [19, 20] published at the time when these values were in use and in three other studies [40, 41, 42] because the manuscripts had been probably already in press when the amended DRVs by Jarosz [24] were published. The amended DRVs by Jarosz [24] were used in two studies [10, 11] and the DRVs by the Institute of Mother and Child [45] were applied in one study [30].

Another important facet is the level of DRVs used by the authors of the cited studies. There are no doubts with the application of AI because this level is worked out when EAR, and that is also RDA, cannot be determined [13]. The problem may arise when using EAR and RDA. Although when assessing or planning diets for groups, EAR should be used [25], in all of the studies in which the new DRVs were used [10, 11, 19, 20, 40, 41, 42], RDA was applied. However, this approach seems to us reasonable because the application of RDA for the assessment of diets planned

for groups may be justified in the case of increased risk of inadequacies. Surely, preschool children may be classified as at risk of inadequacies when taking into account for example various socio-demographic characteristics or psychological and environmental factors influencing preschoolers' food behaviour which often cause children's refusal to eat a preschool meal or some components of this meal. Moreover, RDA may be used for planning and assessing diets for groups which fall in the same age and gender category in the DRVs. In preschoolers, there is no difference in the DRVs according to gender. Nevertheless, the authors compared the nutrient content to RDA for children aged 4-6 years, while 3-year-olds also attend preschool. Only two studies on preschool menus analysis [6, 39], used for comparison the DRVs for both 3-year-olds and 4-6-years-olds. In one study [40] EAR was used but the authors calculated mean DRVs which approach has no longer application after the new concept of assessing and planning the diets has been worked out and implemented [13].

Due to the methodological differences described above, the results of all the cited studies were compared to the same reference values and in the same way, as described in the section *Material and methods*. It is important to note that in one study the results were given only as percent of DRVs and the authors compared their results to the mean calculated from the reference values for 3-year-olds and 4-6-year-olds [40]. In another study, only dinners were assessed [11]. Therefore, in the following summary of the studies, we could not use these studies in our comparison to the reference values showed in tables 1 and 2. However, we included these studies whenever possible using the authors' observations and comments.

Almost all of the analysed preschool menus contained more energy than recommended during the stay at preschool for both 3-year-olds and 4-6-year-olds [1, 9, 19, 27, 30, 39, 40, 41, 42]. In some of the menus, energy content was so high that it exceeded the recommended energy intake for the whole day [1, 19]. Also the dinners in three preschools in Koszalin [11] were reported to contain too much energy. The only exception was one out of the six preschools in the vicinity of Warsaw [1] and one vegetarian preschool in Warsaw [26] in which energy content was slightly lower than 70% of EER for 4-6-year-old children but higher than 70% of EER for 3-year-old children.

Content of energy from protein was within the recommended in almost all of the analysed preschool menus [9, 19, 26, 27, 30, 39, 41, 42]. Only in a preschool in Żyrardów [19] and in six preschools in the vicinity of Warsaw [1], content of energy from protein was too high. Content of energy from fat was reported to be adequate in three studies [9, 30, 39] and in five out of six preschools in the vicinity of Warsaw [1] and in Dziekanów [19]. Only in one preschool in the vicinity of Warsaw [1], content of energy from fat was too low. In all the other preschool menus, content of energy from fat was too high [19, 26, 27, 41, 42], even in a vegetarian preschool in Warsaw [26]. Also the dinners in three preschools in Koszalin [11] contained too much fat. Fat content in preschool menus in Białystok [12] could not be compared according to our methodological assumptions because the authors did not analyse energy content and so energy from fat could not be calculated.

The few studies in which content of fatty acids was analysed [1, 12, 19, 39] showed that content of energy from saturated fatty acids exceeded the recommendations [19, 39], while content of energy from polyunsaturated fatty acids was too low [1, 19, 39]. Also in preschool menus in Białystok [12] fatty acid content was reported to be incorrect because saturated fatty acid content was only 1 g lower than unsaturated fatty acid content, and content of polyunsaturated fatty acids was more than three times lower than the content of saturated fatty acids. Content of energy from monounsaturated fatty acids was adequate in preschool menus in Warsaw and the vicinity [19] and too low in preschool menus in Poznań [39].

Cholesterol content in preschool menus was within the recommended [1, 12, 19, 39] except for a preschool in Łomianki [19] and one out of the six preschools in the vicinity of Warsaw [1]. Although current recommendations do not include any limit on cholesterol intake, we think that foods rich in cholesterol should be avoided in preschool menus and in the children's daily diets because the foods rich in cholesterol are also rich in saturated fatty acids.

