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70 YEARS OF EXISTENCE

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REVIEW ARTICLE

THE 70 YEAR ANNIVERSARY OF THE ROCZNIKI PAŃSTWOWEGO ZAKŁADU HIGIENY / ANNALS OF THE NATIONAL INSTITUTE OF HYGIENE

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ABSTRACT

The article presents the genesis of the foundation and development of 'Roczniki Panstwowego Zakładu Higieny' [Annals of the National Institute of Hygiene] since 1950 to 2019, scientific peer-reviewed journal devoted to research studies on the food and water safety, nutrition, environmental hygiene, toxicology and health risk assessment, and public health. It also shows the difficulties that this journal had initially to struggle with, and its achievements in recent years, aiming to improve its international position. The article discusses the stages of journal's development and activity in terms of scientific, editorial and publishing.

Key words: *scientific journal, Roczniki Panstwowego Zakladu Higieny, Annals of the National Institute of Hygiene, Poland, open access journal, National Institute of Hygiene (PZH)*

STRESZCZENIE

W artykule przedstawiono genezę powstania i rozwój „Roczników Panstwowego Zakladu Higieny" [Annals of the National Institute of Hygiene] od 1950 do 2019 roku, recenzowanego czasopisma naukowego, które poświęcone jest badaniom naukowym w zakresie: bezpieczeństwa żywności i wody, żywienia, higieny środowiska, toksykologii i oceny ryzyka zdrowotnego oraz zdrowia publicznego. Przedstawiono także trudności, z jakimi początkowo zmagało się czasopismo, a także osiągnięcia w ostatnich latach mające na celu podniesienie pozycji międzynarodowej. W artykule omówiono kolejne etapy rozwoju i działalności czasopisma w aspekcie naukowym, redakcyjnym i wydawniczym.

Słowa kluczowe: *czasopismo naukowe, Roczniki Państwowego Zakładu Higieny, Annals of the National Institute of Hygiene, Polska, czasopismo open access, Państwowy Zakład Higieny (PZH)*

The seventy year anniversary of when the Roczniki Państwowego Zakładu Higieny / Annals of the National Institute of Hygiene was founded is a great opportunity to track the journal's history and development. In particular, its key role for popularising and promoting the achievements of Polish scientists in the fields of: food safety and of household use articles, nutritional hygiene and hygiene at the workplace as well as in water, air, and medicines. Such areas formed the mainstream of scientific endeavour at the National Institute of Hygiene (PZH) in journal's founding year of 1950.

In the aftermath of World War II public health issues of nutrition, food safety and the working environment became increasingly important, which drove the intense explosion of scientific research at the National Institute of Hygiene and it's numerous affiliated branches throughout Poland's cities [1]. This resulted in the need to set up a new journal bringing together scientific achievements in these areas. In the primary assumptions, the journal was to publish the results of scientific research carried out at the National Institute of Hygiene and its branches.

The initiator of the foundation of the 'Annals of the National Institute of Hygiene' (originally: 'Roczniki Państwowego Zakładu Higieny') was Professor *Stanisław Krauze*, head of the Department of Research on Food and Articles of Common Use in the National Institute of Hygiene, and the Scientific Council of this Institute, whose chairman was Professor *Ludwik Hirszfeld*, decided to establish the journal.

In the introductory words to the first issue from the year 1950, one can read: "*... thanks to the favorable attitude of the Ministry of Health, Roczniki Państwowego Zakładu Higieny are devoted to the work in the field of testing food and objects of use, food hygiene, occupational hygiene, sanitary engineering and pharmaceutical control. In addition, this journal will publish reports on the activities of the Institute and its departments*". This Introduction was signed by Professor *Ludwik Hirszfeld* (Chairman of the

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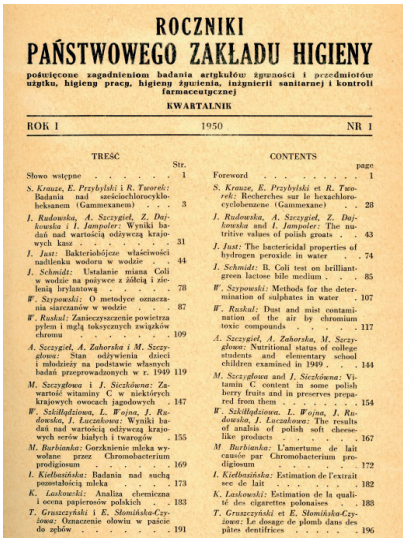
Scientific Council), Professor *Feliks Przesmycki* – (General Director of PZH) and Professor *Stanisław Krauze* (the first Editor-in-Chief of Roczniki Panstwowego Zakladu Higieny).

The intentions of the authorities of the National Institute of Hygiene were clear. 'Annals' were to be not only a journal publishing scientific papers, but also to present a scientific strategy for research on issues closely related to public health. It should be emphasized that at the turn of the 1940s and 1950s, the National Institute of Hygiene together with its branches was the only institution in Poland that could manage to the full extent all areas important for the health of society in the country following the World War II.

The very first published paper heralding the journal's opening, was a study by Prof. *Stanislaw Krauze* et al. published in the 1950 (vol. 1) on hexachlorocyclohexane (HCH), an active ingredient of Gammexane; a commercial insecticide widely available at the time. Compared to DDT, HCH was found to be ineffective in fruit protection. This was also backed up by their toxicological data from animal studies, where a method to determine this compound in food was developed in the Department of Research on Food and Articles of Common Use under the management of Prof. *Krauze*. The work must have been done during 1948-49, only a few years after World War II when Warsaw was just beginning to emerge from ruins. It should be stressed that this research was of a very high quality, where appropriate statistics had been applied to the results and due considerations had also been taken of the physicochemical and biological (toxicological) properties of individual HCH isomers. Most of the papers citied in this publication were from 1946-47, which were very trying times in Poland, where there were shortages of practically everything; nonetheless a world standard of scientific excellence had been achieved.

In addition to research papers from the PZH in Warsaw, this first 1950 issue published 4 papers from the Wroclaw branch and one each from the branches located in Lodz, Kielce and Katowice. The second issue also published papers from other branches in Gdansk, Wroclaw, Lodz, Cracow, Szczecin, Katowice and Walbrzych. A study from outside the PZH (or its branches) originated from the Medical Academy in Warsaw.



ROCZNIKI
PAŃSTWOWEGO ZAKŁADU HIGIENY

poświęcone zagadnieniom badania artykułów żywności i przedmiotów użytku, higieny pracy, higieny żywienia, inżynierii sanitarnej i kontroli farmaceutycznej

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Figure 1. The cover of the Roczniki Państwowego Zakładu Higieny in 1950

The subject matter covered in 1950 was very wide, where it was clear that in the immediate post-war years, the research topics chosen closely reflected regional concerns of each PZH branch and their practical capabilities (Table 1).

Table 1. Publication topics from the Roczniki Państwowego Zakładu Higieny in 1950

Subject matter	Publications origin	Number of publications
Pesticides, methods of determination, toxicological studies, HCH, DDT	PZH, Warsaw	3
Nutritional value of food products, nutritional status of the population, study of meals	PZH, Warsaw	7
Assessment of biocidal properties	PZH, Warsaw	1
Microbiological and chemical testing of water	Wrocław, branch of PZH	2
Air pollution	Łódź, branch of PZH	1
Food research (food contaminants, ingredients, biochemical tests)	PZH, Warsaw Katowice, branch of PZH Gdańsk, branch of PZH Wrocław, branch of PZH Łódź, branch of PZH Kraków, branch of PZH Szczecin, branch of PZH Medical Academy in Warsaw	3 2 1 4 3 2 1 1
Research on the common use articles	Kielce, branch of PZH PZH, Warsaw	1 1
Drugs and vitamins, hormones, pharmaceutical raw materials	PZH Warsaw Wałbrzych, branch of PZH Łódź, branch of PZH	4 1 1
Biochemical studies (people)	Łódź, branch of PZH PZH, Warsaw	1 1
Chemical analysis of cigarettes	Łódź, branch of PZH	1

The last 1950 issue of the 'Annals' (No. 3-4) concludes with a report on how the 'Scientific Action Plan' had been implemented in 1949 and the plan for the coming year. The report reveals what the national needs for public health had been at this time, which covered all operational aspects of the National Institute of Hygiene (PZH) and its branches; not only those reported in the journal [13]. These publications are of valuable historical significance, in that they document the state of Polish science regarding health protection, research opportunities and scientific priorities in war-torn Poland as well as testifying to the ambitions of scientists at that time. It is noteworthy that the scientific quality and standards of work performed was then very high (ie. in scientific planning & implementation, prioritising scientific needs, publications), whether from PZH branches or from their later transformed status as Sanitary-Epidemiological (SANEPID) stations in 1952; subsequently forming a part of the State Sanitary Inspection.

The papers published in the first issue of 'Annals' in 1950 contained extensive summaries in either English or French; according to the author's preference. In the second issue, all abstracts, if presented at all, were in Polish, whilst in issues 3-4, summaries in Russian appeared preceded by ones in English or French. The last issue published a study by Russian scientists on a simplified method developed to measure the calorific value of meals. Nowadays, it is however unclear whether this published work in the 'Annals' arose from just the needs of the authors or if they were due to other reasons.

