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HEALTH RISK OF EXPOSURE TO BISPHENOL A (BPA)

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ABSTRACT

Bisphenol A (BPA) belongs to chemicals that are produced in large quantities worldwide. It is commonly used as monomer in polycarbonate synthesis, plasticizer in the production of epoxy resins, as well as an additive for the elimination of surfeit of hydrochloric acid during the polyvinyl chloride (PVC) production. BPA is not only used in the production of plastics intended to a direct contact with food, including plastic packaging and kitchenware, but also in inner coatings of cans and jar caps. There are various routes of human exposure to this substance such as oral, by inhalation and transdermal. The main sources of exposure to BPA include food packaging and dust, dental materials, healthcare equipment, thermal paper, toys and articles for children and infants. BPA is metabolized in the liver to form bisphenol A glucuronide and mostly in this form is excreted with urine. Due to its phenolic structure BPA has been shown to interact with estrogen receptors and to act as agonist or antagonist *via* estrogen receptor (ER) dependent signalling pathways. Therefore, BPA has been shown to play a role in the pathogenesis of several endocrine disorders including female and male infertility, precocious puberty, hormone dependent tumours such as breast and prostate cancer and several metabolic disorders including polycystic ovary syndrome (PCOS). Because of the constant, daily exposure and its tendency to bio-accumulation, BPA seems to require special attention such as biomonitoring. This observation should include clinical tests of BPA concentration in the urine, which is not only one of the best methods of evaluation of the exposure to this compound, but also the dependence of the daily intake of BPA and the risk of some endocrine disorders.

Key words: *bisphenol A, BPA, estrogens, endocrine disrupting chemicals*

STRESZCZENIE

Bisfenol A (BPA) należy do substancji chemicznych produkowanych na świecie w znacznych ilościach. Używany jest jako plastyfikator i półprodukt w syntezie żywic epoksydowych, tworzyw sztucznych poliwęglanowych oraz jako dodatek do usuwania nadmiaru kwasu chlorowodorowego przy produkcji polichlorku winylu (PCW). BPA nie tylko jest używany do syntezy tworzyw sztucznych służących do produkcji materiałów mających bezpośredni kontakt z żywnością, włączając opakowania z tworzyw sztucznych oraz sprzęt kuchenny, ale także stanowi składnik lakierów do pokrywania wewnętrznych powierzchni puszek metalowych przeznaczonych do żywności i napojów. BPA stosowany jest w produkcji poliwęglanów (PC) i żywic epoksydowych, wykorzystywanych w produkcji wyrobów do kontaktu z żywnością. Może być także stosowany, jako przeciwutleniacz i inhibitor w procesie polimeryzacji tworzyw sztucznych, m.in. polichlorku winylu (PCW). Narażenie na BPA może zachodzić drogą pokarmową, wziewną oraz przez skórę, a głównymi źródłami ekspozycji są opakowania żywności, kurz, materiały stomatologiczne, sprzęt medyczny, papier termiczny, a także zabawki i artykuły przeznaczone dla niemowląt i dzieci. BPA jest metabolizowany w wątrobie do glukuronianu bisfenolu A i w tej postaci jest usuwany z moczem. Ze względu na swą fenolową strukturę BPA wykazuje zdolność jako agonista lub antagonista do interakcji z receptorami estrogenowymi poprzez estrogenowe szlaki sygnalizacyjne. W wyniku takiego działania BPA odgrywa rolę w patogenezie zaburzeń endokrynnych włączając zaburzenia płodności u kobiet i mężczyzn, przedwczesne dojrzewanie, nowotwory hormonozależne, jak rak piersi oraz rak prostaty oraz schorzeń metabolicznych włączając zespół wielotorbielowatych jajników (PCOS). Biorąc pod uwagę stałe, codzienne narażenie na BPA z wielu źródeł oraz tendencje do bioakumulacji uzasadniony jest monitoring biologiczny tego związku. Powinien on w szczególności uwzględniać monitoring BPA w moczu, jako skuteczną metodę szacowania narażenia na ten związek, umożliwiając jednocześnie badanie zależności pomiędzy narażeniem na BPA a ryzykiem występowania niektórych chorób wynikających z zaburzenia czynności układu endokrynologicznego.

Słowa kluczowe: *bisfenol A, BPA, estrogeny, związki endokrynnie czynne*

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INTRODUCTION

Bisphenol A (BPA) belongs to chemicals that are produced in the large quantities. It is commonly used as a plasticizer and an intermediate in the synthesis of epoxy resins, polycarbonate plastics [29] as well as an additive for the elimination of surfeit of hydrochloric acid during the polyvinyl chloride (PVC) fabrication. BPA is widely used in the production of healthcare equipment [52], dental composites [13], contact lenses, spectacle lenses, toys, storage media and window foils [2]. BPA is one of the Food Contact Materials (FCMs), which means that it is used in the preparation of plastics for the manufacture of materials that have direct contact with food [10], plastic packaging, kitchenware, jar cap coatings, and the wall of cans that isolates the food from metal, therefore preventing its corrosion [8].

It is estimated that in 2008 the total world production of BPA was approximately 5.2 million tons [2]. The world's largest producers are the United States (22.9% of global production), Taiwan and Japan (13.1% and 13%, respectively). Synthesis of BPA in Poland is about 12 000 tons per year (0.3% of the world production) [42]. The highest percentage of BPA is used as a component of the polycarbonate (74% of the total amount of produced BPA) and the epoxy resins (nearly 20%). As a result of the mass production, a large number of derivatives of BPA are released into the environment, which consequently leads to increasing pollution and contamination of the soil and groundwater [22]. It is estimated than China itself (where 3.6% of the global amount of BPA is synthesized) produces annually approximately 5 000 tons of post-production waste [57].

HUMAN EXPOSURE TO BPA IN EVERYDAY LIFE

BPA is a widely used compound in daily life. Therefore, there are various routes of human exposure to this substance such as oral, by inhalation and transdermal. The main sources of exposure to BPA include food packaging and dust, dental materials, healthcare equipment, thermal paper, toys and articles for children and infants. Food products are the major source of BPA exposure, which is an order of magnitude higher than for other routes [20]. The most important source of dietary exposure to BPA is canned foods, but it may also be present in fresh foods such as meat, milk or eggs, when animals are bred in the polluted areas or watered with the contaminated water [51]. In addition, the presence of BPA was detected in the food products stored in the cardboard boxes [41].

BPA is widely used in the manufacture of cans for food preservation and for the inside coatings of jar caps [23, 41]. It is used to prevent the direct contact of food with the metal, to ensure the thermal stability and the mechanical strength of the can [8]. Coatings that are the most commonly used for this purpose are made of epoxy resins. Approximately 9% of BPA produced annually is used for the production of the lining material in cans [23]. Heating cans during sterilization or food preparation causes the BPA to leak into the can content from the epoxy coating of the can wall and therefore, increases the potential of BPA dietary exposure [9]. The highest increase of BPA concentration was observed after heating the product at 121°C for 90 minutes. The temperature of heating food products turned out to be more relevant for the migration level of BPA than the time of the heating [30]. Sterilization of the canned food causes migration of the 80-100% of the unconjugated BPA to the content of the can and it seems to depend on the conditions of the process and the ingredients of the product [24]. The foods with lower pH and higher fat content contain higher concentrations of BPA [38]. Contamination with BPA may also be caused by the migration to food stored in polycarbonate plastics (reusable containers, polycarbonate water bottles and drink dispensers) or prepared for consumption, such as bottles for infants and children, especially during heating and microwave cooking [53].

BPA can also migrate into dust from laminate flooring, adhesives containing epoxy resins, paints and household electronic equipment [27]. This compound was detected in 95% of 56 dust samples, with the concentrations ranging between 0.8 μg to 10 μg per gram of dust [18, 36]. Higher values were detected in dust from offices and laboratories, mainly because they were equipped with a vast quantity of furniture and electronic devices. Home exposure among children and infants may be higher due to the presence of commonplace items containing BPA, which very often are being taking by children in to the mouth, as well as by the inhalation of the contaminated air [7]. The exposure through dust was estimated to be less than 5% of the total exposure to BPA [21]. Exposure resulting from polluted air is less than 0.4 ng/kg body weight per day in adults, whereas in infants is estimated to be 5.3 ng/kg of body weight per day [35].

Dental materials consist of monomers that may contain BPA, particularly in the form of bis-GMA (bisphenol A-glycidyl methacrylate). This compound is often released from the dental fillings, sealants or materials used to rebuild the crown of the tooth [13]. It has been shown that the highest concentration of BPA was in the saliva of the patient immediately after acquiring the dental fillings and decreased afterwards. However, chronic exposure to BPA released from dental materials in small doses for a long time cannot be excluded [17]. After applying the reconstruction of

a molar tooth crown, 13 μg to 30 mg BPA per day has been shown to be released [51], which may suggest that dental treatments can be a significant source of BPA exposure, especially in the case of patients who have many dental fillings [20].

Small amounts of BPA (0.3-0.35 μg) can be released from several medical devices, which contain polycarbonate or polysulfone plasticizers such as contact lenses, probes, inhalers, intravenous cannulas, catheters, neonatal incubators or haemodialysis apparatus [6, 21, 26].

BPA is also used in the production of paper for thermal printing in cash registers and payment card terminals. Exposure to BPA from thermal paper occurs through the contact of unwashed hands with food or mouth directly, as well as transdermally [21].

It has been shown that thermal paper receipts are the second, after dietary exposure, most common source of BPA exposure in people over the age of three [16]. Several studies show that the cashiers having prolonged contact with such receipts, presented higher concentration of this compound in the urine compared to the general population (2.4 μg/g and 1.2 μg/g, respectively) [5]. The overall exposure to BPA migrating from thermal paper also depends on the frequency and time of use and cleanliness of hands. It has been estimated that occupational exposure after ten hours of work as a cashier is 71 μg per day whereas in general population it ranges from 7.1 μg to 42.6 μg per day [4].

Long-term exposure to BPA may be also due to the contact with toys and products intended for infants and young children, such as baby dummies and teethers that may be put into the mouth, for several hours during the day. Saliva BPA concentration was shown to be 0.14 – 2.1 μg/l saliva for rattles and 0.11 μg to14 μg/l saliva for pacifiers, after 24h contact with such products [31]. One minute exposure of saliva with pacifiers and teethers caused the presence of BPA at the concentration of 0.3 μg/l and 5.9 μg/l, respectively [53].

METABOLISM AND TOXICOKINETICS OF BISPHENOL A

BPA is metabolized in the liver by the uridine 5'-diphospho-glucuronyl transferase (UGT), which catalyzes the glucuronidation of BPA (Figure 1) [56]. BPA can also be metabolized into other substances such as BPA-sulfate or bisphenol-3,4-quinone [55].

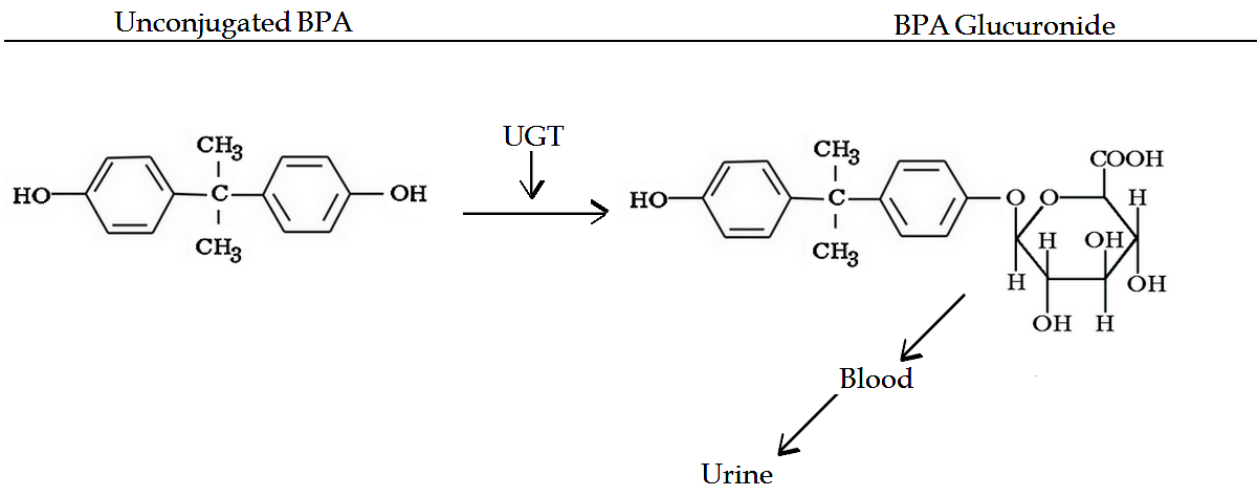

Figure 1. Glucuronidation of BPA in human

The half-life of BPA in the human body is estimated to be 5.4 hours [48].

HEALTH RISKS RELATATED TO BPA EXPOSURE

Due to its phenolic structure BPA has been shown to interact with estrogen receptors and to act as agonist or antagonist *via* endocrine receptor (ER) dependent signalling pathways (Figure 2) [36]. Therefore, BPA has been shown to play a role in the pathogenesis of several endocrine disorders including female and male infertility, precocious puberty, hormone dependent tumours such as breast and prostate cancer and several metabolic disorders including polycystic ovary syndrome (PCOS) [12].

Increased levels of urinary BPA concentration were correlated with a reduced number of sperm in the ejaculate, as well as its reduced motility and viability [33, 46]. The pathomechanism of the fertility disrupting potential of BPA in women as well as in men seems to be due to its estrogenic activity in the hypothalamus which in turn disrupts the proper function of the GnRH

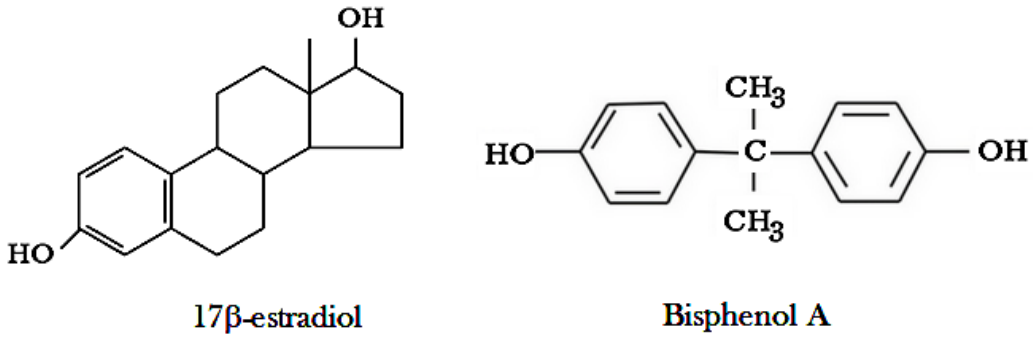

Figure 2. Structural similarity of BPA to 17β-estradiol

pulse generator thus the adequate secretion of the FSH and LH is impaired [14].

Data from animal experiments show that BPA exposure can also be the cause of precocious puberty. Prenatal rat exposure to BPA concentrations of 2 μg/kg body weight per day accelerated puberty in comparison to the control group [28]. It seems that the main mechanism of precocious puberty due to BPA exposure is due to its weak estrogenic activity, which through the positive feedback mechanism stimulate the activity of the GnRH pulse generator, therefore giving the rise in the pituitary LH and FSH secretion [43].

There are reports on a potential role of BPA in the pathogenesis of breast cancer. Studies conducted *in vitro* have shown that the exposure of the human breast cancer cell line to BPA increased its proliferation and caused increased oxidative stress [54]. Similar results were obtained for the MCF-7 estrogen receptor positive cells (ER +), where low levels of BPA significantly increased its proliferation and the expression of the progesterone receptors [32]. High serum BPA concentrations in postmenopausal women also correlated with the mammographic density of the breast tissue [47]. It is also suggested that occupational exposure to BPA increased incidence of breast cancer [11].

BPA may be one of the factors that contribute to the development of prostate cancer. Studies conducted in men with prostate cancer showed a much higher concentration of BPA in the urine of those patients in comparison with the control group [50]. *In vitro* studies have shown that BPA induces the proliferation of the androgen-sensitive human prostate cancer cells [54]. In rats treated with BPA an increase of prostate and epididymis weight was also observed [25]. Moreover, exposure to BPA *in utero* contributed to prostate enlargement in the male offspring [39].

Obesity is a metabolic disorder in which BPA has also been shown to have an impact. Animal studies have shown a correlation between prenatal exposure to endocrine disrupting chemicals, including BPA, and the prevalence of obesity, impaired glucose tolerance and lipid metabolism in mice [40]. Mice exposed to 10 mg BPA/kg body weight per day had higher concentrations of plasma triglycerides, and increased body weight in four months of age comparing to the control group. An endocrine disorder, in the pathogenesis of which BPA may also be involved, is the polycystic ovary syndrome (PCOS) which is the most common endocrinopathy among women of child-bearing age [44]. In patients with PCOS, especially obese ones, BPA serum concentrations were significantly higher compared to healthy controls [49]. The pathogenesis of PCOS is very complex. One of the proposed mechanisms by which BPA may be involved in the pathogenesis of this syndrome is through the activation of the hypothalamic GnRH pulse generator leading to a constant increase of plasma LH concentrations which in turn stimulate the ovarian androgen production and impair proper ovarian follicle development [3, 34]. In addition, BPA has been shown to directly increase ovarian androgen synthesis [58] (Figure 3).

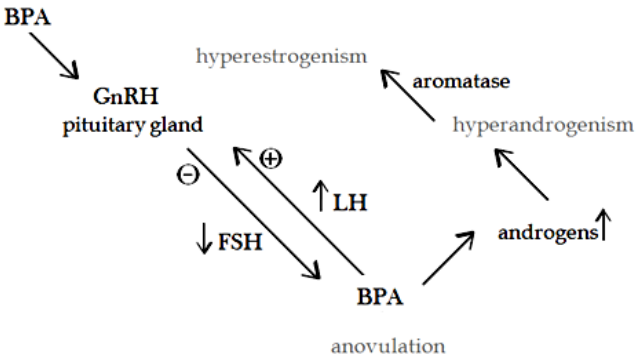

Figure 3. Proposed mechanisms of the BPA action in the pathogenesis of PCOS

BPA AS AN ENDOCRINE DISRUPTING CHEMICAL

According to the European Food Safety Authority (EFSA), an endocrine disrupting chemical is every synthetic or natural compound that meets the following criteria: presents endocrine activity, causes adverse

health effects as well as link between its endocrine activity and adverse affects is believable [15].

As aforementioned, BPA has been shown to present a weak estrogenic activity and therefore may disrupt the proper function of the endocrine system [10]. Thus many international authorities express its concern about the BPA exposure, especially among groups with higher susceptibility to EDC [45]. EFSA applied a total uncertainty factor of 150 (for inter- and intra-species differences and uncertainty in mammary gland, reproductive, neurobehavioural, immune and metabolic system effects) to decrease recommended Tolerable Daily Intake (TDI) from 50 µg/kg bw/day to 4 µg/kg bw/day as a temporary TDI (t-TDI) [16].

As BPA meets all the above criteria it is indisputable that BPA belongs to endocrine disrupting chemicals [1]. It is of human benefit to estimate the exposure to BPA throughout biological monitoring ie. measuring BPA concentration directly in human fluids like blood, urine or breast milk [11]. Thus, biomonitoring seems to be the best method of an assessment of BPA total intake from diverse sources, because of many routes of exposure to this compound.

CONCLUSIONS

Taking into account numerous sources of BPA and endocrine disrupting potential of this chemical it seems to be advisable to introduce a nation-wide biomonitoring in order to evaluate health risk for man with the special attention paid to perinatal and child exposure. Such monitoring may also provide a valuable tool for searching relations between exposure to BPA and prevalence of hormone-related disorders.

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DIETETIC RECOMMENDATIONS AFTER BARIATRIC PROCEDURES IN THE LIGHT OF THE NEW GUIDELINES REGARDING METABOLIC AND BARIATRIC SURGERY

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ABSTRACT

The frequency of obesity occurrence is constantly increasing all over the world and becoming global epidemic. Facing the lack of the efficiency of conservative treatment, patients with II and III degree of obesity are qualified for surgical treatment; however, the efficiency of surgical treatment is connected with permanent change of nutritional habits and previous lifestyle of the patient. Modification of the way of nutrition, regardless of the type of bariatric procedure, should especially include the lowering of food energetic value and change of type, consistency and size of consumed food. Nutritional treatment after bariatric procedures is multistage. It includes clear liquid diet, full liquid diet, pureed diet, mechanically altered soft diet and regular diet. Gradual expanding of the diet protects gastrointestinal tract from chemical, mechanical and thermal irritation by the food. It also should prevent nutritional deficiencies. Significant influence on the result of surgical treatment of obesity has also regular intake of food, consuming products with high nutritional value, avoiding confectionery and fat products, consuming proper amounts of protein (60-80 g/day) and vitamin-mineral supplementation.

Key words: *bariatric surgery, diet/nutrition, morbid obesity*

STRESZCZENIE

Częstość występowania otyłości zwiększa się na całym świecie przyjmując rozmiar globalnej epidemii. Wobec braku skuteczności leczenia zachowawczego, osoby z otyłością II i III stopnia poddawane są leczeniu chirurgicznemu. Warunkiem efektywności leczenia chirurgicznego jest trwała zmiana nawyków żywieniowych i dotychczasowego stylu życia pacjenta. Modyfikacja sposobu żywienia niezależnie od rodzaju zastosowanego zabiegu operacyjnego polega w szczególności na znaczącym obniżeniu wartości energetycznej diety oraz zmianie rodzaju, konsystencji i wielkości spożywanych posiłków. Leczenie żywieniowe po operacjach bariatrycznych jest wieloetapowe. Obejmuje ono: dietę płynną, dietę półpłynną, dietę papkowatą, pokarmy miękkie rozdrobnione oraz zbilansowaną dietę niskoenergetyczną. Stopniowe rozszerzanie diety ma na celu ochronę przewodu pokarmowego przed drażnieniem chemicznym, mechanicznym i termicznym spożywanych pokarmów. Ma jednocześnie zapobiegać niedoborom żywieniowym. Istotny wpływ na skuteczność chirurgicznego leczenia otyłości ma także regularne spożywanie posiłków, spożywanie produktów o wysokiej wartości odżywczej, unikanie słodyczy oraz produktów i potraw tłustych, spożywanie odpowiedniej ilości białka (60-80 g/dobę) oraz stosowanie suplementacji preparatami mineralno-witaminowymi.

Słowa kluczowe: *chirurgia bariatryczna, dieta / żywienie, otyłość olbrzymia*

INTRODUCTION

Prepared in 2012 by WHO report indicates that 50% of adult citizens of European Union has excessive body mass and 17% is obese [19]. In Poland 22% of population is already obese and this rate is constantly increasing [6]. It is estimated that until 2035 every third adult Polish citizen will be obese. In case of patients with morbid obesity (BMI $\geq$40kg/m^2), conservative treatment does not bring effects and that is why they are qualified for surgical treatment. The indication for surgical treatment is also BMI $\geq$ 35 kg/m^2 and co-morbidities such as: diabetes, hypertension, lipid disorders, circulatory heart disease, sleep apnea, arthritis [16,

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29]. Bariatric surgery is highly efficient method of obesity treatment under a condition that patient after the surgery follows dietetic recommendations and is physically active.

The aim of the article was to present actual recommendations regarding the principles of nutrition of patients after bariatric procedures and to highlight the role of dietician in long-term care for obese patients treated surgically.

METHODS OF SURGICAL TREATMENT OF OBESITY

In surgical treatment of obesity, two types of procedures are applied – restrictive and procedures limiting absorption of nutrients. Restrictive procedures include: gastric sleeve resection, vertical-banded gastroplasty (VBG), gastric banding, adjustable gastric banding (AGB), non-adjustable gastric bypass (GBP) proximal and GBP long/limb [17]. Operations limiting absorption of nutrients may be divided into energy absorption limiting operations (Biliopancreatic diversion -BPD) and combined operations, such as: biliopancreatic diversion with duodenal switch (BPDDS) and distal gastric bypass (common limb 100 cm or less) [17]. Restrictive procedures limit the volume of the stomach and narrow the area where food is passed to the intestine which causes intake of smaller portions of food. Malabsorptive procedures are performed in order to limit the absorptive surface of the gastrointestinal tract, shorten the time of food passage and its contact with digestive enzymes. All this leads to decrease of absorption of nutrients with excessive energetic value (carbohydrates and fats).

NUTRITIONAL PREPARATION FOR PATIENTS QUALIFIED FOR SURGICAL TREATMENT OF OBESITY

According to interdisciplinary European guidelines for metabolic and bariatric surgery, decision about performing surgical procedure should be preceded by the assessment of general health state of patient (including the way of nutrition and nutritional status) conducted by multispecialistic team [16, 29]. Depending on the type of planned bariatric procedure patient should also undergo the assessment of bones density, body content and resting energy expenditure which will enable dietician to plan proper diet [16]. Results of own experiment indicate that the way of nutrition of patients qualified for bariatric surgery was not compatible with nutrition recommendations and their diet was insufficient of polyunsaturated fatty acids, folic acid, potassium, vitamin D, calcium, iron and magnesium [21, 22]. Numerous studies proved that patients with morbid obesity frequently reveal latent deficiencies (especially in vitamin D, B_1 and iron) which may increase after the operation [8, 10, 15, 31, 34]. Though, extremely important is nutritional preparation of the patient qualified for bariatric procedure and dietetic care after the operation. First contact of the patient with dietician should be planned at least 3 months before surgical treatment. During this meeting dietician should assess the way of patient's nutrition and explain him/her how it will look like after the surgery. It is important for patient, to follow the rules of balanced, low-energetic diet before the surgery which will lead to loss of body mass, supply all necessary nutrients and complement nutritional deficiencies. During further visits dietician should assess patient's motivation and abilities to follow dietetic recommendations. What is more, during this preoperative period patient should be educated about the principles of expanding and modifying the diet after the surgery.

DIET BROADENING FOR PATIENTS AFTER BARIATRIC PROCEDURES

The review of bibliography shows that regardless of the applied method of surgical treatment of obesity, modification of the nutritional habits includes mainly the lowering of energetic value of consumed food and changing its type, consistency and volume [1, 18, 23, 24, 28].

According to the guidelines established by The American Association of Clinical Endocrinologists, The Obesity Society and American Society for Metabolic & Bariatric Surgery and recommendations of University of Nevada School of Medicine (Table 1) in the first day after the surgery patient should receive intravenous hydration. Calorie-free liquids, without sugar, caffeine and intensively sweetening substances such as water or weak tea are usually added in 1-2 day after the surgery [1, 16, 24, 28]. Those liquids should be consumed with small sips (15-30 mL) in the amount tolerated by the organism. Final liquids intake should be around 1500-1900 mL/day. Drinking with straw is contradiction because it leads to the swallowing of large amounts of air causing the feeling of fullness and discomfort in abdomen [24, 28]. In early postoperative period patients frequently report intolerance of water (gag reflex, metallic taste). It is recommended to substitute it with fruit tea, weak broth, and vegetable juice. It is also possible to add to water lemon juice or calorie-free flavor enhancers.

In the first week after the surgery specialists recommend to substitute the half of calorie-free liquids taken during the day with high-protein liquids (skim milk, acidophilus milk, low-fat soy milk, skim natural yoghurt) with the addition of high protein whey or soy

Table 1. The scheme of nutrition in early postoperative period prepared by University of Nevada School of Medicine [24]

Period after bariatric surgery	Dietetic recommendations in different stages after the surgery
Day 1-2	• only neutral liquids are allowed (without sugar, carbohydrates and caffeine); • liquids should be sipped in the amount tolerated by the organism with gradual increasing of their volume to approx. 1500 mL/day; • drinking with straw should be avoided in order to reduce the amount of swallowed air;
Day 3-7	• continuation of neutral liquids intake in the amount of approx. 1500 – 1900 mL/day (neutral liquids should be the half of daily intake); • introduction of nutritional beverages (low-fat milk, soy milk, low-fat natural yoghurt, mixed soups); • it is acceptable to add powdered whey protein or isolated soy protein to nutritional beverages (no more than 20 g / portion); • introduction of vitamin-mineral supplementation (1 pill twice a day);
Week 2-3	• enlarge the amount of consumed liquids to 1500-1900 mL /day; • nutritional liquids should be substituted with solid, soft, moist, minced, low-fat and high-protein products (eggs, fish, poultry, lean meat, low-fat cottage cheese, boiled bean); • consume 4-6 meals a day (recommended volume of the meal- ¼ cup); • protein should be consumed in the first place in the amount of 60 g/ day;
Week 4-6	• patient should gradually add to diet such products as boiled, soft and/or peeled or pickled fruits (sugar-free); • one soft, solid meal/product should be included in the diet – if it is tolerated; • 4-6 meals should be consumed (recommended volume - ½ cup) with 60-80 g of protein; • in the first place protein should be consumed in the amount of 60-80 g day; • the supply of neutral liquids should be continued in the amount of 1500-1900 mL /day; • liquids should be consumed 30 minutes before or 30-60 minutes after the meal; • meals should be chewed well;
Week 7 and further	• caloric value of the diet should be adapted to height, body mass and age; • meals should be balanced including lean meat, fruits, vegetables and whole-grain products; • raw fruits and vegetables with high content of fiber should be avoided if they are intolerated (celery, corn, artichokes, tomatoes, pineapples, oranges); may be consumed well boiled or grated; • 3 meals and 2 snacks a day should be consumed (volume - 1 cup); • neutral liquids should be consumed in the amount of 1500-1900 mL /day; • liquids should be consumed 30 minutes before or 30-60 minutes after the meal; • products should be well chewed;

protein supplement [24, 28]. Liquid diet is recommended usually for 2 weeks [1, 24, 28]. For further 14 days, blended diet is recommended. During this time patients should consume soft, moist products with low content of fat and high content of protein such as poultry, lean meat, eggs, fish, low-fat cottage cheese, boiled bean. Some researchers highlight the necessity of preparing food in the form of mush, others claim that it is acceptable to consume solid food but in this case slow and careful chewing of every bite is necessary. In the fourth week after the surgery patient may add to the diet such products as boiled, soft vegetables and soft, ripe and peeled fruits but he also should remember to at first consume products containing complete protein. In case of patients after BPD and BPDDS fruits and vegetables should be introduced later – usually six weeks after the surgery [24, 28].

According to the fact that first week after bariatric surgery diet is based mainly on protein products, patients frequently suffer from constipation connected with deficiency of dietary fiber. In such case, dietician may recommend drinking before meals brewed prunes, lactulose in syrup or, in further period (8 weeks after the surgery), wheat bran or dietary fiber with yoghurts, soups with simultaneous hydration of the organism.

6-8 weeks after the surgery pureed diet may be changed for solid diet. Daily menu should contain such products as: lean meat, poultry or fish, vegetables, whole-grain products, fruits in reasonable amounts. Patients after the BPD or BPDDS may include grain products (whole grain crackers, sugar-free corn flakes with milk) no sooner than 12 weeks after the surgery [1, 28]. Some research prove that in the first year after the surgery patients reveal low tolerance for products based on white flour (white bread) rise, pasta, raw vegetables and fruits with fibrous consistency and products with high content of saccharose and fat, that is why they should be eliminated [12, 14, 38] Sutter proved that tolerance to food in patients after gastric banding lowers along with time. However, after gastric bypass the relation is reversed [39]. According to the guidelines of American Association of Clinical Endocrinologists, the Obesity Society, and American Society for Metabolic & Bariatric Surgery patients should avoid bread, pasta and rice until patient is easily consuming 60 g protein per day (in case of patients after BPD or BPDDS 90 g protein) plus fruits and vegetables [28].

PROTEIN DEMAND AFTER BARIATRIC PROCEDURES

Both, in early and in late postoperative period, it is extremely important to provide proper intake of complete protein and optimal hydration (minimum 1500 mL/day). According to experts' current recommendations the amount of protein in diet of patients after bariatric surgery should be 1-1.5 mg per 1 kg of desired body weight which is 60-80 g per day. In case of patients after BPD or BPDDS, demand for protein increases of further 30% and it is 90-120 g/day [16, 20, 24, 28], however, it should be highlighted that there is a lack of clear evidence confirming those facts [28]. *Schinkel* et al. recommend daily intake of protein of 2.1 g per kg of desired body mass (or 0.95 g/kg of current body weight) [37]. According to *Moize* and *Heber*, demand for protein 1.5 g/kg of desired body mass may help to maintain positive nitrogen balance and prevent the loss of lean body mass [20, 32]. What is more, *Heber* et al. highlighted that patients should each day consume 30 g of protein in more than one meal in order to prevent bones and muscles insufficiencies. What is more, protein should be eaten at breakfast to relive the catabolic state of overnight fasting and to regulate appetite and daily food intake [20]. Proper supply of leucine also plays important role according to the fact that it stimulates protein synthesis and inhibits degradation of skeletal muscles proteins [25]. Perfect source of this amino acid is whey, casein, egg white, isolated soy protein.

Results of multiple studies prove that consumption of protein by patients during the first year after the surgery is insufficient in comparison to the demand [3, 30, 32]. Usually, it is caused by intolerance of high--protein products such as red meat (beef, veal), chicken and turkey (except when it is well chopped), eggs and milk [14, 35, 38]. One of the symptoms of protein deficiency is hair loss. In such situation, supplementation is recommended – with high-protein nutrients (isolates of whey protein). What is more, diet should be enriched with zinc sources (milk and dairy products, whole-grain products, pulses) vitamin B_6 (wheat germ, pulses, nuts, yeast) and pantothenic acid (whole-grain products, wheat bran, pulses, yeast). Specialists recommend supplementation with high-protein preparations (especially for patients after malabsorptive and combined bariatric procedures) if protein supply do not exceed 60 g/day [2, 5, 28]. The role of dietician is to estimate the amount of protein consumed every day and adaptation of proper supplementation with high-protein nutrients, individually for each patient.