As many as six studies reported adequate content of energy from carbohydrates [1, 9, 26, 27, 30, 39]. In menus in preschools in Warsaw, Nowa Iwiczna, Żyrardów and Łomianki [19], in preschool in Legnica [41] and in preschool in Wieluń in all four seasons of the year except for autumn [42], content of energy from carbohydrates was too low. It is interesting how much of the carbohydrate content was energy from sucrose. Menus from five preschools in Warsaw and the vicinity [19] and menus from preschool in Poznań [39] contained too much energy from sucrose. It is highly probable that in the remaining preschool menus energy content from sucrose was also too high because in all of the studies on food content analysis, excessive content of sweets [27, 28, 30] and sugar [41, 42] was reported, as mentioned above.

Content of dietary fibre was within the recommended in all of the preschool menus [1, 19, 30, 39] except for one out of the six preschools in the vicinity of Warsaw [1] in which content of this macronutrient was too low for 4-6-year-old children but adequate for 3-year-olds.

All of the preschool menus contained more vitamin A than 70% of EAR and 70% of RDA both for 3-year-olds and 4-6-year-olds. While the lack of the risk of inadequate content of vitamin A in preschool menus is highly favourable, the concern is quite high content of this vitamin in almost all the preschool menus. Although there is no UL for vitamin A expressed as retinol equivalents, comparing vitamin A content to UL for retinol may show how high was the content of this vitamin. It exceeded the UL for 3-year-olds in preschool menus in Warsaw and Dziekanów [20], in Zbuczyn [30], in Poznań irrespective of the season of the year [6], in a vegetarian preschool in Warsaw [26] and in Legnica during spring and winter [41]. Moreover, it exceeded the UL for both age groups in preschool menus in Białystok [32], Żyrardów and Łomianki [20], in Warsaw [30] and in five out of the six preschools in the vicinity of Warsaw [1]. Also in two preschools in Warsaw, vitamin A content was reported to be high [40]. Unfortunately, only in one study content of retinol and β-carotene was included [6] and the UL for retinol was not exceeded. Nevertheless, even if the high content of vitamin A is the result of high β-carotene content, these results show the need to introduce more diverse vegetables in the preschool menus, not only those rich in β-carotene. Our observations from many studies carried out in preschools showed that carrot is the most frequently served vegetable, most probably due to its relatively low price.

It is highly disconcerting that there was no preschool in which the menus contained adequate amount of vitamin D. Moreover, in all of the menus the content of this vitamin was very low [6, 10, 20, 26] – the highest content of vitamin D was merely 1.8 μg and was reported in preschool menus in Dziekanów [20].

In most of the preschools [1, 6, 20, 26, 32] content of vitamin E in the menus was adequate. Only in three out of the six preschools in the vicinity of Warsaw [1] content of this vitamin was too low both for 3-year-olds and 4-6-year-olds. In all of the analysed preschool menus, the authors reported adequate content of vitamin B_1 [1, 6, 10, 20, 26, 30], vitamin B_2 [1, 6, 10, 20, 26, 30] and vitamin B_6 [1, 6, 20, 26].

Content of folate in the preschool menus was diverse. In Nowa Iwiczna [20] the content of folate was the lowest – it exceeded 70% of EAR for 3-year-old children but was lower than 70% of RDA for 3-year-olds, as well as 70% of EAR and 70% of RDA for 4-6-year-olds. Content of folate in preschool menus in Żyrardów and Warsaw [20], in Poznań irrespective of the season of the year [6] and in a vegetarian preschool in Warsaw [26] was higher than 70% of EAR and 70% of RDA for 3-year-old children, as well as 70% of EAR for 4-6-year-old children, but was lower than 70% of RDA for 4-6-year-olds. Only folate content in preschool menus in Dziekanów and Łomianki [20] exceeded 70% of RDA for 4-6-year-olds but at the same time it also exceeded 70% of UL for 3-year-old children because these two levels of DRVs are the same. This observation shows that the portions of meals or at least the portions of selected meal components should be planned separately for 3-year-old children and for 4-6-year-old children.

In all of the studied preschool menus, content of vitamin B_{12} [6, 10, 20, 41] was adequate for children of both age groups. The only exception was the menu in a vegetarian preschool in Warsaw [26] in which content of vitamin B_{12} was lower than 70% of EAR for 3-year-old children. It implies that no fortified foods were included in these vegetarian menus although it is well recognised that following vegetarian diets increase the risk of vitamin B_{12} deficiency.