After one year of publication experience, the journal editors considered it advisable to provide author guidelines for submissions; the first being published by the Editorial Office in 1951 (Nos. 1-2). As well as general information, manuscript specifications were given, abbreviation policy stated (according to resolutions made by the Polish Academy of Arts & Sciences from 1936), measurement units defined and a unified format adopted for citing and listing the bibliography, that included approved abbreviations for the most often citied journals [11]. These specifications however proved insufficient because the work in the journal's editorial was unpaid and that the foremost duties of editorial personnel was to undertake research and teaching, where preparing appropriately formatted manuscripts required much editorial effort. In the following year it was therefore decided to limit a manuscript volume to 20 pages, with detailed rules on author revisions to be made with a minimum of delay using proof-reading codes according to the Polish Standard PN N-06001, followed by "express resubmission to the journal's editor-in-chief on the very same day". This requirement was necessary because of the need to keep up to the quarterly throughput of publication in a timely manner. In subsequent years, such author instructions and any supplementary requirements were repeatedly given.

In the 'Annals' third publication year (1952, vol. 3), the date at which a manuscript submission had been received was now provided at the end of the article, whilst the actual print date was given on the title page. This demonstrates that the time elapsed from manuscript delivery to publication often took around 6-9 months. Details on forthcoming articles in the following issue (No 4; closing the year) were also provided together with editorial-board portfolio information. However, such a desirable practice did not last too long; nevertheless it demonstrated the editor's striving for transparency in the publishing process. On the last page of the cover, a list was provided of scientific journals published by the State Medical Publishing House (*Panstwowy Zaklad Wydawnictw Lekarskich*) and the terms of their subscription. The 'Information for Authors' states the reimbursement for publication, which is payed to the first author, and that the fee for offprints, whenever desired, is 1 to 3 zlotys each payable to the editorial office depending on the manuscript size.

Although the journal was primarily intended for the exchange of scientific information, achievements and describing the experiences of staff from the PZH and its branches (located throughout many Polish cities), it also found numerous readers from other scientific centres. These readers gradually became part of the regular Annals' authors who would like to share their knowledge and scientific experiences. Already in 1952 there were 4 articles published from the Department of Agricultural Technology at the University of Poznan and two articles from the Department of Foodstuffs Research at the Warsaw Medical Academy [5, 15]. Articles from other PZH branches were also published that included the Maritime Branch in Gdynia [21], and the branch in Częstochowa [12].

In 1953, the layout of the cover was changed. The front page remained as before with the journal title, year, issue number and the scope of the subject matter, whilst the table of contents was moved to the inside cover.

The editors introduced a new section to the first issue from 1954, a 'Question and Answer Box', asking readers '*to send reports of unresolved or contentious issues found in the scientific literature or from laboratory practice that were thematically related to the remit of the 'Annals.'* This was supposed to allow the exchange of views/information between scientists. Another new feature was to submit laboratory notes that could be placed in subsequent issues on free pages; the so-called 'vacant pages'. The first entry in the 'Question and Answer Box' concerned manganese accumulation in foodstuffs and that the symptoms of poisoning with this metal can be confused with lathyrism poisoning from certain legumes.

The editorial board was still receiving submissions from its former PZH branches, which by then had acquired a new legal status, upon being transformed into SANEPID stations. Despite their duties being gradually

shifted to control and monitoring, they still managed to continue their research and send articles to our editorial office on identified food hazards, e.g. packaging, as published from the SANEPID Station in Kielce [2]. Up till now, the custom of submitting papers for publication in scientific journals is still being continued by many of the SANEPID stations.

The Annals' editors always ensured to maintain an appropriate high level of published materials. A published paper by the then Editor-in-Chief Professor *Stanislaw Krauze*, marking the 10th anniversary of independence of the People's Republic of Poland, stated as follows: '*The Annals gave young scientists their first start. While their work was not always up to the required standards at the beginning, advice given by the editorial office to young scientists enabled them to formulate their thoughts in proper scientific fashion. It was very pleasing when improvements were seen in past authors making new submissions* [6]'. This was the approach taken with young scientists who had just embarked on the difficult career path in their scientific development.

Even though reports and future plans for scientific research were no longer being published in the 'Annals', a separate monograph on this subject was still included by the Director of the National Institute of Hygiene, Professor *Feliks Przesmycki*, who reported on its achievements, especially in those areas where the greatest progress had been accomplished: typhus, acute bowel disease, *streptococcus*, anaerobes, tularemia, antibiotics, *tick-borne encephalitis*, *Heine-Medina* disease, flu, *smallpox, trichinosis*, environmental hygiene, Narew river water testing, food poisoning, oil research, collective nutrition, rational nutrition in the canteen, nutritional testing of products and the development of medical guidelines for four group diets [14].

In 1956, Professor *Marcin Kacprzak* was appointed as Editor-in-Chief of the 'Annals' who was also the head of the Department of Hygiene and Rector of the Warsaw Medical Academy at that time. Before World War II he had worked at the National School of Hygiene of PZH as the head of the Epidemiology and Statistics Department. In the Letter from the Editor he drew attention for the need to include environmental hygiene issues in the 'Annals' and proposed to increase the frequency of the journal's publication. In 1956, the 'Annals' accordingly changed from being a quarterly to a bimonthly; i.e. 6 issues published per annum, so forming one volume.

From the third issue onwards, an additional section was introduced entitled 'Abstracts from the literature abroad', positioned at the end of each issue. These were prepared by PZH scientists, some of whom in 1956-57 were as follows: *S. Krauze, I. Bernstein, K. Chodorowska, S. Adamowiczowa, H. Romanowski, C. Hiszpańska, B. Secomska, W. Morkowska, J. Leowski, H. Młodecki, A. Pliszkowa, Z. Markuze, Z. Bożyk, M. Rakowska, M. Marciszewska-Szoplik, J. Kelus, M. Szczygłowa, B. Piasecka, J. Załęski, J. Siedlecka.* Others had just signed with their initials. Because of the very limited access to foreign scientific literature in those times, such summaries were an invaluable source of knowledge about global scientific progress made in research.

The first submissions from abroad were published in 1956 & 1957 which were received from the Institute of Hygiene in Prague (Czechoslovakia), dealing with food and nutrition issues [8, 9, 17]. A new section also appeared entitled 'Chronicle', where the most important events on research in food and environmental hygiene were reported. In addition, a detailed report was provided by Professor *S. Krauze* from the II Convention of the 'International Society for the Study of Nutrient and Life Substances' held in Hannover. This contained a resolution on the 'hazards of car exhaust fumes' (resolution 13), in which this health problem had already been recognised, particularly the issues of lead contamination and the introduction of remedial measures thereof, that included abandoning the practice of 'ethylising' petrol with organic lead compounds [7].

From 1957, the Editors-in-Chief of the 'Annals' changed quite often. Professor *Alexander Szczygiel* was appointed in 1958 for one year, followed again by Professor *Stanislaw Krauze* who up to 1964 alternated this position with Professor *Jan Just*. Between 1965 and 1981 only Professor *Jan Just* held this position. This however did not affect the journal's publication which continued to come out bimonthly, publishing ever more and more work of authors outside the PZH and SANEPID stations.

The PZH celebrated its 45th anniversary in 1963 chaired by Professor *Marcin Kacprzak*, and a report of these events was published in the following year,. As well as state representatives being present during the proceedings, there were other delegates from national institutes as well as those from abroad: the Academy of Sciences and Institutes of Microbiology and Hygiene from the Soviet Union, Bulgaria, Czechoslovakia, Yugoslavia, the German Democratic Republic and the Institute of Serology in Copenhagen. It is also worth noting that as part of the PZH jubilee, the 70th birthday of Professor *Feliks Przesmycki* was included in the celebrations; a previous PZH director and oldest employee of this Institute [20].

In the 15th year since its inception, the editors of the 'Annals' provided a summary of their publication record, which showed that 812 scientific papers had been published, mostly dealing with food and nutritional hygiene [22].

A growing and noteworthy interest of researchers from other institutes had been observed who wished to publish in our 'Annals', thereby helping to make the journal well-known and as one that can be relied upon in having an increasing number of subscribers and readers.

Jumping ahead 10 years to 1974, vol. 25 (the 30th anniversary of the Polish Peoples Republic (PRL)), the currently acting Editor-in-Chief Professor *Jan Just* reported that the 'Annals' had now published 1567 original papers since its inception, i.e. another 755 papers over this decade. This was a significant advance reflecting intensified scientific and research activities along with a raised interest in submitting to the journal [3]. This year was also the 25th anniversary of the journal's founding and Professor *Jan Just* wrote an article describing achievements made so far and reported an assessment statement made by the 4th Faculty of Medical Sciences of the Polish Academy of Sciences *'The PZH Annals belongs to Group I journals without any reservations*'. He also stressed that the 'Annals' are constantly referred to in Chemical Abstracts, Biol. Abstracts, *Index Medicus* and Nutrition Abstracts [4]. The following year (1975), Professor *Stanisław Krauze* presented in issue No 3 the achievements of scientific research and control over food and household use articles in Poland during 30 years, underlining the significant contribution made by the Department of Food and Articles of Common Use at the PZH.

In 1977, an article was published by *Halina Sadowska* from the Ministry of Health and Welfare presenting an analysis of food laws that were current in different countries and confronted it with the Polish 'Act on Health Conditions of Food and Nutrition' from 1970 [16]. The author emphasised the impact of the FAO/WHO *Codex Alimentarius* Commission on food legislation, in which Poland had also participated. Two years later in 1979, *Aleksander Szczygieł* presented current nutritional issues facing Poland, paying attention to nutritional shortcomings and health problems so arising, as well as the changed outlooks on the principles of rational nutrition [19]. Another article by *Halina Mazur's* in the same issue described health impact studies performed on polyvinyl chloride (PVC) packaging for foodstuffs that took account of the harmful effects produced by chemical substances present in this material [10].