Own observation indicates that patients have problems with estimation of daily consumption of protein. It seems to be reasonable for dietitian to establish the list of products which may be a good source of this nutrient along with the definition of the volume of portion (in grams and home measures) and the content of protein (in grams) per 1 portion of product. It will enable to easily compose nutritional portions. What is more, dietician should educate patient in the field of products selection and cooking techniques which may minimize the risk of nutritional intolerance (such as emesis, abdominal pain, the feeling of distension, heartburn).

DUMPING SYNDROME

Meals should be consumed regularly, 5-6 times a day, in small portions, without hurry, each for approximately half an hour. Each bite should be properly chewed. It is also important to drink between meals, 30 minutes before or 30-60 minutes after the meal, especially by patients after GBP [24, 28]. It is connected with minimized risk of early hypoglycemia syndrome called dumping syndrome. The most common consequences of this syndrome are emesis, flatulence, diarrhea, dizziness, and palpitations. Dumping syndrome is caused by accelerated gastric emptying of unhydrolysed, hyperosmolar ingest which, while moving directly into intestinal lumen, causes binding of huge amount of water from the circulatory system in order to equalize osmotic pressure [12, 24]. Gastrointestinal and circulatory system disorders occur also in patients consuming extensive portions of food and those consuming monosaccharides (sweetened beverages, sweets, extensive amounts of fruits, etc.) [24]. Flatulence and diarrhea may be a result of milk consumption by patients with lactose intolerance.

ENERGY AND BASIC NUTRIENTS DEMAND IN LATE POSTOPERATIVE PERIOD

Efficient treatment of obesity after surgical procedure depends mainly on limiting the demand for calories. It is important for dietician to cooperate with patient, estimate his individual energetic demand considering his daily physical activity and estimate proper supply for protein. Estimating individual energetic demand let patient to maintain negative energetic balance which is necessary to lose weight.

In long-term dietetic treatment target energetic value of the diet should be individually adjusted to the age, height and ideal body mass of patient. Review of literature revealed that during the first year after the surgery energetic value of patients' diets is 700-900 kcal per day [11, 32]. 12-36 months after the surgery it is between 1000 and 1400 kcal [4, 32, 33]. Protein

consumption should be 1.0-2.1 g per 1 kg of due body weight which is approximately 25% of caloric value of the diet [1, 32, 37]. The proportion of fats in diet's energetic value should not be higher than 30% [23, 32, 33]. Besides the amount of fat in diet, its quality is also important. Especially recommended are fish fat and olive oil [33]. Energetic value of the diet should be complemented with carbohydrates (approximately 45%) derived from vegetables, fruits and whole-grain products such as rolled oats, fine grits, dark bread. They are great source of fiber, vitamins and minerals. The amount of carbohydrates in daily portion of food should not be lower than 100g which enables total burning of fatty acids and protects systemic protein against its utilization as an energetic material [7]. It was also proved that 100 g of carbohydrates in diet lowers of 40% the loss of nitrogen [1].

FOOD PYRAMID FOR PATIENTS AFTER BARIATRIC PROCEDURES

It seems that the most accessible and understandable form of nutritional recommendations presentation is food guide pyramid. It shows patients which products and in what amounts should be chosen in order to compose balanced and low-energetic meals. *Moize* et al. prepared for patients after gastric bypass "bariatric food pyramid" [33]. At the bottom of the pyramid there are: daily mineral-vitamin supplementation, proper amount of liquids and daily physical activity. The first level of the pyramid includes high-protein and low-fat products. *Moize* et al. recommend daily intake of 4-6 high-protein meals where 1 portion is: 60 g of lean meat (beef, pork or poultry), 60 g of oily sea fish or 80 g of lean fish (white fish), 80 g of lean curd, 140 g of milk, 115 g of yoghurt, 50 g of eggs, 80 g of boiled bean or lentil. It also has to be mentioned that oily fish should be consumed at least 3 times a week. On the second level of the pyramid authors put low-energetic food with high content of fiber (vegetables, fruits) and vegetable oils. They recommend daily intake of 2-3 portions of fruits and 2-3 portions of vegetables (all kinds of vegetables in the amount of 85 g). Due to the fact that fruits' energetic value is different, they were divided into two groups – with low content of carbohydrates (1 portion is 140 g of melon, watermelon, strawberries, grapefruit, apples or oranges) and with high content of carbohydrates (1 portion is 70 g of grapes, apricot, bananas, cherries, nectarines or lychees). According to the fact that vegetable oils provide significant amount of energy, they should be consumed in the amount of 2-3 teaspoons a day. Third level of the pyramid includes 2 portions of starch products (1 portion of starch products is 90 g of boiled rice or pasta, 30 g of whole-grain bread or cereal products, 80 g of boiled pulses or 85 g of boiled potatoes). Fourth and last level of the pyramid includes high-energetic products, containing saturated fats, cholesterol and sweets which should be avoided by patients [33].

NUTRIENTS DEFICIENCIES AND DIET SUPPLEMENTATION

Bariatric procedures are strictly connected with the risk of deficiencies both, in macro- and micronutrients. After malabsroptive and combined types of bariatric procedures, malabsorption of protein and protein-soluble fats and vitamines (A, D, E, K) as well as iron, calcium, B vitamins (B_1, B_6, B_{12} and folic acid) [8, 9, 18, 40]. Resection or reduction of the stomach results in decreased digestion and absorption of protein, iron, vitamin B_{12} and other nutrients provided along with animal protein products. Restrictive methods require consumption of very small meals which may lead to deficiencies in nutrients. What is more, frequently occurring nausea and uncontrollable vomiting caused by consuming too big portions may lead to the intensification of nutritional deficits and dehydration of the organism.

Due to vitamins and minerals deficiencies in patients after bariatric procedures, routine supplementation is recommended. According to current recommendations of American experts standard vitamin-mineral supplements (containing 400 µg/day of folic acid) should be applied with 1 pill 2 times a day [18, 28, 40]. Chewable or liquid formulas are preferred [16, 26, 27]. Recommendations about vitamins and minerals supplementation consider mainly application of calcium (in the form of calcium citrate) in the amount of 1200-2000 mg/day, vitamin D in the amount of 1000 – 2000 IU/day and for menstruating women also elemental iron (with vitamin C) in the dose of 40-65 mg per day. In case of vitamin B_{12} deficiencies, supplementation should be started with 500 µg/day orally or 1000 µg/month intramuscularly. In case of patients after BPD/DS, vitamin A should be also supplemented in the amount of 5000-10000 IU/day as well as vitamin K in the amount of 300 µg/day [18, 28, 40].

Each patient after bariatric procedure should be under long term dietetic control in order to determine and develop appropriate nutritional habits. Research indicates that patients under dietetic control achieved better results in body mass loss after the operation than those who did not receive such help [13, 35].

CONCLUSIONS

Proper way of nutrition after bariatric procedure not only helps with body mass loss and prevents regaining weight but also may protect against intolerances and nutritional deficits, mitigate them and prevent serious postoperative complications.

Conflict of interest

The authors declare no conflict of interest.

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AN ASSOCIATION BETWEEN ORGANOPHOSPHATE PESTICIDES EXPOSURE AND PARKINSONISM AMONGST PEOPLE IN AN AGRICULTURAL AREA IN UBON RATCHATHANI PROVINCE, THAILAND

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ABSTRACT

Background. *Parkinson's* disease (PD) is a ubiquitous disease. However, PDs prevalence in the population of agricultural communities lacks understanding and there has been no epidemiological study on the association between pesticides exposure factors and risk for PD.

Objective. To investigate the potential association between organophosphate pesticides exposure and Parkinsonism by using a screening questionnaire in agricultural areas.

Material and Methods. Ninety elderly people living in agricultural areas participated in a cross-sectional study conducted at Tambon Hua-Rua Health Promoting Hospital in April 2014. Screening questionnaires for *Parkinson's* disease, Test-mate ChE (Model 400) for blood cholinesterase (ChE) levels of both blood enzymes erythrocyte cholinesterase (AChE), and plasma cholinesterase (PChE) were used as measurement tools. Descriptive statistics for frequencies and percentage distributions were used primarily to summarize and describe the data. Sensitivity, specificity, positive and negative predictive values were calculated.

Results. The age range of the participants was 50 to 59 years old, with an average age of 53.9±2.87 years. The majority of the participants were female (62.2%), 82.2% of respondents were farmers. Most of participants (76.7%) reported that they applied insecticides in their farms. Ninety persons participated and completed the 11-item questionnaire. Of these, 17 (18.9%) felt that they lost balance when turning or that they needed to take a few steps to turn right around and 16.7% of participants indicated that they felt the need to move slowly or stiffly. The study found the prevalence of abnormal AChE levels was 28.9% (95%CI=19.81-39.40) and 17.8% of PChE levels (95%CI=10.52-27.26). To predict Parkinsonism, AChE, and PChE level, with a cutoff score of 5 or higher there had to be a sensitivity of 0.31, specificity of 1.00, positive predictive value (PPV) of 1.00 and negative predictive value (NPV) of 0.78 for AChE. While PChE, the score value of 5 or more had a sensitivity of 0.19, specificity of 0.93, PPV of 0.38 and NPV of 0.84.

Conclusion. This study described an association between pesticides exposure and Parkinsonism. The questionnaire appears to be useful for Thai agriculturists as a screening tool for Parkinsonism and cholinesterase levels regarding to pesticides exposure.

Keywords: *organophosphate, pesticides exposure, Parkinsonism, cholinesterase activity*

INTRODUCTION

Parkinson's disease (PD) is a degenerative disorder, a type of movement disorder. It happens when dopamine, a brain chemical is not produced enough by nerve cells in the brain. One's genetic makeup is believed to be a cause of PD; chemical exposure in the environment might play a role, but most cases do not seem to run in families [1]. Currently, there are many types of pesticide exposures that may occur through contaminated water and food [2]. Some studies have linked the geographical distribution of pesticides usage with the prevalence of PD [3-6]. The symptoms of PD may present as one or more of the following categories: primary motor symptoms, secondary motor symptoms, non-motor symptoms, and coping with symptoms. Primary motor

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symptoms include resting tremors, slowness of movement, and poor balances are examples [7]. Currently, it is difficult to diagnose PD. There is no laboratory test for PD that can be administered for diagnosis; this is why doctors use a patient's medical history and a neurological examination to make the diagnosis. PD is common in the elderly and begins developing around the age 60, but it can start earlier. Some of the previous studies reported the average ages of PD patients were 55 to 60 year-olds and most of the patients were more than 50 years of age [3, 8, 9]. It is more often found in men than in women. Currently, there is no cure for PD but early diagnosis and medical care can help slow down the progression of the symptoms and help the patient have a better quality of life [1].

At present, Thailand has no study on the statistics of PD for prevalence or incidence rate. Thai *Parkinson's* disease registry project was started in March 2008. There are currently more than 60,000 patient cases registered. The prevalence of PD in Thailand was 424.57 PD cases per 100,000 persons. The largest prevalence of PD was in the Central Region of Thailand, higher than the rate of the overall population in the country. This may suggest that the variation is caused by the different amounts of chemicals in use but never confirmed by a check-up and/or drawing patient blood samples, consequently, it was only a presumption [9]. From the previous studies in PD patients it was shown that patients who were exposed to pesticides, organochlorines and paraquat correlated to having PD [10, 11] and occupational exposures to pesticides were linked with PD [12].

Agricultural work is an important sector that can strengthen Thailand's economy. Some of the problems these workers encounter are health related problems caused by toxic chemicals such as pesticides that are used for pest control and agricultural application. As a result, agriculturists as well as the general public may be exposed to such substances through ingestion, inhalation, and dermal absorption [13]. One biomarker that can be used to measure the effect of pesticides is the activity of cholinesterase enzymes [14]. An annual report of the Bureau of Occupational and Environmental Diseases has concluded that the cholinesterase enzymes in blood of agriculturists across Thailand had depressed levels. In 2002, out of 563,354 persons it was founds that 89,926 persons (15.96%) had risky and unsafe cholinesterase levels [15].

Ubonratchathani province is a province in the Northeastern of Thailand. It is the agricultural area that mainly grows chili. The main districts that grow chili are in the province of the Mueang district, Muang Sam Sip district, Khueang Nai district, Sirindhorn district, and Phibun Mangsahan district. The province has a growing chili area is 6,605 Rais (1 rai = 0.4 acre), where 11,229 tons of chili product are produced per year. Chili farming activity occurs from December until April, chili farmers also grow rice after they harvest the chili. Chili farmers apply fairly high rates of pesticides [16], the province had 42 patients poisoned by pesticides or 2.35 per hundred thousand persons in the populations with no mortality in 2008. In 2009 reports, the province had 75 patients poisoned by pesticides or 4.20 per hundred thousand, there are no mortality statistics. In 2009 cholinesterase enzyme levels in 3,321 agriculturists were studied and it was found that 1,053 agriculturists, that is 31.71% of the agriculturist, had depressed cholinesterase levels. As a result, agriculturists in Ubon Ratchathani who grew vegetables such as chili or fruits by using pesticides had risky and unsafe cholinesterase enzyme levels higher than the average risky and unsafe cholinesterase enzyme levels in agriculturists across the country (annual report in Hua-Rua Health Promoting Hospital, 2011). The pesticides that chili farmers in the Hua-Rua sub-district, Mueang district, Ubon Ratchathani Province used were organophosphate pesticides (OP) such as chlorpyrifos and profenofos [16,17].

There is no data on the prevalence of PD in the agricultural area in the Hua-Rua sub-district, Mueang district, Ubonratchathani Province and there was no information on the association between pesticides exposure factors and the risk for PD. Our research aim is to investigate the possible association between pesticides exposure and PD by using a screening questionnaire among elderly people living in chili farming community who may be at risk group because of senility, employment in an agricultural occupation, and continued pesticides exposure including the use of pesticides in household and residential areas.

MATERIAL AND METHODS

This study was cross-sectional study. The study population was primarily elderly persons who were living in the Hua-Rua agricultural community. There are 90 elderly people living in the study area. Previous studies have shown the average age range of PD patients is 55 to 60 years old [3, 8, 9]. The participants were selected by purposive sampling; age between 50 to 59 years, included men and women. Those who have a history of cardiac disease, renal or hepatic insufficiency diagnosed by a doctor, using any neurological related medication and had Injuries/Head Trauma that had caused any type of harm to brain or central nervous system were excluded from the study. Representatives recruited participants from each house (one subject per household). Health care officers at the Tambon Hua-Rua Health Promoting Hospital performed the purposive sampling

with the criteria used to obtain the target sample number (90 participants).

Measurement tools

1. Questionnaire
   The questionnaire is separated into two parts: (1) to obtain general information and individual background and (2) a screening questionnaire for *Parkinson's* disease. The screening questionnaire for *Parkinson's* disease, originally come from *Setthawatcharawanich* et al. [18]. The questionnaire consisted of 11 questions with an answer of yes-no for the questions.

2. Blood test by Test-mate ChE (Model 400), EQM
   The Test-mate ChE Cholinesterase Test System is based on the Ellman method. Acetylthiocholine (AcTC) or butyrylthiocholine (BuTC) is hydrolyzed by AChE or PChE, producing carboxylic acid and thiocholine, respectively, with reaction to the Ellman reagent (DTNB, dithionitrobenzoic acid) so as to create a yellow color that is gauged spectrophotometrically at 450 nm. The rate of color formation is in proportion to the amount of either AChE or PChE [19]. Nurses collected 20 μL of blood per person from the participants at Tambon Hua-Rua Health Promoting Hospital, in which optimum temperature was controlled at less than 30 °C as recommended by Test-mate ChE Cholinesterase Test System (Model 400) specification. The analysis of cholinesterase levels in erythrocyte and plasma using Test-mate was also performed.

Data analysis

Interpreted level of cholinesterase: for AChE, if values are less than or equal to 2.92 U/mL this indicates possible pesticide poisoning thus the participant should be removed from the exposure and/or treated with anticholinergics. A cholinesterase level of more than 2.92 U/mL value is considered normal. For PChE, if the values were less than or equal to 1.56 U/mL it indicates possible pesticide poisoning and the participant should be removed from the exposure and/or treated with anticholinergics. A cholinesterase level of more than 1.56 U/ mL value is considered normal (U/mL reference from Test-mate ChE (Model 400), EQM).

Using a licensed SPSS Version 16 for windows, general characteristics and socio-demographic were described by frequency, percentage, and mean. Sensitivity, specificity, a positive predictive value (PPV) and a negative predictive value (NPV) were calculated. PPV; was defined as the number of true-positive studies divided by the sum of true-positive and false-positive studies and NPV; was defined as the number of true-negative studies divided by the sum of true-negative and false-negative studies.

Ethics consideration

The experimental protocol was approved by the Ethics Review Committee for Research Involving Human Research Subjects, Health Sciences Group I, Chulalongkorn University with the certified code no.056/2014.

RESULTS

General characteristics and socio-demographic

The participants ranged from 50 to 59 years old, with an average age of 53.9±2.87 years. The majority of the participants were female (62.2%) and 82.2% of the respondents were farmers. Most of participants (76.7%) indicated that they applied insecticides on their farms. 61.1% of respondents reported that the source of drinking water for their family was the tap water. In the past six months, approximately 58.9% of respondents suffered some type of illness. Table 1 describes sample population profile.

Table 1. Socio-demographic characteristics of the respondents (n=90)

Characteristics	Number (n=90)	Percentage (%)
Gender		
Male	34	37.8
Female	56	62.2
Occupation		
Unemployed	4	4.50
Chili farmers	37	41.1
Rice farmers	37	41.1
Others	12	13.3
Insecticide uses		
Yes	69	76.7
No	21	23.3
Source of drinking water		
Tap water	55	61.1
Ground water	17	18.9
Well water	2	2.20
Others	16	17.8
Frequently of illness in the past six months		
Never	36	40.0
Sometimes	53	58.9
Usually	1	1.10

A screening questionnaire for Parkinson's disease

Ninety persons participated and completed the 11-item questionnaire. Of those who completed the survey, 17 (18.9%) felt that they lost balance when turning or that they needed to take a few steps to turn right around, 16.7% of participants indicated that need to move slowly or stiffly and 15.5% of respondents felt that it was difficult to get up again after sitting down. Table 2 demonstrates the number of participants giving a positive answer to each question on a screening questionnaire for *Parkinson's* disease.

Table 2. Number of participants giving a positive answer to each question on a screening questionnaire for *Parkinson's* disease (n=90)

Items	n	%
1. Have you noticed that you become clumsier or have more difficulty with tasks that involve fine hand control: for example, doing up your buttons?	5	5.60
2. Have your handwriting changed and become smaller compared to when you were young?	0	0
3. Do you feel you move slowly or stiffly?	15	16.7
4. Do you walk with a stooped posture?	11	12.2
5. Have you noticed that you do not swing your arms when you walk as much as you used to?	6	6.70
6. Do you find it difficult to start walking from a standstill or have difficulty in stopping suddenly when you want to?	5	5.60
7. Have you noticed that a tremor of your hands, arms, legs or head?	7	7.80
8. Do you have a lack of facial expression or tend to drool with your mouth half-open?	5	5.60
9. Have you noticed that your voice has become softer or more monotonous?	8	8.90
10. When you turn, do you lose balance or do you need to take quite a few steps to turn right around?	17	18.9
11. After you sit down, do you find it difficult to get up again?	14	15.6

Prevalence of abnormal ChE levels both AChE and PChE

The study found that the prevalence of abnormal AChE levels was 28.9% (95%CI=19.81-39.40) and 17.8% of PChE levels (95%CI=10.52-27.26). Table 3 demonstrates the number and percentage of participants with cholinesterase activities.

Table 3. Number and percentage of participants with cholinesterase activities resulted

	n	%	95% CI
AChE			19.81-39.40
Abnormal*	26	28.9	
Normal	64	71.1	
PChE			10.52-27.26
Abnormal**	16	17.8	
Normal	74	82.2	

* Less than or equal 2.92 U/mL
** Less than or equal 1.56 U/mL

Performance characteristics of AChE, PChE and a screening questionnaire for Parkinson's disease

Sensitivity, specificity, a positive predictive value and a negative predictive value were calculated for sum of the simplified score using all 11 questions with AChE and PChE level. To predict Parkinsonism and AChE and PChE level, the score value of 5 or more had a sensitivity of 0.31, specificity of 1.00, PPV of 1.00 and NPV of 0.78 for AChE. While PChE, the score value of 5 or more had a sensitivity of 0.19, specificity of 0.93, PPV of 0.38 and NPV of 0.84 (Table 4).

Table 4. Performance characteristics of AChE, PChE and a screening questionnaire for *Parkinson's* disease at different cut-off points

	Cut-off	Sensitivity	Specificity	PPV	NPV
AChE	≥3	0.50	0.98	0.93	0.83
	≥4	0.50	0.98	0.93	0.83
	≥5	0.31	1.00	1.00	0.78
	≥6	0.08	1.00	1.00	0.73
PChE	≥3	0.25	0.86	0.29	0.84
	≥4	0.25	0.86	0.29	0.84
	≥5	0.19	0.93	0.38	0.84
	≥6	0.13	1.00	1.00	0.84

Abbreviations:
PPV; positive predictive value, NPV; negative predictive value

DISCUSSION

In this study, it was found that the average AChE of participants was 3.31 ±0.56 U/mL. The AChE activity in this study was higher than the AChE activity in the previous study, which showed that AChE activity in farm workers was (2.63 ±0.55 U/mL) and in non-farmers was (2.80 ±0.53 U/mL) [20]. The possible reasons are both that growing different products and crops is associated with different exposure to organophosphates, and consequently with different AChE activity or that the previous study was conducted in high pesticides usage areas. The study showed that farmers are likely to have lower AChE activity than non-farmers as stated in the Argentina [21] study that compared AChE between direct and indirect exposed groups. The present study found the prevalence of abnormal AChE levels to be 28.9% and 17.8% for PChE levels. This study described that residential pesticides exposure among people who live in agricultural communities are possibly exposed to pesticides indirectly by their main occupation in the community.

A validated questionnaire for *Parkinson's* disease can be useful as a screening as well as a decrease time for the patient to complete the questionnaire. However, a physical examination of positive screening questionnaire should be concern for a final diagnosis. From the statistical analysis the respondents that felt to lose balance when turning or that needed to take a few steps before turn right around, felt that they moved slowly or stiffly and that 15.5% of respondents felt difficulty to get up again after sitting down. The results were similar to previous studies, which showed that motoric disorders are the main symptoms for Parkinsonism diagnosis [6, 22, 23]. Previous studies suggested that the presence of tremors was a good

indicator and recognizing characteristic [24, 25] as tremors are the most common presenting symptom of *Parkinson's* disease [26]. However it may not be a reliable predictor in a community group [27]. In 2000, *Chan* et al. reported the validation of screening questionnaires and found that 93.7% of *Parkinson's* disease patients in hospital group identified tremor while 62.5% in the community group.

This study indicated that the score value of 5 or more can be used as a cutoff score for predicting *Parkinson's* disease and pesticide exposure. These results were similar to previous studies which reported that a cutoff score of 5 or more ensured the best balance between sensitivity and specificity [18, 27].

CONCLUSIONS

Many previous studies have linked pesticides use with *Parkinson's* disease. In this study it was found that the study area uses a wide variety of pesticides. People in the community were exposed to pesticides used in their community and it could be assumed that people in this community may be exposed either by multiple pathways. From the results, it seemed likely that people's exposure to pesticides may be associated with an increased risk of *Parkinson's* disease or Parkinsonism as well. A screening questionnaire tested in this study is a useful tool to detect *Parkinson's* disease. However, the questionnaire should not replace the physical examination and the medical documentation of *Parkinson's* disease, which should be used to confirm the results of the questionnaire. In addition, the screening questionnaire can be used as a screening tool for Parkinsonism and pesticides exposure. The recommendation is to reduce pesticides exposure to reduce risk from *Parkinson's* disease. Risk management and risk communication is critical for the prevention and reduction of PD risk.

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Conflict of interest

The authors declare no conflict of interest.

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AUTHENTICITY OF FOOD PRODUCTS IN THE POLISH MARKET CHECKED DURING 2005 -2012

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ABSTRACT

Background. Food fraud/adulteration has ever increasingly become a dominant food issue of the modern world in both developed and developing countries. It is presumed that globalisation is mainly one of the underlying reasons.

Objective. To assess and analyse the occurrence of food fraud on the Polish market during 2005-2012.

Material and Methods. Adulteration of foodstuffs was determined from official food inspections carried out by the Agricultural and Food Quality Inspection (IJHARS) in 2005-2012. On average, foodstuff manufacturers inspected ranged from 1300 companies in 2011 to 3000 in 2006. The amount of results so collected, allowed a meaningful assessment to be thus made of food fraud on the Polish market.

Results. Food fraud was found to vary in the Polish market for the specific areas researched (ie. organoleptic properties, physico-chemistry and labelling) as well as in the agri-food sector. Levels of food fraud were not significantly different to those observed in other countries.

Conclusions. Appropriate control measures, at both national and international levels, are thereby indicated to halt the adulteration of foodstuff products that constitute a health hazard or pose a life-threat to consumers as well as constituting a financial fraud.

Key words: *authentic food, food fraud/adulteration, food quality, organoleptic properties, labelling, plant derived foodstuffs, animal derived foodstuffs*

STRESZCZENIE

Wprowadzenie. Zjawisko fałszowania żywności staje się coraz bardziej dominujące we współczesnym świecie. Dotyczy ono zarówno krajów rozwijających się jak i rozwiniętych. Za główną jego przesłankę uznaje się globalizację.

Cel. Celem artykułu była analiza i ocena występowania zjawiska zafałszowania produktów spożywczych znajdujących się na rynku polskim w latach 2005-2012.

Materiał i metody. Oceny zjawiska zafałszowania produktów spożywczych dokonano na podstawie analizy wyników badań produktów spożywczych pobieranych podczas kontroli przeprowadzonych w latach 2005-2012 przez Inspekcję Jakości Handlowej Artykułów Rolno-Spożywczych (IJHARS). W okresie tym Inspekcja kontrolowała rocznie przeciętne od 1300 w 2011 roku do 3000 w 2006 roku przedsiębiorstw produkujących produkty spożywcze. Liczba wyników badań pozwoliła na dokonanie miarodajnej oceny żywności na rynku polskim, pod względem jej zafałszowania.

Wyniki. Analiza wyników badań kontrolnych żywności znajdującej się na rynku w latach 2005-2012 wykazała zróżnicowaną skalę zafałszowania żywności na rynku polskim w poszczególnych obszarach badawczych (cechy organoleptyczne, parametry fizykochemiczne, znakowanie) oraz sektorach przemysłu spożywczego. Poziom ten nie odbiega jednak istotnie od rozmiarów tego zjawiska w innych krajach.

Wnioski. Uzyskane dane wskazują na potrzebę działań kontrolnych zarówno na poziomie krajowym jak i międzynarodowym w celu zahamowania praktyk fałszowania produktów spożywczych niebezpiecznych dla zdrowia i życia konsumentów, a także finansów.

Słowa kluczowe: *autentyczność żywności, fałszowanie produktów spożywczych, jakość żywności, cechy organoleptyczne, znakowanie, żywność pochodzenia roślinnego, żywność pochodzenia zwierzęcego*

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INTRODUCTION

Increasingly, the problems of food quality and fraud have grown with the dynamic development of global trade in foodstuff products, the lengthening supply/distribution chain and the greater anonymity of the food market.

Fraudulent food has been around for hundreds if not thousands of years [4]. It is however only within the last 200 years, during the industrial revolution and the rise of the 'anonymous consumer' concept/model that a real explosion of this phenomenon has occurred. At present, the issue of food fraud is being intensively dealt with by institutions at the national, regional (EU) and global (Codex Alimentarius) levels.

Investigating and assessing food fraud on the Polish market forms an important part of the surveillance undertaken by the Agricultural and Quality Inspection (IJHARS) within their remit on the product quality of commercial agri-foodstuffs. Through this, it is understood that characteristics of agri-foodstuffs include organoleptic, physico-chemical and microbiological properties related to manufacturing technology, size or weight, and the requirements arising from manufacture, packaging, presentation and labelling not covered by sanitary, veterinary or phyto-sanitary stipulations [10].

Commercial quality control of foodstuffs covers 3 basic features: organoleptic properties, physico-chemistry and package labelling which is defined in the 'economic consumer safeguards' formulation. Irrespective of this, food must meet appropriate requirements of health and nutritional quality which is defined as the so called 'health safety'. This means that foodstuffs cannot contain ingredients or substances hazardous to health or those are life threatening to the consumer and, furthermore, it should have biologically optimal proportions of nutritional components [8]. Fulfilling these conditions constitute the criteria for food safety.

Current technological advances observed in foodstuff manufacture are paralleled with progress in food fraud. The methods of adulteration depend on the food type and the technological means of manufacture which change according to advances made in such production processes. As a result, more sophisticated investigative methods are constantly being needed to detect food fraud [3].

The aim of this article is to determine the level of food fraud in the Polish market based on surveillance studies carried out by the IJHARS laboratories during 2005-2012.

MATERIALS AND METHODS

Analysis and assessing food fraud on the Polish market was performed by IJHARS staff from foodstuff surveillance conducted during 2005-2012. In this time, from 1300 inspections in 2012 to 3000 in 2006 were carried out at food manufacturers. On average 5000-5500 samples of foodstuffs were taken. The analyses were undertaken by IJHARS laboratories with PCA accreditation (Polish Accreditation Centre) to ensure result quality. Around 30,000 to 35,000 physico-chemical parameters were measured. Such large numbers of results have thus enabled a meaningful assessment of food fraud to be made.

RESULTS AND DISCUSSION

MAIN AREAS OF FOOD FRAUD

The main areas of food fraud consist of the following:

Changing the raw materials

This represents one of the main areas of food fraud and, for example, can occur by deliberately adding cheaper meat or animal protein in cold meat products or using meat injected with collagen. Such counterfeiting can be most commonly detected by using the Polymerase Chain Reaction (PCR) that can determine and quantify the meat raw material if any are concealed by the manufacturer. This technique can also detect any raw materials present from plant sources eg. soy.

Adding mechanically deboned meat (MDB)

This is obtained as residual meat tissue that has been mechanically separated from bone for either pork or poultry. Such additions affect both the foodstuff production costs and its nutritional value. Meat products that consist of MDB should be regarded by consumers as being of low quality and having shorter expiry dates. When investigating for undeclared MDB material, the calcium content can be used for the initial screening of foodstuffs suspected of being adulterated which, if positive, are then subjected to additional microscopic analysis.

Colouring additives for improving foodstuff appearance

Making food choices is very often governed by visual assessment. In order to achieve a desired appearance when using various raw material substitutes, manufacturers more frequently use colouring additives; for instance in pasta, non-alcoholic beverages, cheese, fish and meat.

Altering the fish species

These analyses are more frequently undertaken because the more popular and expensive types of fish are substituted with those less well known and cheaper. For detecting such fraud, sarcoplasmic profiling is per-

Table 1. Main irregularities in commercial quality observed in the bread and pasta (2005-2012)

Foodstuff products / Types of irregularities
Bread
• A lower mass of product to that declared. • Incorrect proportions and structure/composition of ingredients to those declared. • A lack off, or incorrect description of the bread type according to the sort of flour used (eg. mixed, wheat or rye). • Absence of the percent composition of a given ingredient described within the product name, eg. wholemeal rye flour, sunflower seeds in wholemeal bread. • No information about any allergenic ingredients, eg wheat flour, sesame seeds. • Providing incorrect standard values for bread eg. in rye bread when the amounts of wheat and rye flour demonstrate a mixed composition. • Placing the conventionally used term 'EKO' within the product labelling suggesting thereby that it is organically produced.
Pasta
• Whenever turmeric spice is allegedly added but is undetectable in the taste and aroma. • Incorrect surface appearance, deformation and/or rupture. • Unretained shape or form after cooking or being undercooked despite using recommended preparation times. • Not in accordance with the appropriate properties of the product after cooking (falling apart, excess viscosity). • Lowered contents to those declared. • The presence of ordinary wheat flour in pasta declared as being made from durum flour. • Contamination by minerals (eg. sand). • Labels misinforming the customer about the product profile and/or name, eg; (a) 'homemade pasta' containing ingredients which are not normally used at home (tumeric or products with Vitamin A). (b) 'homemade pasta' manufactured without eggs but with replacement flavouring. (c) 'homemade pasta' containing food flavouring manufactured by the latest technology; (d) 'best quality guarantee', 'traditional taste, 'guarantee of quality and taste a many years of experience and tradition'; descriptions suggesting special qualities compared to others with the proper documentation. (e) 'flavoured pasta' without any actual flavour. (f) applying two different package descriptions eg. 'egg pasta' on the front and Just 'pasts' on the back which misleads the consumer. • Misleading the consumer on content, eg. (a) In 'egg pasta' no information about the egg ingredient, (ie whether eggs, powdered eggs, egg mass), only the terms like 'beaten eggs' or 'whole' eggs' included. (b) Using terms like 'no preservatives' or 'no food colourings' which mislead the consumer as legal requirements not in fact ban such substances.

formed using isoelectric focusing (IEF) for comparing the patterns of separated protein with those from known standard fish types.