None of the preschool menus posed the risk of inadequate content of niacin [1, 6, 20, 26, 30]. In preschools in Warsaw, Dziekanów, Żyrardów and Łomianki [20], in five out of the six preschools in the vicinity of Warsaw [1], and in preschools in Warsaw and Zbuczyn [30], the menus contained more niacin than 70% of UL for 3-year-old children. Moreover, in preschools in Warsaw and Dziekanów [20] and in two out of the six preschools in the vicinity of Warsaw [1], the menus contained more niacin than 70% of UL for 4-6-year-old children. Only in preschool in Nowa Iwiczna [20], in one out of the six preschools in the vicinity of Warsaw [1], in a vegetarian preschool in Warsaw [26] and in Poznań irrespective of the season of the year [6], niacin content in the menus did not exceed 70% of UL for any age group.

In five studies, the authors reported adequate content of vitamin C in all of the analysed preschool menus [6, 10, 20, 30, 32]. In the menus in one out of the six preschools in the vicinity of Warsaw [1] and in winter menus in a preschool in Legnica [41], content of vitamin C was so low that it did not reach even the 70% of EAR for 3-year-olds. In spring menus in a preschool in Wieluń [42], in the menus in one out of the six preschools in the vicinity of Warsaw [1], in spring and autumn menus in a preschool in Legnica [41] and in a vegetarian preschool in Warsaw [26], content of vitamin C exceeded 70% of EAR for 3-year-olds but it was lower than 70% of RDA for this age group and 70% of EAR for 4-6-year-old children. In the menus in one out of the six preschools in the vicinity of Warsaw [1] and in autumn and winter menus in a preschool in Wieluń [42], content of vitamin C was higher than 70% of RDA for 3-year-olds and 70% of EAR for 4-6-year-olds but it was lower than 70% of RDA for 4-6-year-old children. This indicates that the preschool menus must have contained insufficient amount of vegetables and fruit which is totally unexpected in a vegetarian preschool.

Calcium content in preschool menus in

a vegetarian preschool in Warsaw [26] and in two out of the six preschools in the vicinity of Warsaw [1] was extremely low because it did not reach even the 70% of EAR for 3-year-old children. The menus in a preschool in Zbuczyn [30], spring and autumn menus in a preschool in Poznań [6], the menus in two out of the six preschools in the vicinity of Warsaw [1], as well as all the menus in a preschool in Wieluń [42] and Legnica [41] irrespective of the season of the year, contained more calcium than 70% of EAR for 3-year-old children but less than 70% of RDA for this age group and less than 70% of EAR for 4-6-year-old children. Moreover, the menus in another preschool in Warsaw [30] and the menus in another preschool among the six preschools in the vicinity of Warsaw [1], as well as summer and winter menus in a preschool in Poznań [6] contained more calcium than 70% of RDA for 3-year-old children but less calcium than 70% of EAR for 4-6-year-old children. Only the menus in one out of the six preschools in the vicinity of Warsaw [1] and the menus in a preschool in Koszalin [10] contained more calcium than 70% of RDA for 4-6-year-old children. Such considerable deficit of this crucial mineral during most of the day is hardly likely to be compensated by intake of calcium at home.

Phosphorus and magnesium content was adequate because in all preschool menus content of these minerals was higher than 70% of RDA for 4-6-year-old children and did not exceed 70% of UL for both age groups in the case of phosphorus. In the case of magnesium, the UL is set only for magnesium from supplements and preschool menus do not include any supplements.

Sodium content in preschool menus was high and it exceeded 70% of UL for both age groups in the menus of four out of the six preschools in the vicinity of Warsaw [1] and in a preschool in Poznań irrespective of the season of the year [6]. Moreover, in the menus in a preschool in Poznań in every season of the year [6] and in two out of the six preschools in the vicinity of Warsaw [1], sodium content was so high that it exceeded the 100% of UL for 4-6-year-old children. In the menus of one out of the six preschools in the vicinity of Warsaw [1], sodium content did not exceed 70% of UL for 3-year-old children and in another one it did not exceed 70% of UL for 4-6-year-old children. On the other hand, in a vegetarian preschool in Warsaw [26] sodium content in the menus was very low and did not reach even the 70% of AI for 3-year-olds.

Potassium content was adequate only in three out of the six preschools in the vicinity of Warsaw [1] and in winter menus in a preschool in Poznań [6]. In the menus in the remaining preschools, content of potassium either did not reach 70% of AI for 3-year-olds, as in the case of two out of the six preschools in the vicinity of Warsaw [1], or exceeded this level but was lower than 70% of AI for 4-6-year-olds, as in the case of the menus in one out of the six preschools in the vicinity of Warsaw [1], spring, summer and autumn menus in a preschool in Poznań [6] and – surprisingly – in the menus in a vegetarian preschool in Warsaw [26].