In 1982, Professor *Doctor h.c. Maksym Nikonorow* became Editor-in-Chief of the 'Annals' who had been a long-time head of the Department of Food and Articles of Common Use Research at the PZH. He managed the editorial office until his demise in 1985. Asoc. Professor *Bogumila Urbanek-Karlowska* then took over the Editor-in-Chief position who had hitherto been the secretary to the Editorial Office.

In 1986 the 'Annals' volume 37, number 3, was devoted to the memory of Professor *Maksym Nikonorow*, where the scientific work undertaken at his Department were published.

In 1988, abstracts of works from journals abroad were published for the last time, (previously launched in 1956), because of the improving situation in the country and the easier access to foreign journals describing the latest scientific developments.

In 1990, the State Department of Medical Publishers and the 'Ruch Company' withdrew respectively from the publishing and distribution of the 'Annals' due financial difficulties. Both of these tasks were taken over by the PZH which have been running these until now. However, the high costs of publishing led the PZH to revert back to publishing quarterlies from 1991 onwards.

In 1994, *Dr Kazimiera Cwiek-Ludwicka*, the author of this article, took over the position of the Annals' Editor-in-Chief and who also heads the Section on Food Contact Materials at the Department of Research on Food and Articles of Common Use at the PZH. She has been fulfilling this role for the last 25 years.

The mission of the 'Annals' has always been the pursuit of the highest possible scientific standard by all its Editors-in-Chief. The names of the scientists holding this position up to the 70th anniversary of the journal (1950-2019) are given in Table 2 and have always been entrusted to scientific staff of the PZH.

Table 2. Editors-in-Chief of the Roczniki Państwowego Zakładu Higieny during 1950-2019

Names of the Editors-in-Chief	Tenure periods of the Editors-in-Chief	Number of years as Editor-in-Chief
Prof. dr Stanisław Krauze	1950-55, 1959, 1962-64	9
Prof. dr Marcin Kacprzak	1956, 1957	2
Prof. dr Aleksander Szczygieł	1958	1
Prof. dr Jan Just	1960 - 1961, 1965-1981	18
Prof. dr Maksym Nikonorow	1982 - 1985	5
Assoc. Prof. Bogumiła Urbanek-Karłowska	1986 - 1994	8
Dr Kazimiera Ćwiek-Ludwicka	1994 - 2019 (and still)	25

In 1996, the No. 1 issue was devoted to presentations from a Symposium entitled 'Organochlorine compounds in the environment: a health risk', jointly organised by the Ecology and Health Foundation and the Polish Toxicological Society, which took place on 4-6th May 1995 in Dębe near Warsaw. Its aim was to assess the health risk of organochlorine compounds collected from various environmental sources in Poland. These compounds consisted of volatile chlorinated hydrocarbons (THMs) and polychlorinated aromatic hydrocarbons that included organochlorine insecticides, polychlorinated biphenyls (PCBs), dioxins and furans.

In subsequent years the 'Annals' were regularly issued without any delays. The constant raising of the journal's prerequisite quality thresholds in science has led to significant improvements in manuscript submissions, thereby increasing the journal's standing but at the expense of fewer papers being accepted for publication, following peer-review.

After 2004, intensive efforts were made to raise the scientific ranking of the journal to make it more attractive to readers from abroad. Gradually the make-up of the editorial committee was expanded to include scientists from other institutes in Poland.

The journal's format was increased in 2009 and the text is printed in two columns so as to be compatible with commonly used standards.

An International Scientific Board has been operating since 2012, with increasing number of scientists from foreign scientific institutions being invited to participate. From 2013 the journal has been published exclusively in the English language. On the present cover, next to the current name of the journal, the English title is also given; i.e. Annals of the National Institute of Hygiene (Figure 2).

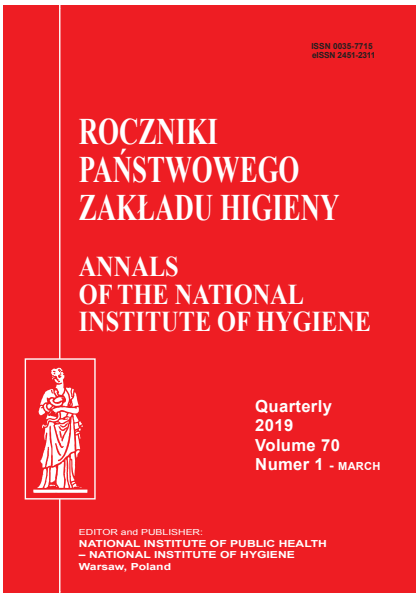

Figure 2. The cover of the Roczniki Państwowego Zakładu Higieny in 2019

A list of subject editors is also provided, that encompass the following areas of expertise: food safety, food and environmental analysis, nutrition, environmental hygiene, toxicology and risk assessment, public health together with a names list of the language and statistical editors.

By 2016, foreign scientists now represent more than half of the International Scientific Board. They come from scientific institutions and universities abroad, (17 members), as follows: two members each from England and China, three from the USA and one each from Australia, Belgium, Denmark, Spain, the Netherlands, Japan, Colombia, Mexico, Pakistan and Sweden.

Foreign reviewers are invited to peer-review submissions. Double-blind review process is maintained. Approved submissions, after the review, are assigned a DOI (*Digital Object Identifier*) that allows them to be published online onto the journal's website without waiting for the entire issue number to be completed and printed. This 'on-line first' publication thus allows earlier chances of a paper being cited.

JOURNAL WEBSITE

The website of the 'Roczniki Panstwowego Zakladu Higieny' was launched in 1995 intended to provide readers with ready on-line access to its publications as well as informing about how the journal operates, importantly on the editorial staff, instructions for authors and for reviewers etc. This being constantly updated where new functions have been introduced enabling rapid access to full-text articles from the last 25 years as obtained by searches using author's name, key word, year of publication or article's title [18].

BIBLIOGRAPHIC DATABASES

The 'Roczniki Panstwowego Zakladu Higieny' have been indexed for many years in both domestic and foreign bibliographic databases, including PubMed / Medline, Scopus, EBSCO, AGRO, Polish Medical Bibliography/Central Medical Library, Index Copernicus Int., CNKI Scholar, and DOAJ (Directory of Open Access Journals), the largest international database of peer-reviewed open access journals.

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The ‘Roczniki Państwowego Zakładu Higieny’ [Annals of the National Institute of Hygiene] established in 1950 by the National Institute of Hygiene are issued continuously to the present day.

The further development of our journal lies in the hands of the authors. We deeply believe that the scientific articles submitted for the publication in the Roczniki Państwowego Zakładu Higieny/Annals of the National Institute of Hygiene being the subject of research in the broadly understood range of public health, environment, food and nutrition, water and air safety, as well as the quality of healthcare will be of interest of readers in Poland and abroad. And the journal itself will become a platform for the exchange of scientific experiences for numerous scientists interested in these scientific areas.

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REVIEW ARTICLE

ROLE OF DIET-RELATED FACTORS IN CEREBRAL ANEURYSM FORMATION AND RUPTURE

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ABSTRACT

Cerebral aneurysms (CAs) are dilations of the wall of an artery in the brain filled with blood. The prevalence of unrupted CA in general population is estimated at approximately 3%. Ruptured aneurysms are the cause of 85% of spontaneous subarachnoid hemorrhage (SAH) cases. The formation of cerebral aneurysms results from various factors, including chronic inflammation, hemodynamic stress and vascular wall remodeling. Reactive oxygen species may induce the endothelial dysfunction possibly through the activation of Nuclear Factor Kappa-B, which is a key regulator of the proinflammatory genes. Hypertension may additionally increase the hemodynamic stress and activate the local renin-angiotensin system. The aim of this review was to assess the role of selected diet-related factors in the formation and rupture of cerebral aneurysms. It appears that inadequate intake of dietary antioxidants, hyperhomocysteinemia, hypertension (including incidental elevated blood pressure) and alcohol consumption may increase the risk of intracranial aneurysms. Individuals at high risk of CA formation and/or rupture should consume adequate amounts of antioxidant vitamins (vitamin C, vitamin E and carotenoids), B vitamins (vitamin B_6, vitamin B_{12} and folate), flavonoids and n-3 fatty acids, limit alcohol and caffeine consumption and regularly control their blood pressure. Vegetables, fruits, grains, pulses, nuts and fish, as well as herbs, spices and tea, should be the major components of the daily diet. Due to the synergistic effect of various dietary components on health, Mediterranean diet or Dietary Approach to Stop Hypertension (DASH) diet, as they meet abovementioned requirements and have high anti-inflammatory potential, are thus recommended for the prevention of cerebral aneurysm formation and rupture.