Adding phosphorous compounds

The reasons for adding the above to meat, fish and their products thereof, are to increase their water retention/absorption, thus providing a product with a greater mass. Such fraudulent practices can be discovered by performing thin layer chromatography (TLC) separation of the phosphorus compounds.

Adding non-dairy fats to dairy products

Methods for detecting these are used in the fats from dairy products such as butter, cream, milk or powdered milk. When positive, further confirmation is sought by using the following:

- phytosterol detection (ie. plant-based sterols)
- tocopherol and tocotrienol analysis for identifying palm oil additives
- methods for determination of fatty acid content

In current practice for dairy product surveillance, particular stress is placed on detecting fraud in regio-

Table 2. Main irregularities in commercial quality observed in the fruit juices and nectars/concentrates (2005-2012)

Physico-chemistry features • Lowered 'millimoles NaOH consumed /100 ml'(ie. reflection of amino acid content) and ash content to that declared in apple juice made from concentrates. • General acidity higher than that declared (as apple acid) in orange juice made from a concentrate, • Elevated citric acid compared to d-isocitrate. • Increased water-soluble pectin. *Labelling* • Given information suggests that a product has specific properties eg. 'no preservatives' for apple juice directly pulped or for raspberry nectar where it is illegal anyway for it to contain preservatives. • Missing items in the list of manufacturing ingredients eg glucose-fructose syrup in apple-morello cherry juice manufacture from fruit concentrates, citric acid. • Supplied information like 'rich in natural Vitamin C' or 'with Vitamin C' for a given product to which ascorbic acid is added during manufacture thus suggesting that the source of this vitamin are the fruit itself. • Absence of the percent composition of a given ingredients described within the product name eg apple-morello cherry juice produced from fruit concentrates.

Table 3. Main irregularities in commercial quality observed in the dairy products (2005-2012)

Organoleptic properties
• Abnormal taste, aroma and consistency.
• Variable colouration, budding in cheeses.
• Abnormal consistency in semi-liquid products (eg cream, cream cheeses) or a foreign taste and aroma of cream cheese).
Physico-chemical features
• Lowered or elevated average levels of fat.
• Presence of foreign fats (eg vegetable fat) or plant sterols.
• Increased water content, especially in cream cheeses.
• Decreased protein content in most dairy products.
• Butter adulterated with vegetable fats.
• Lowered net mass (eg rennet cheese).
• Increased freezing point of water (pasteurised milk).
• The presence of cow's milk in goats' cheese.
• Reduced bacterial numbers of *Lactobacillus subsp. Bulgaricus.*
Labelling
• A longer sell-by date than that according to standards.
• Not all manufacturing ingredients are specified (eg calcium chloride).
• Labelling a product as 'Class I' when the manufacturer does not designate such a quality class.
• Specifying ingredients that were not used in the manufacture, whether labelled on lists or graphics, eg fruit, vegetables.
• Providing incorrect percent composition of basic ingredients (eg cheeses used in processed cheese) as compared to the manufacturer's recipe.
• No information on treatment processes used in product manufacture (eg pasteurization, homogenisation).
• Quantitative information is lacking on a given ingredient stressed in the product name; the so called QUID.

Table 4. Main irregularities in commercial quality observed in the processed meats (2005-2012)

Processed red meat products
Organoleptic properties
• Abnormal appearance (slippery surface, altered colour).
• Inappropriate aroma and jellified areas visible in cross section.
Physico-chemical features
• In products declared to be of pork origin, the presence of other raw material sources eg from poultry, beef, including MDB meat.
• Presence of bone fragments.
• Elevated amounts of water, fat and salt.
• Lowered protein content.
• Presence of undeclared nitrates/nitrites and phosphates.
Labelling
• No information on every raw material used in product manufacture (eg MDB poultry, smoked flavourings, water, pork rind, starch, yeast extract, pork fat, flavour promoters, thickening agents).
• Information lacking on allergenic ingredients present eg soy protein, mustard and celery.
• Unclear labelling of finished product (eg no manufacturing or food-processing information like whether the product is smoked, baked steamed or homogenised).
(a) Misleading information provided to the consumer.
(b) Regarding a product type, for instance, using trade names such as 'ham' to describe such a product containing finely milled ingredients consisting of 50% pork-fat products
(c) In food processing methods used, for eg, adopting descriptions like traditional, home-made, farm produce, tradition and taste, traditional taste when the required documentation to confirm such thigs is lacking.
Processed poultry products
Organoleptic properties
• In products made from meat-fat material with additional homogenisation, suggesting the presence of whole muscle tissue.
Physico-chemical features
• Presence of undeclared pork ingredients.
• Presence of undeclared starch, soy products, phosphates.
• Elevated levels of water, fat and salt.
• Decrised declared protein content (up to 15%),
Labelling
• Not including all raw materials used in product manufacture (eg water, flavourings, MDB meat, pork, flavour promoters, thickening agents.
• Adopting a name misleading the consumer eg;
(a) 'Poultry loin', suggesting a link with pork
(b) 'Olde Polish Style Chicken' when the raw materials also contain pork when they should be just from poultry.
• Incorrect (decreased) meat content.
• The chicken meat content of a product's ingredients is missing.

Table 5. Main irregularities in commercial quality observed in the fish and processed fish (2005-2012)

Fresh fish
Fresh fish belongs to those foodstuff groups usually demonstrating the largest transgressions regarding quality. This stems from the sensitivity during transporting such foodstuffs of short consume-by dates or from placing low quality fish products on the EU market from other countries eg mainly from Asia. *Organoleptic properties* • Presence of residues (ie. peritoneum, blood clots, mouth parts, heart, stomach and tail fins). *Labelling* • Fish species not provided on goods. • Fishing location not given. • No labels in Polish and/or illegible labelling.
Processed fish
Organoleptic properties • The product ingredients do not match the declared contents of vegetables and spices and other supplements that are absent. • Sardines of different sizes disorderly packed making separation difficult, some sardines with disrupted meat showing visible internal tissue. *Physico-chemical features* • Lowered fish meat content (by up to 30% to that declared by manufacturer). • Elevated glazing content (dup to 9.1%). • Decreased basic ingredient content eg vegetables. *Labelling* • Not all the raw ingredients used in manufacture are listed such as; salt, sugar, vegetables, spices and extracts supplements. • No quantitative information of ingredients within the product name eg. vegetables, prunes, ground spices. • Adopting information misleading the consumer such as: • Omitting to mention that added vegetables were dried. • Stating two different cuts of fish at the same time eg fillets and chops. • Incorrectly adopting the name 'Mattias' for herrings fished in October after the first spawning. • When stated 'Produce of Poland' when the main ingredient comes from the North East Atlantic. • The food processing method is not given (eg. marination, boiling, frying) in given products eg for sterilized fish preserve. • Information lacking on the net mass of fish after separation.

nally produced cheeses like 'oscypek' (smoked ewe's milk cheese), 'redykolka' (a derivative of the previous) or 'bryndza' (sheep milk cheese) made in the Tatra mountains which are officially registered in the EU list of name-protected foodstuff products. For detecting fraud when cow's milk is added to sheep or goats milk, then fat separation methods are employed followed by identifying milk protein fractions (γ-casein).

Refined oil additives in olive oil

For investigating adulterated olive oil, methods for discriminating between added refined oils and those present from cold-pressed olive oil are used. These are based on determining 3,5-stigmastadiene which is a product arising during the refining from the dehydration of β-sitosterol. Additionally, the trans-isomer content is measured, whose presence may indicate that high temperatures have been used during processing. This becomes more important in extra virgin olive oil which probably has the best legal safeguards of all vegetable oils in the EU [1, 2].

EXTENT OF ADULTERATION IN FOODSTUFFS

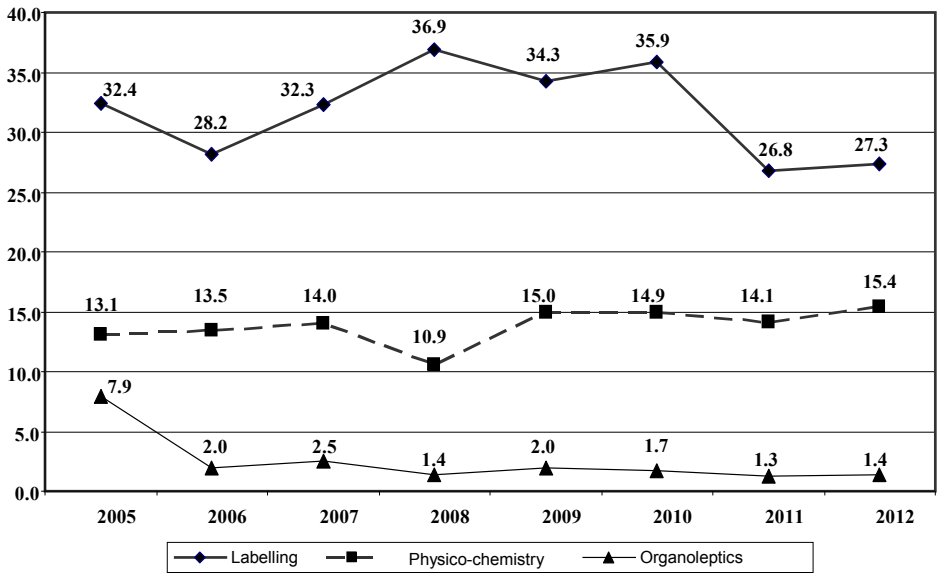
Assessing foodstuff quality control in terms of irregularities/transgressions and fraud is conducted in 3 ways:

- organoleptic properties (ie. taste, aroma, colour, appearance, consistency)
- physico-chemical characteristics that vary according to foodstuff product group such as fat, water, protein, carbohydrate, salt, sugar, humidity, volume, acidity etc.
- foodstuff labelling.

Foodstuff organoleptic forms the initial part of the foodstuff assessment that usually does not provide an unequivocal answer if fraud is present, although some detected irregularities may have arisen from fraud. Confirmation of fraud is only achieved by detecting irregularities in the physico-chemical parameters and the foodstuff labelling. In the former, 70-80% cases of irregularities constitute foodstuff fraud [5]. This is made with reference to the original definition of *Krauze* [7], from 50 years ago, where fraud is taken as misleading the consumer through changing an ingredient(s) of high quality to one of a lower quality or 'false labelling' ie. misrepresentation of the actual content, or manufacturing place, date and method together with properties and nutritional value. Foodstuff labelling is of thus of economic importance as well as being important to the consumer.

Organoleptic assessment

In 2005, irregularities for this area rose by 7.9%, mainly in foodstuffs such as butter (56% of surveyed batches), fish products (14%) and poultry (11.8%).



Source: Based on own presesentation from results obtained by IJHARS inspections during 2005 – 2012.

Figure 1. Inspected foodstuff batches showing transgressions according to quality control parameters as found during 2005-2012 (in %).

However during 2006-12, such levels were 1.5% on average (Figure 1). Put in a different way, in 2005, there was one in 12 transgressions in foodstuff products, whereas during 2006-12 this had decreased to one in 60. Most of the transgressions in plant derived products occurred in 2006, 2008, 2009 and 2012 whilst those in animal products were in 2005, 2007, 2010 and 2011.

Physico-chemical characteristics

During 2005-12, irregularities for the above were noted in 13-15% foodstuff batches under surveillance and their rises have been small but steady, from 13.1% in 2005 to 15.4% in 2012.[1] A satisfactory result of 10.9%[2] was achieved in 2008 resulting from relatively favourable outcomes in physico-chemical studies on red meat products. Physico-chemical transgressions in meat product batches for 2008 were 5%, but were 11.5% in 2010 and 23.5% in 2012.

Transgressions in foodstuffs of animal origin were found to be the highest during 2008-13 with 11.5% recorded for 2008 and 17.6% in 2012, and the highest amounts found in 5 out of the 8 years of this period. Foodstuffs derived from plants however showed batch transgressions in physico-chemical parameters of 11.7% in 2007 to 13.4% in 2006.

The preponderance of fraud in foodstuffs derived from animals over those from plants, reached levels of even 6% in 2012. Only during 2009-2011 were there more transgressions in plant derived foodstuffs than animals.

Generally speaking the authenticity of plant derived foodstuffs was higher than those of animal origin by around 1.5-2.0%.

Foodstuff labelling

This area showed the most transgressions, which varied from 26.8% in 2011 to 36.9% in 2008. Within the study time frame, various trends could be discerned. Transgressions rose from 32.4% in 2005 to 36.8% in 2008, followed by staying steady at 35% over 2008-10 after which it significantly fell to 27% in 2011-12.

Fraud in the physico-chemistry from plant derived foodstuffs was higher than those originating from animals. In terms of foodstuff labelling, there were more transgressions in plant derived foodstuffs than animal ones, differences being from 0.7% in 2011 to 9.1% in 2005.

FOODSTUFF FRAUD ACCORDING TO FOOD TYPE

Levels of authenticity and fraud varied across food types as well as quality control parameters.

Organoleptic properties

Most transgressions in this area occurred in processed fruit and vegetables, which during the study period

[1] In the first half of 2013, physico-chemical transgressions for foodstuffs exceeded 16% and for the whole of 2013 were 19.3% indicating a deterioration in these quality control parameters over 2008-13.

[2] Surveillance over bread has been omitted from the calculations, which in 2008 constituted over 50% of all foodstuff products derived from plants and 30% from overall surveillance from which 0.5% were found to be transgressions. In terms of surveillance over just bread, then transgressions in 2008 amounted to 7.6%.

(2005-12) so in time slot comprising eight periods / years of control was present 7 times on the list of the 5 most transgressed foodstuffs. Bread and baked products were found six times on the list and pasta 5. Amongst the plant derived foodstuffs that frequently appeared were food concentrates, cereals, non-alcoholic beverages and herbs/spices (condiments). Foodstuffs of animal origin present on the list included dairy products (7 times), poultry (6 times) and butter (4 times). Whether foodstuffs were genuine was also questioned in fish and fish products along with processed red meat and eggs.

Physico-chemical characteristics

For plant derived foodstuffs, fraud was found in cereals (5 times present on list), pasta (5 times), frozen and processed vegetables (5 times) and 3 times for respectively grape/wine products, breadcrumbs, honey and beer. Cereals were found overall to have the most fraud, which is of significant import as these products form the dietary basis for the majority of consumers.

Fraud detected in foodstuffs of animal origin included butter, milk fats and dairy products (5 times), processed fish (5 times), processed red meat (4 times), processed white meat (3 times), fish marinades (3 times) and remaining processed meat products (8 times). In all, the dominant foodstuff types in this group were processed meat, and dairy and fish products. Eggs were only once present on this list.

Foodstuffs labelling

This area had the most numerous transgressions. For the plant derived foodstuffs, the most common were bread (4 times), pasta (3 times) and twice for breadcrumbs and fermented wine products. In addition, other frequently appearing ones were olive oil, juices, nectars and dried fruit. In foodstuffs of animal origin, the most common transgressions noted were for processed red meat (11 times), processed fish (7 times) and 3 times respectively for delicatessen products, butter and fat spreads. As opposed to the many foodstuff types of plant origin, transgressions in animal derived ones were confined to just processed red meat and processed fish.

The level of transgressions in food labelling is of concern. In many batches, levels reached even over 10%. During 2005-12, of the 80 inspections that had the biggest transgressions, every second batch of products was found to be incorrectly labelled in 24 inspections. In at least 1/4 product batches (25%), incorrectly labelled foodstuff products were found belonging to 77 batches (96.3% of products in a batch being incorrectly labelled) and in more than 1/3 (33%) batches consisting of 69 batches (86.3%). In some product batches incorrect labelling exceeded 70% and sometimes even 90%.

Methods of food fraud depend on the specifics of particular foodstuffs and the types of manufacturing technologies involved and their continual advancement and development. Fundamental transgressions, that are typical examples of fraud and which were found during inspections of foodstuffs derived from plants are shown in Tables 1 and 2, whilst those from animals in Tables 3, 4 and 5.

It is estimated that within the EU, the scale of food fraud is around 20% and thus the European Parliament intends to toughen the penalties imposed on those companies allowing such practices.

A need therefore exists for rapid information exchange at the EU level concerning cases of food fraud. At the national level, measures are now being undertaken for making inspections more effective. At the EU level a need therefore exists for rapid information exchange concerning cases of food fraud; special system for monitoring of food fraud to be based on the RASFF system (Rapid Alert System for Food and Feed) [9], which should thereby decrease levels of transgressions and improve the authenticity of food throughout the EU.

CONCLUSIONS

1. The several thousand food inspections analysed over 2005-12 in this study, has demonstrated significant irregularities in foodstuffs present on the Polish market.
2. The fewest transgressions were for organoleptic properties of foodstuffs (1-1.5% of analysed batches). Those for physico-chemical characteristics, were estimated at 15% that slowly but constantly rose to over 17% in 2013, ie. 1:6 batches were found to be fraudulent.
3. The scale of transgressions and fraud were greatest for foodstuff labelling, however in 2011-12 this improved. During 2008-10 levels were at 35% but in 2011-12 they decreased to 27%.
4. Appropriate action is thus required at both national and EU levels over the surveillance and monitoring of food fraud in order to bring about improvements.

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CONSUMPTION OF BLACK AND GREEN TEAS AS A DIETARY SOURCE OF POLYPHENOLS IN POLISH INHABITANTS OF THE MAZOVIAN REGION

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ABSTRACT

Background. Tea is a very popular drink throughout many parts of the world, that includes Poland. The tea infusion (cup of tea) itself contains phenolic compounds with anti-oxidant properties that constitute 30% of the dry mass of tea leaves responsible for a health promoting effect on the human body.

Objectives. To estimate the determinants and amounts of black and green tea consumed by a selected population group, along with their polyphenols intake from tea.

Material and Methods. A survey was conducted of 281 subjects in 2012 from the Mazovian region of Poland, recruited from social-networking sites which had been sent a web application questionnaire (Mini-ankiety.pl).

Results. Subjects were aged 18-56 years, of whom the majority (73%) were aged 21-30 years. City dwellers constituted 86%, whilst those remaining were from small towns (14%). Black tea was drunk by 80% of whom 39% did so daily, whilst green tea was drunk by 72% of whom 17% did so daily. Determinants affecting the amounts of tea drinking were principally gender, education, place of residence and number of household members. Women significantly drank more than one cup of green tea daily compared to men. Those with a higher education significantly drank more than one cup of black tea daily compared to those with lower education levels. Homeowning subjects with 2 household members significantly drank more than one cup of green tea daily than the others. The average daily intakes of polyphenols from black tea in those who drank so regularly was 503 mg and that for green tea was 361 mg.

Conclusions. The main source of tea polyphenols was found to be black tea as this was drunk more often than green tea. There is a need for promoting more green tea to be drunk as a source of polyphenols.

Key words*: black tea, green tea, polyphenols, polyphenols intake from tea*

STRESZCZENIE

Wprowadzenie. Herbata jest bardzo popularnym napojem spożywanym w wielu rejonach świata, w tym w Polsce. Zawarte w składzie naparów herbacianych związki fenolowe wykazują antyoksydacyjne działanie. Stanowią one ponad 30% suchej masy liści i to właśnie im herbata zawdzięcza swój prozdrowotny wpływ na organizm.

Cel badań. Celem badań było oszacowanie poziomu i uwarunkowań spożycia herbaty czarnej oraz zielonej w wybranej populacji, a także szacunkowa ocena spożycia polifenoli wraz z herbatą.

Materiał i metoda. Badanie przeprowadzono w 2012 roku wśród 281 osób za pośrednictwem aplikacji internetowej Mini--ankiety.pl, do której adres internetowy został rozpowszechniony na portalach społecznościowych.

Wyniki. W badaniach udział wzięły osoby w wieku od 18 do 56 roku życia, przy czym najliczniejszą grupę (73%) stanowiły osoby w wieku 21-30 lat. Wśród badanych 86% osób pochodziło z dużego miasta, a pozostałe (14%) zamieszkiwały małe miasta. Uzyskane wyniki wskazały, że 80% badanej populacji spożywało herbatę czarną, z czego 39% codziennie. Herbatę zieloną spożywało 72% badanych z czego codziennie -17%. Czynniki mające wpływ na ilość spożywanej herbaty to przede wszystkim płeć oraz wykształcenie, a także miejsce zamieszkania i liczba osób w gospodarstwie domowym. Kobiety istotnie częściej w ilości 1 szklanki/dzień pijały napar z zielonej herbaty w porównaniu do mężczyzn. Respondenci z wykształceniem wyższym istotnie częściej (codziennie) spożywali herbatę czarną i zieloną w porównaniu z osobami z niższym wykształceniem. Ankietowani zamieszkujący mieszkanie własne w gospodarstwie dwuosobowym istotnie częściej pijali 1 szklankę/dziennie naparu z zielonej herbaty. Średnia ilość polifenoli przyjmowana dziennie z herbatą czarną wśród osób deklarujących jej regularne spożycie wyniosła 503 mg, natomiast z herbatą zieloną 361 mg.

Wnioski. W badanej populacji, ze względu na wyższe spożycie, lepsze źródło polifenoli stanowiła herbata czarna niż zielona. Istnieje konieczność większego propagowania picia herbaty zielonej, jako źródła polifenoli.

Słowa kluczowe*: herbata czarna, herbata zielona, polifenole, pobranie polifenoli z herbatą*

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INTRODUCTION

The tea beverage is obtained from the *Camellia sinensis* (L.) plant, which not counting water is the most common drink consumed throughout the world. It is of enormous nutritional significance to many global populations. From its origins in China at around 2700 BCE, tea drinking has rapidly expanded.

Tea drinking initially became widespread due to its health benefits although it soon also became very popular because of its uncommonly good taste/flavour. The many different tea varieties and its huge worldwide consumption make it an essential part of many cultures as well as fulfilling important social functions. Tea infusions are a vital source of dietary antioxidants. They are also impart various physiological effects such as stimulant, refreshment, pain relief, reducing body mass, anti-cancer, reducing cardiovascular disease and strengthening the immune system [3, 11].

Due to the presence of polyphenols, tea has a high antioxidant potential thus being of benefit to the human body and these, at 36%, are the most important antioxidant compounds of which flavonols (or catechins) are the most numerous (80%). They principally consist of epigallocatechin gallate (EGCG), epigallocatechin (EGC) and epicatechin gallate (ECG). Other polyphenols present in smaller amounts are catechin, gallocatechin, catechin gallate, epigallocatechin and epicatechin digallate [7, 12]. Such polyphenols in tea infusions demonstrate antioxidant and, indirectly, anti-inflammatory and anti--cancer properties, as confirmed by *in vitro* and *in vivo* clinical studies. These compounds inhibit transcription factors sensitive to changes in the redox balance, show pro-oxidative enzyme activity and may induce anti-oxidative enzymes in the Phase II auto-oxidative process. Many studies confirm that oxidative damage to DNA, lipids or protein is vitally significant to cancer development. The formation of nitrogen and oxygen free radicals in the human body are often too much for defence mechanisms to cope with. Dietary antioxidant intake is thereby particularly important in preventing chronic disease. Both green and black teas are a rich source of polyphenols with antioxidant properties, which may thus beneficially impact the human body [5]. The study aim was to therefore estimate the amounts and determinants of consumption green and black tea in a selected population, together with estimating polyphenols intakes derived from drinking such teas.

MATERIAL AND METHODS

The survey was conducted by means of an internet application (available on www.mini-ankiety.pl) that was made distributed throughout social networking sites.

The questionnaire was designed for determining the rates and amounts of green and black tea drunk, along with determinants/factors affecting such consumption. There were 22 questions covering anthropometry, demographics (eg. types of household, numbers of household members), education, rates and amounts of green and black tea consumption, presence of additives in tea, reasons for making tea variety choices, the significance of chosen tea quality and the drinking of other beverages. Replies to most questions required selecting a single definite response from a closed list. Some however were half-open ended, where more than one reply could be chosen. Several questions on anthropometry were also open-ended that included age, height, body mass and place of residence.

The flavonoid content was estimated from the USDA Flavonoid Data base prepared by the U.S. Department of Agriculture, Agricultural Research Service [4], from which the mean polyphenols content in 100 g of an 1% infusion of black or green tea was taken as respectively 119 and 121 mg.

Statistics were performed on the Statistica 6.0 package. The Chi^2 test for independence was used to assess if there were any significant associations between black and green tea intakes with the studies variables (ie. gender, age, BMI, education, water consumption, place of residence and number of family members). A significance level of $p \leq 0.05$ was adopted.

RESULTS AND DISCUSSION

The study subjects were 158 men and 123 women aged 18-56 years, of whom the most frequent were aged 21-30 years (73%). Most lived in the large city of Warsaw (86%) whilst the others came from small cities (Legionowo, Piaseczno and Pruszkow). Subjects possessing higher education were the most common (62%), whereas those with middle, vocational and secondary education were respectively 15%, 1% and 6%. Of all, 6% claimed to be students. According to their BMI, 68% subjects had normal body mass, 23% were overweight, 5% obese and 4% underweight. Family homes accounted for 39% subjects, 36% were homeowners and 20% lived in rented flats; the smallest group (5%) lived in rented rooms or student accommodation. Two member households were found to be the most frequent (28%), with respectively 3, 4 and single membered households at levels of 24%, 21% and 17%.

Black tea was daily drunk by 39% subjects with those most often having one cup daily (19%) and 39% added sugar. Green tea was daily drunk by 17% subjects with those most often (35%) having one cup daily and 52% not adding anything (Table 1).

Table 1. Ways of consumption tea in the subjects studied

	Black tea		Green tea	
	Numbers n=281	%	Numbers n=281	%
Types of tea drunk:				
Tea bags	180	64.1	104	37.0
Instant tea	3	1.0	-	-
Loose leaf	41	14.6	98	34.9
Tea not drunk	57	20.3	79	28.1
Consumption frequency				
Daily	111	39.5	48	17.1
1 – 2 times weekly	35	12.5	43	15.3
3 – 4 times weekly	29	10.3	33	11.7
5 – 6 times weekly	18	6.4	24	8.5
Less than once weekly	36	12.8	60	21.4
Not applicable	52	18.5	73	26.0
Daily consumption				
1 cup	56	19.9	100	35.6
2 cup	52	18.5	40	14.2
3 cup	33	11.7	9	3.2
4 cup	20	7.2	6	2.1
More	7	2.5	6	2.1
Not applicable	113	40.2	120	42.8
Additives used				
Sugar	96	34.2	32	11.4
Lemon	38	13.5	10	3.6
Milk	2	0.70	0	0
Honey	15	5.30	7	2.5
None used	75	26.7	147	52.3
Not applicable	55	19.6	85	30.2
Reasons for drinking*:				
Taste	143	-	115	-
For health	14	-	133	-
As a stimulant	20	-	29	-
Thirst quenching	80	-	51	-
From habit	92	-	15	-
Not applicable	57	-	48	-

* - more than one answer can apply.

In Poland, black tea is currently one of the most popular beverages. Together with the UK, Ireland, Holland and Germany, Poland has one of the highest consumption rates in Europe [8]. According to the Polish Chief Statistical Office (GUS), the average annual tea consumption is 1 kg (dry mass) per person; this being equivalent to drinking almost 1.5 cups of tea (infusions) daily. According to a 2010 report [15], 64% of Poles drink tea twice daily, 21% once daily and over 15% did so four or more times daily.

Of the 281 subjects, apart from tea, 89% also most frequently drank mineral water, 54% fruit/vegetable juices and 54% coffee. Next to follow were isotonic beverages at 40%, whilst 30% consumed fizzy sweetened drinks (cola, fanta, sprite) and 30% fresh fruit drinks. Lower consumption rates of sweetened non-fizzy fruit or nectar drinks (22%) were observed along with 21% frozen teas (Nestea type) and 19% energy drinks. The least frequent drinks were fresh vegetable juices at 10%.

A significant relationship was seen between the frequency and amounts of green tea drunk with gender (Table 2), where women more often drank one cup daily (p=0.001) than men. Another significant association was observed where those drinking mineral water, more frequently drank black (p=0.048) and green teas (p=0.02). Subjects with higher education, had significantly higher rates (daily) of black and green tea consumption compared to the other less educated subjects; respectively p=0.018 and p=0.013. There was also a significant link demonstrated between amounts of green tea drunk with the place of residence and numbers of household/family members; those living in their own homes (p=0.023) in two membered households (p=0.003) more frequently drank one cup of green tea daily.

Education was found to affect rates of tea consumption (along with that of polyphenols), where those with higher education, daily drank more which may be related to having a higher awareness of the tea's health benefits. Women also decidedly drank more green tea than men, however there was no such difference for black tea. A possible explanation could be that information on green tea can be mostly found in women's magazines.

Table 3 shows the subjects' estimated polyphenols intakes from black and green teas. Those drinking black

Table 2. The effect of studied determinants/factors on the frequency and amount of black/green tea consumed in subjects under study

Factors	Black tea		Green tea	
	Frequency	Amount	Frequency	Amount
Gender	NS*	NS	0.001**	0.002
Age	NS	NS	NS	NS
BMI	NS	NS	NS	NS
Education	0.018	NS	0.013	NS
Place of residence	NS	NS	NS	0.023
Number of household members	NS	NS	NS	0.003
Mineral water consumption	0.048	NS	0.020	0.015

* NS-satistically insignificant; ** p value by Chi^2 test

tea consumed 503 mg polyphenols daily, whilst those drinking green tea consumed 361 mg polyphenols daily.

Table 3. Polyphenols intake from black/green tea in studied subjects

Daily tea consumption	Polyphenols intake from tea [mg/person/day]
Black tea	
1 cup (n=56)	238
2 cups (n=52)	477
3 cups (n=33)	715
4 cups (n=20)	954
Mean (n=161)	503
Green tea	
1 cup (n=100)	242
2 cups (n=40)	485
3 cups (n=9)	727
4 cups (n=6)	970
Mean polyphenols intake (n=155) [mg/person/day]	361

Analytical data on the amounts of polyphenols in tea normally consider tea infusions. Their practical preparation however varies according to country and consumer preference. For this reason it is difficult to compare flavonoid amounts in tea infusions from various sources and methods of brewing tea. The amounts of polyphenols in tea infusions rise in relatively linear fashion according to the number of tea leaves used. The brewing time however does not significantly affect flavonoid content in the infusion as most become quickly extracted within 3 minutes of starting the brew and their quantities do not significantly rise if the brewing time is extended [2, 19].

Due to the proven health benefits of drinking green tea, (as a source of polyphenols), it seems reasonable and appropriate to promote and popularise this custom. Because of the antioxidant properties of the polyphenols found in tea, their beneficial effects can be seen on preventing and treating cardiovascular disease, cancer, diabetes as well as their anti-bacterial actions and as an assist in reducing body mass [1, 6, 10, 14]. Furthermore, green tea contains the least oxalates when compared to other types of tea [13].

CONCLUSIONS

1. Black tea provided a better dietary source of polyphenols than green tea because it was drunk more by the studied subjects.
2. Gender, education, place of residence and number of household members were found to be the main factors determining polyphenols intakes from drinking tea.
3. Consumption of green tea should be promoted more as a valuable source of polyphenols.

Conflict of interest
The authors declare no conflict of interest.

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STUDIES TO DETERMINE WHETHER UNDERGROUND WATERS IN WIELKOPOLSKA REGION (POLAND) CONTAINING HUMUS SUBSTANCES ARE SUITABLE FOR PRACTICAL PURPOSES

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ABSTRACT

Background. Water derived from Miocene aquifer in Wielkopolska region (Poland) has a 'brown-black' colouration resulting from humus substances. Because this colour is difficult to remove, such water is considered unfit for human consumption. The presence of naturally occurring humus acids with known biochemical properties may however lend such water for use in medicine, cosmetics or agriculture.

Objective. To determine and evaluate the properties of 'brown-black' Miocene waters from analysing their physico-chemistry properties, mineral content and the presence and structures of humus acids.

Material and Methods. The test material was 4 samples of intensely coloured 'brown-black' underground waters from Miocene aquifer taken from the Greater Poland region at different locations; Obrzycko and Braczewo (both by Szamotuly), Sepno (by Koscian) and in Poznan (Szkolna Street).

Results. The water type was HCO_3-Cl-Na with dissolved minerals ranging at concentrations of 828.5 mg/dm^3 (Poznan) to 1600.5 mg/dm^3 (Obrzycko). Fluorides were present at 0.71 mg/dm^3 (Poznan) to 1.41 mg/dm^3 (Braczewo) whilst iron (II) (ferrous ion) ranged from >10 mg/dm^3 (Obrzycko) to 22.7 mg/dm^3 (Sepno). Levels of humus acids varied between 188.6 mg/dm^3 (Sepno) to 1501.8 mg/dm^3 (Obrzycko) with predomination humic acids over hymatomelanic acids by factors from 1.3 to 10.6.

Conclusions. Due to the test water's mineral content, which includes significant levels of iron II, fluoride and humus acids (> 50 mg/dm^3), it is suggested that it has therapeutic value and is suitable for medicinal bath treatments and in manufacturing medical products or cosmetics.

Key words: *miocene water, specific humus therapeutic water, humus substances, differential absorption spectra UV/VIS*

STRESZCZENIE

Wprowadzenie. Na terenie Wielkopolski w utworach miocenu występują wody "brunatno-czarne", których barwa pochodzi od związków humusowych. Wody te, ze względu na trudności w usuwaniu zabarwienia uznawane są za nieprzydatne do zaopatrywania ludności. Obecność kwasów humusowych naturalnego pochodzenia o udokumentowanych badaniami właściwościach biochemicznych, może determinować racjonalne wykorzystanie takich wód , m.in. do celów leczniczych, kosmetycznych czy rolniczych.