Content of iron was lower than 70% of RDA for 3-year-old children only in the menus of one out of the six preschools in the vicinity of Warsaw [1]. Content of iron higher than 70% of RDA for 3-year-old children but lower than 70% of RDA for 4-6-year-old children was reported in the menus in preschool in Koszalin [10], Poznań [6], Legnica [41], Warsaw and Zbuczyn [30] and in three out of the six preschools in the vicinity of Warsaw [1]. Adequate content of iron was found in the menus in preschool in Wieluń [42], in two out of the six preschools in the vicinity of Warsaw [1] and in a vegetarian preschool in Warsaw [26].

None of the preschool menus was reported to contain inadequate amount of zinc [1, 6, 26, 30, 32]. However, in preschools in Warsaw and Zbuczyn [30], in preschools in Białystok [32], in a preschool in Poznań irrespective of the season of the year [6], in a vegetarian preschool in Warsaw [26] and in five out of the six preschools in the vicinity of Warsaw [1], the menus contained more zinc than 70% of UL for 3-year-old children and additionally, the menus in two out of the six preschools in the vicinity of Warsaw [1] contained more zinc than 70% of UL for 4-6-year-old children.

All of the preschool menus contained more copper than 70% of RDA for 4-6-year-old children [1, 6, 26, 30, 32]. However, content of copper exceeded 70% of UL for 3-year-old children in the menus in almost all the preschools, that is in three out of the six preschools in the vicinity of Warsaw [1], preschools in Warsaw and Zbuczyn [30], preschools in Białystok [32], a preschool in Poznań irrespective of the season of the year [6] and a vegetarian preschool in Warsaw [26]. None of the preschool menus contained more copper than 70% of RDA for 4-6-year-old children.

Manganese content, analysed in the menus only in a preschool in Poznań [6], was higher than 70% of UL for both age groups in all the seasons of the year.

This summary shows that preschool menus should be modified according to the current nutrition recommendations. Energy content should be lowered to cover the needs of children during their stay at preschool but it should not be excessive. Attention should be paid to the fats used for cooking and at the table in order to reduce energy from saturated fatty acids and increase energy from unsaturated fatty acids, especially polyunsaturated ones. Energy from carbohydrates should be increased, however, this should be achieved by increasing content of starch. Content of mono- and disaccharides should be

reduced. High content of vitamin A should be avoided, while content of vitamin D needs urgent increase. Attention should be also paid to vitamin C content to avoid deficits. Calcium and potassium content should be increased, whereas sodium content needs rapid reduction. Iron content may also be a nutrient of concern.

This summary shows that the portions of the meals, or portions of meal components, should be planned separately for 3-year-olds and for 4-6-year-olds to reduce the risk of excessive content of a nutrient for the younger group of children. Some results are highly surprising, for example the one that vitamin C may be a nutrient of concern in the preschool menus since it is well known to all people that fruit and vegetables are recommended to be eaten in large amounts. Similarly, it is unexpected to observe such low content of calcium due to many social campaigns broadcast on TV which aimed to spread the knowledge about the necessity to eat milk and dairy products to provide calcium for children's bone health.

Finally, the results from the vegetarian preschool showed that the staff was not prepared to plan vegetarian meals. Firstly because the menus contained deficient amounts of the nutrients which in vegetarian diets are present in high amounts, such as vitamin C and potassium. Secondly, because the menus were deficient in the nutrients which are known to be at higher risk of inadequacy, such as vitamin D, vitamin B_{12} or calcium, and should therefore be supplemented or provided in fortified foods. These results indicate that the analysis of vegetarian menus in other vegetarian preschools should be the aim of future research.

Moreover, almost all authors of the summarised studies [1, 6, 9, 10, 19, 20, 28, 39, 40, 41, 42] concluded that their results show the need to provide nutritional education in order to improve preschool menus. The education is necessary for the whole preschool staff, but in particular for those who are responsible for planning and preparing meals for the children. The educational programme should include such areas of nutrition as principles of nutrition during childhood, nutritional prevention of diet-related diseases, rich sources of vitamins and minerals, the role of nutrients and principles of composing a diet, as well as the principles of preparing meals. The previous studies on nutritional knowledge of both preschool staff [3, 4, 34, 35, 36] and preschoolers' parents [2, 5, 33, 37, 38] showed insufficient knowledge in all of the mentioned areas of nutrition.

CONCLUSIONS

1. Studies on energy and nutrient content of preschool menus should be carried out regularly in order to improve nutrition of children during their stay at preschool and vegetarian menus should be studied to fill the gap in the literature.
2. The methodology of assessing preschool meals should be the same in order to provide the possibility to compare both the results and the conclusions.
3. Preschool menus should be adjusted to the needs of 3-year-old children and 4-6-year-old children separately.
4. The nation-wide education programme for preschool staff should be worked out and implemented in order to teach the preschool staff about the current nutrition recommendations for children, as well as the nutritional needs of 3-year-old children and 4-6-year-old children.

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