Key words: *cerebral aneurysm, diet, antioxidant intake, hypertension, hyperhomocysteinemia, alcohol consumption*

STRESZCZENIE

Tętniaki mózgu to ograniczone poszerzenia światła naczynia krwionośnego wypełnione krwią. Występowanie tętniaków mózgu w ogólnej populacji wynosi około 3%, a pęknięcie tętniaka jest przyczyną 85% przypadków krwotoku do przestrzeni podpajęczynówkowej. Na powstanie tętniaka mózgu wpływa wiele czynników, w tym przewlekły stan zapalny, stres hemodynamiczny i przebudowa ścian naczyń mózgowych. Reaktywne formy tlenu mogą nasilać dysfunkcję śródbłonka m.in. poprzez aktywację jądrowego czynnika transkrypcyjnego NF-κB, który jest głównym regulatorem genów związanych z przebiegiem procesu zapalnego. Ponadto wysokie ciśnienie tętnicze krwi może nasilać stres hemodynamiczny oraz aktywować lokalny układ renina-angiotensyna-aldosteron. Celem artykułu był przegląd piśmiennictwa dotyczącego roli wybranych czynników związanych z dietą i z ryzykiem powstania i pęknięcia tętniaków mózgu. Wydaje się, że niewystarczająca podaż składników o działaniu antyoksydacyjnym, hiperhomocysteinemia, nadciśnienie tętnicze (w tym nagłe skoki ciśnienia tętniczego krwi) oraz spożycie alkoholu mogą zwiększać ryzyko rozwoju tętniaków mózgu. Osoby o podwyższonym ryzyku powstania i/lub pęknięcia tętniaka mózgu powinny więc stosować dietę o odpowiedniej zawartości witamin antyoksydacyjnych (witamina C, wit. E i β-karotenu), witamin z grupy B (witamina B_6, witamina B_{12} i foliany), flawonoidów i kwasów tłuszczowych z rodziny n-3, ograniczyć spożycie alkoholu i kofeiny, a także regularnie monitorować wartości ciśnienia tętniczego krwi. Stosowana dieta powinna być bogata w warzywa, owoce, produkty zbożowe, nasiona roślin strączkowych, orzechy i ryby, jak również przyprawy, zioła i herbatę. Ze względu na synergistyczny efekt działania różnych składników diety na zdrowie, w prewencji tętniaków mózgu rekomendowane powinny być diety: śródziemnomorska i DASH, charakteryzujące się odpowiednią zawartością wymienionych składników oraz wysokim potencjałem antyoksydacyjnym.

Słowa kluczowe: *tętniaki mózgu, dieta, podaż antyoksydantów, nadciśnienie tętnicze, hiperhomocysteinemia, spożycie alkoholu*

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INTRODUCTION

Cerebral aneurysms (CAs) are defined as dilations of the wall of an artery in the brain filled with blood. The worldwide prevalence of unrupted CA is estimated at approximately 3% [47]. Brain aneurysm may remain asymptomatic, cause non-specific neurological symptoms (as change in vision or dilated pupil), leak or rupture. The symptoms of a ruptured cerebral aneurysm usually include severe headache, nausea and vomiting, stiff neck, seizure and loss of consciousness [11]. Ruptured aneurysms are the cause of 85% of spontaneous subarachnoid hemorrhage (SAH) and are fatal in about 40% of cases. The annual rate of SAH is approximately 6-16 per 100 000 people [55].

CAs are usually diagnosed using an magnetic resonance imaging (MRI) or a computerized tomography (CT) scan. The incidence of SAH is higher in women than in men and increases with age. Medical factors associated with the incidence of unrupted CAs are: family history of aneurysm or SAH, autosomal dominant polycystic kidney disease, connective tissue disorders, intracranial arteriovenous malformation and coarctation of the aorta. Common modifiable risk factors include also cigarette smoking, hypertension, drug abuse and heavy alcohol consumption [21, 47]. Diet is rarely mentioned as a direct risk factor for CA formation or rupture, however it indirectly participates in the pathogenesis of CAs but also may affect other risk factors.

The aim of this review was to assess the role of dietary intake and selected diet-related factors in the formation and rupture of cerebral aneurysms.

PATHOPHYSIOLOGY OF CEREBRAL ANEURYSMS

The formation of cerebral aneurysms results from the multifactorial mechanisms, however it is believed that the key factor that determines the development of this process on a structural level is a defect of the cerebral arteries. The weakening of the wall of an artery may cause the disruption of the internal elastic lamina. Moreover, the reconstitution of the collagen fiber results in the additional collagen and elastin degradation which leads to the artery wall remodeling. All these processes may cause the inner membrane to bulge and form aneurysms [13]. Recently, several genes and genetic loci were found to be related to the development of cerebral aneurysms but obtained results seems to be rather group-specific due to the strong population heterogeneity [46]. Nonetheless, the prevalence of unrupted CAs appears to be significantly higher among the first-degree relatives of those affected with brain aneurysms (19.1%) compared with the general population (2-3%) [7].

Structural remodeling of the cerebral arteries may be modulated by hemodynamic and oxidative stress. High levels of free radicals, mainly superoxide (O_2•) and hydrogen peroxide (H_2O_2), induce chronic inflammation and cell injury. The possible sources of free radicals in cerebral arteries are vascular nicotinamide adenine dinucleotide phosphate oxidase (NADPH), hemeoxygenase-1 (HO-1) and inducible nitric oxide synthase (iNOS). *Aoki* et al. [3] observed that reactive oxygen species (ROS) were overproduced in the aneurysmal walls, while the deletion of the ROS-producing gene, p47phox, inhibited CAs formation and decreased inflammation level in aneurysmal walls.

ROS may affect the endothelial dysfunction primarily through the activation of Nuclear Factor Kappa-B (NF-κB) which is a key regulator of the proinflammatory genes, including vascular cell adhesion molecule-1 (VCAM-1) and monocyte chemoattractant protein-1 (MCP-1). MCP-1 induces macrophage recruitment and its inactivation was shown to inhibit CAs formation in animal models [1]. Endothelial dysfunction is followed by smooth muscle cell phenotypic modulation and eventually cell apoptosis. It appears that the level of macrophage infiltration and smooth muscle cells proliferation is associated with the risk of aneurysm rupture [14].

Inflammation may be exerted by coexisting hypertension, which increases hemodynamic stress and activates the local renin-angiotensin system (RAS). RAS can control vascular remodeling not only through smooth muscle cell migration and proliferation, but also by the activation of NF-κB [25, 43]. All the above-mentioned mechanisms may be also intensified by cigarette smoking which is considered as an independent but modifiable risk factor for cerebral aneurysm formation and rupture. *Woo* et al. [50] observed that the odds ratio for aneurysmal subarachnoid hemorrhage in group of current smokers without family history of SAH was 3.1 (95% CI 2.2-4.4) compared to current nonsmokers. Smoking may increase wall shear stress, cause endothelial dysfunction and smooth cell proliferation and intensify inflammatory response through various mechanisms, including extracellular signal-regulated protein kinase 1 and 2 (ERK1/2) and NF-κB pathways [10].

DIET-RELATED RISK FACTORS FOR CEREBRAL ANEURYSM FORMATION AND RUPTURE

Antioxidant intake

As oxidative stress and inflammation play a key role in cerebral aneurysms formation and rupture, therapies focused on the inhibition of inflammatory cascade may provide a beneficial effect on CAs prevention

and treatment. In animal models, anti-inflammatory agents, such as tolylsam (metalloproteinase-2, -9 and -12 inhibitor), edaravone (free radical scavenger) and celecoxib (cyclooxygenase-2 (COX-2) inhibitor), decreased the size and the incidence of advanced CAs [2-4]. Hasan et al. [17] observed that the risk of subarachnoid hemorrhage was lower in patients with unrupted CAs who used aspirin, which is known as a COX-2 inhibitor, compared with those who never used acetylic acid.

Dietary components with antioxidant activity include carotenoids, vitamin C, vitamin E and flavonoids. In various studies antioxidant intake was inversely associated with the risk of cardiovascular disease, coronary heart disease, stroke and cardiovascular/total mortality [5, 9, 20]. The cumulative effect of dietary antioxidants may be illustrated by total antioxidant capacity (TAC) index which is also considered as an indicator of the quality of the diet [32]. *Rautiainen* et al. [34] shown that total antioxidant capacity was associated with lower risk of hemorrhagic stroke among women with the history of cardiovascular diseases (the hazard ratio for the highest vs. lowest quartile of TAC 0.55; 95% CI 0.32-0.95; p for trend 0.03). In a study performed by *Colarusso* et al. [12] women in the highest quartile of antioxidant capacity had a 27% lower HR of total stroke in comparison with women in the lowest quartile (95% CI 0.53-0.99; p for trend 0.03).

Marzatico et al. [24] showed that systemic plasmatic levels of vitamin A and vitamin E were lower in patients suffering from SAH compared with controls with unrupted CA (p=0.038 and 0.0158, respectively), while the activity of A1AT, an enzyme inhibitor that protects the tissues from inflammatory damage, was reduced in group of patients with SAH (p=0.019). According to authors, reduced antioxidant status and consequent oxidative stress might increase the sensibility of alpha1-antitrypsin (A1AT) to oxidative reactions and influence the rupture of brain aneurysms. In a study performed by *Gopal* et al. [16] the injection of angiotensin II, a regulatory peptide involved in maintaining homeostasis of cardiovascular system, induced cerebral aneurysm formation in ApoE -/- mice by modulating the mRNA levels of matric metalloproteinases (MMPs), plasminogen activators and adhesion molecules. β-carotene supplementation regulated the expression of above-mentioned genes, reduced the circulating macrophage levels and prevented aneurysm formation.

Curcumin (diferuloylmethane) is the main curcuminoid of turmeric (*Curcuma longa*) having anti-inflammatory and radical scavenging properties. Antioxidant effect of curcumin may be associated with the inhibition of pro-inflammatory enzymes, including COX-2, iNOS and lipoxygenase (LOX). Oral administration of curcumin reduced the activity of NF-κB and lowered aortic concentrations of pro-inflammatory cytokines and tissue remodeling in experimental abdominal aortic aneurysms [30]. *Bo* et al. [6] observed that curcumin decreased apoptosis in cerebral aneurysm-induced smooth muscle cells of male albino rats possibly through the reduction of the p53 expression.