Cel. Celem opracowania było rozpoznanie i ocena właściwości „brunatno-czarnych" wód poziomu mioceńskiego na podstawie wyników analiz: fizyko-chemicznych, składu mineralnego oraz zawartości i struktury kwasów humusowych .

Materiał i metody. Materiałem do badań były wody podziemne „brunatno-czarne" z mioceńskich warstw wodonośnych, pochodzące z 4 ujęć na terenie Wielkopolski w miejscowościach: Obrzycko i Brączewo – k/Szamotuł, Sepno – k/Kościana oraz w Poznaniu – (ul. Szkolna), charakteryzujące się intensywną barwą i klarownością.

Wyniki. Badane „brunatno-czarne" wody z terenu Wielkopolski są wodami typu HCO_3 -Cl-Na zawierającymi od 828,5 mg/dm^3 (Poznań) do 1600,5 mg/dm^3 (Obrzycko) rozpuszczonych składników mineralnych. W wodach tych obecne są fluorki w stężeniu: od 0,71 mg/dm^3 (Poznań) do 1,41 mg/dm^3 (Brączewo) oraz w 2 ujęciach (Obrzycko, Sepno) żelazo (II) w stężeniu > 10 mg/dm^3 (do 22,7 mg/dm^3). Badane wody zawierają w przedziale stężeń od 188,6 mg/dm^3 (Sepno) do 1501,8mg/dm^3 (Obrzycko) kwasy humusowe, w których przeważają kwasy huminowe nad hymatomelanowymi w stosunku od 1,3 do 10,6.

Wnioski. Ze względu na skład mineralny, w tym znaczącą zawartość żelaza (II) i fluorków a także zawartość kwasów humusowych w stężeniu > 50 mg/dm^3, proponuje się badane wody uznać jako swoiste lecznicze wody humusowe oraz wykorzystać je do celów leczniczych w formie kąpieli oraz do produkcji preparatów leczniczych czy kosmetycznych.

Słowa kluczowe: *woda mioceńska, swoista lecznicza woda humusowa, związki humusowe, różniczkowe widmo absorpcji UV-VIS*

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INTRODUCTION

The underground water from the Miocene aquifer found throughout the Polish lowlands, (particularly the Greater Poland region), is intensively coloured 'brown-black' (>120-28000 mgPt/dm^3). Historically, it had been used for generating steam in steam engines, in filling fire extinguishers or for industry as water in heat exchangers, but rarely for agriculture [11, 12, 15]. However, because of the high treatment costs this water is uneconomical for human consumption as for example as drinking water. The water's discolouration is due to humus compounds, mainly humic acids, which are particularly present in peat, lignite and soil as well as some surface waters. In peat treatments, these substances form a significant part of the organic component. Their large presence arises from their biochemical properties [10, 13, 18] and as such, constitute the treatment's active ingredients because of their antioxidant, antibacterial and astringent actions along with physicochemical properties of adsorption, complexation and ion exchange. Fulvic, hymatomelanic and humic acids are the main humus substances that are bioavailable and bioactive at their appropriate concentrations and chemical form, particularly if soluble [6]. Studies have shown that water is a natural solvent for humus substances as well as those linked to minerals. Early work on the pharmacodynamics and chemistry of Miocene water from Braczewo [1, 2] has indicated the potential for exploiting the biochemical properties of such water.

The study aim was to thus determine the composition of minerals and organic material in chosen 'brown--black' water samples obtained from Miocene aquifer waters and evaluate the results according to criteria set/judged for waters to be therapeutic [20].

MATERIALS AND METHODS

Subject material were 4 samples of 'brown-black' underground waters from Miocene aquifer taken at different locations in the Greater Poland region; Obrzycko and Braczewo (both by Szamotuly), Sepno (by Koscian) and in Poznan (Szkolna Street). Subsequent analyses consisted of determining the following;

a) Physicochemical and organoleptic properties.
b) The contents of basic minerals, specific therapeutic substances and humus acids which included humic, fulvic and hymatomelanic acids along with total organic carbon.

Where the following analytical techniques were employed;

- A multifunctional CX-701 (Elmetron) electrometric analyser using a PT-100 temperature sensor (Elmetron) and electrodes for the following measurements: pH (ERH-Hydromet), electric conductivity (EC-60-Elmerton), redox potential (EPtAgP-323W-Eurosensor), fluoride (ion selective fluoride Orion 9609BNWP-Thermo) and iodides using an ion selective iodide-(Detektor) electrode of the RL-100 -Hydromet.
- Spectrophotometry (U-1800-Hitachi) for determining colour, iron, metasilicic acid and absorbances at A_{465}, A_{665}.
- Total organic carbon (TOC) using the TOC-V_{CSH} (Shimadzu) analyser.
- Sodium and potassium by the BWB-XP 2011 flame photometer.
- Gravimetric method for measuring sulphates and humus acids (after precipitation and drying).
- Complexometric titration for determining calcium, magnesium, argentometric titration for chloride and acidimetric titration for bicarbonate.

From the test samples, humus acid fractions of fulvic acid, humic acid and hymatomelanic acid were first isolated by selective solvent extraction (acid, alcohol, base) followed by obtaining their spectra between 200-800 nm. The precise extraction procedure and spectrophotometry are detailed elsewhere [2], where for the latter, quartz cuvettes were used at a path length of 1cm and scan rate of 800nm/min. The spectra were then subjected to Savistky-Golay spectral smoothing followed by 4th derivative numerical differentiation. Specific humus acids were identified by their absorption peaks from a comparison with humus acid standards (from Fluka) at a concentration of 1g/dm^3 [7].

RESULTS AND DISCUSSION

The basic physico-chemical and organoleptic properties of test samples are presented in Table 1 (ie. colour, redox potential, pH, conductivity and absorbance at 465 and 665 nm).

Table 1. Some physico-chemical features of the tested miocene waters

Water source	Colour [mg Pt/dm^3]	Redox potential [mV]	pH	Conductivity [μS/cm]	Absorbance (λ)	
					465 nm	665 nm
Obrzycko	28 000	- 142.5	7.70	1986	3.399	0.928
Braczewo	3 500	- 126.6	7.49	1863	1.667	0.394
Sepno	3 500	- 231.7	7.33	810	1.042	0.267
Poznan	4 100	- 84.9	7.31	1024	1.485	0.365

The hydro-geochemical redox potential (E_h) conditions prevailing in the Miocene water aquifer were found to be reducing and ranged from 7.0 (Sepno) to 11.8 (Poznan), [16]. An indicator of humification has been taken as the absorbance ratio A_{465}/A_{665} [14, 17] and was determined as being 3.66 (Obrzycko), 4.23 (Braczewo), 4.08 (Poznan) and 3.90 (Sepno). Ratio values < 5 are considered to show that the aromatic centres of humus acids therein have a high degree of condensation, with cyclic structures predominating over aliphatic chains [3, 4, 19, 21].

Table 2 shows the cationic and anionic contents, as well as other the specific therapeutic compounds.

Table 2. Test water content of cations, anions and specific therapeutic compounds.

Water source	Cations and anions							Specific therapeutic compounds			
	Concentration [mg/dm³]										
	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	HCO_3^-	SO_4^{2-}	$Fe^{2+/3+}$	F^-	I^-	H_2SiO_3
Obrzycko	408.2	7.14	71.1	7.90	452.0	617.5	< 1.0	22.71	1.32	0.08	12.5
Braczewo	406.5	6.14	27.1	9.11	407.7	520.8	< 1.0	2.15	1.41	0.09	14.2
Sepno	242.5	5.02	29.1	11.5	214.8	451.0	< 1.0	13.02	1.36	0.08	11.2
Poznan	188.9	5.11	43.2	10.9	241.0	311.4	< 1.0	2.85	0.71	0.09	23.6

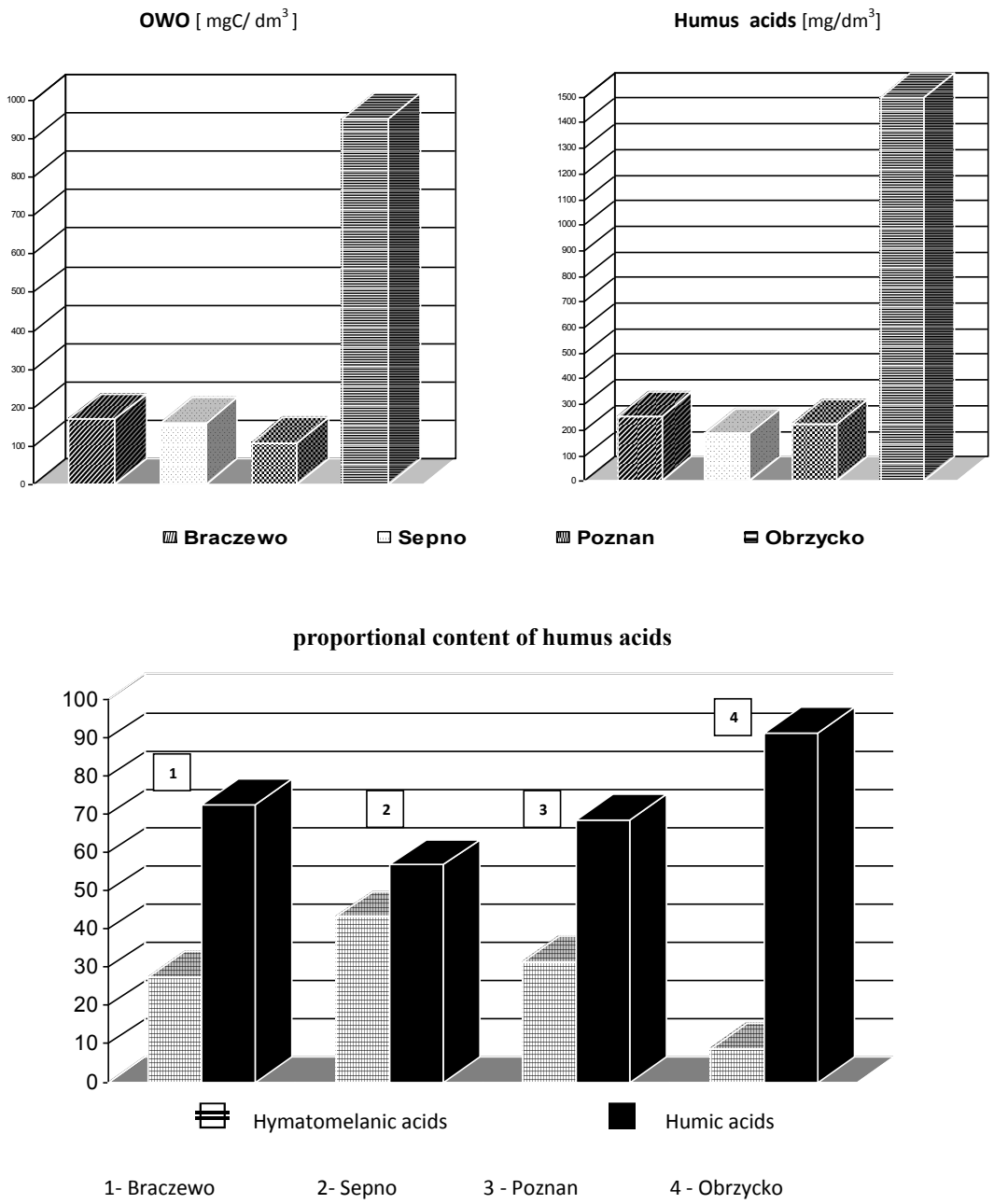

Figure 1. The proportional TOC content and content of humus acids divided into their respective fractions (hymatomelanic acid, humic acid) in test waters

The tested water was found to belong to the HCO_{3-}-Cl-Na type with levels of minerals in general being 0.16% (Obrzycko), 0.14% (Braczewo), 0.10% (Sepno) and 0.08% (Poznan). Of the other specific therapeutic compounds, fluoride had the highest concentrations, ranging from 0.71 mg/dm^3 (Poznan) to 1.41 mg/dm^3 (Braczewo) but was below the 2 mg/dm^3 limit. Significant amounts of iron (II) were found in Obrzycko (22.7 mg/dm^3) and Sepno (13.0 mg/dm^3) compared to therapeutic standard levels of 10.0 mg/dm^3. Iodide concentrations lay between 0.08 to 0.09 mg/dm^3. The content of humus acids divided into their respective fractions (hymatomelanic acids, humic acids and TOC) are presented in Figure 1.

Humus acids were measured as being between 188.6 mg/dm^3 (Sepno) to 1501.8 mg/dm^3 (Obrzycko). All samples

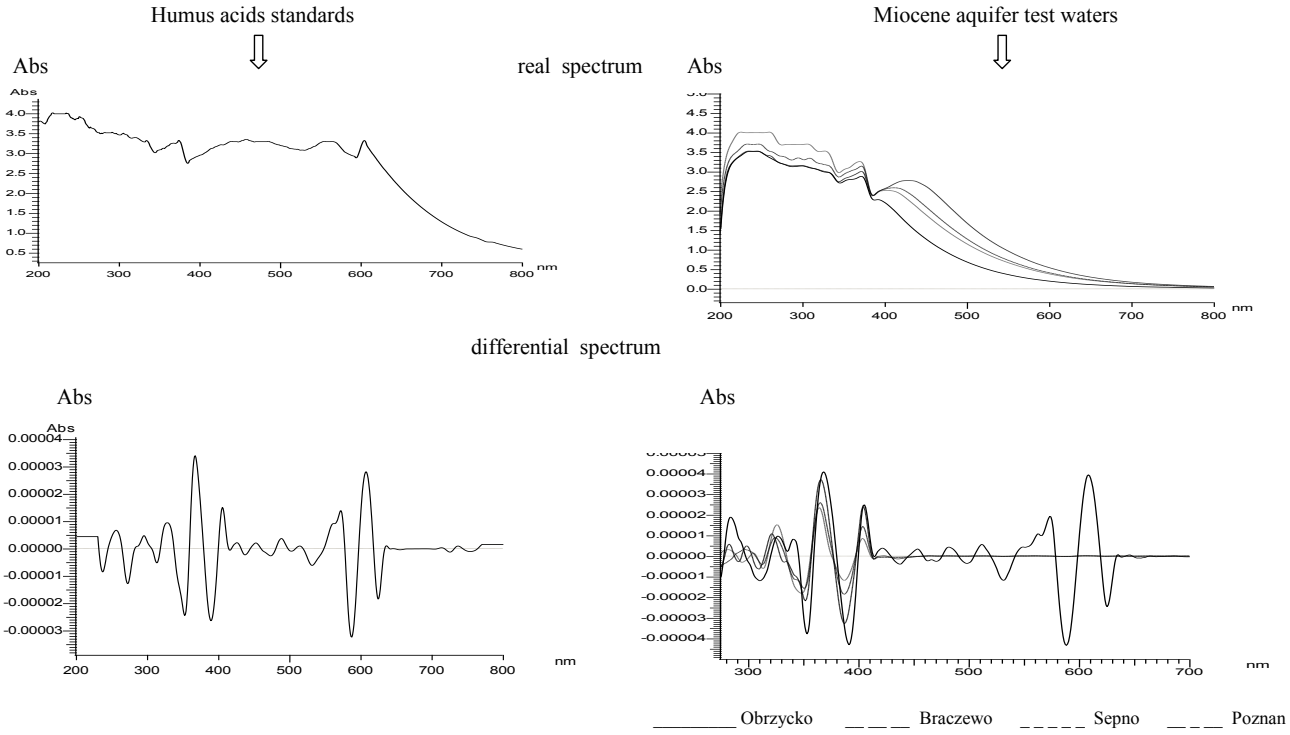

Figure 2. Real and differential absorptive spectra of humus acids standards and brown-black humus waters

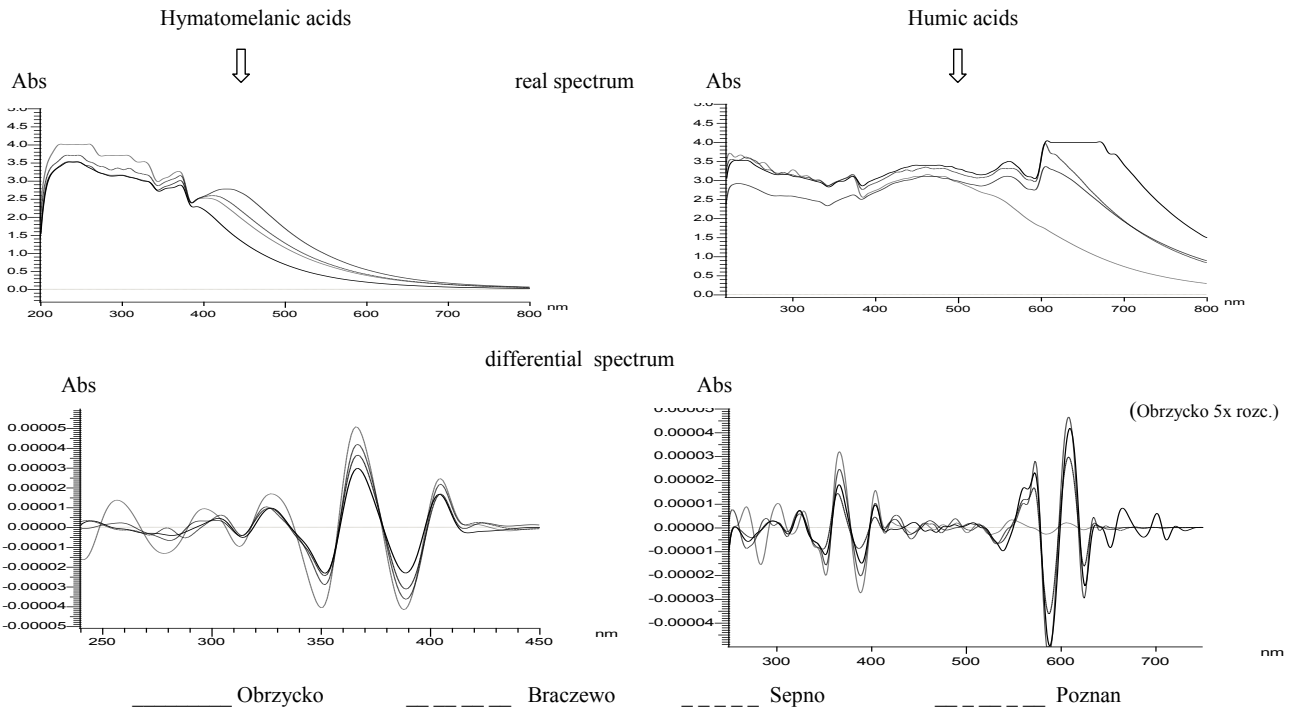

Figure 3. Real and differential absorptive spectra of hymatomelanic and humic acids isolated from Miocene aquifer test waters

demonstrated a clear predominance of humic acids over hymatomelanic acids ranging from 1.3-fold in Sepno to 10.6-fold in Obrzycko. Fulvic acids were however absent.

Real and differentiation absorption spectra for humus acid standards are presented in Figure 2, whilst those for humus acids isolated are shown in Figure 3.

It was found that the absorption spectra for 'brown--black' waters are similar to the humus acid standards and to those substances present in peat [5, 7]. These similarities are first evident in the curve shape of actual spectra, with absorbance decreasing monotonically with increasing wavelength around from the transition area between the UV to the visible range. Secondly in the differentiated spectra, where the absorption peaks characteristic of specific humus acids were in both cases similar. Furthermore, when the test waters were heated to 80 °C there was no precipitation observed (including any of the humus acids).

In summing up it should be noted that our earlier studies touted the possibility of using some Miocene waters for Health-Spa baths in conjunction with waters containing sulphides and bisulphates. Their use in manufacturing cosmetics containing humus acids was also considered [9].

CONCLUSIONS

1. Sampled underground test waters from Poznan, Sepno, Obrzycko and Braczewo have a chemical composition that indicate a use in balneotherapy (mainly through mineral baths and body cavity irrigation) as well as in cosmetics and agriculture
2. Findings could be used to support an additional type of classification for therapeutic waters; a novel kind which contains at least 50 mg/dm^3 of humus acids.

Conflict of interest

The authors declare no conflict of interest.

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lenia właściwości leczniczych naturalnych surowców leczniczych właściwości leczniczych klimatu, kryteriów ich oceny oraz wzoru świadectwa potwierdzającego te właściwości (Dz. U. Nr 80 poz. 565).

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PROFILES OF SELECTED NUTRIENTS AFFECTING SKIN CONDITION IN CHILDREN WITH ATOPIC DERMATITIS

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ABSTRACT

Background. Atopic dermatitis (AD) is a chronic inflammation of the skin recognised to be one of the first clinical signs of allergy. In the first years of life, epidemiological evidence has demonstrated that common causative foods of a child's diet are: cow's milk, hen's eggs, wheat and soya. Children with AD being treated with elimination diets are at risk of nutritional deficiencies that include those nutrients required for ensuring proper skin structure and function.

Objective. The aim of the study was to assess dietary intake of nutrients which affect skin condition in children with AD being treated with a milk-free diet.

Materials and Methods. Subjects were 25 children aged 4-6 years with AD undergoing the milk exclusion diet and 25 age-matched healthy controls. The energy and nutritional value of diets were evaluated that included those components affecting skin condition; ie. vitamins A, D, E, B_2 and C; minerals iron (Fe) and zinc (Zn); polyunsaturated fatty acids (PUFAs). The Dieta 5.0 programme was used for dietary assessment and outcomes were then related to dietary recommendations.

Results. There were no significant differences between groups in mean energy values and mean intakes of protein, fats and carbohydrates ($p>0.05$). The percentage of subjects with low energy value were 44% and 36% in respectively Groups I and II. Deficiencies of fat intake were observed in 60% in Group I and 44% in Group II. There were however no risks in the dietary intakes of protein, carbohydrate, vitamins A, B_2 and C nor of Fe and Zn. Deficiencies of dietary intakes were observed in respectively Groups I and II in the following; vitamin E (24% vs 64%), vitamin D (36% vs 92%), linoleic acid (36% vs 72%), α-linolenic acid (36% vs 40%) and long chain PUFAs (96% in both groups).

Conclusions. Ensuring recommended dietary supply of those nutrients affecting skin condition is required for both groups of children. Children with AD had better balanced diets in respect of the studied nutrients that may reflect the influence of continuous healthcare received from physicians and dieticians.

Key words: *atopic dermatitis, children, cow's milk allergy, dietary intake, nutrients*

STRESZCZENIE

Wprowadzenie. Atopowe zapalenie skóry (AZS) to przewlekła choroba zapalna skóry będąca jedną z pierwszych manifestacji klinicznych alergii. Z danych epidemiologicznych wynika, że pokarmami, które najczęściej uczulają dziecko w pierwszych latach życia są: mleko krowie, jajo kurze, pszenica i soja. Dzieci z AZS leczone dietą eliminacyjną znajdują się w grupie ryzyka wystąpienia niedoborów pokarmowych, w tym także niedoborów składników niezbędnych do prawidłowej budowy i funkcjonowania skóry.

Cel badań. Ocena spożycia wybranych składników odżywczych wpływających na stan skóry przez dzieci z atopowym zapaleniem skóry leczonych dietą bezmleczną.

Materiał i metody. Badaniami objęto 50 dzieci w wieku 4-6 lat. Grupę I (n=25) stanowiły dzieci z AZS leczone dietą bezmleczną, grupę II – kontrolną (n=25) dzieci zdrowe. Oceniono wartość energetyczną i odżywczą ich diet, w tym podaż składników wpływających na stan skóry: witamin A, D, E, B_2 i C, składników mineralnych: Fe, Zn oraz niezbędnych nienasyconych kwasów tłuszczowych. Do oceny diet wykorzystano program żywieniowy Dieta 5.0, a uzyskane wyniki odniesiono do zaleceń żywieniowych.

Wyniki. Diety obu grup nie różniły się istotnie pod względem średniej wartości energetycznej oraz średniego spożycia białka, tłuszczu i węglowodanów ($p>0.05$). Odsetek dzieci o niskiej, w stosunku do normy, podaży energii w grupie z AZS i kontrolnej wyniósł odpowiednio 44% i 36%. U 60% dzieci z grupy I i u 44% z grupy II zaobserwowano niedoborowe spożycie tłuszczu. Nie stwierdzono ryzyka niedoboru białka, węglowodanów, witamin A, B_2, C oraz żelaza i cynku. Zaobserwowano deficyty spożycia: witaminy E (u 24% dzieci z AZS vs 64% w grupie kontrolnej), D (u 36% dzieci z AZS vs 92% w grupie kontrolnej), kwasu linolowego (u 36% dzieci z AZS vs 72% w grupie kontrolnej) i α-linolenowego (u 36%

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dzieci z AZS vs 40% w grupie kontrolnej) oraz długołańcuchowych wielonienasyconych kwasów tłuszczowych – u 96% dzieci w obu grupach.
Wnioski. Konieczne jest zapewnienie prawidłowej podaży niedoborowych składników wpływających na stan skóry w dietach obu grup dzieci. Diety dzieci z AZS były lepiej zbilansowane pod względem większości ocenianych składników odżywczych, na co wpływ mogła mieć stała opieka zarówno pediatry jak i dietetyka.

Słowa kluczowe: *atopowe zapalenie skóry, dzieci, alergia na białka mleka krowiego, dieta bezmleczna, składniki odżywcze*

INTRODUCTION

Atopic dermatitis (AD) is a chronic, relapsing inflammatory skin condition which constitutes one of the first clinical signs of allergy [16]. Recent years have witnessed a significant increase of AD cases [8, 33]. Studies also show that 2-3% of all children up to 3 years are affected by this condition. AD's aetiology arises from multiple factors. Major roles in its development are played by having a genetic predisposition, immunological disorders, epidermal barrier disruption and an abnormal skin reaction towards environmental factors [29].

For young children in particular, the allergic effects of foods in the pathogenesis of AD have been debated over many years. Epidemiological evidence has most frequently pointed to cow's milk, hen's eggs, wheat and soya as being the main culprit allergens during the first years of life [7]. Children with AD being treated with elimination diets are a group at risk of dietary deficiencies, including those nutrients responsible for "healthy" skin development and function such as some of the water- and fat- soluble vitamins: C, B_2 and A, D, E, respectively, along with certain minerals like Fe, Zn, Se, Cu and polyunsaturated fatty acids (PUFAs) of the n-3 and n-6 groups. The latter includes long chain polyunsaturated fatty acids (LCPUFAs); mainly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

Thus, ensuring an adequate supply of these nutrients may ameliorate the course of AD, together with its clinical symptoms. The presented work is thereby focused on analysing AD children's nutrition who are being treated with a milk-free diet; taking into consideration dietary intakes of those nutrients which are responsible for skin condition according to recommended dietary standards.

MATERIAL AND METHODS

Subjects were n=25 children (Group I), aged 4-6 years diagnosed with cow's milk allergy (CMA) suffering from AD, who were being treated with milk free-diet. All these subjects had been under the medical and dietetic care in the Gastroenterology Outpatient Clinic at the Warsaw Institute of Mother and Child. The controls, Group II (n=25) consisted of healthy children on traditional diet. According to the dietary assessment methodology [4, 10], the daily food rations (DFR) of children were estimated on the basis of 3 days record, randomly chosen from the dietary records (including one holiday), using the "Photograph Album of Food and Dishes" [28]. The energy and nutritional value of DFR was calculated using nutritional Dieta 5.0 programme [31].

Mean dietary intake of selected nutrients that affected skin condition was determined for vitamins C, B_2, A, D and E, minerals Fe and Zn as well as PUFAs from the n-3 and n-6 families in both subject groups and related to recommended dietary intake standards [12]. The proportions of children falling below the EAR (Estimated Average Requirement) and AI (Adequate Intake) were evaluated in both groups.

Nutritional status was assessed by Body Mass Index (BMI) which was standardised according to growth charts for Warsaw children [22] to obtain BMI z-scores independent of gender and age. Due to the fact that measured variables were not normally distributed, the *Mann-Whitney* U Test was used to assess the significance of differences between the studied groups using defined parameters of nutritional status and diet. A $p<0.05$ level was adopted as being significant. The analyses were performed by the Statistica 10 PL package.

RESULTS

The median, and mean age ± standard deviation (SD) for Group I subjects were 3.3; 3.5±1.7 years and

Table 1. Characteristics of study groups

Variables	Group I (n=25)			Group II (n=25)			P values (*Mann-Whitney* U test)
	Mean	SD	Median	Mean	SD	Median	ns
Age (years)	3.5	1.7	3.3	4.3	2.0	3.4	ns
Body weight (kg)	16.1	4.3	14.9	15.9	4.7	15.5	ns
Height (cm)	101.0	12.7	101.5	101.8	14.9	104.0	ns
BMI (kg/m^2)	15.6	1.5	15.6	15.1	1.6	14.6	ns
BMI z-score	-0.4	0.9	-0.5	-0.6	1.1	-0.9	ns

ns –statistically nonsignificant

3,4; 4.3±2.0 years in the Group II controls; this difference being nonsignificant (p>0.05). Likewise, mean body weight, height and BMI were not significantly different between the study groups. Nutritional status in all subjects can be considered as normal. The mean BMI z-score for Group I children being -0.4±0.9 whilst that for controls was -0.6±1.1. Subjects' age, anthropometric traits and indices are presented in Table 1.

The nutritional profiles in the diets in both groups of children were not significantly different for mean intakes of energy and macro-nutrients; protein fats and carbohydrates (p>0.05). The percentage of children with low caloric intakes compared to EAR were respectively 44% and 36% in Groups I and II. Deficiencies in fat intakes were observed in respectively 60% and 44% in Groups I and II. There was no risk of intake deficiencies seen for protein and carbohydrates (Table 2).

were found to be several – fold lower than those recommended, with lowered AI values in 96% of children from both study groups (Table 2).

Most of the dietary LA and ALA in both groups came from vegetable fats, whereas LCPUFAs were derived from meat, poultry, fish and eggs (Table 3).

The children's diet in both study groups covered the nutritional requirements for vitamins A, B_2 and C, with mean intakes of riboflavin being significantly lower (p<0.05) in Group I compared to Group II (Table 2). The main dietary sources of vitamins A and C in both groups were vegetables and juices along with extensively hydrolysed whey/casein formulas for the AD group and growing up milk, cow's milk and dairy products for the controls. Vitamin B_2 intake originated from extensively hydrolysed whey/casein formulas for children with AD and milk and dairy products including

Table 2. Dietary intakes of selected nutrients in respect of Polish nutritional recommendations 2012 [12] in children with AD (group I) and healthy controls (group II)

Energy /Nutrients	Group I			Group II			P values (*Mann-Whitney* U test)	EAR/AI*	Percentage of intakes below EAR/AI	
	Mean	SD	Median	Mean	SD	Median			Group I	Group II
Energy (kcal)	1235.8	347.1	1251.9	1308.2	392.3	1255.0	ns	1400 kcal	44%	36%
Protein (g)	43.1	17.7	36.7	49.8	20.8	46.5	ns	16 g	0%	0%
Fat (g)	42.1	13.9	41.0	48.5	18.0	43.8	ns	54 g	60%	44%
Cholesterol (g)	142.0	106.3	120.2	209.5	118.6	176.8	0.02	-	-	-
Polyunsaturated fatty acids (g) (PUFAs)	6.9	4.0	7.0	5.8	3.6	4.7	ns	-	-	-
Linoleic acid (LA) (g)	7.1	3.5	6.6	4.9	3.2	4.1	0.006	4% Energy*	36%	72%
α-linolenic acid (ALA) (g)	1.0	0.6	0.8	0.9	0.4	0.8	ns	0.5% Energy*	36%	40%
LCPUFAs (g)	0.04	0.06	0.02	0.07	0.18	0.03	ns	0.25 g	96%	96%
n-6:n-3 ratio	7.7	3.5	7.3	6.3	4.4	4.7	0.03	-	-	-
LA:ALA ratio	8.0	3.8	7.8	6.6	4.4	4.6	0.054	-	-	-
Total carbohydrates (g)	182.5	59.7	164.4	176.7	55.6	170.4	ns	130 g	--	-
-including those digestible (g)	169.3	54.4	152.0	166.6	51.8	164.0	ns	100 g	4%	8%
Iron (mg)	9.6	3.6	9.2	7.5	2.9	6.5	0.04	4 mg	0%	0%
Zinc (mg)	6.5	2.2	6.2	6.0	1.7	5.8	ns	4 mg	0%	0%
Vitamin A (µg)	1256.4	988.2	988.1	830.7	428.8	759.6	ns	300 µg	4%	0%
Vitamin E (mg)	8.6	3.3	7.3	5.5	2.4	5.3	0.0004	6 mg*	24%	64%
Vitamin D (µg)	5.8	3.0	5.7	2.8	2.6	2.1	0.0001	5 µg*	36%	92%
Vitamin B_2 (mg)	1.0	0.3	0.9	1.2	0.5	1.2	0.008	0.5 mg	0%	0%
Vitamin C (mg)	91.3	55.9	76.2	77.8	50.6	67.1	ns	40 mg	4%	4%

EAR – Estimated Average Requirement; AI – Adequate Intake; LCPUFA Long chain polyunsaturated fatty acids; ns – statistically non-significant

Children's dietary PUFAs levels demonstrated that recommended intakes of linoleic acid (LA) and α-linolenic (ALA) acid were not being met by 36% of the children with AD (Group I). The median, and mean dietary intakes ± standard deviation (SD) of LA in Group I and Group II were 6.6; 7.1±3.5 g and 4.1; 4.9±3.2 g, respectively. Furthermore, 72% of the control group children did not meet the AI levels for linoleic acid. Mean dietary intakes of LCPUFAs in the children

growing up milk for controls and was also provided to both groups from meat, poultry and cereals (Table 3).