In a case-control study performed by *Okamoto* et al. [26], involving 201 patients with incident SAH and 201 controls, the antioxidant intake score was associated with the reduced risk of subarachnoid hemorrhage after adjustment for confounding variables (lowest vs. highest score: OR 0.54; 95% CI 0.30-0.99). An antioxidant intake score was estimated for each participant based on the data from the food frequency questionnaire (FFQ). Food products from the FFQ were grouped into five categories: green/yellow vegetables, fruits, soy products, rice and tea. Antioxidant intake from dietary supplements was not considered in the study. Dietary pattern characterized by high intake of soy products was associated with lower risk of SAH (highest vs. lowest quartile: OR 0.46; 95% CI 0.18-0.88) [27]. The highest risk for SAH was observed in group of participants who rarely consumed soy products and simultaneously smoked cigarettes (OR 5.3; 95% CI 2.0-14.3). Less frequent intake of soy products was related to elevated risk of SAH independently of smoking habits [28]. Habitual green tea consumption was associated with decreased risk of SAH. Individuals consuming ≥1 serving per day had ORs of 0.56 (95% CI 0.32-0.98) in comparison with these who did not consume green tea (p for trend <0.001) [29].

Hyperhomocysteinemia

Homocysteine (Hcy) is a sulfur amino acid biosynthesized from the essential amino acid methionine. Elevated serum Hcy level is considered an independent risk factor for cardiovascular diseases. Peng et al. [31] observed that the highest compared to lowest homocysteine level categories were associated with a 66% increased risk of coronary heart disease mortality (RR 1.66; 95% CI 1.12–2.47; p=0.012), 68% increased risk of cardiovascular mortality (RR 1.68; 95% CI 1.04–2.70; p=0.033) and 93% increased risk of all-cause mortality (RR 1.93; 95% CI 1.54–2.43; p<0.001). According to *Wald* et al. [49] the reduction of blood homocysteine level by 3 μmol/l might reduce the risk of deep vein thrombosis by 25% (8%-38%), stroke by 24% (15%-33%) while ischemic heart disease by 16% (11%-20%). In a meta-analysis of seven studies performed by *Zhou* et al. [54] Hcy levels were significantly higher in group of patients with intracerebral hemorrhage compared to healthy controls (standard mean difference 0.59; 95% CI 0.51–0.68, p<0.001).

Xu et al. [52] observed that a high L-methionine diet (1g/kg/d) was related to increased plasma homocysteine levels and accelerated cerebral aneurysm formation after ligation of the left common carotid artery in rats. Methionine treatment increased the expression of iNOS, MMP-2, MMP-9 and vascular endothelial growth factor (VEGF) in aneurysmal walls, what indicates the possible effect on vascular wall modeling in a rat model. In another study subarachnoid hemorrhage resulting from aneurysm rupture was observed more frequently in rats with methionine-induced hyperhomocysteinemia compared to controls ($p<0.05$). The level of interleukin-6 (IL-6), mRNA level of MMP-9 and the ratio of MMP-9 to the tissue inhibitor of metalloproteinase-2 (TIMP2) were also higher in group of methionine-treated rats ($p<0.05$) [22].

Hyperhomocysteinemia as a risk factor for intracranial aneurysms in human was analyzed in a case-control study performed in Chinese population. The serum homocysteine level was significantly higher in group of patients with intracranial aneurysms compared to aneurysm-free controls (19.98±10.84 µmol/L vs. 15.13±5.55 µmol/L; $p<0.001$). Total Hcy level >15 µmol/L was associated with higher risk of CA development (adjusted OR 2.196; 95% CI 1.188-4.057; p=0.012) [36]. Nevertheless, in a study performed by *Rosi* et al. [37] in Brazil, median homocysteine serum level was similar in group of patients with CA in comparison with controls (10.5 µmol/L [8.3-14.0] vs. 10.7 µmol/L [8.2-13.3]; p=0.450). No statistically significant difference in the prevalence of hyperhomocysteinemia was observed in group of patients and controls (20.4% vs. 7.9%, respectively; p=0.073).

Elevated Hcy levels may result from nutritional deficiencies of folate, vitamin B_6 and B_{12}. Although the results of studies concerning the beneficial effects of reduction of serum Hcy on cardiovascular diseases and mortality are not conclusive, it appears that adequate vitamin B intake may possibly protect from intracranial aneurysm formation. *Ren* et al. [36] observed that serum homocysteine level was negatively correlated with vitamin B_{12} and folate levels in group of individuals with CAs (r=-0.531; $p<0.001$ and r=-0.349; $p<0.001$, respectively). In a study performed by *Korai* et al. [22] folic acid eliminated the unfavorable effect of methionine on aneurysm growth in rats, what indicates a relationship between elevate Hcy level and CAs formation.

Hypertension

Hypertension is one of the most common risk factors for aneurysm formation and rupture. The mean incidence of pre-existing hypertension was observed in 43.5% of individuals with intracranial aneurysm compared to 24.4% in the general population [18]. In a study of *Isaksen* et al. [19] mean systolic blood pressure (BP) was higher in patients with aneurysmal subarachnoid hemorrhage compared to controls (154.0 ± 32.5 mmHg vs. 136.3 ± 23.3 mmHg; p=0.017). An increase in systolic BP of 20 mmHg was an independent risk factor for SAH (OR 2.46; 95% CI 1.52-3.97).

According to the Guidelines for the management of patients with unruptured intracranial aneurysms defined by the American Heart Association/American Stroke Association in 2015, individuals with unrupted CA should monitor their blood BP and undergo anti-hypertensive treatment [44]. In a study performed by *Tada* et al. [43] the normalization of blood pressure after CA formation prevented aneurysm rupture in mice and the effect was dose-dependent. The use of anti-hypertensive agents reduced the risk not only by decreasing BP but also by inhibiting the activity of the local RAS system.

The modifiable risk factor for incidental high blood pressure is caffeine intake. *Isaksen* et al. [19] observed that drinking more than five cups of coffee per day was more common among patients with SAH compared to controls (85% vs. 59%, p=0.004) and was an independent risk factor for SAH (OR 3.86; 95% CI 1.01-14.73). In a study performed by *Vlak* et al. [48] coffee consumption was a trigger risk factor for aneurysm rupture (RR 1.7; 95% CI 1.2–2.4). Similar relationship was observed with reference to cola consumption (RR 3.4; 95% CI 1.5–7.9). Coffee consumption accounted for 10.6% of the cases of CA rupture.

There is no evidence based on clinical trials indicating that lowering BP may be used in the primary prevention of aneurysm formation. Nonetheless, it appears that maintaining normal blood pressure might have beneficial effect in individuals who are at high risk of CA formation due to family history. As nutritional factors are associated with the risk of hypertension, dietary modifications, e.g. Mediterranean diet or Dietary Approach to Stop Hypertension (DASH) diet should be recommended.

Alcohol consumption

Alcohol consumption is another established risk factor for CA rupture. It may affect aneurysm risk through inflammation-mediated mechanisms but also by increasing blood pressure [33, 35]. In a meta-analysis of 14 observational studies performed by *Yao* et al. [53] heavy alcohol consumption (>30 g per day) was associated with an increased risk of SAH (RR 1.78; 95% CI 1.46-2.17) compared to no alcohol intake. An increase in alcohol intake by 10 g per day was observed to increase the risk of SAH by 12.1%. *Can* et al. [8] shown that current alcohol use was related to ruptured cerebral aneurysm status in comparison with no alcohol consumption (OR 1.36; 95% CI 1.17-1.58).

No relationship was observed with reference to former alcohol use (OR 1.23; 95% CI 0.92-1.63).

In the light of the recent research, beneficial level of alcohol intake does not exist in the general population [15]. It is considered that recommended levels of its consumption presented in most of the current guidelines should be lowered [51]. Individuals at high risk of CA formation, as well as subjects with unruptured aneurysms, should particularly benefit from alcohol limitation.

Dietary recommendations in clinical practice

Dietary recommendations in prevention of CA formation and rupture should focus on the adequate intake of anti-inflammatory agents, vitamin B_6, vitamin B_{12} and folate, avoidance of alcohol and maintenance of normal blood pressure. Dietary nutrients with anti-inflammatory properties include mainly antioxidant vitamins (vitamin C, vitamin E and carotenoids), flavonoids and n-3 fatty acids, which reduce the pro-inflammatory eicosanoid production [40]. Dietary sources of these nutrients are fruit and vegetables, herbs and spices, tea, nuts and seeds and fatty fish. A rich source of folate are leafy greens, nuts and pulses, vitamin B_6 – grains, poultry and fish, while vitamin B_{12} – animal products [23].

Shiue et al. [39] performed a case-control study to determine whether specific dietary habits might be associated with the risk of subarachnoid hemorrhage in Australasian population. Authors shown that consumption of fat or skin on meat was related to higher risk of SAH (p for trend 0.04), while inverse relationship was observed with reference to skim or reduced-fat milk (p for trend 0.01) and fruit consumption (p for trend 0.04). Adjusted OR was highest in group of individuals who consumed fat or skin on meat more than 4 times a week compared with those with no fat or skin on meat intake (OR 1.70; 95% CI 1.09-2.66). Moreover, frequent adding salt to dishes was associated with higher risk of SAH in individuals with history of hypertension, both taking anti-hypertensive drugs (OR 2.58; 95% CI 1.29-5.13) and those without pharmacological treatment of hypertension (OR 2.88; 95% CI 1.46-5.70). According to authors, 15% (5-24%) of SAH cases were attributed to eating fruit less than once a week [38].

Due to the synergistic effect of various dietary components on health, it appears that nutritional recommendations in CA prevention should be based on the overall healthy dietary pattern, not only on single product or nutrient intake. According to existing evidence on the association between diet-related factors and aneurysm risk, specific dietary models which might be recommended for patients at high risk for developing the disease are Mediterranean (modified by eliminating wine intake) or DASH diets. Both of them are used in the nutritional therapy of hypertension and due to high consumption of vegetables and fruits they provide significant amounts of antioxidants and folate [41, 45]. High anti-inflammatory potential is attributed especially to Mediterranean diet because of its characteristic composition of herbs, spices and fats [42].

CONCLUSIONS

Risk factors for cerebral aneurysm formation and rupture which may be altered by nutritional modifications include: inadequate intake of dietary antioxidants, hyperhomocysteinemia, hypertension and alcohol intake. Individuals at high risk of CA formation and rupture should consume adequate amounts of vegetables, fruits, grains, nuts and fish, which are good sources of antioxidant vitamins (vitamin C, vitamin E and carotenoids), B vitamins (vitamin B_6, vitamin B_{12} and folate), flavonoids and n-3 fatty acids. Alcohol limitation, regular blood pressure control and avoidance of caffeine, a risk factor for incidental high blood pressure, should be advised. Mediterranean and DASH diets appear to meet above-mentioned requirements, they may be thus recommended for prevention of cerebral aneurysm formation and rupture.

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ORIGINAL ARTICLE

ASSESSMENT OF CHANGES IN THE OCCURRENCE OF *FUSARIUM* TOXIN AND OCHRATOXIN A IN POLAND RELATED TO EXTREME WEATHER PHENOMENA

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ABSTRACT

Background. Mycotoxins – substances harmful to humans, are ubiquitous in the environment. Mycotoxins are generated primarily by *Penicilium*, *Aspergillus* and *Fusarium* genus fungi. Their presence is associated with the unavoidable presence of mold fungi in the environment. The presently observed adverse climatic changes could negatively affect agriculture, causing erosion and loss of organic matter from soil, promulgation of pests and plant diseases, including those originating from pathogenic molds, and also migration of certain mold species into new regions, ultimately creating more favorable conditions for generation of mycotoxins.

Objective. The purpose of this work was to investigate contamination of cereals in Poland with *Fusarium* and ochratoxin A. Elucidating a correlation between precipitation levels in the individual Provinces and reported levels of the investigated mycotoxins, referring to the generally available meteorological databases, would result in more efficient planning of sampling processes and focusing further preventive actions associated with establishing sampling plans for the following years.

Material and methods. Investigations were performed on cereal and cereal product samples taken by the official foodstuffs inspection staff. Some 100 samples were taken annually in the 2009-2012 period (357 samples in total). Tests were performed using high performance liquid chromatography coupled with mass spectrometry (HPLC-MS/MS). Precipitation data were obtained from the Central Office of Statistics, based on data received from the Institute of Meteorology and Water Management.

Results. Analysis of the influence of precipitation levels during vegetation period on mycotoxin levels in the investigated foodstuffs was performed by associating each recorded content of deoxynivalenol (n=52, corresponding to 14.6% tested samples), zearalenone (n=30, 8.4%), total T-2 and HT-2 toxins (n=21, 5.9%) and ochratoxin A (n=88, 24.6%) above quantification limit with precipitation levels within the Province from which the sample originated. Deoxynivalenol and zearalenone levels show distinct variability corresponding with variability of precipitation levels, well reflecting the reported higher deoxynivalenol and zearalenone levels observed during the rainy years of 2011-2012. Variability in average ochratoxin A levels was not statistically significant. The relatively higher mycotoxin levels in 2009 may result from the heavy rainfall and flooding of 2007-2008. Dependence between the precipitation levels and number of samples showing levels above quantification limit has been also observed for deoxynivalenol. However, a similar analysis made for zearalenone and ochratoxin A does not point to any significant relationship. No data analysis was possible in reference to total T-2 and HT-2 toxins content due to the insufficient number of results available. However, it should be noted that 21% analyzed samples in 2009 contained T-2 and HT-2 levels above the quantification limit, with average of 8.9 µg/kg, whereas in 2010-2012 only one sample of the 263 tested contained contaminants in quantities above the quantification limit.

Conclusions. The model used for forecasting presence of mycotoxins in cereals does not allow its practical application during routine generation of official control and monitoring plans on national scale. Notably, tests performed show that exceeding of maximum contamination levels occurred just incidentally, notwithstanding the adverse weather conditions. Further systematic collection of data on mycotoxin contamination of agricultural crops is required for effective continued investigations.

Key words: *mycotoxins, cereal products, formation, weather condition, prediction, Fusarium toxin, ochratoxin A*

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STRESZCZENIE

Wprowadzenie. Mikotoksyny – związki o niepożądanym działaniu dla człowieka są powszechne w środowisku. Są wytwarzane głównie przez grzyby z rodzajów *Penicilium*, *Aspergillus* i *Fusarium.* Ich występowanie jest związane z nieuniknioną obecnością grzybów pleśniowych w środowisku. Niekorzystne zmiany klimatyczne, jakie obecnie są obserwowane, mogą spowodować niekorzystne zmiany w rolnictwie, takie jak erozja i utrata materii organicznej z gleby, rozpowszechnianie się szkodników i chorób roślin, w tym wywołanych przez patogenne pleśnie, jak również migrację niektórych gatunków pleśni na nowe regiony, oraz stworzyć dogodniejsze warunki do wytwarzania mikotoksyn.

Cel. Celem pracy było zbadanie zanieczyszczenia toksynami *Fusarium* i ochratoksyną A zboża w Polsce i stwierdzenie korelacji pomiędzy wielkością opadów na terenie poszczególnych województw a poziomami badanych mikotoksyn, z wykorzystaniem powszechnie dostępnych baz danych meteorologicznych, co pozwoliłoby na wydajniejsze planowanie pobierania próbek oraz skoncentrowanie dalszych działań zapobiegawczych przy tworzeniu planów pobierania próbek na następne lata.

Materiały i metody. Materiał do badań stanowiły próbki zboża i produktów zbożowych pobrane przez pracowników urzędowej kontroli żywności. Pobrano po ok. 100 próbek w okresie 2009-2012 (łącznie 357 próbek). Do badań zastosowano metodę wysokosprawnej chromatografii cieczowej sprzężonej z spektrometrią mas (HPLC-MS/MS). Dane dotyczące opadów pochodziły ze strony Głównego Urzędu Statystycznego, gdzie wykorzystano dane Instytutu Meteorologii i Gospodarki Wodnej

Wyniki. W celu analizy wpływu poziomu opadów w okresie wegetacji na poziomy mikotoksyn w badanych środkach spożywczych każdej zarejestrowanej zawartości powyżej granicy oznaczalności deoksyniwalenolu (n=52, co odpowiada 14,6% zbadanych próbek), zearalenonu (n=30, 8,4%), sumy toksyn T-2 i HT-2 (n=21, 5,9%) oraz ochratoksyny A n=88, 24,6%) przypisano wartość opadów na terenie danego województwa, z którego pochodziła próbka. W przypadku deoksyniwalenolu i zearalenonu wyraźnie widoczna jest zmienność poziomów tych mikotoksyn, która jest adekwatna do zmiany poziomu opadów, dobrze odzwierciedlając wyższe poziomy deoksyniwalenolu i zearalenonu w deszczowych latach 2009-2010, względem bardziej suchych lat 2011-2012. Zmienność średniego poziomu ochratoksyny A nie jest istotna statystycznie. Relatywnie wyższy poziom mikotoksyn w latach 2009 może wynikać z bardzo deszczowych i powodziowych lat 2007-2008. Dla deoksyniwalenolu współzależność obserwuje się także pomiędzy poziomem opadów, a liczbą próbek powyżej wartości granicy oznaczalności. Jednak podobna analiza dla zearalenonu i ochratoksyny A, nie wskazuje na istotną zależność. Z uwagi na niewystarczającą liczbę wyników, nie była możliwa analiza danych w odniesieniu do sumy toksyn T-2 i HT-2. Należy jednak odnotować, że w 2009 roku 21% zbadanych próbek zawierało poziom toksyn T-2 i HT-2 powyżej granicy oznaczalności, a wartość średnia wyniosła 8,9 μg/kg, w kolejnych latach tj. 2010-2012 zarejestrowano zaledwie jedną próbkę spośród 263 zbadanych zawierającą poziom zanieczyszczenia powyżej granicy oznaczalności.

Wnioski. Zastosowany model przewidywania występowania mikotoksyn w zbożach nie pozwala na praktyczne zastosowanie go w podczas rutynowego tworzenia planów urzędowej kontroli i monitoriungu w skali całego kraju. Należy stwierdzić, że mimo niekorzystnych warunków pogodowych, jakie wystąpiły w trakcie realizacji badań, przekroczenia najwyższych dopuszczalnych poziomów zanieczyszczenia pojawiały się incydentalnie

Słowa kluczowe: *mikotoksyny, produkty zbożowe, zjawiska pogodowe, przewidywanie, toksyny Fusarium, ochratoksyna A*

INTRODUCTION

Consequences of climatic changes have aroused attention of researchers and the public opinion. European Commission report for central Europe (Poland, Czech Republic, Slovakia, Hungary, northern Romania, eastern Austria, southern and eastern Germany) forecasts the possibility of average annual temperature increases by 3-4 °C, increased precipitation in winter and reduced in summer, along with increased risk of flooding. This could lead to adverse changes in agriculture, including erosion and loss of organic material from soil, spreading of pests and plant diseases, including those caused by pathogenic molds, into new regions, favoring generation of mycotoxins – toxic secondary metabolites – from species considered until now to be non-toxin generating [14, 15, 16].