Both groups demonstrated deficient intakes of the fat soluble vitamins E and D. When comparing median, and mean intakes ± standard deviation (SD) of these vitamins in Groups I and II, the following results were respectively observed: 7.3; 8.6±3.3 mg vs 5.3; 5.5±2.4 mg for vitamin E, 5.7; 5.8±3.0 µg vs 2.1; 2.8±2.6 µg for vitamin D, 24% vs 64% children below the recommended

Table 3. Sources, (expressed as percentage), of those selected nutrients affecting skin condition in diets of children from Group I and Group II (controls)

Nutrient	Study group	Cereals (calculated as flour)	Potatoes	Vegetables, fruit, seeds, juices and beverages	Milk & dairy products/ extensively hydrolysed whey/casein formulas	Meat, cold meats, poultry, eggs, fish	Fats	Others
Iron	I	**18.9%** Flour, pasta, groats, rice 12%, bread 4%, cereal flakes 2%	**3.3%**	**22.8%** Vegetables 9%, fruit 5%, juices 3%, legumes 6%	**35.0%** Extensively hydrolysed whey/casein formulas 35%	**18.0%** Meat, poultry 9%, cold meats 5%, eggs 4%	**0.3%**	**1.7%**
	II	**30.1%** Flour, pasta, groats rice 10%, bread 9%, cereal flakes 12%	**3.6%**	**21.8%** Vegetables 7%, fruit 7%, juices 5%, legumes 3%	**16.3%** Growing up milk 12%, milk and dairy products 4%	**22.6%** Meat, poultry 8%, cold meats 6%, eggs 8%	**0.4%**	**5.2%**
Zinc	I	**17.9%** Flour, pasta, groats, rice 11%, bread 6%	**3.2%**	**16.7%** Vegetables 8%, fruit 3%, legumes 4%	**28.7%** Extensively hydrolysed whey/casein formulas 28,7%	**31.8%** Meat, poultry 20%, cold meats 7%, eggs 4%	**0.2%**	**1.5%**
	II	**17.7%** Flour, pasta, groats, rice 8%, bread 9%	**2.7%**	**11.7%** Vegetables 5%, fruit 3%, legumes 2%	**32.2%** Growing up milk 12%, cheeses, cream cheeses 10%, milk 9%	**31.7%** Meat, poultry 14%, cold meats 9%, eggs 8%	**0.2%**	**3.9%**
Vitamin A	I	**1.5%**	**0.0%**	**68.4%** Vegetables 47%, juices 20%	**19.0%** Extensively hydrolysed whey/casein formulas 19%	**6.1%** Eggs 4%, cold meats 2%	**5.0%** Margarine 4%, butter and cream 1%	**0.0%**
	II	**1.4%**	**0.1%**	**56.8%** Vegetables 38%, juices 17%	**19.3%** Growing up milk 8%, milk 6%, cheeses, cream cheeses 5%	10.2% Eggs 9%, Cold meats 1%	12.2% Margarine 6%, butter and cream 6%	0.0%
Vitamin E	I	**5.3%**	**0.4%**	**19.5%** vegetables 10%, fruit 7%, juices 2%	**29.9%** Extensively hydrolysed whey/casein formulas 29.9%	**5.0%**	**39.8%** Oils 24%, margarine 15%	**0.1%**
	II	**9.5%**	**0.4%**	**22.8%** vegetables 11%, fruit 6%, nuts 3%	**12.5%** Growing up milk 8%, milk and dairy products 4%	**8.8%**	**45.8%** Oils 23%, margarine 20%	**0.2%**
Vitamin D	I	**5.1%**	**0.0%**	**0.4%**	**69.1%** Extensively hydrolysed whey/casein formulas 69.1%	**15.2%** Meat, poultry, cold meats 8%, eggs 5%, fish 2%	**8.3%** Margarine 8%	**1.9%**
	II	**5.0%**	**0.0%**	**1.0%**	**41.5%** Growing up milk 37%	**34.7%** Meat, poultry, cold meats 15%, eggs17%, fish 3%	**17.7%** Margarine 16%, butter and cream 2%	**0.0%**

Vitamin B_2	I	**10.3%** Flour, pasta, groats, rice 6%, cereal flakes 2%, bread 2.5%	**2.9%**	**19.3%** Vegetables 9%, fruit 7%	**30.7%** Extensively hydrolysed whey/casein formulas 28%	**30.8%** Meat, poultry, cold meats 21%, eggs 9%	**0.3%**	**5.5%**
	II	**14.5%** Flour, pasta, groats, rice 4%, cereal flakes 7.5%, bread 3%	**1.8%**	**11.5%** Vegetables 4%, fruit 5%	**45.9%** Milk 23%, cheese, cream cheese 14%, growing up milk 6%	**24.6%** Meat, poultry, cold meats 13%, eggs 12%	**0.4%**	**1.3%**
Vitamin C	I	**3.1%**	**8.7%**	**55.6%** Vegetables 28%, fruit 18%, juices 10%	**22.2%** Extensively hydrolysed whey/casein formulas 22%	**0.1%**	**0.0%**	**10.2%** Enri-ched food
	II	**4.8%**	**8.2%**	**76.2%** Vegetables 21%, fruit 29%, juices 26%	**10.2%** Growing up milk 7%, milk, yoghurt 3%	**0.1%**	**0.0%**	**0.5%**
PUFAs	I	**10.9%** Flour, pasta, groats, rice 5%, bread 5%	**0.5%**	**14.4%** Vegetables, fruit 5%, legumes 8%	**0.1%**	**16.5%** Meat, poultry, cold meats 14%, eggs 2%	**57.4%** Oils 33%, margarine 24%	**0.1%**
	II	**15.8%** Flour, pasta, groats, rice 5%, bread 9%	**0.5%**	**10.3%** Vegetables, fruit 4%, legumes3%, nuts, seeds 3%	**7.1%**	**20.8%** Meat, poultry, cold meats 16%, eggs 4%	**45.0%** Oils 24%, margarine 19%	**0.4%**
LCPUFAs	I	**3.6%**	**0.0%**	**0.0%**	**0.0%**	**96.4%** Meat, poultry, cold meats 22%, fish 47%, eggs 27%	**0.0%**	**0.0%**
	II	**2.1%**	**0.0%**	**0.0%**	**0.0%**	**97.8%** Meat, poultry, cold meats 14%, fish 54%, eggs 29%	**0.1%**	**0.0%**
LA	I	**9.8%** Flour, pasta, groats, rice 4,5%, bread 4,5%	**0.4%**	**11.3%** Vegetables, fruit 3%, legumes 7%	**16.8%** Extensively hydrolysed whey/casein formulas 16,8%	**13.3%** Meat, poultry, cold meats 11%, eggs 2%	**48.2%** Oils 26%, margarine 22%	**0.1%**
	II	**16.8%** Flour, pasta, groats, rice 5%, bread 10%	**0.5%**	**9.9%** Vegetables, fruit 3%, legumes 3%, nuts, seeds 3%	**9.2%** Growing up milk 7%, dairy products 2%	**19.4%** Meat, poultry, cold meats 15%, eggs 4%	**43.8%** Oils 22%, margarine 21%	**0.4%**

ALA	I	**5.1%**	**0.6%**	**18.4%** Vegetables, fruit 9%, legumes 8%	**15.2%** Extensively hydrolysed whey/casein formulas 15%	**9.1%**	**51.6%** Oils 47%, margarine 4%	**0.0%**
	II	**7.9%**	**0.6%**	**12.4%** Vegetables, fruit 8%, legumes 4%	**18.4%** Milk 7%, cheese, cream cheese 7%, growing up milk 3%	**11.5%**	**49.0%** Oils 38%, margarine 8%	**0.2%**
EPA	I	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%** Meat, poultry, cold meats 28%, fish 72%	**0.0%**	**0.0%**
	II	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%** Meat, poultry, cold meats 13%, fish 87%	**0.0%**	**0.0%**
DPA	I	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%** Meat, poultry, cold meats 62%, fish 38%	**0.0%**	**0.0%**
	II	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%** Meat, poultry, cold meats 45%, fish 55%	**0.0%**	**0.0%**
DHA	I	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%** Meat, poultry, cold meats 16%, fish 40%, eggs 44%	**0.0%**	**0.0%**
	II	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**100.0%** Meat, poultry, cold meats 11%, fish 39%, eggs 50%	**0.0%**	**0.0%**

PUFAs– polyunsaturated fatty acids, LCPUFA – long chain polyunsaturated fatty acids, LA – linoleic acid, ALA – α-linoleic acid, EPA -eicosapentaenoic acid, DHA - docosahexaenoic acid, DPA – docosapentaenoic acid.

AI for vitamin E and correspondingly 36% vs 92% for vitamin D. In this respect, a more balanced diet is thereby seen in those children with AD subjected to a milk-free diet (ie. Group I). Significant dietary sources of vitamin E in both child groups were vegetable oils, vegetables and fruit, together with extensively hydrolysed whey/casein formulas for Group I subjects. The main source of vitamin D were extensively hydrolysed whey/casein formulas for Group I subjects and growing up milk in Group II subjects and meat and egg products for both groups (Table 3).

There were no dietary deficiencies seen for Fe and Zn intakes for both groups, although mean Fe intakes were significantly higher in the AD children's group ($p<0.05$) (Table 2). Dietary iron was mainly derived in Group I children from extensively hydrolysed whey/casein formulas, vegetables, fruit, cereals, meat, poultry and eggs, whereas the sources for the healthy controls (Group II) were mainly cereals, meat and its products and eggs (Table 3).

DISCUSSION

The basic method for treating CMA, which exhibits various clinical symptoms including those of AD, is by using milk-free diet. This type of diet is differently tolerated by children, particularly toddlers, that may thereby cause deficiencies in various nutrients to arise and that may include those important for a 'healthy' condition of the skin.

Amongst the many studies on atopic skin inflammation, only a few are focused on the intake of those dietary nutrients that are beneficial for skin condition. Of these, two studies [14, 20] showed lower energy values of diets in pre-school children with AD. In our study we found that mean daily energy intakes in 44% of AD children were lower than the EAR standards, which was linked to a lowered dietary fat intake in 60% children; a finding being adverse to health as this constitutes building block components vital for all cells, including skin cells.

Another important building block component for skin cells are amino acids originating from dietary proteins. Some are used in synthesising collagen or horn structures eg. keratins or elastins. The current study showed that the mean protein intake in children with AD significantly exceeded the EAR. Similar findings were observed by *Buczek* et al. [1], *Gołębiowska-Wawrzyniak* et al. [9] and *Paganus* et al. [21] in groups of children suffering from CMA. Similarly, the higher than recommended protein intakes of the presented study in the healthy children group is also in accordance with other studies [9, 30, 32].

Several dietary vitamins and minerals are necessary for skin cell growth and differentiation and are also required for skin regeneration and protection against harmful oxygen free radicals. Recent years have also witnessed greater awareness in the health benefits of anti-oxidants where, for example, they enhance the immune system especially in times of stress and so reduce disease risk. Studies by *Kim* et al. [14] and *Oh* et al. [20] have suggested that an adequate supply of dietary antioxidants may decrease the risk of atypical skin inflammation whilst also pointing out the existence of dietary deficiencies in the antioxidant vitamins A and C in children suffering from AD. Vitamin C is necessary for the normal construction of fibrous tissue for the skin. The dietary content of vitamins A and C found for the studied children with AD agreed with recommendations. Another dietary component with powerful antioxidant properties is vitamin E where it has been shown that high intakes reduce AD incidence. Furthermore, some authors consider that determining dietary vitamin E content is a better indicator of AD risk than measuring serum vitamin E concentrations [20]. The benefits of vitamin E in AD are, amongst others, its effect on the integrity of intercellular connections. This vitamin prevents membrane damage in cells making up skin through protecting cellular lipids, including PUFAs, from oxidation [34]. The current study however shows dietary intakes deficient in vitamin E for both children with AD and the healthy controls.

Ever more frequently, attention is focusing on the action of n-3 fatty acids, particularly the LCPUFAs in preventing or treating AD. It is also stressed that low intakes of PUFAs contribute towards the development of atopic diseases that include AD [5]. The role of n-3 fatty acids are important as anti-inflammatories [25]. They decrease the severity of skin inflammation helping to reconstruct the lipid mantle of the skin and thereby setting in order its protective physiological function. EPA is considered to be mainly responsible for the anti-inflammatory action competing with arachidonic acid (AA) in leukotrienes and prostaglandin formation, however DHA also possesses potential anti-inflammatory and immunomodulatory action [11]. Indeed, the beneficial effects of DHA supplementation on reducing inflammatory reactions have been proven [15, 18]. In the presented study, the dietary intakes of both child groups were found to be deficient in LCPUFAs as well as for PUFAs. The reason for this being a low consumption of marine fish, fish oils and seafood ('fruits of the sea'). In the AD child group, such behaviour arose from the concern that children might also demonstrate an allergic response to the fish protein parvalbumin allergen [23]. Low PUFAs intakes in AD children due to low consumption have also been observed by *Dunder* et al. [6].

For the healthy controls, it would seem that the low fish consumption merely reflects incorrect dietary practice.

In the development of atopic diseases, it is now recognised that the role of pro-inflammatory fatty acids of the n-6 group feature prominently, especially if there is an abnormal ratio with the n-3 ones [5, 15, 17, 19, 27]. According to *McAnulty* et al. [19] the correct PUFA n-6/n-3 ratio in traditional diets should vary between 1:1 to 2:1, however according to *Simopoulous* [27] this ratio should range between 2:1 to 3:1 to enable inflammation to become reduced. These findings are important when considering the fact that over recent years the dietary consumption of PUFAs in Europe has risen, but only for the n-6 ones [2, 6, 19, 27]. Many studies have also shown the n-6/n-3 ratio to now be abnormal, even rising up to 20:1 [19, 27].

The current study demonstrates that the ratios of n-6 to n-3 and LA to ALA in the Group I and healthy controls were 7.3:1 vs 4.7:1 and 7.8:1 vs 4.6:1, respectively. Current recommended dietary standards in Poland (2012) [12] provide reference values neither for the n-6/n-3 ratio nor for LA to ALA, where it is argued by expert opinion that the competition between these acids/family of acids for the same metabolic enzymes precludes defining a reference for their relative proportions. Earlier reference standards from 2008 in Poland [13] nevertheless defined the n-6 to n-3 and LA to ALA as ranging from 5:1 to 10:1. From dietary recommendations in 2001 [34], the optimal n-6 to n-3 ratios for fatty acids for children and adults ranged 4:1 to 6:1.

Vitamin D is an example of a fat soluble vitamin performing multi-functional roles. In addition to its effects on bone metabolism, it demonstrates immunomodulatory and indirect anti-bacterial action. Such effects may be particularly beneficial to children suffering from AD. This study showed deficient intakes of this vitamin for both groups. Nonetheless, it is worth noting that those with AD had a twofold higher dietary intake of vitamin D compared to the healthy controls and that the proportion of children with AD showing dietary intake deficiency of vitamin D was almost threefold lower compared to controls. Dietary deficiencies of vitamin D intakes in both, children allergic to cow's milk protein and healthy children were also observed by *Gołębiowska-Wawrzyniak* et al. [9]. Other studies by *Weker* et al. [32] and *Charzewska* and *Weker* [3] also showed Vitamin D deficiencies in the diets of Polish children aged 1-3 years and 4 years. The potentially beneficial effects of vitamin D for children suffering from AD is supported by *Rowicka* and *Riahi* [26] study who found lower serum concentrations of 25(OH)D (25-hydroxy vitamin D) in children with AD than healthy children, where in the former those with acute AD had the lowest 25(OH)D concentrations. Similar results were recorded by *Peroni* et al. [24].

An adequate dietary intake of Fe and Zn for children with allergies may be advantageous for immune system cells responsible for developing AD inflammation and for decreasing intestinal absorption of nutrients in those suffering from this condition. Such intakes are also vital in correct keratin formation and in preventing dry skin, which for AD sufferers is very relevant. AD children treated with a milk exclusion diet are vulnerable to dietary deficiencies of Fe and Zn [9, 14, 20], which is related, *inter alia*, to the inadequate nutritional consumption of some extensively hydrolysed whey/casein formulas [9]. Some children with CMA additionally require excluding veal and beef from their diets; these being rich sources of these minerals. However, the dietary intakes in AD children from the presented study were not deficient in either Fe or Zn, with the main sources being provided by extensively hydrolysed whey/casein formulas and meat products.

The current study highlights the role played by the main nutrients affecting skin condition in children allergic to cow's milk protein as well as in having adequate dietary intakes.

CONCLUSIONS

Our study has identified the need for ensuring an adequate dietary intake of key nutrients responsible for skin condition in children with AD as well as healthy children: vitamins E and D, PUFAs (ie. linoleic and α-linolenic acid and its derivatives) and LCPUFAs (ie. docosahexaenoic acid eicosapentaenoic acid).

Despite the observed deficiencies, the diets of children with AD were better balanced in respect to most of the assessed nutrients, probably due to receiving continuous healthcare from paediatricians and dieticians.

Conflict of interest

The authors declare no conflict of interest.

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DIETARY SOURCES OF LUTEIN IN ADULTS SUFFERING EYE DISEASE (AMD/CATARACTS)

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ABSTRACT

Background. Epidemiological studies indicate that by consuming 6-14 mg lutein daily, the risk of acquiring eye diseases like age-related macular degeneration (AMD) or cataracts becomes reduced. Their symptoms can also by such means be alleviated and treatment improved.

Objectives. To estimate dietary intakes of lutein obtained from foodstuffs and supplements along with determining its main sources in selected groups of adults suffering from eye disease and healthy controls.

Material and Methods. The study was performed in Warsaw and its neighbourhoods during 2008-12. Subjects were 375 adults aged 50-97 years, of whom half had been diagnosed with AMD and/or cataracts; constituting the test group. Dietary intakes of lutein were assessed by Food Frequency Questionnaire Method whilst interview questionnaires assessed the intake of supplements.

Results. Overall, the average dietary intake of lutein from foodstuffs was 2.5 mg daily, with the test group being significantly higher than healthy controls (2.9 vs 2.1 mg daily). Women's intakes were also higher than in men (2.9 vs 2.1 mg daily), as were those possessing higher or secondary education compared to the others with primary or vocational education (2.7 vs 2.3 mg daily). Fresh vegetables were found to be the main dietary sources of lutein that included green leafy vegetables and frozen vegetables, constituting respectively 63% and 13% of the dietary intake. Dietary supplements containing lutein were taken by 109 subjects of whom most had eye disease (over 80%); where the average daily consumption of lutein from this source was 6.5 mg.

Conclusions. For older people, the dietary intake of lutein from foodstuffs may be insufficient to prevent eye disease. Taking daily dietary supplements would thus be indicated to make up such deficiencies of lutein.

Key words: *lutein, dietary intake, foodstuffs, dietary supplements, eye disease, adults*

STRESZCZENIE

Wprowadzenie. Wyniki badań epidemiologicznych wskazują, że spożycie luteiny w ilościach od 6 do 14 mg na dzień zmniejsza ryzyko wystąpienia chorób oczu typu AMD (zwyrodnienie plamki żółtej związanej z wiekiem) oraz zaćmy, jak również łagodzi ich objawy i wspomaga leczenie.

Cel badań. Oszacowanie spożycia luteiny z żywnością i suplementami oraz wskazanie jej głównych źródeł w diecie wybranej grupy osób dorosłych, w kontekście współwystępowania chorób oczu.

Materiał i metody. Badanie przeprowadzono w latach 2008-2012 w Warszawie i okolicach. Badaną grupę stanowiło 375 osób dorosłych w wieku 50-97 lat, przy czym połowa to osoby ze zdiagnozowanymi chorobami oczu tj. AMD i/lub zaćmą. Wielkość spożycia luteiny z produktów spożywczych określono za pomocą metody częstotliwości spożycia zaś z suplementów diety na podstawie wywiadu ankietowego.

Wyniki. Średnie spożycie luteiny z żywności w badanej grupie ogółem wynosiło 2,5 mg/dzień i było istotnie wyższe w grupie osób ze zdiagnozowaną chorobą oczu w stosunku do osób zdrowych (2,9 vs. 2,1 mg/ dzień), u kobiet w stosunku do mężczyzn (2,9 vs. 2,1 mg/ dzień) oraz u osób z wykształceniem średnim lub wyższym niż podstawowym lub zawodowym (2,7 vs. 2,3 mg/ dzień). Głównymi żywieniowymi źródłami luteiny były warzywa świeże, w tym: zielone warzywa liściaste, z których pochodziło łącznie 63% tego związku oraz warzywa mrożone (13%). Stosowanie suplementów diety będących źródłem luteiny zadeklarowało 109 respondentów, przy czym były to głównie osoby z chorobami oczu (80%). Średnie spożycie luteiny z suplementów diety wynosiło 6,5 mg/dzień.

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Wnioski. W grupie osób starszych spożycie luteiny z żywności może być niewystarczające w prewencji chorób oczu. Stąd też, zasadne jest włączenie do ich całodziennej racji pokarmowej suplementów diety będących źródłem luteiny w celu wyrównania jej niedoborów.

Słowa kluczowe: *luteina, spożycie, żywność, suplementy diety, choroby oczu, osoby dorosłe*

INTRODUCTION

Lutein is one of the most important xanthophylls found in the human body and possesses the unique feature of being able to accumulate in the eyeball, especially the lens and macula. Due to its antioxidant and photo-protectant properties, it shields the eye from oxidative changes and degeneration as well as affording the human body protection against the development of various chronic diseases [1, 3, 16, 23]. Because lutein cannot be synthesised by the human body, a sufficient intake from the diet is essential; whether from foodstuffs or supplements. Many studies have demonstrated that serum lutein concentrations are related to its dietary intake [4, 15, 22]. Furthermore, high lutein tissue levels is a contributing factor for reducing the risk of contracting various diseases, including AMD and cataracts together with affecting visual acuity and alleviating the aforementioned conditions [3, 17, 20].

Despite high dietary intakes being beneficial to health, it is often the case that a low-variety diet poor in vegetables and fruit, particularly in the elderly, does not provide sufficient amounts of lutein. It is therefore important to find out the reason for such deficiencies and the factors affecting the amounts of lutein consumed. In Poland, there is hardly any scientific data published on dietary sources of lutein for adults, especially any that are linked to eye disease (AMD/cataracts), thus the presented study is aimed to address this issue through evaluating lutein dietary intakes from foodstuffs and supplements.

MATERIAL AND METHODS

The study surveyed 375 adult subjects, aged 50-97 years (mean age 67 ± 10 years) during 2008-2012 who were residing in Warsaw and its environs. The test group consisted of 189 patients (50.4%) attending the Warsaw Clinical Eye Hospital that had been diagnosed with AMD and/or cataracts. Controls were 186 subjects without such disease and who were considered at work as being healthy. In all, there were 207 women (55%) and 168 men (45%). All subjects expressed their approval for taking part in the survey.

Lutein consumption was assessed by means of the food frequency questionnaire method concerning the month preceding the study day. Average dietary intakes of this carotenoid and the contributing foodstuffs were thereby determined by also using published data of lutein content in foodstuffs [6, 7, 9, 14, 19, 21]. Subjects were additionally requested to complete a questionnaire concerning gender, age, place of residence, education, (ie. demographics), whether lutein containing supplements were taken and their state of health. The dietary supplement data was thus combined with that from the foodstuffs to calculate the joint dietary intakes of lutein daily. Statistical analyses were performed on the Statistica ver. 10 software. The *Shapiro-Wilk* test was used to assess for normality. Significant differences were evaluated between groups by the *Mann-Whitney* U test for two unrelated variables and the *Kruskal-Wallis* test when more than two unrelated variables were considered. A level of $p \leq 0.05$ was adopted as demonstrating significance.

RESULTS

The mean dietary intake of total lutein for all subjects amounted to 2.5 mg daily ranging widely between 0.2 to 12.4 mg. In subjects suffering from AMD and/or cataracts (ie. the test group), such intakes were significantly higher than controls; on average by 35% (Table 1). In terms of gender, significantly more women consumed dietary lutein than men (2.9 vs 2.1 mg daily). It was also observed that subjects possessing secondary and higher education significantly consumed more lutein originating from foodstuffs than those others (p=0.01). There were however no significant differences observed, when groupings were made according to the other demographic factors, for example age, place of residence etc. It was nevertheless noticed that subjects aged 65-74 years consumed 24-27% more lutein compared to those below 65 years and above 75 years. Dietary supplements were taken by 109 subjects (around 30%) of whom in the test group this constituted 50% but only 10% in the controls. The mean dietary consumption of lutein delivered by supplements was 6.5 mg daily and ranged between 0.3 to 20.0 mg daily (Table 2). In addition, those persons taking lutein containing supplements also ate significantly more of the foodstuffs rich in lutein than those who did not (3.1 vs 2.3 mg daily). Lutein consumption from jointly foodstuffs

Table 1. Effect of demographics on subjects' dietary lutein intake from foodstuffs

Variable	Lutein intake (mg/day)				P-value
	Mean ± SD	P10	P50	P90	
Population in total (n=375)	2.50 ± 1.98	0.71	1.80	5.45	-
Eye diseases:					
Yes (n=189)	2.13 ± 1.80	0.69	1.43	4.66	<0.001*
No (n=186)	2.88 ± 2.09	0.83	2.35	5.93	
Gender:					
Women (n=207)	2.87 ± 2.12	0.79	2.31	5.94	<0.001*
Men (n=168)	2.05 ± 1.70	0.68	1.42	4.37	
Age:					
50 - 64 years (n=153)	2.32 ± 1.95	0.70	1.62	5.10	NS**
65-74 years (n=128)	2.88 ± 2.20	0.85	2.14	6.23	
≥ 75 years (n=94)	2.27 ± 1.64	0.59	1.83	4.80	
Place of residence:					
City >100 thousand inhabitants (n=257)	2.55 ± 1.94	0.82	1.97	5.38	NS*
City < 100 thousand inhabitants (n=118)	2.40 ± 2.07	0.59	1.63	5.80	
Education:					
Primary and vocational (n=171)	2.28 ± 1.92	0.63	1.6	5.14	0.01*
Secondary and higher (n=204)	2.68 ± 2.03	0.81	2.11	5.70	

SD - standard deviation; P10 - 10th percentile; P50 - 50th percentile; P90 - 90th percentile
Mann-Whitney U test; **Kruskal-Wallis* test (p≤0.05)

and supplements amounted to a mean of 9.6 mg daily, of which 68% were derived from supplements. Other factors like eye disease, gender, age, place of residence and education were also found to significantly affect the level of dietary lutein consumption from supplements.

The many dietary foodstuff sources of lutein were fresh vegetables (63%), including green leafy vegetables; Table 3. Apart from these vegetables, another significant source of this xanthophyll were frozen and processed vegetables, respectively 13% and 5%. The remaining foodstuffs such as fruit, fruit products, cereal products and eggs delivered significantly less lutein; in total up to 6% of the daily dietary intake. When accounting for persons suffering from both eye diseases (ie. AMD and cataracts), then they consumed significantly more lutein derived from fresh vegetables, (mainly from green leafy vegetables and fruit), compared to controls, (mean 2.0 vs 1.4 mg daily). The healthy controls however ate significantly more lutein derived from cereal products and eggs than those with eye disease; 0.4 vs 0.3 mg daily.

DISCUSSION

The presented study demonstrates that those suffering from eye disease (AMD/cataracts) consumed significantly more dietary lutein from foodstuffs than the healthy controls. Analogous findings were reported by *Khachik* et al. [15], where subjects afflicted by AMD consumed 29% more lutein compared to healthy persons (3.0 vs 2.0 mg daily). Lower dietary intakes of lutein from defined foodstuffs in Polish subjects, (estimated as 1.78 mg daily), were however noted from a study using data from the Central Statistical Office in Poland [10]. Nonetheless, a subsequent study on n=512 Polish adults found average dietary intakes of lutein to be somewhat

Table 2. Dietary intakes of lutein from foodstuffs and supplements according to presence/absence of eye disease

Subject	Lutein intake (mg/day)			P-value
	total population	no eye diseases	eye diseases	
Foodstuffs without supplements:	(n=266)	(n=170)	(n=96)	
Foodstuffs	2.28 ± 1.82[1] 1.64 0.21 – 8.84	2.08 ± 1.79 1.38 0.27 – 8.64	2.64 ± 1.83 2.15 0.21 – 8.84	0.001*
Foodstuffs with supplements	(n=109)	(n=19)	(n=90)	
Foodstuffs	3.05 ± 2.25 2.55 0.32 – 12.43	2.62 ± 1.89 1.89 0.50 – 7.62	3.14 ± 2.32 2.60 0.32 – 12.43	NS
Supplements	6.52 ± 5.23 6.00 0.25 – 20.00	6.60 ± 6.85 3.00 0.25 – 20.00	6.50 ± 4.93 6.00 0.25 – 20.00	NS
Together	9.57 ± 5.80 7.82 1.41 – 32.43	9.21 ± 7.09 7.03 2.19 – 24.37	9.64 ± 5.53 8.03 1.41 – 32.43	NS

[1] Mean ± standard deviation, median, range; **Mann-Whitney* U test (p≤0.05)

Table 3. Sources of dietary lutein from foodstuffs according to presence/absence of eye disease

Products	Study population						P-value[2]
	total population (n=375)		no eye diseases (n=189)		eye diseases (n=186)		
	Lutein intake						
	mg/day	%	mg/day	%	mg/day	%	
Fresh vegetables, sub-divided:	1.58 ± 1.48 1.06 0.02 - 9.56	63.2	1.27 ± 1.29 0.74 0.02 - 7.47	59.9	1.89 ± 1.59 1.50 0.10 - 9.56	65.7	<0.001
green leafy vegetables	0.87 ± 1.16 0.38 0.0 - 6.03	34.9	0.64 ± 0.98 0.19 0.0 - 4.36	30.0	1.11 ± 1.27 0.68 0.0 - 6.03	38.7	<0.001
other vegetables	0.62 ± 0.54 0.46 0.0 - 3.47	24.7	0.54 ± 0.49 0.39 0.0 - 3.08	25.4	0.70 ± 0.58 0.53 0.01 - 3.47	24.1	0.005
potatoes	0.09 ± 0.07 0.08 0.0 - 0.51	3.6	0.10 ± 0.07 0.08 0.0 - 0.51	4.5	0.08 ± 0.06 0.07 0.0 - 0.34	2.9	NS
Frozen vegetables	0.32 ± 0.76 0.0 0.0 - 4.67	12.7	0.23 ± 0.67 0.0 0.0 - 4.67	10.9	0.40± 0.84 0.0 0.0 - 4.56	14.1	NS
Processed vegetables	0.12 ± 0.18 0.03 0.0 - 0.95	4.8	0.11 ± 0.20 0.02 0.0 - 0.95	5.2	0.13 ± 0.17 0.05 0.0 - 0.93	4.5	NS
Legume seeds	0.03 ± 0.10 0.0 0.0 - 1.22	1.1	0.04 ± 0.13 0.0 0.0 - 1.22	1.7	0.02 ± 0.06 0.0 0.0 - 0.60	0.7	NS
Fruit	0.12 ± 0.18 0.07 0.0 - 1.47	4.7	0.10 ± 0.16 0.05 0.0 - 1.29	4.6	0.14 ± 0.20 0.09 0.0 - 1.47	4.7	<0.001
Processed fruit	0.04 ± 0.09 0.01 0.0 - 1.24	1.6	0.03 ± .06 0.0 0.0 - 0.47	1.6	0.05 ± 0.11 0.01 0. 0 - 1.24	1.7	NS
Cereal products	0.16 ± 0.10 0.13 0.0 - 0.58	6.0	0.17 ± 0.11 0.15 0.0 - 0.58	7.9	0.13 ± 0.09 0.11 0.0 - 0.51	4.5	0.001
Eggs	0.15 ± 0.14 0.11 0.0 - 0.88	5.9	0.18 ± 0.16 0.13 0.0 - 0.88	8.2	0.12 ± 0.10 0.11 0.0 - 0.80	4.1	0.001

[1] Mean ± standard deviation, median, range; *Mann-Whitney* U test ($p \leq 0.05$)

higher at 2.7 mg daily [12]. Studies from abroad have yielded a wide range of such values, lying from 1.4 to 3.3 mg daily, which were dependent on the location, study duration, dietary habits and socio-demographic factors [2, 18]. In our study, the factors that significantly differentiated the subjects into groups were found to be gender and education.

Women consumed 38% more lutein than men. A USA study showed similar results for 98 subjects aged 45-73 years, where women consumed 20% more lutein than men (1.8 vs 1.5 mg daily) [5], whilst those with secondary and higher education consumed 18% more than the others. The impact of education was also observed by *Hamulka* et al. [12] with subjects possessing higher education consuming 23% more lutein than those with primary education. Such differences could have arisen from the higher educated group being more aware of nutritional issues.

Fresh or processed vegetables were found to be the main source of dietary lutein (80%) of which the most was supplied by fresh green leafy vegetables (35%) and the other remaining vegetables (25%). Related studies in Poland showed similar findings. According to *Hamulka* et al. [10], vegetables were the principal dietary source of lutein (at 64%) daily. A USA study by *Bermudez* et al. [2] demonstrated spinach, broccoli and iceberg lettuce as being the main dietary sources of lutein. Both our study and others, however indicate that fruit, cereal products and eggs were of less importance as dietary sources of lutein; constituting no more than 8% of its total dietary intake [10, 12].

The average lutein intake in subjects derived from taking dietary supplements was 9.6 mg daily with single lutein doses most commonly being 3 or 6 mg. Those with AMD or cataracts predominantly took the following supplements, as recommended by their opticians;

'Ocuvite Lutein', 'Nutrof' and 'VitaLux plus'. Like findings were observed by *Hamulka and Nogal* [11] where the main reason for taking such supplements were because of opticians' advice, usually recommending 6 mg single doses. Nevertheless, most other studies don't take into account the dietary lutein intake derived from supplements. There are however many studies devoted to the effect of dietary lutein from supplements on concentrations of lutein in the serum and eye macula, together with determining the efficacy of various supplements. Studies by *Rosenthal* et al. [22] and *Khachik* et al. [15] reported a proportionally higher increase in blood lutein when taking large doses of lutein from supplements. Similar results were demonstrated by *Bone* et al. [4] which revealed a positive dependence between lutein doses taken from supplements (5 to 20 mg) with blood concentrations and optical density of pigment in the eye macula.

Despite many studies showing the beneficial effects of lutein on the human body, standard daily intakes have not yet been established nor have the upper safety limits been set [13]. Nonetheless, epidemiological studies indicate that taking 6 to 14 mg of lutein in the daily diet decreases the risk of eye diseases such as AMD or cataracts as well as in alleviating their symptoms if present [1, 8, 24]. It would seem from both our study and in others, that a diet with little variation, especially in the elderly, leads to lutein deficiency. For this reason it becomes necessary for lutein to be delivered from supplements, thus making up any deficiencies, particularly in high risk groups ie. those in whose families suffer from AMD and/or cataracts, in the elderly or persons actually diagnosed with the aforesaid eye conditions.

CONCLUSIONS

1. Overall, dietary intakes of lutein from foodstuffs were 2.5 mg daily, but were significantly higher in subjects suffering from AMD and/or cataracts as well as in women and those possessing secondary or higher education.
2. The main dietary sources of lutein were fresh vegetables, including green leafy vegetables (supplying 63%) and frozen vegetables (at 13%).
3. Dietary food supplements containing lutein were mainly taken by those subjects diagnosed with AMD and/or cataracts. Their average daily consumption being 6.5 mg; constituting 68% of the dietary intake.
4. Dietary intakes of lutein may be deficient in the elderly for preventing eye disease, especially AMD and cataracts. It is therefore necessary to make up any dietary deficiencies for high risk groups by daily taking suitable supplements.

Conflict of interest
The authors declare no conflict of interest.

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EVALUATION OF MINERAL STATUS IN HYPERTENSIVE PATIENTS UNDERGOING PHARMACOTHERAPY

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ABSTRACT

Background. The widespread and increasing occurrence of obesity, hypertension and associated disease has necessitated serial testing in order that risks of contracting such conditions become minimised through appropriate therapy and prevention. Many studies report that nutritional factors significantly affect the aetiology of hypertension and obesity that include mineral uptake. There are only a few studies however which are focused on the body's changing mineral content during pharmaco-therapeutic treatment.

Objectives. To determine concentrations of minerals in the hair and urine of hypertensive patients in conjunction with assessing their nutrition.

Material and Methods. Subjects were 17 patients presenting with essential hypertension and 18 healthy controls. Atomic absorption spectrometry (AAS) was used to measure Mg, Ca, Fe, Zn and Cu in the hair and urine on a Zeiss AAS-3 instrument. Dietary mineral intakes were assessed by interview over 24 hours prior to the analysis.

Results. The hypertensive group had significantly lower urine concentrations of Ca and Mg as well as Mg and Zn in hair. Urinary zinc excretion was significantly increased in this group compared to controls, but dietary intakes of Cu were reduced. The dietary mineral intakes were found to be unrelated to the concentrations of such minerals in the hair and urine.

Conclusions. Compared to controls, excretion of Ca and Mg were reduced in hypertensive subjects, whereas Zn excretion was higher, and Mg and Zn were relatively low in the hair. Daily dietary intakes of Cu were also reduced in the hypertensive.

Key words: *hypertension, minerals, nutritional status, atomic absorption spectrometry method*

STRESZCZENIE

Wprowadzenie. Ze względu na szeroko rozpowszechnione występowanie otyłości i nadciśnienia tętniczego oraz wzrost częstości zachorowań konieczne jest prowadzenie szeregu badań, które pozwoliłyby na minimalizację ryzyka wystąpienia tych chorób, dzięki właściwej terapii i prewencji. Liczne badania donoszą o istotnym wpływie czynników żywieniowych, w tym podaży składników mineralnych, na etiologię nadciśnienia tętniczego i otyłości. Natomiast niewiele jest badań dotyczących zmian zawartości składników mineralnych w organizmie zachodzących pod wpływem farmakoterapii.

Cel. Celem badań była ocena stężenia składników mineralnych we włosach i moczu pacjentów z nadciśnieniem tętniczym oraz ocena sposobu ich żywienia.

Materiał i metody. W badaniu uczestniczyło 17 pacjentów z pierwotnym nadciśnieniem tętniczym i 18 pacjentów zdrowych. Zawartość Mg, Ca, Fe, Zn, Cu we włosach i moczu oznaczono metodą spektrofotometrii atomowo-absorpcyjnej (AAS), przy użyciu spektrofotometru Zeiss AAS-3. Oceny spożycia poszczególnych składników mineralnych dokonano przy pomocy 24-godzinnego wywiadu żywieniowego przeprowadzonego w dniu poprzedzającym badanie.

Wyniki. Stwierdzono istotnie niższe stężenia Ca i Mg w moczu grupy badanej. Zaobserwowano istotne obniżenie zawartości Mg i Zn we włosach osób chorych na nadciśnienie tętnicze. Wydalanie Zn z moczem było istotnie zwiększone w stosunku do grupy kontrolnej. Ponadto wykazano niższe spożycie Cu wśród badanych osób. Nie wykazano istotnych statystycznie zależności między spożyciem poszczególnych składników mineralnych a ich zawartością we włosach i moczu.

Wnioski. U osób z nadciśnieniem tętniczym obserwowano zmniejszone wydalanie Ca i Mg, a zwiększone Zn w moczu oraz względnie niskie stężenie Mg i Zn we włosach. W całodziennych racjach pokarmowych osób z pierwotnym nadciśnieniem tętniczym występowała zbyt niska podaż Cu.

Słowa kluczowe: *nadciśnienie tętnicze, składniki mineralne, stan odżywienia, metoda AAS*

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INTRODUCTION

Hypertension is a chronic disease of the circulation. It is the most commonly occurring modern day disease belonging to the poly-metabolic syndrome group. If untreated, it may lead to cardiovascular complications and disorders of metabolism, haemodynamics and neuroendocrinology. For such reasons it is necessary to tailor treatment to the individual. Such treatments depend on the magnitude of the hypertension, its duration and any complications arising, with an increased BMI being a risk factor. Adopting pharmacotherapy does not however preclude non-pharmacotherapy treatments (e.g. reducing body mass, increasing physical activity) when used, above all, systematically in order to ensure effectiveness. As well being genetically predisposed, the pathogenesis of hypertension includes a major role for high salt and high fat diets, obesity, low levels of physical activity, smoking and excess alcohol consumption. Changing dietary habits is important in preventing and treating hypertension. In preventing circulatory disorders, anti-oxidant vitamins and minerals are key; the latter including Potassium (K), Sodium (Na), Calcium (Ca), Magnesium (Mg), Iron (Fe), Copper (Cu) and Zinc (Zn), with particularly Mg affecting hypertension. An appropriate intake of this element facilitates blood vessel relaxation leading to blood reducing pressure [15, 22]. Keeping to a diet balanced with Ca (≈900 mg intake) and Mg (≈350 mg intake) allows blood pressure to normalise [19]. For Ca alone, its hypotensive action results from dietary supplementation when intakes are low [1, 12]. According to *Hatton* and *McCarron*, increasing blood pressure arises from a defect in Ca metabolism that leads to hypercalciuria and increased secretion of parathyroid hormone. Increasing Ca intakes normalises the hypercalciuria and restores the hormonal balance [14]. Many studies have indicated the beneficial effects of Ca supplementation with an increased dietary salt intake [33]. The role of Fe and Cu in hypertension pathogenesis is still not fully known. However, mildly decreased Fe levels are recognised to be significant in preventing cardiovascular disease, but excessive levels cause atherosclerotic lesions through participating in lipid peroxidation, generating active oxygen species and thereby damaging the endothelium [8, 26].

Studies by *Goch* et al. reported lowered Zn but increased Cu plasma concentrations in hypertensive patients. Furthermore, the serum Zn/Cu molar ratio was decreased in those with hypertension when coupled with a prolonged duration of the illness [9, 34]. The anti-oxidant elements selenium and Zn are considered to play a large role in the pathogenesis of hypertension. Zn possesses antioxidant properties that stabilise the cell membrane and significantly affects the activities of zinc-dependent enzymes [20]. *Goch* et al. [11] demonstrated a positive correlation between low Zn levels and increased blood pressure, suggesting that mineral supplementation could thus be beneficial in dealing with hypertension.

The study aim was to therefore assess the body's mineral nutritional status based on determining the mineral content in hair and urine along with the dietary habits of subjects suffering from hypertension.

MATERIAL AND METHODS

Permission for undertaking the study was obtained from the Bioethical Commission (No. 86/09) at the Medical University of Poznan. Subjects were Poznan residents living in the Swarzedz district consisting of 19 women and 16 men, aged 57.72 ±10.53 years. Two groups were formed; test and controls. The latter were healthy individuals that were not taking any pharmacotherapy nor vitamin-mineral supplements. The former were patients diagnosed with hypertension according to the criteria set by the Polish Hypertension Society and who had been undergoing treatment for the last 2 years. The controls were made up of 18 subjects (8 women and 10 men) aged 45.8 ±13.5 years, who underwent an anthropometric and dietary survey and from whom hair and urine samples were obtained for the measurement of Ca, Mg, Fe, Zn and Cu.

Subjects were interviewed on their diet according to the method of 'current reporting' by using a 'Photograph Album of Foodstuffs and Dishes' (provided by the National Institute of Food and Nutrition, Poland) [28]. Dietary data was recorded from the 24 hours preceding the study, from which calorific values and the dietary composition of specified nutrients were obtained. Calculations also took into account the culinary/technological losses set at 10%.

Levels of Ca, Mg, Fe, Zn and Cu were then measured in samples of hair and urine. A cut 1 cm length of hair growing from the skin at 6 locations of the occipital part of the head was used as samples. Hair that had been dyed or permed was not used so as to avoid any artifactual environment effects. Hair samples were then washed in acetone and deionised water, followed by drying at 105-110ºC, which were then dried, weighed and then mineralised with HNO_3 in a Mars CEM apparatus. A fasting urine sample was obtained after nigh time. The mineral elements were measured by atomic absorption spectroscopy (AAS) on the Zeiss AAS-3 instrument.

RESULTS

The profiles of the test (n=17) and control (n=18) groups are shown in Table 1 with the former aged

Table 1. Profiles of studied groups

Parameter	Test group			Control group		
	Mean	W	M	Mean	W	M
Numbers subjects	17	11	6	18	8	10
AGE						
AM±SD	59.8 ± 6.3	61.5 ± 6.3	56.8 ± 5.6	45,8 ± 13,5	46.9 ± 15.2	44.4 ± 11.8
Median	60.0	62.0	56.0	42.0	46.0	38.5

W- Women, M- Men, AM - arithmetic mean, SD- standard deviation

Table 2. Daily dietary intakes of nutrients and calories for studied subjects

Parameter		Test group			Control group		
		Mean	W	M	Mean	W	M
Calories[kcal]	AM±SD	1559.1±547.7	1213.4±572.7	1892.8±312.0	1934.1±610,5	1468.1±526.2	2185.2±575.3
	Median	1533.4	1511.3	1883.5	1859.7	1818.9	2299.2
Protein [g]	AM±SD	55.5±15.5[a]	40.5±14.1	65.0±14.2	70.3±19.2[a]	52.8±14.3	76.6±21.0
	Median	50.4	45.9	67.0	69.0	61.1	72.5
Fats [g]	AM±SD	68.2±37.0	58.8±35.4	95.8±21.8	82.8±37.5	67.0±29.2	99.9±35.5
	Median	71.1	49.3	103.5	80.6	60.0	96.4
Carbohydrates [g]	AM±SD	195.0±69.4	150.5±76.6	210.2±56.9	247.6±75.7	187.3±79.3	268.7±69.4
	Median	187.2	165.9	206.2	238.6	214.4	306.6
Saturated fatty acids [g]	AM±SD	25.2±17.1[b]	22.4±16.4	35.5±14.3	33.6±12.5[b]	26.7±11.4	40.3±9.1
	Median	24.8	15.2	31.9	33.9	27.3	37.0
Monounsaturated fatty acids [g]	AM±SD	27.9±15.1	23.1±13.9	39.5±9.7	30.3±16.0	24.5±12.2	37.1±15.9
	Median	26.4	21.0	39.4	27.1	18.6	38.9
Polyunsaturated fatty acids [g]	AM±SD	9.8±5.4[c]	8.2±4.2	13.7±5.3	12.8±9.4[c]	10.5±6.9	15.0±10.8
	Median	9.3	7.1	13.6	9.5	8.1	12.4
Cholesterol [mg]	AM±SD	271.3±255.1	230.4±276.1	273.3±236.1	240.0±131.4	189.8±48.1	307.4±139.5
	Median	164.7	160.2	181.0	198.1	138.0	294.3
Sucrose [g]	AM±SD	33.5±21.4	29.3±22.8	30.2±20.4	40.7±25.4	33.0±36.2	37.6±13.1
	Median	32.9	31.5	38.9	32.9	32.3	37.1
Dietary fibre [g]	AM±SD	15.2±4.9	11.6±4.6	17.9±4.6	21.7±10.1	17.4±7.6	24.6±11.2
	Median	14.7	12.2	17.7	20.5	15.7	22.9

[a, b, c] – Statistically significant at $p<0,05$, DDI – Daily dietary intake, AM- Arithmetic mean, SD- Standard deviation, W- Women, M- Men

59.8 ±6.3 years and the latter 45.8 ±13.5 years. In all there were 19 women and 16 men taking part. Dietary intakes of macro and micro-nutrients are shown in Table 2. The average calorific intake in the controls was 23-39% lower than recommended values. Daily dietary intakes of protein in the hypertensive were also significantly lower than controls (55.5 g vs. 70.3 g). It is noteworthy that the dietary calories derived from fat exceeded recommended values for both groups. Dietary carbohydrates were lower in the test group compared to controls, where healthy men had 20% higher intakes than the hypertensive. The test group consumed significantly lower amounts of saturated fatty acids than controls (25.2 g vs. 33.6 g).

There were was no significant differences in dietary monounsaturated fatty acids between both groups, however significant differences were observed for dietary polyunsaturated fatty acids between test and controls; respectively 9.8 ±5.4 g vs. 12.8 ±9.4 g. Both groups showed mean dietary intakes of cholesterol to be lower than the recommended value for maximum consumption (330 g). In addition, it was observed in both groups that the dietary fibre intake was 35% higher in women than men. The dietary analyses also included daily intakes of chosen minerals (Table 3) and the proportion of recommended standard intakes that this represents. A significantly lower intake of Cu in the test group was found compared to controls; respectively 0.9 ±0.3 mg vs 1.1 ±0.4 mg. Dietary Mg intakes constituted 72.7% of the Recommended Daily Allowance (RDA) in the hypertensive and 94.1% RDA for healthy controls. In men, recommended dietary Mg intakes were 105.2% RDA in the controls. Fe levels in the diet of the test group were lower than controls (72% RDA). Hypertensive women consumed less Fe than healthy women control (67.9% RDA vs. 72% RDA), whereas for men this position was reversed (67.9% RDA vs. 58.1% RDA). The dietary requirement targets for Zn in the test group were attained by 58% and 67% for controls.

The mean concentrations of mineral elements (Ca, Mg, Fe, Cu, Zn) in hair and urine are presented in Tables 4 and 5. Urinary Mg and Ca in the test group were lower than for controls. Healthy women had 30% higher urinary levels of Ca than the hypertensive, whereas this

Table 3. Daily dietary intakes of mineral elements measured in studied subjects

Parameters		Test group			Control group		
		Mean	W	M	Mean	W	M
Ca [mg]	AM±SD	426.0±256.2	356.3±284.0	471.6±212.0	655.3±409.6	563.4±473.5	618.2±373.0
	Median	386.6	340.3	527.6	625.3	625.3	590.8
Mg [mg]	AM±SD	218.0±77.5	169.7±72.6	245.6±85.3	282.2±131.4	218.0±90.0	315.7±153.3
	Median	213.7	183.5	232.7	240.3	223.7	282.1
Fe [mg]	AM±SD	9.5±5.2	7.6±6.4	9.4±2.5	10.1±4.1	7.8±1.8	11.6±4.8
	Median	8.0	7.3	9.3	9.3	7.6	10.4
Zn [mg]	AM±SD	8.7±3.1	7.0±3.6	10.9±3.0	10.1±4.3	8.0±1.7	12.0±5.0
	Median	9.0	6.9	11.5	9.5	7.4	10.8
Cu [mg]	AM±SD	0.9±0.3[a]	0.7±0.3	0.9±0.2	1.1±0.4[a]	0.9±0.2	1.3±0.5
	median	0.9	0.8	1.0	1.0	0.9	1.2

[a] – statistically significant at $p<0.05$, DDI – daily dietary intake, AM- arithmetic mean SD- Standard deviation, W- Women, M- Men

Table 4. Mineral content of hair in studied subjects

Parameters		Test group			Control group		
		Mean	W	M	Mean	W	M
Ca [µg/g]	AM±SD	1742.0±1580.7	1505.2±1589.6	2073.5±1687.0	1356.2±1217.6	1905.3±1567.1	875.7±543.1
	Median	1153.1	400.0	1553.8	887.5	1517.9	847.9
Mg [µg/g]	AM±SD	58.8±48.2	32.1±181.6	94.4±54.1	60.4±36.1	59.5±41.1	60.9±35.1
	Median	40.8	33.0	83.0	50.4	54.9	50.5
Fe [µg/g]	AM±SD	67.3±96.4	60.0±111.0	80.6±68.9	35.2±31.9	28.0±22.2	41.5±38.9
	Median	30.9	25.6	68.9	30.2	22,.	31.6
Cu [µg/g]	AM±SD	13.8±7.7	13.8±7.5	13.8±9.1	13.0±10.0	12.4±7.6	13.6±12.2
	Median	11.2	12.4	8.6	9.2	9.4	9.2
Zn [µg/g]	AM±SD	212.4±136.3	192.1±127.5	249.5±156.1	220.9±63.5	207.0±59.3	232.1±67.7
	Median	163.5	163.5	173.5	219.6	219.6	218.1

$p> 0.05$, W-women, M- men, AM- arithmetic mean, SD- standard deviation

increase was higher in men at 55%. Despite generally low Zn consumption, this element was significantly raised in the urine of hypertensive. There were no other significant differences in mineral elements between the test group and healthy controls. Molar ratios of the mineral analytes were also calculated, which in the following cases proved significant; Fe/Zn in hair (with the test group being higher at 0.36 ±0.36 vs. controls at 0.018 ±0.16), Zn/Cu in urine (with the test group being higher at 9.46 ±6.36 vs. controls at 8.36 ±7.71) and Zn/Cu in hair (with the healthy controls being higher at 20.48 ±9.21 vs. hypertensive at 16.07 ±7.47.

DISCUSSION

Healthy nutrition plays an important role in treating and preventing hypertension. Vital areas include consuming dietary fibre, polyunsaturated fatty acids and minerals, of which Ca, Mg, Zn, Cu and Fe are important. Also of import, is that these minerals are present in appropriate proportions. A deficient intake in one may disrupt the effects of the others leading to abnormalities in metabolism and humoral blood pressure control through effects on the synthesis of protein, hormones and other factors influencing epithelial function. Such inter-dependencies have been observed by *Steffen* et al. [25], who studied the effects of dairy product consumption on the development of hypertension. This study was performed on n=4304 subjects aged 18 -30 years, where a low dietary intake of Ca was observed in those with hypertension. A WOBASZ study aimed at determining Polish nutritional habits, found that Ca intake levels were 51% and 41% of those recommended in respectively men and women [27]. Similar findings were reported by *Mi-Hyun* et al. that estimated a daily dietary Ca intake of 360.5 mg for hypertensive and 429.9 mg in healthy subjects [23]. An increased consumption of Ca is linked with its increased urinary excretion. A positive association between Ca ions and blood pressure levels was observed by *Ram* et al in hyper- and normal – tensive patients [24], as likewise a study by *Hamet* et al. on 182 Canadian subjects [13]. However, a study by *Taylor* on subjects taking the DASH diet did not find any effect of dietary Ca intake on its urinary levels [32]. When measuring micro- and macro-components of hair Ca concentrations were insignificantly higher in a test group (463.3 µg/g) compared to controls (437.0 µg/g) [11]. Similar results were found in the presented study. Raised levels of Ca in hair have

Table 5. Urinary mineral content in studied subjects

Parameters		Test group			Control group		
		Mean	W	M	Mean	W	M
Ca [μg/ml]	AM±SD	125.4±84.4[a]	135.3±99.7	105.5±18.3	217.1±151.5[a]	195.0±152.3	233.7±173.5
	Median	105.0	118.8	87.8	170.7	170.7	176.6
Mg [μg/ml]	AM±SD	62.2±28.3[b]	59.0±25.3	68.8±35.7	97.1±40.6[b]	93.7±46.9	100.0±38.0
	Median	50.3	56.6	50.3	87.7	96.5	85.8
Fe [μg/ml]	AM±SD	0.34±0.18	0.31±0.19	0.43±0.14	0.32±0.21	0.31±0.17	0.32±0.24
	Median	0.29	0.26	0.45	0.24	0.26	0.22
Cu [μg/ml]	AM±SD	0.060±0.035	0.050±0.027	0.087±0.037	0.057±0.038	0.053±0.023	0.060±0.048
	Median	0.051	0.051	0.086	0.051	0.056	0.042
Zn [μg/ml]	AM±SD	0.54±0.55[c]	0.41±0.28	0.82±0.88	0.36±0.25[c]	0.26±0.09	0.44±0.31
	Median	0.38	0.32	0.42	0.28	0.28	0.37

[a, b, c]- statistically significant at $p<0.05$, W -women, M- men, AM- arithmetic mean, SD- standard deviation

been reported by *Durkalec-Michalski* et al. (1381±780 μg/g vs. 1102±869 μg/g) in 30 patients [4]. A 12% higher excretion of Ca compared to healthy controls was found by a retrospective study by *Eisner* et al. [6] on 462 patients. The current study showed reduced Ca excretion in the hypertensive patients compared to the healthy controls.

Many studies confirm the positive effect of Mg on the circulatory system. *Chiuve* et al. found, in a prospective cohort study, that dietary magnesium levels affect the development of coronary heart disease [3]. An assessment of dietary supplementation with magnesium and added vitamin B_6 was undertaken by *Kozielec* et al. which determined mean Mg levels in hair and found those lowest to be in patients treated with diuretics (at 11.4 μg/g) and those highest in patients on *beta*-blockers (at 32.87 μg/g). In all patient groupings, there was a significant increase in ionised Mg after supplementation which was linked to the proportional decrease in clinical symptoms as previously observed. Also following the supplementation, the systolic and diastolic blood pressures fell respectively by 20 mm Hg and 10 mm Hg [18].

There is numerous data indicating an inverse association between dietary Ca and Mg intakes with blood pressure, however much less is known about Ca and Mg urinary excretion and its link to blood pressure. *Kesteloot* et al. [17] showed a positive relationship between 24 hour urinary Ca and Mg excretion and blood pressure in two cross sectional studies, where in the case of Mg excretion and blood pressure, the link was more pronounced in women than men [17]. A study by *Goch* et al. compared Mg concentrations in hair, serum and urine of 170 subjects divided into 3 groups; those clinically healthy, and hypertensive patients with or without complications. There were no significant differences in hair Mg levels between groups; as found in the presented study, whereas the urinary Mg daily excretion in the 3 groups were respectively 248 ±98 mg, 270 ±148 mg and 274 ±169 mg [10]. The current study showed mean urinary Mg levels from the morning in hypertensive to be significantly lower than the healthy controls. Of note is a Mg result obtained by *Durkalec-Michalski* in hair where levels were significantly higher in the test group than controls; 104±122 μg/g vs. 64±54 μg/g [4]. A reverse observation was reported in another study, *Goch* et al. [11], as was also seen in the presented study. Patients that suffered acute ischemic stroke were found to have higher Mg levels in hair than controls [16].

Iron, as a constituent of antioxidant enzymes also affects blood pressure levels. The current study observed no differences in daily dietary intakes of Fe between test and control groups [16], unlike the *Całyniuk* et al. study which did. They looked at adolescent nutrition in boys aged 16-18 years and found higher dietary Fe levels in hypertensive boys compared to their healthy peers [2]. The *Michalski* study reported mean Fe levels of 47.6 ±40.2 μg/g in hypertensive compared to healthy controls; 36.6 ±20.7 μg/g [21]. Hair levels of Fe were determined as being 17.25 ±13.19 μg/g in hypertensive and 21.43 ±15.49 μg/g in healthy subjects by *Goch* et al [11], however Zn levels in hair were significantly lower in hypertensive than healthy subjects. Lower Zn levels in hair were also demonstrated by *Tang* et al. [31] and *Michalski* [21]; 163±111 μg/g vs. 235±52 μg/g. In another study by *Goch* et al. [10], plasma levels of Zn and Cu were measured in those suffering from arterial hypertension (hypertension) dived into 3 groups depending on symptom duration and with or without complications. This found that decreased Zn concentrations and increased plasma Cu, along with a decreased Zn/Cu ratio occurred for the duration of hypertension, whilst an increase in Zn and Cu plasma concentrations coupled with a decreasing Zn/Cu ratio occurred in those hypertensives that suffered complications. It was also observed that the 24 hour urinary Zn and Cu excretion and the Zn/Cu ratio increased, while the hypertension lasted together with its complications [10]. A study by *Vivoli* et al. [29], conducted on 31 hypertensive patients and 31 healthy controls, found significant associations

of Zn and Cu levels between serum and urine in those suffering from hypertension. For the controls, the correlations in serum and urine were respectively r=0.577 and r=0.394 between Zn and Cu, in which a similar correlation in urine was observed in the presented study (r=0.58). The relationship between Cu and Zn concentrations with hypertension were confirmed by a study by *Dzięgielewska-Gęsiak* et al. [5]. This study showed higher serum Cu concentrations in the test subjects compared to healthy clinical controls, coupled also with higher Zn concentrations in the hypertensives than in the controls [5]. Such results suggest a link between hypertension and a lack of a Zn-Cu balance [29]. Furthermore, *Taneja* and *Mandal* [30] reported higher urinary Zn and Cu concentrations in hypertensive patients compared to healthy subjects. The current study also determined the daily dietary intakes of Cu. These intakes were significantly lower in hypertensive than the healthy controls. Levels of Cu found by *Goch* et al. in hair were higher in those with hypertension (10.75 ±12.03 µg/g) compared to healthy subjects (8.01 ±4.39 µg/g) [11]. In the presented study, together with that of *Michalski*, Cu levels were comparable for the controls; being respectively 36.0 ±25.9 µg/g and 38.1 ±18.9 µg/g. In the latter study [21], the molar ratios were determined for Ca/Mg, Fe/Zn, Cu/Fe and Zn/Cu, where significant differences were only observed for the Cu/Fe ratio between test subjects (3.15±6.37) and controls (1.31 ±0.71), which was not seen in the presented study. The Fe/Zn ratio was found [21] to be lower in the test group (0.73 ±1.01) than controls (0.19 ±0.11). Similar findings were seen in the current work where the Fe/Zn ratio was higher in the hypertensive than controls. The Ca/Mg ratio found by *Goch* et al. [11] was 22.04 ±17.55 in hypertensive and 23.92 ±27.47 in healthy subjects.

CONCLUSIONS

1. Hypertensive patients consumed rather fewer foodstuffs rich in copper.
2. In the hypertensive, the amounts of calcium and magnesium excreted in urine were lower, but urinary Zn was higher compared to healthy controls.

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Conflict of interest
The authors declare no conflict of interest.

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THE EFFECT OF GIRLS ATTITUDES TOWARDS THE HEALTH BENEFITS OF FOOD ON SELECTED DIETARY CHARACTERISTICS. THE GEBAHEALTH PROJECT

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ABSTRACT

Background. Dietary habits are formed at an early age and to a large extent they affect such nutritional behaviour in adulthood. Mothers in particular, influence family nutrition. In this respect, their knowledge, attitudes and behaviour about nutrition are responsible for the schooling of future generations. Many aspects of the link between food and health with nutritional behaviour in girls remain, however, unknown.
Objectives. To determine the effect of girls attitudes towards the health benefits of food on selected dietary characteristics.
Material and Methods. Study included 186 girls aged 13-21 years. Using a food frequency method the three dietary characteristics were obtained; food intake variety, fibre intake and fat intake, all of them expressed by a graded scale. Three validated questionnaires were used; FIVeQ, BSQFVF and BSQF. The girls attitudes towards the health benefits of food were rated from one of the survey's six parts, comprising of 8 statements from the Health and Taste Attitude Scale (HTAS) accordingly graded. Statistical analyses used logistic regression.
Results. The mean index of food intake variety was 28.7 foods/week (ranging 0–60), whilst the mean dietary intakes of fibre and fat were 16.7 points (0-36 range) and 18.2 points (0-52 range), respectively. Girls from the upper tertile with favourable attitudes on food health benefits had an odds ratio (OR) for adequate fat intake (<22 points) of 3.1 (95% CI: 1.28, 7.52; $p < 0.05$), as compared to those from the middle-neutral attitudes tertile, with an OR = 1.00. The ORs for the relatively high food intake variety and acceptable fibre intake were 1.05 in girls from the positive-upper tertiles, which were not significant.
Conclusions. The positive attitudes of girls towards the health benefits of food are conducive for making more favourable food choices and lowered dietary fat intake, however this did not significantly affect fibre intake nor food intake variety.

Key words*: girls, nutrition, attitudes, health*

STRESZCZENIE

Wprowadzenie. Nawyki żywieniowe są kształtowane w młodym wieku i w dużym stopniu decydują o zachowaniach żywieniowych w życiu dorosłym. Kobiety mają szczególny wpływ na sposób żywienia rodziny. Ich wiedza, postawy i zachowania względem żywności kształtują zachowania żywieniowe kolejnych pokoleń. Nie poznano wielu aspektów związku między postawami względem żywności i zdrowia a zachowaniami żywieniowymi dziewcząt.
Cel. Celem badań była analiza wpływu postaw dziewcząt względem walorów zdrowotnych żywności na wybrane cechy odżywiania.
Materiał i metody. Badaniami objęto 186 dziewcząt w wieku 13-21 lat. Metodą częstotliwości spożycia oceniono trzy cechy odżywiania: urozmaicenie spożycia żywności oraz spożycie błonnika i tłuszczów, które wyrażono w skalach punktowych. Wykorzystano trzy walidowane kwestionariusze: FIVeQ, BSQFVF i BSQF. Postawy dziewcząt względem walorów zdrowotnych żywności oceniono przy użyciu jednej z sześciu części (8 stwierdzeń) Skali Postaw Względem Zdrowia i Smaku (HTAS), przedstawiającej postawy w skali punktowej. W analizie statystycznej użyto regresji logistycznej.

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Wyniki. Średni wskaźnik urozmaicenia spożycia żywności wynosił 28.7 produktów/tydzień (zakres: 0-60), średnie spożycie błonnika wynosiło 16.7 punktów (zakres: 0-36), a średnie spożycie tłuszczów 18.2 punktów (zakres: 0-52). Dziewczęta z górnego-pozytywnego tercyla postaw względem walorów zdrowotnych żywności miały iloraz szans odpowiedniego spożycia tłuszczów (<22 punktów) równy 3.10 (95%CI: 1.28; 7.52; p<0.05) w porównaniu z dziewczętami ze środkowego-neutralnego tercyla postaw (OR=1.00). Ilorazy szans dla względnie dużego urozmaicenia spożycia żywności i akceptowanego spożycia błonnika u dziewcząt z górnego-pozytywnego tercyla postaw wynosiły 1.05 i były nieistotne.
Wnioski. Pozytywne postawy dziewcząt względem walorów zdrowotnych żywności sprzyjały korzystniejszym wyborom żywności i mniejszemu spożyciu tłuszczów, lecz nie miały istotnego wpływu na spożycie błonnika i urozmaicenie spożycia żywności.

Słowa kluczowe: *dziewczęta, odżywianie dziewcząt, postawy, zdrowie*

INTRODUCTION

Girls and young women are recognised for belonging to a population group that are particularly vulnerable for having inappropriate eating habits and suffering from adverse health effects [28]. To a young body, nutrition is one of the most important environmental factors determining adequate development in terms of the physical, emotional and intellectual. Identifying and the sufficiently early correction of such nutritional errors, form the primary basis of any preventative action. Inappropriate nutrition at a young age significantly increases the risk of metabolic disease in adult life. The beneficial effects of such preventative measures are important to the health of the individual and society because women's health directly affects their reproductive health and that of subsequent generations [9, 11, 26, 28]. Food preferences, its consumption and nutritional behaviour to a large extent depend on the habits acquired in childhood and adolescence [12].