Mycotoxins – substances harmful to humans, are ubiquitous in the environment, with *Penicilium*, *Aspergillus* and *Fusarium* genus being the principal sources thereof. Their presence is associated with the unavoidable presence of mold fungi in the environment. Mycotoxins are present in agricultural products having fundamental importance for humans – in cereals (aflatoxins, ochratoxin A, *Fusarium* toxins) in oil seeds (aflatoxins) and their processed products. Their presence has been reported in other foodstuffs, such as nuts, spices, dried fruit, coffee, wine, processed fruit products (aflatoxins, ochratoxin A, patulin). Their presence has been reported also in animal derived raw materials, transferred in mycotoxin contaminated feed. Mycotoxins are stable when subjected to majority of processes used in the food processing industry, including resistance to elevated temperatures. These substances are important acute toxins, are carcinogenic, immunotoxic nephro- and hepa-toxic [2, 3, 9].

Considerable progress in food toxicology and development of analytical techniques over the last few years focused attention to toxins generated by the *Fusarium* genus fungi, widespread in the moderate climate zone, including rural areas of Europe. The genus has been found mainly in cereals and cereal products. *Fusarium* toxins are generated in result of (cereal) plant infection in field, during florescence.

Hence, their abundance depends on climatic conditions prevalent using the vegetation period, with increased precipitation and high moisture content during cereal florescence resulting to with the, so-called, "*Fusarium* years" [6, 13, 19], when toxin levels become exceedingly high. The toxins constitute a group of substances with differentiated chemical structure and wide spectrum of toxic action. Toxicological assessment has been performed so far for the following *Fusarium* toxins: deoxynivalenol (DON), nivalenol (NIV), T-2 and HT-2 toxins, zearalenone (ZEA) and fumonisin (FB) [9, 10, 11, 21, 23].

Ochratoxin A (OTA) is generated in moderate climate principally by *Penicillium verrucosum* and is included into the group of the, so called, storage toxins exuded, among others, during storage of grain under inappropriate conditions (too high moisture content). Ochratoxin A has widespread and well documented harmful action, i.e. is nephro-toxic, teratogenic, immunotoxic and probably also neuro-toxic.

Floods ravaged many east European countries in May and June 2010. Heavy rainfall on 14-18 May led to water level increases in the upper Vistula and Odra Rivers basins. The second flood wave was caused by intensive precipitation on 1-2 June. Many embankments were broken, particularly in the Śląskie, Małopolskie, Podkarpackie, Świętokrzyskie, Lubelskie and Dolnośląskie provinces. Press reported flooding of approx 554,000 hectares and 30,000 people had to be evacuated.

Therefore, it was decided to determine the changes in mycotoxin levels present in samples of cereal products originating from different areas of Poland from harvests of 2010 (when those catastrophic wide-area floods occurred) and over the following years., and to assess the changes in exposure of people to the above stated toxins.

The prevailing food laws impose preparation of annual official control and monitoring sampling plans required by the food control office. Such plans serve both to verify compliance with the applicable regulations as well as for early detection of risk factors, thus enabling activities eliminating the hazards and mitigating risks to human health [4, 8].

The purpose of this work was to investigate whether contamination of cereals in Poland with mycotoxins (*Fusarium* and ochratoxin A) is related in any way with data from generally available meteorological databases. Elucidating a correlation between precipitation levels in the individual Provinces and reported levels of *Fusarium* and ochratoxin A would result in more efficient planning of sampling processes and focusing further preventive actions associated with establishing sampling plans for the following years.

MATERIAL AND METHODS

Samples

Cereal and cereal product samples weighing not less than 1 kg were taken according with Commission Regulation (EC) No. 406/2006 by employees of the State Sanitary Inspection [5]. As high differences between Fusarium toxin contamination levels were expected, some 100 samples were taken annually over the period from 2009 to 2012. 357 samples were taken in total, in that:

- approx. 70% wheat flour types 500 and 550,
- approx. 15% wheat flour type 2000 (full grain),
- approx. 15% rye flour.

Where possible, the samples originated from mills situated in area covered by the given Provincial Sanitary Epidemiological Station. The samples with their sampling protocols were submitted to the Food Safety Laboratory in National Institute of Public Health-National Institute of Hygiene (NIZP-PZH), where investigated mycotoxin levels were determined.

Methodology of determination

Tests were performed using own modification of the Sulyok high performance liquid chromatography coupled with mass spectrometry (HPLC-MS/MS) [12, 18]. Pure for analysis Merck reagents were used, except for acetonitrile and ammonium acetate, with Baker purity for mass spectrometry quality. Standards, including radio-labeled standards were from Biopure. Reverse osmosis and dematerialized water was used. Method parameters have been stated in Tables 1 and 2. Precipitation data were taken from the Central Office of Statistics web page, and originated from the Institute of Meteorology and Water Management [22].

RESULTS AND DISCUSSION

Analysis of the influence of precipitation levels during vegetation period on mycotoxin levels in the investigated food stuffs was performed by associating each recorded content of deoxynivalenol (n=52, corresponding to 14.6% tested samples), zearalenone (n=30, 8.4%), total T-2 and HT-2 toxins (n=21, 5.9%) and ochratoxin A (n=88, 24.6%) above quantification limit with precipitation levels within the Province from which the sample originated. Precipitation levels from May to August were included, i.e. during period from cereal florescence to harvest. Fungi infections resulting in presence of *Fusarium mycotoxins* took place at that time. Presence of ochratoxin A, for which the highest number of contaminated samples was observed, results in turn from growth of *Aspergillus ochraceus* fungi after harvest, during storage of cereals.

Weather conditions during harvest may be relevant for growth of pathogenic fungi, but storage conditions of cereals constitute a separate factor of key importance.

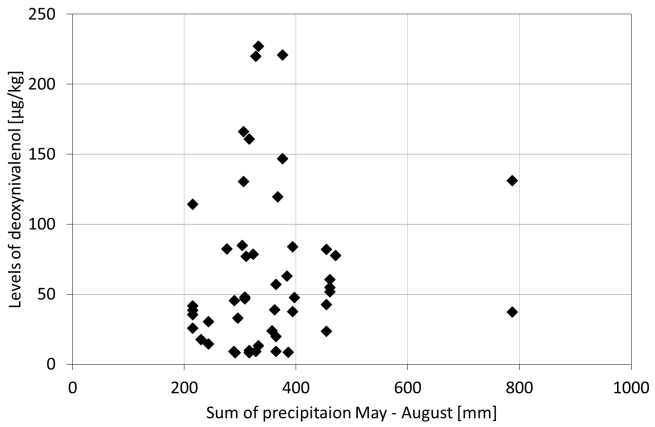
Figures 1. a) - d) present levels of mycotoxins reported depending on precipitation levels. Extremely high mycotoxins level results of were discarded.

Table 1. Working conditions of MS / MS mass spectrometer (Waters Quattro Micro API MRM mode, ES + ionization

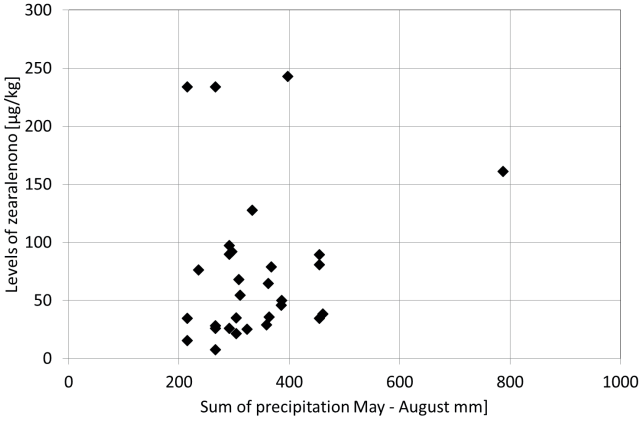
Toxin /IS	Parent ion (m/z)	Daughter ion (m/z)	Cone voltage	Collision energy
DON	297.10	249.10	22	12
NIV	313.10	125.00	24	12
ZEA	319.20	301.00	21	10
OTA	404.00	239.00	26	24
HT-2	442.2	263.20	18	13
HT-2 C13 (IS)	464.3	278.1	20	14
T-2	484.3	305.1	24	14
FB1	722.30	334.3	46	40
FB2	706.4	336.2	48	40
Source parameters				
Capillary	4.00 kV			
Cone	20.00 V			
Extractor	2.00 V			
Temperature	100ºC			
Evaporation temperature	350ºC			
Gas flow on the cone (N2)	50 l/h			
Evaporative gas flow (N2)	500 l/h			

Figure 1. Levels of occurrence of a) deoxynivalenol, b) zearalenone, c) the amount of T-2 and HT-2, and d) ochratoxin A in the test samples based on the total rainfall between May and August