Women influence on family eating behaviour in a particular way. Their nutritional knowledge, attitudes and behaviour shape the nutritional behaviour of their succeeding offspring. Nutritional health concerns, attitudes and being pro-healthy depend on, amongst others, their knowledge, experience and awareness about health and the environment as well as the personal traits of the individual [4, 7, 9, 14, 24, 31].

By attitudes it is understood to mean a relatively stable structure of cognitive, emotional and behavioural processes in women towards their wards [8]. Nutritional indicators of attitude are knowing the principles of an adequate diet, the significance of nutrition and healthy eating in prevention and disease development, sentiments regarding eating, foods and tendencies for adopting defined nutritional behaviours. It has been shown that having nutritional knowledge significantly increases the consumption of fruit and vegetables but lowers intakes of fat [30]. European studies have found that women, the elderly and those better educated more frequently take care to eat healthily, whereas men are chiefly guided by taste and habits [25]. Women that possessed more knowledge on health and eating had more positive indicators towards nutrition [8].

The many aspects of food and health associated with nutritional behaviour in girls require more in-depth study. The study aims were to assess girl's attitudes about the health benefits of foods on selected dietary characteristics.

MATERIALS AND METHODS

The study was conducted as part of the GEBaHealth No. N N404 068540 pilot project.

Subject group

Consisted of 186 girls aged 13-21 years (Table 1) selected by convenience sampling. The sample recru-

Table 1. Sample profile

Characteristics	Category	n	Sample percentage (%)
Total		186	100
Age group	13-15 years	62	33
	16-18 years	66	36
	19-21 years	58	31
Region	Olsztyn	96	52
	Poznań	90	48
Mother's education	Primery/vocational	38	20
	Secondary	84	45
	Higher	64	35
Father's education	Primary/vocational	54	29
	Secondary	82	44
	Higher	50	27
Place of residence	Countryside	68	37
	Town ≤100,000 inhabitants	37	20
	Town >100,000 inhabitants	81	43
Self-reported economic status	Less than average	8	4
	Average	139	75
	Above average	39	21
BMI (kg/m^2)	Mean ± SD	20.8±2.7	

n – sample number ; SD – Standard Deviation

ited during 2011-12 from secondary and high schools in the Poznan and Olsztyn regions of Poland. Initially 190 subjects were gathered but 4 were removed due to incomplete data [19].

Assessing chosen dietary characteristics

Food consumption rates were based on assessing 3 aspects of nutrition as follows;

- Food intake variety as an important and overall measure of appropriate nutrition.
- Dietary fibre intake as a measure of eating pro-healthy foods.
- Dietary fat intake as a measure of eating foods not conducive to health especially when consumed in excess.

Three validated questionnaires were used for the assessment [6].

- Food Intake Variety Questionnaire, (FIVeQ).
- Block Screening Questionnaire for Fruit/Vegetable/ Fibre Intake, (BSQFVF).
- Block Screening Questionnaire for Fat Intake, (BSQF), modified in-house.

Both block questionnaires had been shortened for the NHANES II study [17].

The FIVeQ questionnaire was validated by the test--retest procedure in a study on subjects over 65 years [18] and calibrated on young women subjects using a 7-day food record as a reference method (unpublished results). Consumption data on 63 food groups and their amounts was thus obtained using the FIVeQ over the last 7 days [18]. There were two reply categories to which scores were allotted ie. 'no' – 0 pts and 'yes' – 1 pt. The diversity of consumed foods was expressed by a food intake variety index (FIVeI) calculated as the number of food items eaten weekly (60 foods/week maximum), excluding the three alcoholic beverage groups; beers, wines and spirits. According to the FIVeI, consumption results were graded into the following categories: low (<20 foods/week), sufficient (20-29 foods/week), satisfactory (30-39 foods/week) and very good (≥40 foods/week).

Information on consumption rates were obtained using the BSQFVF questionnaire on 9 food groups which were the main sources of dietary fibre [27]. The rates were graded into 5 categories as follows; 'less than once weekly' – 0 pts, 'once weekly' – 1 pt, '2-3 times weekly' – 2 pts, '4-6 times weekly' – 3 pts and 'daily' – 4 pts. On the basis of summed totals, each person was graded according to their dietary fibre intake as follows; (1) very low (<20 pts), (2) insufficient (20-29 pts) and (3) sufficient (≥ 30 pts).

With the BSQF questionnaire, including the in-house modifications, data was collected on normally found rates of consuming 13 food groups which are either fats in themselves or constituted important sources of dietary fats [27]. Intake rates were graded into 5 categories as follows; 'less than once monthly' – 0 pts, '2-3 times monthly' – 1 pt, '1-2 times weekly' – 2 pts, '3-4 times weekly' – 3 pts and '5 or more times weekly' – 4 pts. Dietary fat intakes were graded into the following numerical categories as follows; (1) very high (>27 pts), (2) high (25-27 pts), (3) moderately high (22-24 pts), (4) appropriate (18-21) and (5) most favourable (<18 pts).

Girls attitudes towards the health benefits of foods

These were assessed by one of the six Health Taste Attitude Scales (HTAS) regarding the health benefits of foods [22]. The scale is composed of 8 statements, each with 7 replies to choose from as follows; 'strongly disagree', 'disagree', 'rather disagree', 'neither agree nor disagree', 'rather agree', 'agree' and 'strongly agree'. Each answer was rated numerically in ascending magnitude, ie. from one to seven points, respectively. Four of the statements however were recoded so as to reflect positive increases in a given trait such that 'strongly disagree' was assigned 7 pts whilst 'strongly agree' had one pt. At the end, the points were added up ie. 8-56 pts and three categories of girls were identified based on their attitudes towards the health benefits of foods according to a tertile distribution as follows; (1) the bottom-negative tertile (≤31 points, 33% of sample); (2) the middle-neutral tertile (32-37 points, 34% of sample); (3) the upper-positive tertile (≥38 points, 33% of sample).

Statistical analysis

Summary statistics were calculated for dietary intakes of fibre and fat along with the food intake variety from the proportions of subjects according to the distribution of variables. These results were in part used for defining categories followed by logistic regression analysis.

The distributions of dietary fat and fibre intakes as well as food intake variety according to negative, neutral and positive attitudes towards the health benefits of food were compared by the chi^2 test. The *Kruskal-Wallis* test was used to compare mean values for the dietary characteristics.

The effect of attitudes towards the health benefits of food was assessed by logistic regression, which for each dietary characteristics subjects were divided into two categories according to the variables distribution and the summary statistical measures as well as the criteria established by those who developed the questionnaires. Subjects were differentiated into; (1) food intake variety levels; relatively high >34 foods/week or relatively low ≤34 foods/week, (2) dietary fibre intake levels; acceptable (≥20 pts) or non acceptable (<20 pts), (3) dietary fat intake levels; adequate (<22 pts) or non adequate (≥22 pts.)

According to attitudes towards the health benefits of consumed foods, girls from the upper-positive tertile or the lower-negative tertile had ORs showing relatively high food intake variety, acceptable fibre intake and adequate fat intake. For the middle-neutral tertiles a reference point of an OR=1.00 was adopted. From this, in terms of attitudes, the chances of incidence of favourable dietary characteristics (modeled incidence) were calculated in relation to the group with unfavourable dietary characteristics (reference level). The *Wald* statistic was used to evaluate the significance of the effects of these attitudes. The Statistica 9.0 PL StatSoft software was used for performing the statistics and significance levels were taken as being $p<0.05$.

RESULTS

The mean rate for the food intake variety was 28.7 foods/week (range 0-60), mean dietary fibre intake was 16.7 pts (0-36 range) and mean dietary fat intake was 18.2 pts (range 0-52); Table 2. The mean score for girls attitudes towards the health benefits of food was 34.1 pts, which was very close to the median of 34 pts. Significantly lower points for fibre intakes were seen in girls belonging to the lower-negative tertile for food health benefit attitudes (mean of 15.3 pts), compared to those from the middle-neutral tertile (17.2 pts) or from the upper-positive tertile (17.6 pts); Table 3. Girls from the upper-positive tertile consumed significantly less fat (mean 15.1 pts) than those from lower-negative tertile (19.5 pts) or the middle-neutral tertile (19.8 pts).

Table 2. Statistical measures of girls dietary characteristics and attitudes towards the health benefits of food

Characteristics	x	SD	Med	Min	Max	P33	P66
Food intake variety (foods/ week)	28.7	6.3	29	15	44	25	31
Fibre intake (pts)	16.7	5.2	16	4	35	14	18
Fat intake (pts)	18.2	6.1	18	3	35	16	21
Attitudes towards the health benefits of food (pts)	34.1	7.3	34	16	54	31	37

x – arithmetic mean, SD – Standard deviation, Me – Median, Min – minimum, Max – Maximum, P33 – percentile 33, P66 – percentile 66

Table 3. Dietary characteristics and attitude of girls towards the health benefits of food (mean ± SD)

Characteristics	Total	Tertiles for attitudes towards the health benefits of food		
		Lower-negative[1]	Middle-neutral[2]	Upper-positive
Sample number	186	62	63	61
Food intake variety (foods/ week)	28.7±6.3	27.7±6.6	29.2±6.2	29.3±6.6
Fibre intake (pts)	16.7±5.2	15.3±4.5[A,B]	17.2±5.6[A]	17.6±5.2[B]
Fat intake (pts)	18.2±6.1	19.5±4.9[A]	19.8±6.3[B]	15.1±5.8[A,B]

[1]≤31 pts, [2]32-37 pts, [3]≥38 pts, [A-A, B-B] Significant differences at $p<0.05$

Table 4. Dietary characteristics distribution according to girls attitudes towards the health benefits of food (%)

Characteristics	Total	Tertiles for attitudes towards the health benefits of food		
		Lower-negative[4]	Middle-neutral[5]	Upper-positive[6]
Sample number	186	62	63	61
Food intake variety[1]				
Low	6	8	5	7
Sufficient	48	56	44	43
Satisfactory	39	31	44	43
Very good	6	5	6	8
Fibre intake[2]				
Very low	72	81	68	67
Insufficient	26	19	29	31
Sufficient	2	0	3	2
Fat intake[3]				
Very high	8	6	14	2
High	5	6	6	3
Moderately high	16	24	14	10
Appropriate	25	26	33	16
Most favourable	46	37[A]	32[B]	69[A,B]

[1]Low: <20 foods/week, Sufficient: 20-29 foods/week, Satisfactory: 30-39 foods/week, Very good: ≥40 foods/week, [2]Very low: <20 pts, Insufficient: 20-29 pts, Sufficient: ≥30 pts, [3]Very high: >27 pts, High: 25-27 pts, Moderately high: 22-24 pts, Appropriate: 18-21 pts, Most favourable: <18 pts, [4]≤31 pts, [5]32-37 pts, [6]≥38 pts, [A-A, B-B] Significant differences at $p<0.001$

Table 5. Odds ratios (OR) found for favourable dietary characteristics according to girls attitudes towards the health benefits of food.

Characteristics	Total	Tertiles for attitudes towards the health benefits of food		
		Lower-negative[4]	Middle-neutral[5]	Upper-positive[6]
Sample number	186	62	63	61
Relatively high food intake variety[1]				
Number of cases	58	16	21	21
Percentage of cases (%)	31	26	33	34
OR (95% CI)		0.70 (0.32; 1.52)	1.00	1.05 (0.50; 2.22)
Acceptable fibre intake[2]				
Number of cases	52	12	20	20
Percentage of cases (%)	28	19	32	33
OR (95% CI)		0.52 (0.22; 1.19)	1.00	1.05 (0.49; 2.25)
Adequate fat intake				
Number of cases	132	39	41	52
Percentage of cases (%)	71	63[A]	65[B]	85[A,B]
OR (95% CI)		0.91 (0.44; 1.90)	1.00	3.10* (1.28; 7.52)

[1]>34 foods/week, [2]≥20 pts, [3]<22 pts, Numbers in brackets are 95% confidence intervals, [4]≤31 pts, [5]32-37 pts, [6]≥38 pts, Significant differences at: [A-A]p<0.01, [B-B]p<0.05, *p<0.05

The logistic regression and distribution analyses confirmed the differences in the fat intake results for girls' attitudes. The most favourable fat intakes were found in the girls with attitudes from the upper-positive tertile (69%), compared to those from the lower-negative tertile (37%) or the middle-neutral tertile (32%); Table 4. Furthermore, girls from the upper-positive tertile gave an OR for adequate fat intake (<22 pts) of 3.1 (95%CI: 1.28; 7.52; p<0.05), compared to the girls from the middle-neutral tertile (OR=1.0); Table 5. Insignificant ORs were found in girls from the upper--positive tertiles attitudes and the lower-negative tertiles for both the relatively high food intake variety and the acceptable fibre intake.

DISCUSSION

The study has demonstrated that girls with a positive attitude towards the health benefits of food has a favourable impact on making food choices for ensuring a significant source of dietary fat. There was no such association seen with food intake variety nor for dietary fibre intake. Girls with such positive attitudes had a 3 times higher chance of eating foods with lowered (and appropriate) fat content compared to those with neutral attitudes. Similar relationships between attitudes and fat intake have been seen in many other studies [20, 23, 32]. For instance studies from 2008 demonstrated that, irrespective of age, girls showed an interest in health that included appropriate nutrition [4]. These subjects reported that the correct principles of nutrition are achieved by eating foods enriched in vitamins, minerals and bifidobacteria along with having regular mealtimes, frequently eating fruit, introducing low fat foods into their diets and controlling the caloric value of their diets. A surprising outcome in the presented study was an absence of any link between having a positive attitude towards the health benefits of food with dietary fibre intake and the food intake variety. Like results were obtained by *Aikman* et al. [1], showing that such attitudes did not correlate with rates of food intake in both men and women. This lack of a relationship may be due concealment of true attitudes arising from the unwillingness of subjects to share their real beliefs and opinions [16]. It is also possible that people do not fully realise themselves what their attitudes are. However, if an given attitude is taken as certain, then making the wrong dietary choices may arise from a limited availability to foods despite having the aforementioned positive attitudes. Despite possessing appropriate knowledge and attitudes, adequate access to foods may be limited due to economic concerns or logistic problems, eg. a lack of time. It is also assumed that having a positive attitude regarding food is generally a good indicator for appropriate nutrition, when the attitude effect is more evident if account is taken of an average person's behaviour over long time periods instead of assessing a single behaviour.

Studies performed in the Polish Pomerania region showed that subjects' views on diets and their health effects were in accordance with the principles of healthy eating, although their attitudes were neutral [2]. Other studies reported similar findings when checking nutritional knowledge of high school students and its impact on lifestyle and risk of cardiovascular disease. Even though subjects had wide knowledge in such areas, there was no correlation observed with their pro--healthy nutritional behaviour [3]. Studies on students

also found that although they knew about the principles of healthy eating, their nutritional behaviour was inappropriate [20, 21]. Other studies however indicate that health concerns and awareness about the impact of diet on health increases with age and is most clearly obvious in the elderly and sick [13, 29]. Many studies related to attitudes and eating habits of the young from various regions of Poland stress the necessity of conducting nutritional education and promoting a healthy lifestyle [5, 10, 17]. Work by *Kearney* et al. [15] showed that levels of knowledge may affect eating behaviour in adulthood, however this knowledge does not necessarily translate into appropriate eating habits, as is often the case that people are unable to put this into practice. A further confounding factor, is the contradictory information relayed by the mass media resulting in lowered levels of trust for the general public audience. Nowadays, it is the Internet, TV and the daily press that are the main sources of knowledge on nutrition for the younger generation [24, 28]. It seems however, that just education alone will not bring about the required outcomes if it is not associated with promoting a healthy lifestyle subject to multi-stage evaluation. Given the above, it can be concluded that certain types of nutritional behaviour in girls and young women are a significant problem and may contribute towards a worse health state of our society.

Study strengths and weaknesses

The weakness of the study are the convenience sampling method and relatively small sample size. The sample was also not randomly taken, however the socio-economic and demographics status of the subjects matched that of the country as a whole. Advantages include the use of logistic regression. Calculating ORs are an indicator of how often a defined event occurs (beneficial dietary charcteristics) which allows sample size-dependent corrections to be made. This increases the power of the results thereby making them fit for making generalisations.

CONCLUSIONS

The positive attitudes of girls towards the health benefits of food are conducive for making more favourable food choices and lowered dietary fat intake, however this did not significantly affect fibre intake nor food intake variety.

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Conflict of interest

The authors declare no conflict of interest.

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ANTHROPOMETRIC ASSESSMENT OF THE NUTRITIONAL STATUS OF CHILDREN AND ADOLESCENTS RESIDING IN SELECTED POLISH ORPHANAGES BASED ON THEIR ENERGY INTAKE AND PHYSICAL ACTIVITY LEVEL

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ABSTRACT

Background. Actions to the prevention of overweight and obesity should be first addressed to the youngest population and their parents, guardians as well as teachers. The major objectives of prevention and treatment of overweight and obesity programme should be focused on modification of nutritional habits and promotion of physical activity.

Objective. The aim of this study was to evaluate the nutritional status, intake of energy and macronutrients as well as the physical activity of students from orphanages in Krakow.

Material and methods. Study was performed in 5 orphanages located in Krakow (Poland), which were under control of Social Welfare Centre in Krakow. The study involved 153 students, 67 girls and 86 boys, aged from 7 to 20 years. Nutritional status was assessed by anthropometric measurements. The protein and total fat content in diets was measured by chemical analyses and carbohydrates were calculated by difference. Physical activity level of children and adolescents was assessed by questionnaire.

Results. Over 80% of boys and about 90% of girls had a normal body mass. Students have spent their free time on additional physical activity from 1h 34 min/day to 5 h 12 min/day. They also have spent their free time on sedentary activities on average 4 h/day. Daily diets of students did not met recommendations for energy, carbohydrates and fats. Intake of protein was too high and exceeded the estimated average requirement even over three times.

Conclusions. Despite the insufficient intake of fat and carbohydrates, students generally showed a proper BMI value. This suggests that excess intake of protein was used for maturation process and was additional source of energy. Reported additional physical activity was satisfactory.

Key words: *students of orphanages, nutritional status, nutrients intake, physical activity*

STRESZCZENIE

Wprowadzenie. Działania dotyczące zapobiegania nadwadze i otyłości powinny być kierowane głównie do dzieci, ich rodziców, opiekunów prawnych, a także do nauczycieli. Powinny one koncentrować się głównie na monitorowaniu i korygowaniu nawyków żywieniowych oraz promowaniu aktywności fizycznej.

Cel. Celem pracy była ocena stanu odżywienia, spożycia energii i makroskładników, a także aktywności fizycznej dzieci domów dziecka w Krakowie.

Materiał i metody. Badania przeprowadzono w 5 domach dziecka, będących pod nadzorem Miejskiego Ośrodka Pomocy Społecznej. W badaniach wzięło udział 153 wychowanków, w tym 67 dziewczęta i 86 chłopców, w wieku od lat 7 do 20 lat. Stan odżywienia dzieci oceniano przy pomocy pomiarów antropometrycznych. W całodziennych racjach pokarmowych dzieci i młodzieży oznaczono, metodami chemicznymi, zawartość białka i tłuszczu. Ilość węglowodanów obliczono z różnicy. Poziom aktywności fizycznej u dzieci i młodzieży oceniono przy pomocy kwestionariusza.

Wyniki. Ponad 80% chłopców i ~90% dziewcząt miało prawidłową masę ciała. Czas poświęcony na dodatkową aktywność fizyczną, przez wychowanków krakowskich domów dziecka, wahał się w granicach od 1h 34 min./dobę do 5 h 12 min./dobę, czyli w pełni pokrywał zalecaną ilość, wynoszącą 1 h/dobę. Zajęcia sedenteryjne trwały średnio 4 h/dobę.

W sposobie żywienia badanej młodzieży występowały błędy, polegające na niepełnym pokryciu zapotrzebowania na energię, węglowodany, tłuszcze oraz błonnik pokarmowy. Równocześnie stwierdzono nadmierne ilości biała w racjach, przekraczające wartości zalecane nawet ponad 3-krotnie.

Wnioski. Pomimo niedostatecznej ilości energii, tłuszczów i węglowodanów w racjach pokarmowych wychowanków domów dziecka, wartości wskaźnika BMI były na ogół prawidłowe. Sugeruje to, że nadmierne spożycie białka było wykorzystane do procesów wzrostu i rozwoju oraz jako dodatkowe źródło energii. Czas przeznaczony na dodatkową aktywność fizyczną przekraczał zalecany czas.

Słowa kluczowe: *wychowankowie domów dziecka, stan odżywienia, sposób żywienia, aktywność fizyczna*

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INTRODUCTION

Obesity has become a major public health problem around the world in the twenty-first century. Statistical data shows the worrying trends, not only because that the percentage of obese people constantly grow, but also because a lot of children in early stage of development become obese. Statistical data have shown that more than 22 million of children under five years old are obese around the world. It has been also reported that obesity affected 5 to 10% of children under 10 years of age [9, 25].

Prevention of obesity should be primary addressed to the population below 18 years of age and their parents as well as teachers. The major objectives of prevention and treatment of overweight and obesity programme should be focused on modification of eating habits and increased physical activity. Properly developed prevention of obesity can bring benefits to the society, primarily by reducing costs on health care related to the treatment of diet-related diseases, as well as the economic impact of disability and premature mortality. Prevention of obesity and underweight of children and adolescents should become a priority of health policy in all countries around the world [25, 29].

Orphanages are responsible not only for the child's physical and psychological development, but also for adequate living conditions. In these institutions nutritional education should be important part of teaching programme. Due to the fact that children and adolescents are the group most vulnerable to the effects of poor nutrition, it is reasonable to undertake studies concerning the assessment of nutritional status, nutritional habits and the physical activity of children and youth from orphanages.

Monitoring and analysis of parameters of physical development is an essential factor of the assessment of growing of children. Weight losses, inhibition of body weight gain, or improper weight gain are often the first symptoms of disorder or health problems. Evaluation of nutritional status of children is an important tool in assessment of proper growth and requirements for nutrients [24, 25, 29].

The aim of this research was to evaluate the nutritional status of residents of orphanages, located in Krakow as well as assessment of selected elements of lifestyle, which included energy, macronutrients intake and physical activity.

MATERIALS AND METHODS

Study was performed in 2008 in 5 orphanages located in Krakow (Poland), which were under control of Social Welfare Centre in Krakow. The study involved 67 girls and 86 boys, aged from 7 to 20 years (Table 1). The study included seven measurements commonly used in the assessment of nutritional status: height, weight, arm and chest circumference, as well as the thickness of three skin folds (triceps above, under the shoulder and the iliac crest).

Weight was measured by a trained person using a Digital Scale (Radwag Radom, Poland). Weight was measured in kilograms with an accuracy of 100 g. Height was measured using a stadiometer with a vertical backboard and moveable headboard with an accuracy of 1 mm. On the basis of measurements of weight and height, body mass index (BMI) was calculated.

The thickness of skinfolds was measured with *Harpender* skinfold caliper (measuring pressure: 10 gms/mm^2 constant over range) with an accuracy of 0.1 mm. The sum of three skinfolds thickness was used to estimate total and subcutaneous body fat content [26]. Assessment of nutritional status was performed in relation to the age, using the growth charts prepared by the University of Physical Education in Krakow [5]. In this study the value of the parameters, between 10 and 90 percentile were considered as the proper, while values below 10 and above 90 percentile were used for indicating respectively underweight, overweight and obesity.

Questionnaire evaluating the physical activity of the children and adolescents was performed anonymously, through face to face interviews. The survey was related to the frequency and type of physical activity undertaken by children and adolescents. Based on these results, the average time spent to perform regular daily activities, other physical activity (handball, volleyball, tennis, cycling, etc.) [h/person/day], and the time spent on passive activities (watching TV, computer, homework) [h/person/day] was calculated. Results were compared to the daily physical activity recommendations, prepared by the World Health Organization. The European

Table 1. Characteristics of children and adolescents from orphanages

Orphanages	Male [n]	Female [n]	Age [years]		Weight [kg]	
			range	$\bar{x}$	range	$\bar{x}$
I	8	15	7-13	11.0	13-43	25.3
II	-	30	11-18	15.0	55-61	59.3
III	26	14	8-20	15.0	20-79	48.7
IV	12	8	14-20	16.6	42-72	52.0
V	40	-	13-20	16.7	35-96	55.4

Union and its Member Countries recommend at least 60 minutes daily physical activity of moderate intensity for children and youth in school age. This activity should be carried out in the forms of developmentally appropriate, enjoyable and involving different exercises, with an emphasis on the development of motor skills [6].

Assessment of nutritional pattern was completed based on chemical analysis of daily diets of children and youth. Daily diets were collected in four seasons of 2008. Homogenized and freeze-dried daily diets were used for the determination of protein, with using *Kjeldahl* method and total fat content with *Soxhlet* method [7]. Total carbohydrates were calculated by the difference between dry mass of daily diets and sum of total fat, protein and ash content. The energy content of daily diets was calculated based on the level of digestible carbohydrates, fat and protein, using Atwater factors i.e. 4 kcal, 9 kcal, 4 kcal/1 g respectively.

In order to assess the meeting of recommendations for macronutrients and energy obtained results were compared with Polish recommendations [12]. For protein the EAR (estimated average requirement) value was used. To assess the intake of fat with daily diets the level of 30% of recommended value for provide energy, from this nutrient, was used. Carbohydrates intake was compared to recommended range of intake in the prevention of chronic disease (55-75% of total energy) – i.e. 137-187 grams of carbohydrate/1000 kcal. For energy intake the recommended value for children with moderate physical activity was used.

RESULTS

Most of students from orphanages had correct body mass. Excessive body weight, indicating a presence of overweight or obesity, was found in 6% of boys and 6% girls. Too low body mass, indicating the thinness or underweight, was measured in 14% of boys and 5% of girls (Table 2).

Proper BMI value was characterized in 86% of boys and in 92% girls. The thickness of the sum of three skin folds was proper in 83% and 85% respectively. More frequently the underweight than overweight and obesity were observed based on BMI value as well as on the sum of three skin folds in assessed group of children and adolescents (Table 2).

The important finding of this study is that more frequently extremely low content of fat was measured

Table 2. Percentage of children and adolescents in the results of anthropometric measurements

Measurements	Unit	Male					Female				
		EL	VL	Standard	VH	EH	EL	VL	Standard	VH	EH
Weight	kg	13	0	81	2	4	5	0	90	0	5
Height	cm	15	0	83	2	0	5	2	90	0	3
BMI	kg/m^2	6	2	86	0	2	0	0	92	0	8
Arm circumference	cm	4	2	84	4	6	2	0	95	0	3
Chest circumference	cm	4	0	81	10	5	0	0	90	2	8
The thickness of skinfolds above triceps	mm	2	2	90	0	6	0	0	92	0	8
The thickness of skinfolds under the shoulder	mm	6	0	86	0	8	7	0	88	0	5
The thickness of skinfolds under the iliac crest	mm	6	4	90	0	0	10	0	87	0	3
The sum of three skinfolds thickness	mm	9	2	83	2	4	10	0	85	0	5

EL- extremely low value, VL- very low value, S- standard, VH- very high (overweight), EH- extremely high (obesity).

Table 3. Time used for sedentary and additional physical activity by children and adolescents

Gender	Sedentary activities [min (h)/person/day]							Additional physical activity [min (h)/person/day]	
	Watching TV		Playing computer games		Doing homework		Total		
	range	$\bar{x}$	range	$\bar{x}$	range	$\bar{x}$	$\bar{x}$	range	$\bar{x}$
Female	34-253	113 (1.9)	27-164	77 (1.3)	21-83	39 (0.6)	230 (3.8)	52-207	119 (2.0)
Male	21-328	125 (2.1)	6-204	71 (1.2)	13-18	50 (0.8)	246 (4.1)	58-456	220 (3.7)

Table 4. The most common forms of additional physical activity undertaken by children and adolescents

Physical activity	Female		Male	
	n	[%]	n	[%]
cycling	28	70.0	41	67.2
skating	27	67.5	15	24.6
dancing	27	67.5	7	11.5
bowling	9	22.5	4	6.6
playing tennis	1	2.5	4	6.6
playing soccer	23	57.5	53	86.9
playing volleyball	28	70.0	15	24.6
playing basketball	24	60.0	21	34.4
playing handball	0	0.0	4	6.6
mountaineering	0	0.0	5	8.2
table tennis	21	52.5	30	49.2
rowing	0	0.0	3	4.9
canoeing	0	0.0	1	1.6
playing golf	1	2.5	0	0.0
running on a treadmill	14	35.0	11	18.0
sprint	7	17.5	11	18.0
long-distance running	2	5.0	9	14.8
baseball game	3	7.5	2	3.3
jumping rope	17	42.5	5	8.2
hiking	23	57.5	29	47.5
walking	38	95.0	38	62.3
swimming	15	37.5	25	41.0
gym	3	7.5	16	26.2

than high content of it in students. It may suggest that students had higher content of muscle mass. What is more, results of the questionnaire concerning to evaluation of physical activity of assessed children and adolescents indicate, that students have chosen active forms of spending free time instead of passive ones (Table 3). It is probably the reason of lower content of fat in assessed population. Residents of orphanages have also spent their time after school on sedentary activities (~ 4 h/day), mostly watching TV (~ 2 h/day). More than an hour a day they have played on computer or they have used the Internet. An average of 45 min. was necessary for homework. Boys, compared to girls, almost twice longer, but less than 4 hours per day, spent their free time on additional physical activity. Among the boys dominated the following forms of physical activity: playing soccer (87%), cycling (67%) or walking (62%). Less popular were: table tennis (49%), hiking (48%) and swimming (41%). Girls, when chosen active form of spending free time they usually preferred: walking (95%), cycling (70%), rolls (68%) and dancing (68%). The most commonly practiced by the girls team games were: volleyball (70%), basketball (60%) and soccer (58%) (Table 4).

Results concerning assessment of intake basic nutrients with daily diets have shown that average intake of energy, fat and carbohydrate met of about 80% recommended values. The intake of protein with daily diets exceeded EAR value and ranged from 115 - 362% (average 214.2%). It has been also found that the intake of basic nutrients was varied, coefficient variation (CV) ranged from 22.2% to 27.1%. (Table 5).

DISCUSSION

Body mass, height, BMI, thickness of skinfolds

Results obtained in this study indicate that the majority of students (~81% boys and ~90% girls) were characterized by normal weight, height and BMI value. A significant deficiency in body weight was measured in 13% of boys and 5% of girls, and overweight or obesity in 6% of population. These results were confirmed by measurements of thickness of skinfolds (Table 2). Once again, these studies confirm the usefulness of BMI (assessed based on growth charts) to the initial assessment of the degree of obesity in children and the general condition of percentage of fat in development age. Similar findings were published by *Ozimek* and co-workers [22].

In available literature there is a few information concerning nutritional status of children from orphanages [30]. Results obtained in this study are similar to data published by other authors, which assessed nutritional status of children and/or adolescents from other places of residence.

Table 5. Intake of energy and basic nutrients by children and adolescents

		Energy [kcal/person/day]	Total proteins [g/person/day]	Total fats [g/person/day]	Digestible carbohydrates [g/person/day]
Intake	range	1455.9-3141.9	52.2-121.1	40.6-113.1	198.7-443.0
	$\bar{x} \pm$ SD	2161.9 ± 486.7	87.2 ± 19.5	68.7 ± 18.6	307.3 ± 74.4
	CV	22.5	22.4	27.1	24.2
Meeting of requirements [%]		84.0	214.2	80.3	62.1- 84.9

$\bar{x}$ - mean, SD - standard deviation, CV- coefficient variation [%]

In Polish survey conducted by the Department of School Medicine Institute of Mother and Child in 1995 (2 mln of children and adolescents were assessed), repeated in 2005 (adolescents aged 13-15 years), it was shown that similar percentage of adolescents was obese, more frequently in girls than in boys. Additionally it was found that higher percentage of girls (compared to our studies) and similar percentage of boys were overweight [14]. Results obtained in our study are confirmed also by data published by *Małecka-Tender* et al. [17]. *Chabros* et al. [4] reported that the percentage of girls with overweight, obesity as well as with weight deficiency was higher.

Our data did not correspond with results published by other authors. A study in primary schools in Milan showed that the lowest percentage of children's with proper BMI, as well as higher percentage with overweight and obesity [2]. Other research showed that the excessive thinness, overweight and obesity was found in higher percentage of students of primary and secondary schools [3, 11, 15].

Too high or too low intake of nutrients with daily diets by children and adolescents may cost serious health problem in future. It can predispose to develop of overweight in the future and consequently, lead to health complications such as endocrine complications, hyperlipidemia, insulin resistance, hypertension and liver steatosis. Overweight and obesity in children also have negative psychosocial effects [25, 29].

In this study we have found that the correct value of the thickness of skinfolds was measured in ~ 90% of the participants both genders (in relation to a wide range of standards, between 10 and 90 percentiles). We also reported the strong correlation between the thickness of skinfold and gender. The average thicknesses of various skinfolds were higher in girls than in boys. What is more, boys had more often proper content of fat compared to girls.

Skin-fold thickness in girls from 8 years of age has a tendency to spread, and in boys - especially on hands - to decrease. In boys two years before the maturation the thickness of subcutaneous fat increases. During the intensive growth of boys the percentage of fat usually does not change or decreases [28]. This was also observed in this study. Among younger children, up to 10 years of age, a higher percentage of boys than girls (40% and 9% respectively), had a higher content of fat, providing the occurrence of overweight. In older age groups, girls had a higher content of subcutaneous adipose tissue, providing the overweight or obesity, compared to boys. *Mleczko* et. al. [19] reported the long term changes in growth of students of the Academy of Physical Education in Krakow between the years 1972 and 2008. These authors showed that the percentage of fat, expressed as the sum of skinfolds under the shoulder, on the arm and iliac crest, increased within 36 years. These authors suggest that these changes are the typical for intergenerational change, but sharply marked. A similar trends has been reported by *Chrzanowska* et al. [5], *Miałkowska* and *Pietraszewska* [18] and by *Radochońska* and *Perenc* [23]. Last authors found that between first (1978/79) and third (2003/04) period of studies (25 years) thickens of skinfolds of boys, aged 3-18, increased almost double. In the case of girls the thickness of the skinfolds increased by about 8 mm. On the other hand girls had lower content of fat and the percentage of them with deficiency in body mass and very low content of fat was increased [23]. *Langnase* et al. [16] showed the highest fat content (calculated from measurements of skinfolds) in children from families with lower incomes.

Physical activity level

The natural need for being active is the largest in childhood, and decreases with age. Physical activity is an important factor in prevention of chronic non-communicable diseases. Lack of exercise causes abnormal metabolic processes; it has also a negative impact on the mental health. Physical activity not only stimulates the development of children and adolescents, but also slows the aging process and relieves the symptoms of involution individual's in mature [22]. In our study we found that children and adolescents from orphanages spent their free time watching TV, playing on computer and doing homework about four hours per day. Boys, compared to girls, almost two time longer had spent their time on additional physical activity. It was about 4 hours per day. According to the guidelines of the World Health Organization and the European Union it is recommended at least an hour per day, moderate intensity physical activity for children and adolescents [6]. Results obtained in our study are not similar to data published by other authors. *Jegier* et al. [13] showed that 26% to 50% of adolescents had insufficient amount of physical activity. It has been well reported that boys, regardless of age, are more physically active than girls [1, 32]. It was also confirmed in our studies. More than 50% of adolescents have spent their free time usually watching TV 1-2 h/day. Watching TV during weekends and for 3-4 h/day, declared 31% of adolescents [27]. *Ouwens* et al. [21] reported that 24% pre-adolescent children watched TV less than 30 min./day, 33% watched TV between 30 min. and one hour, 26% between one and two hours and 17% watched TV more than 2 h/day. TV-watching was positively associated with snacking, external eating and emotional eating, but it was not associated with BMI. International survey on health behavior of school children showed that ~40% respondents watched TV 2-3 h/day, both on school days and weekend [10].

Intake of energy and basic nutrients

Assessment of nutritional pattern of children and adolescent of orphanages located in Krakow showed many mistakes related to the amount of energy and nutrients intake. Improper composition of daily diets were also found in orphanages located in Poznań [30]. Poorly balanced diet can result in fluctuations in blood glucose levels, lowering the concentration, reduction of mental and physical activity, and thus may have an impact on the effectiveness of studying. In addition, irregularities in food consumption can cause changes in metabolic rate. It causes higher conversion of energy from consumed food in fat [8]. Although proteins are important during the growth of children but on the other hand their metabolites may affect the liver and kidneys function. Long-term excessive protein intake in future can cause development of metabolic disorders e.g. high level of homocysteine, it increased risk of the atherosclerotic process and decreased absorption of calcium [12]. In addition, it has been reported that excided intake of proteins with daily diets by children and adolescents is correlated with a higher BMI [31].

CONCLUSIONS

Although the majority of assessed children from Polish orphanages had proper body weight and satisfactory additional physical activity level, eating habits should be changed. These changes should apply to increase the participation of total carbohydrates and fat as well as to decrease of total protein in the diets.

These irregularities indicate the necessity of intervention and monitoring of energy and nutrition intake by children from other orphanages.

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Conflict of interest

Authors declare no conflict of interest.

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INFLUENCE OF NON-DIETARY FACTORS ON THE PREVALENCE OF ABDOMINAL OBESITY AS A MAJOR COMPONENT OF THE METABOLIC SYNDROME AMONG 17-18-YEAR-OLD YOUTH

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ABSTRACT

Background. Youth nutrition and their nutritional status are conditioned by many factors, some of the main ones being: economic, social, climatic, cultural, and psychological factors as well as nutritional knowledge. With the growing problem of overweight and obesity among children and young people, the incidence of the metabolic syndrome is also increasing.

Objective. The aim of the study was to assess the impact of demographic, sociological and psychological factors on the incidence of obesity among 17–18-year-old adolescents from Wroclaw and vicinity as a major risk factor for the development of the metabolic syndrome.

Material and Methods. The study was conducted in three upper-secondary schools in Wroclaw, Poland. In the surveyed group (17-18 years old, n = 269) girls accounted for 59.5% and boys constituted 40.5%. Majority of young people were Wroclaw citizens (72.9%). Centile charts elaborated by the Children's Memorial Health Institute were adopted for the evaluation of anthropometric parameters. Evaluation of the impact of non-dietary factors on the manner of nutrition was carried out using own questionnaire.

Results. Based on the tests, abdominal obesity was determined among 34.5% of adolescents aged 17 years and among 65.5% of these aged 18 years. Obesity was more common in girls carrying genetic burden of the disease. Youth with the largest waist circumference most often declared to use slimming diets - 6.7%, and the lowest hunger sensation in stress - 3.4%. In addition, 30.5% of the adolescents with the smallest waist circumference and 11.5% with the largest waist circumference declared to be non-smoking. Occasional alcohol consumption was declared by 30.1% of young people with the smallest waist circumference, and 13.4% with the largest waist circumference.

Conclusions. Youth with abdominal obesity significantly more likely than those with normal waist circumference applied slimming diets. Significant impact on the formation of abdominal obesity among girls had inherited disease burden.

Key words: *adolescents, abdominal obesity, socioeconomic status, psychological factors, poor nutritional behaviours*

STRESZCZENIE

Wprowadzenie. Sposób żywienia młodzieży i ich stan odżywienia są uwarunkowane przez wiele czynników, a główne z nich to: czynniki ekonomiczne, klimatyczne, kulturowe, psychologiczne i społeczne oraz wiedza żywieniowa. Wraz z rosnącym problemem nadwagi i otyłości wśród dzieci i młodzieży narasta problem rozwoju zespołu metabolicznego.

Cel. Celem badań była ocena wpływu czynników demograficznych, socjologicznych i psychologicznych na częstość występowania otyłości brzusznej wśród 17-18 letniej młodzieży z Wrocławia i okolic jako głównego czynnika ryzyka rozwoju zespołu metabolicznego.

Materiał i metody. Badania zostały przeprowadzone w trzech wrocławskich szkołach ponadgimnazjalnych. W grupie badanych uczniów w wieku 17-18 lat (n= 269) dziewczęta stanowiły 59,5%, natomiast chłopcy 40,5% ogółu badanych. 72,9% badanych pochodziło z Wrocławia. Do oceny parametrów antropometrycznych przyjęto opracowane w Instytucie Pomnik-Centrum Zdrowia Dziecka siatki centylowe. Ocena wpływu czynników pozażywieniowych na sposób żywienia została przeprowadzona za pomocą autorskiego kwestionariusza opracowanego w Katedrze Żywienia Człowieka Uniwersytetu Przyrodniczego we Wrocławiu.

Wyniki. Stwierdzono występowanie otyłości brzusznej wśród 34,5% nastolatków w wieku 17 lat i wśród 65,5% młodzieży 18-letniej. Otyłość występowała częściej u dziewcząt obciążonych dziedzicznie tą chorobą. Dziewczęta istotnie częściej niż chłopcy zwracały uwagę na swój wygląd i były bardziej krytyczne w stosunku do swojej masy ciała. Zadowolenie ze swojego wyglądu istotnie częściej deklarowały osoby o najmniejszym obwodzie talii. Młodzież z największym obwodem

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talii najczęściej deklarowała stosowanie diet odchudzających - 6,7%, i najmniejsze odczuwanie głodu w stresie - 3,4%. Niepalenie papierosów deklarowało 30,5% młodzieży z najmniejszym obwodem talii i 11,5% z największym obwodem talii. Okazjonalne spożywanie alkoholu deklarowało 30,1% młodzieży z najmniejszym obwodem i 13,4% z największym obwodem talii.

Wnioski. Młodzież z otyłością brzuszną istotnie częściej niż osoby z prawidłowym obwodem talii stosowała diety odchudzające. Wśród czynników pozażywieniowych istotny wpływ na powstawanie otyłości brzusznej wśród dziewcząt miało dziedziczne obciążenie tą chorobą.

Słowa kluczowe: *młodzież, otyłość brzuszna, status socjoekonomiczny, czynniki psychologiczne, niewłaściwe zachowania żywieniowe*

INTRODUCTION

Youth nutrition has to ensure the proper physical and mental development and utilization of the genetically-determined developmental potential. A properly designed diet should prevent typical diseases of the adolescence period as well as reduce the risk of development of food-related diseases [2].

Nutrition is conditioned by many factors, some of the main ones being: economic, climatic, cultural, psychological and social factors as well as nutritional knowledge. Socioeconomic status reflects the diversity of society. It specifies where individuals or groups are located in the social structure. It is determined by a corresponding level of income, education, occupational status, family structure, and place of residence. These relationships have been frequently addressed in both national [1, 11, 15, 16, 24, 29] and foreign [8, 9, 19, 21, 27] studies in recent years.

Adequate nutrition during childhood and adolescence determines the state of health in adulthood. Among 50-80% of children and youth, overweight and obesity persist into adulthood [6]. These disorders represent a growing social problem in recent years. There are many reasons for this including lifestyle change, low physical activity, stress or irregular eating habits. Until recently, majority of overweight or obese people were adults, while at present, this group is growing in young people and children. Worldwide, 66% of adults are overweight, and 34% are obese. In Europe, 50% of the population is overweight and 30% is obese [9]. In Poland, according to the WOBASZ study (Nationwide Multicenter Study on the State of Polish Population Health), conducted in the years 2003-2005, 27.9% of women and 40.4% of men were overweight, while 22.4% of women and 21.2% of men were obese [4, 12]. According to the report of International Obesity Task Force (IOTF), 155 million children and young people in the world are overweight or obese, and this includes 30-45 million of children and young people [10]. In Europe 16-22% of children and youth are overweight or obese, and 4-6% of them are obese [27].

In Poland, according to the National Institute of Food and Nutrition (IZZ) in Warsaw, 11.1% of girls and 15.9% boys are overweight, and 3.4% of girls and 4.0% of boys are obese [2]. With the growing problem of overweight and obesity among children and young people, the incidence of the metabolic syndrome is also increasing, and its main components are: abdominal obesity, hypertension, and abnormal lipid and carbohydrate metabolism. Identification of factors constituting the metabolic syndrome at the age of development offers the possibility of early initiation of treatment and reducing the risk of developing a full-blown metabolic syndrome.

The aim of this study was to assess the influence of demographic, sociological and psychological factors on the incidence of abdominal obesity among 17-18-year--old youth from Wroclaw and vicinity as a major risk factor for the development of the metabolic syndrome.

MATERIAL AND METHODS

Characteristics of the study group

The study was conducted between November 2010 and May 2011 in three upper-secondary schools in Wroclaw, participating in the "Health-Promoting School" program. The group of students (n = 269) consisted of 160 girls and 109 boys aged 17-18 years, enrolled in the first and second classes. Girls accounted for 59.5% and boys 40.5% of the surveyed students. First grade students accounted for 54.0% of the study group (146 persons), and second graders constituted 46.0% (123 persons). Most students attended specialized secondary schools (147 persons), constituting 54.6% of the total, followed by a technical secondary school students (101 persons, 37.5%), and a vocational school (21 persons, 7.8%). 72.9% of participants were from Wroclaw, 11.1% lived in towns, while 15.2% in rural areas. The largest group (69.9%) in the young people investigated was this with complete families - living only with their parents or with additional siblings. 30.1% of the surveyed students came from incomplete families including 27.4% of single-parent families, 1.5% declared that they

lived only with siblings, and 1.1% with a person from extended family. The inclusion criteria were as follows: age of students, the consent given by the parents and young people to carry out the study, and participation of students in a complete cycle of tests.

Ethical aspects

Parents, guardians or students who were of age, provided written informed consent to the study. In a statement provided guarantees covering confidentiality. The study was approved by the Research Ethics Committee of the Medical University in Wroclaw (KB-376/2009) which is affiliated with the Council for National Research Ethics in Poland.

METHODS

Anthropometric analysis

In the studied group of young people, body mass and height were measured using a medical scale equipped with a stadiometer (medical mechanical column scale ADE) without shoes and upper clothing. Measurements of waist circumference and hip circumference were performed using a measuring tape. Hip circumference measurements were performed at the level of the iliac crest, while the waist measurement was made midway between the superior iliac crest and the lower margin of the iliac arch. Centile charts developed at the Children's Memorial Health Institute were adopted for the evaluation of anthropometric parameters [14] at the following cut-off points: waist circumference > 95th percentile - abdominal obesity (central) (17–18-year-old girls > 80 cm, 17-year-old boys > 90 cm, 18-year-old boys > 91 cm), BMI > 85th percentile – overweight (17–18-year-old girls 23.9-26.6 kg/m^2, 17-year-old boys 24.9-27.4 kg/m^2, 18-year-old boys 25.5-28.2 kg/m^2), and BMI > 95th percentile – obesity, 17-18-year-old girls > 26.6 kg/m^2,17-year-old boys > 27.5 kg/m^2, 18-year-old boys > 28.2 kg/m^2.

Analysis of non-dietary factors

Evaluation of the impact of non-dietary factors on the manner of nutrition was carried out using own questionnaire developed at the Department of Human Nutrition at Wroclaw University of Environmental and Life Sciences. The questionnaire contained questions about gender, age, family structure of the young people, parents' education, place of residence, metabolic diseases in the family, self-evaluation of weight, paying attention to weight, satisfaction with appearance, cigarette smoking, alcohol consumption as well as general knowledge of nutrition and influence of advertisings on food choices. The questionnaire was validated on a group of 50 personal. Nutritional knowledge was tested by a questionnaire.

Statistical analysis of the results

All the results were subjected to statistical analysis using StatSoft software Statistica 10. Accordance of continuous anthropometric data with normal distribution was checked with the *Shapiro-Wilk* test. Parametric tests to assess the impact of non-dietary factors on selected anthropometric parameters of the study group could not be used due to the absence of accordance with the normal distribution. In order to characterize the group of young people examined, median (Me), quartile deviation (Q), and the 75th and 95th percentile values of selected anthropometric indicators were calculated. Significant correlations between discontinuous non-dietary factors and selected anthropometric parameters were calculated using multi-way tables and the relationships were shown with the *Chi*-square test. Level of significance was set at $p < 0.05$.

RESULTS AND DISCUSSION

The youth surveyed in this study was divided into three groups according to waist circumference:
Group 1 (n = 131 - G = 62, B = 69) – waist circumference < 75th percentile
Group 2 (n = 80 - G = 57, B = 23) – waist circumference 75-95th percentile
Group 3 (n = 58 - G = 41, B = 17) – waist circumference > 95th percentile

The relationship between age and waist circumference is shown in Figure 1.

Based on the tests performed, abdominal obesity was determined among 34.5% of young people aged 17 years and among 65.5% of these aged 18 years. *Cook* et al. [3] reported the presence of abdominal obesity among 9.8% of the group in a study conducted among American adolescents (n = 2430) aged 12-19 years. *Cruz* et al. [4] reported the presence of abdominal obesity among 62% of the group in a study conducted among Spanish young people (n = 126) aged 8-13 years. The study *of Firek- Pędras* et al. [7] showed the presence of abdominal obesity among 63% of the group including 64 children aged 6-18 years. Different conditions of the studies, various group sizes and different cut-off point confirming the presence of abdominal obesity were the main reasons for disparity of results. However, most studies point to the spreading problem of obesity among increasingly younger population.

The non-dietary factors that increase the risk of obesity include cigarette smoking and alcohol consumption. In our study, the highest percentage of young people, re-

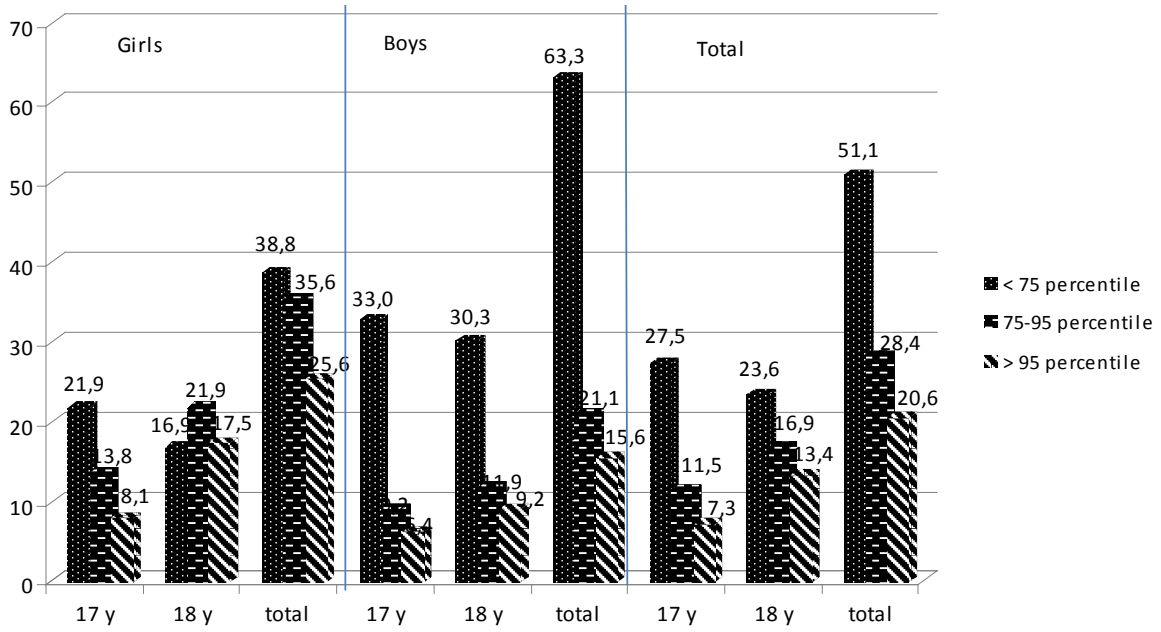


Figure 1. The effect of age on the incidence of obesity among the young people in the study

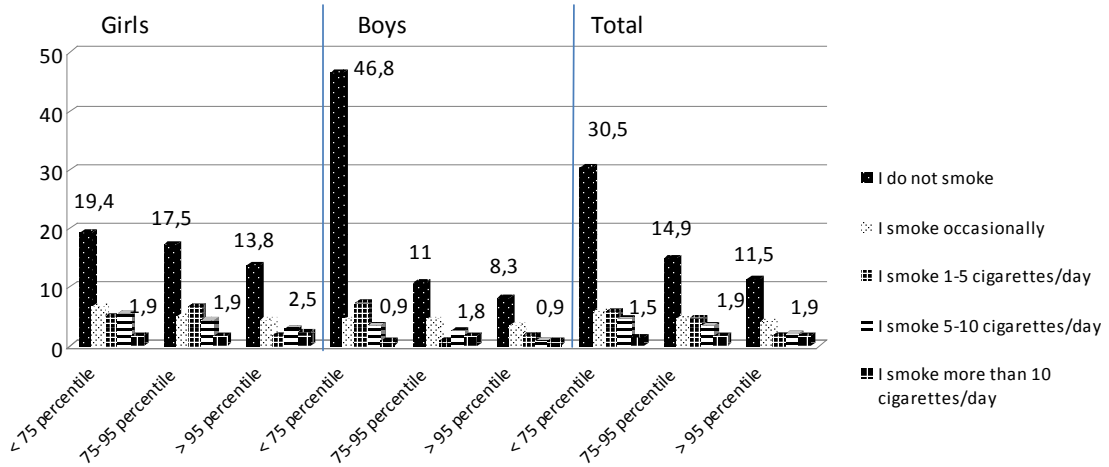


Figure 2. Prevalence of smoking among the young people in the study in relation to waist circumference

gardless of gender and waist circumference, declared to be non-smoking. Among youth with the smallest waist circumference, smoking was 30.5%, while among those with the largest waist circumference 11.5% declared to be smoking (Figure 2). The study of *Szczerbiński* et al. [26] found 26.5% of their study group to be regular smokers, while in the study of *Myers and Kelly* [18] 75% of young people were habitual smokers, and 61% had smoked 10 or more cigarettes a day. The study by *Sygit* et al. [25] carried out on 300 people aged 15-19 years from Western Pomerania showed that 21% of young people were overweight and 86.9% of young people with obesity regularly smoked cigarettes. In our study over 10% of students with abdominal obesity declared to be smokers. In this study occasional alcohol consumption was declared by 30.1% of young people with waist circumference < 75th percentile, 21.6% of the group with waist circumference within 75th and 95th percentile, and 13.4% of the group with waist circumference above 95th percentile (Figure 3). The study of *Sygit* et al. [25] showed that 48.6% of overweight youth and 43.5% with obesity, regularly consumed alcohol. *Szczerbiński* et al. [26] in a study conducted among 17–19-year-old youth from the Sokółka county showed that alcohol consumption was declared by 80.4% of young people studied, and 17.3% of these teenagers were at least once in their lifetime in a state of intoxication.

Metabolic diseases that occur most frequently in the immediate family of the young people from the study are shown in Figure 4.

Our results showed a statistically significant correlation between the incidence of obesity in the family, and diabetes and obesity occurring together in specified subgroups of girls and waist circumference (Figure 4). Diabetes was significantly more frequent among parents of boys whose waist circumference was below the 75th

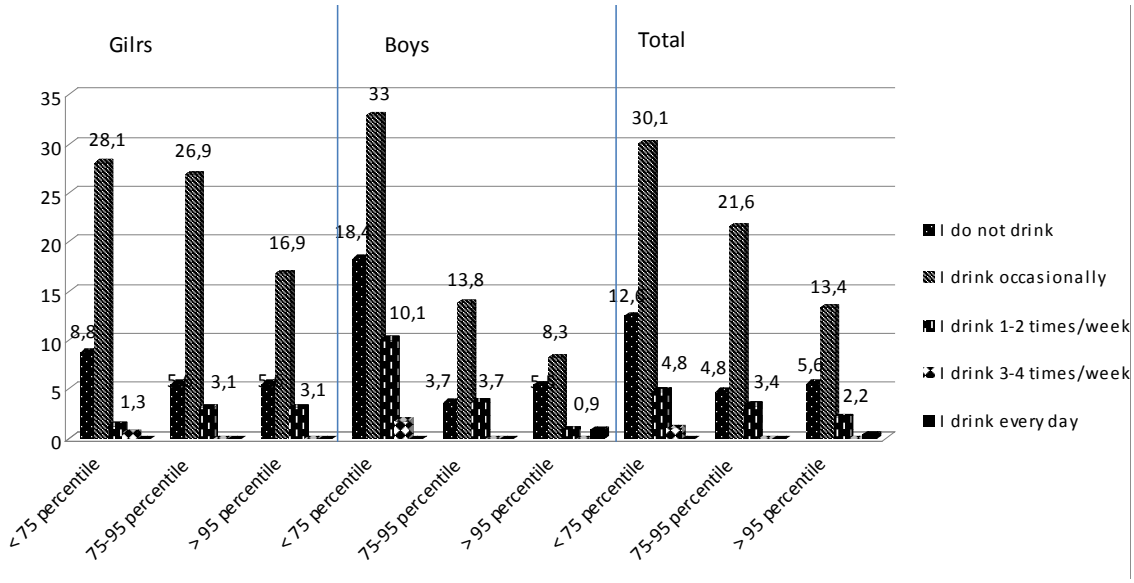


Figure 3. Prevalence of alcohol consumption among the young people in the study in relation to waist circumference

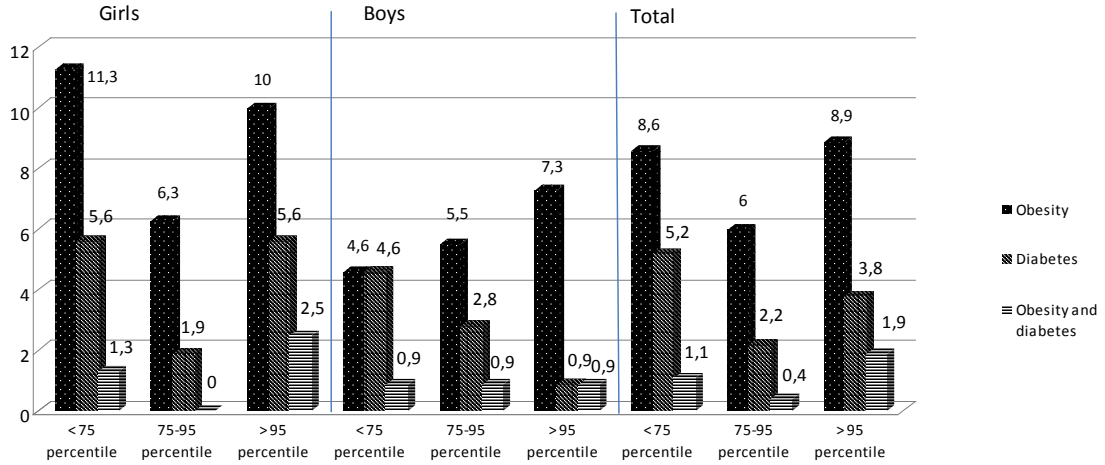
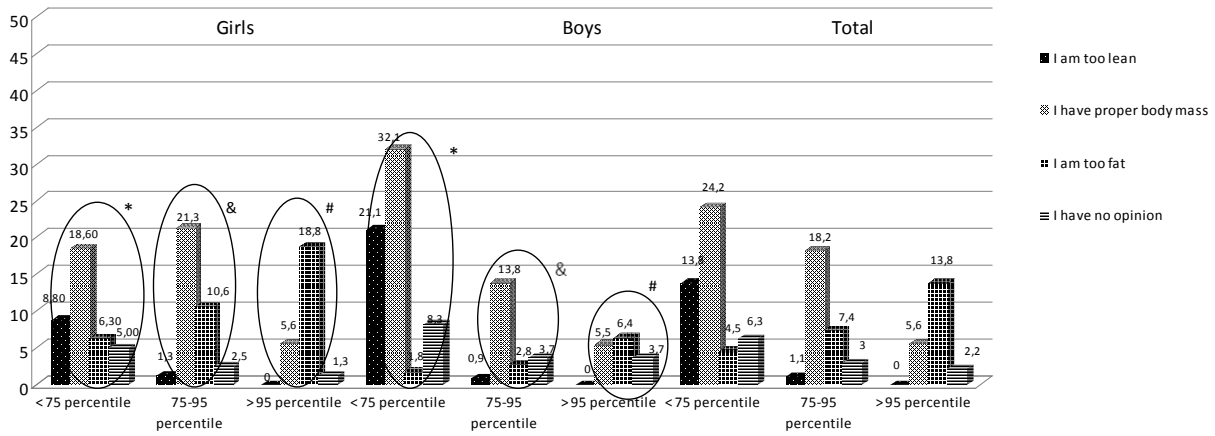


Figure 4. The occurrence of diseases in the immediate family in relation to the waist circumference

percentile. Obesity and diabetes occurring together were significantly more common among parents of girls with the largest waist circumference, similarly as obesity was significantly more frequent among parents of boys with abdominal obesity (Figure 4). *Wada* et al. [28] found that family history of diabetes was associated with impaired glucose metabolism manifesting already at an early age. *Maddah* [17] conducted a study among children aged 6-17 years showed that the prevalence of overweight and obesity have been more frequent, if their parents had type 2 diabetes.

Equally significant influence, as the burden of genetic metabolic diseases and abnormal lifestyle, on the occurrence of obesity among young people, was played by psychological aspects. Selected factors are shown in Table 1 and in Figure 5.

The results obtained indicate that the greatest attention to appearance was paid by the persons with the smallest waist circumference – 20.8% (Table 1). Significantly more young people with a waist at < 75th percentile considered it a proper body mass, while young people with abdominal obesity significantly more often believed that they are too fat. Girls and boys from subgroup 1 were most satisfied with their appearance – 37.2%, but at the same time they most often felt stress and the associated hunger before going to school (Table 1). Boys with a normal waist circumference below 75th percentile were less critical in the self-assessment of body mass than girls as 32.1% of them believed their mass is appropriate, while only 18.6% of girls in this subgroup considered their weight to be normal (Figure 5). Youth of the largest waist circumference, greater than 95th percentile, was significantly more likely to declare the use of weight loss diets – 6.7% of the group, while their sensation of hunger in stress was lowest – 3.4% (Table 1). Approximately 19% of girls with abnormal waist circumference thought they were too fat, while the percentage of boys in this subgroup was 6.4% (Figure 5).



*, &, # - Statistically significant differences between gender in percentile groups

Figure 5. Estimation of own body weight vs. actual waist circumference

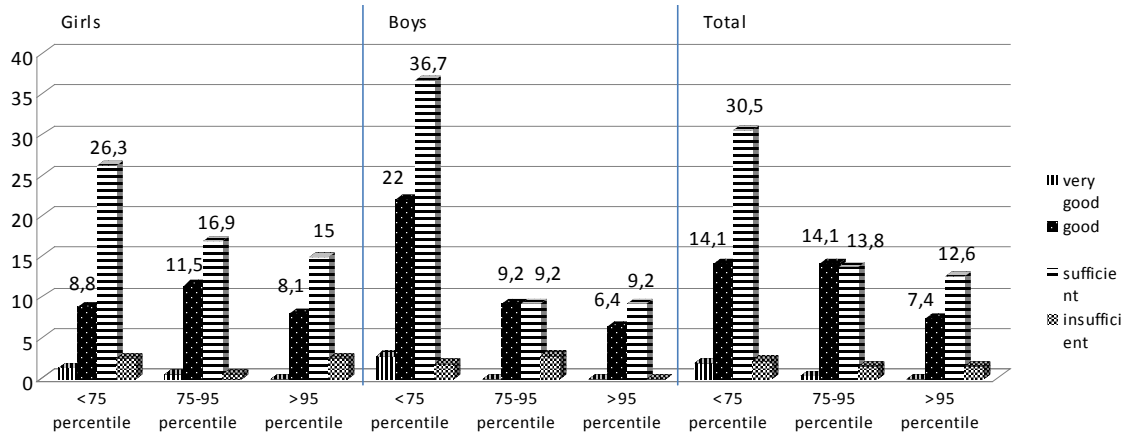


Figure 6. Subjective evaluation of nutritional knowledge among the young people in the study in relation to waist circumference

The study of *Korzycka-Stalmach* et al. [13] conducted on a group of 561 people aged 13 years and their parents, showed statistically significant differences between their own assessment of their body mass and the actual value, and this effect was gender-dependent. Almost 4% of girls and nearly 11% of boys with overweight/obesity evaluated their body mass as normal. *Piotrowska* et al. [22] found that girls with excessive body mass often felt that they are too fat (6.6%) than considered their body mass as normal (4.2%), while those with normal body weight significantly more often (36.9%) have paid attention to their appearance than teens with malnutrition (5.4%). The girls who were overweight, applied a weight loss diet significantly more

Table 1. Selected psychological factors in groups with diverse waist circumference

Waist circumference	Paying attention to own body weight (%)	Satisfaction with appearance (%)	Feeling of stress before going to school (%)	Feeling of hunger in stress (%)	Use of weight loss diet (%)
	Yes	Yes	Yes	Yes	Yes
Group 1 (n=131) <75th percentile	20.8[1]	37.2[1]	6.3[1]	13.8[1]	3.4[1]
Group 2 (n=80) <75th-95th> percentile	14.9[1]	21.2[2]	5.2[1]	6.0[1]	3.0[1]
Group 3 (n=58) >95th percentile	12.6[1]	12.6[3]	6.0[1]	3.4[1]	6.7[2]
Whole group (n=269)	48.3	71.0	17.5	23.1	13.1

1, 2, 3 - homogeneous groups. Statistically significant differences between homogeneous groups in response to particular questions.

likely than the girls with normal body mass. *Wojtyła--Bucior* et al. [30] in their study asked approximately 1,000 teenagers from the Kalisz county, whether they are satisfied with their appearance. Approximately 65% of them declared dissatisfaction, giving excessive body mass as the main cause. Girls were twice as likely as boys to declare that they do not accept their figure and that they are dissatisfied with excessive body mass.

The evaluation of nutritional knowledge of students included in the study is shown in Figure 6.

The young people in our study, regardless of gender and the circumference of the waist, most often declared that their nutritional knowledge was sufficient (Figure 6). Differences in the frequency of correct answers were statistically significant within gender. The study of *Owoc* et al. [20] conducted among 150 students aged 16-19 years from Warsaw secondary schools, found no statistically significant difference in responses to questions about nutritional knowledge, but more correct answers were given by girls and boys attending secondary schools of general education.

CONCLUSIONS

1. Significant impact on the formation of abdominal obesity among 17-18 girls had inherited disease burden.
2. Youth with abdominal obesity significantly more likely than those with normal waist circumference applied slimming diets.
3. Satisfaction with appearance was significantly more often reported by young people with the smallest waist circumference.

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Conflict of interest

The authors declare no conflict of interest.

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