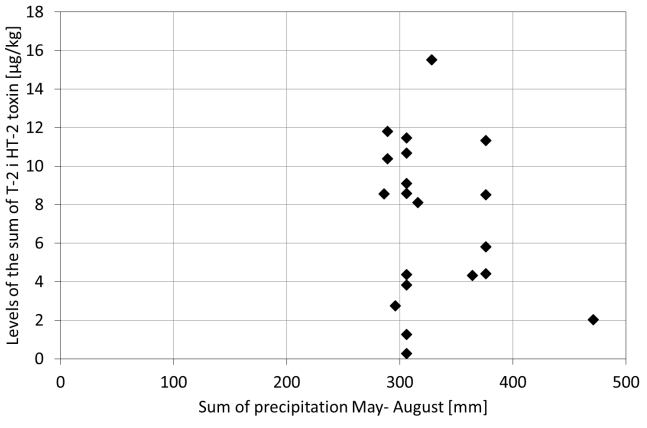
a) deoxynivalenol



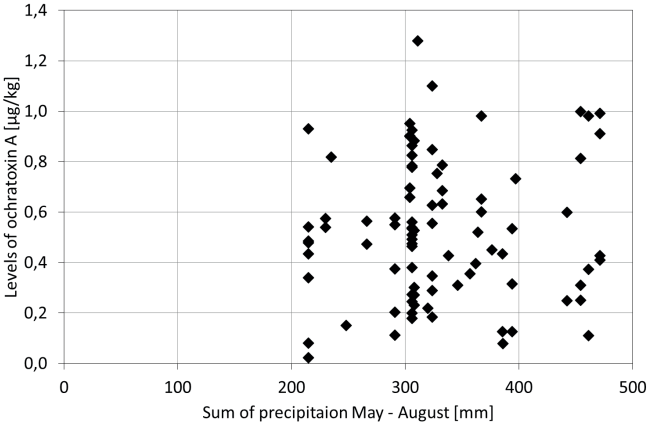
b) zearalenone



c) sum of T-2 i HT-2 toxin



d) ochratoxin A



Observation of individual points does prove existence of link between precipitation levels and presence of mycotoxins. Absence of dependence for ochratoxin A could be justified by higher importance of storage conditions and short-term and local weather conditions during the harvest. T-2 and HT-2 toxins and zearalenone had relatively fewer results above the quantification limited (below 10%), and these could have been insufficient to conclude existence of any dependence. Absence of any dependence between reported deoxynivalenol (frequent contaminant of cereals in Poland) levels and precipitation data is a more important finding. Probably, growth of toxin exuding fungi is considerably affected also by other factors and agricultural procedures, such as temperature during vegetation, pests, as well as crop-dusting. Lower temperatures coupled with high precipitation levels are disadvantageous for growth of *Fusarium* genus fungi.

A different approach may be taken by relating number of samples contaminated above/below the quantification limit with precipitation, and defining an average precipitation level for such subpopulation of samples for each of the investigated mycotoxins. Calculation results have been presented in Table 3.

Table 2. Performance of the analytical method

Parameters	DON	ZEA	OTA	HT-2	T-2
Fortification level (µg/kg)	100	10	0.25	7.5	7.5
Recovery (%)	81.2	49.1	84.5	96.1	97.7
SD	17.7	0.71	0.1099	1.20	0.47
RSD (%)	5.1	14.4	65.1	14.3	6.5
Fortification level (µg/kg)	200	20	0.5	15	15
Recovery (%)	89.2	72.2	83.0	99.2	96.6
SD	28.5	1.80	0.0897	1.08	1.18
RSD (%)	6.4	12.5	14.5	6.8	8.2
Fortification level (µg/kg)	400	40	1	30	30
Recovery (%)	89.2	48.0	46.3	103.7	98.0
SD	32.3	1.49	0.0849	1.31	1.77
RSD (%)	5.2	7.8	12.7	4.0	6.0

Table 3. Method performance parameters, detection limits (LOD) and quantification limits (LOQ)

Mycotoxin	LOD (3 x S/N)		LOQ (10 x S/N)	
	ng/ml	ng/g	ng/ml	ng/g
DON	5.0	2.0	16.3	6.5
ZEA	15.3	6.1	51.3	20.5
OTA	0.18	0.07	0.60	0.24
HT-2	2.8	1.1	9.3	3.7
T-2	0.3	0.1	0.8	0.3

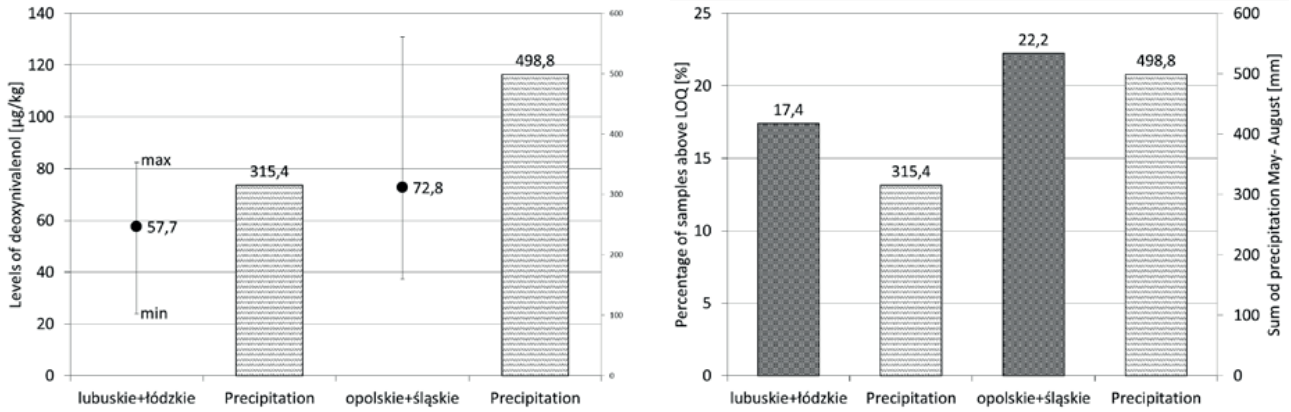
However, also this approach does not lead to elucidating existence of a relationship between the number of contaminated samples and average precipitation levels. Precipitation levels for both populations are not significantly different: in case of deoxynivalenol, average precipitation level of contaminated samples is just slightly higher than for not contaminated ones (difference is 17.6 mm, with standard deviation for precipitation level being 97.6 mm). Precipitation level averages for zearalenone are identical in both analyzed subpopulations, and in case of total T-2 and HT-2 toxins, contaminated samples are associated with slightly lower precipitation levels as compared with the non-contaminated ones. A similar observation has been found for ochratoxin A, although it still lacks statistical significance; however, in this case the conclusion could be associated with higher importance of storage conditions as compared with cereal vegetation period.

Data for the collected 357 samples taken from all Provinces also allow analysis of external mycotoxin contents relative to external weather conditions. This model of research involved selecting two provinces where cereals are harvested: with lowest average total precipitation in May-August for a period of 4 years – Lubuskie and Łódzkie (n=23, average precipitation 31.4) and with highest total – Śląskie and Opolskie (n=18 average precipitation 498.8 mm). Figure 2 for these Provinces presents average mycotoxin levels above quantification limit, ratio of the number of samples below and above quantification limit and precipitation level; comparative data for the entire

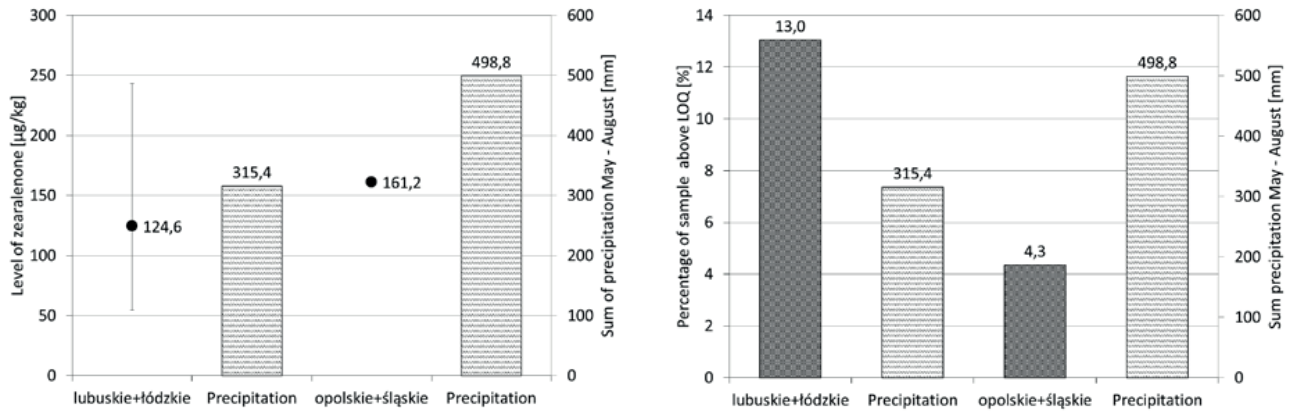
country have been included, also. Such analysis was made for deoxynivalenol, zearalenone and ochratoxin A; total T-2 and HT-2 toxins in both compared areas had low incidence of results (just one value above LOQ = 0.1 ng/g). Graphs for deoxynivalenol and zearalenone show increase in average in line with increase in precipitation levels, thus proving to some extent the effect of increased precipitation levels on increase in mycotoxin content. Such trend is also visible for deoxynivalenol as an increase in the ratio of number of samples above the quantification limit to all samples taken in those areas. However, no clear trend is visible for zearalenone. In turn, the average contamination levels and ratios of numbers of samples in both compared areas do not differ significantly for ochratoxin A, confirming that weather conditions (precipitation) do not affect ochratoxin A levels.

Figure 2 The mean, minimum and maximum occurrence a) deoxynivalenol, b) zearalenone and c) ochratoxin A in the samples above the limit of quantification against the average rainfall in the provinces of extremely high and low average precipitation in 2009-2012. Percentage of samples above the limit of quantification against the amount of precipitation discussed.

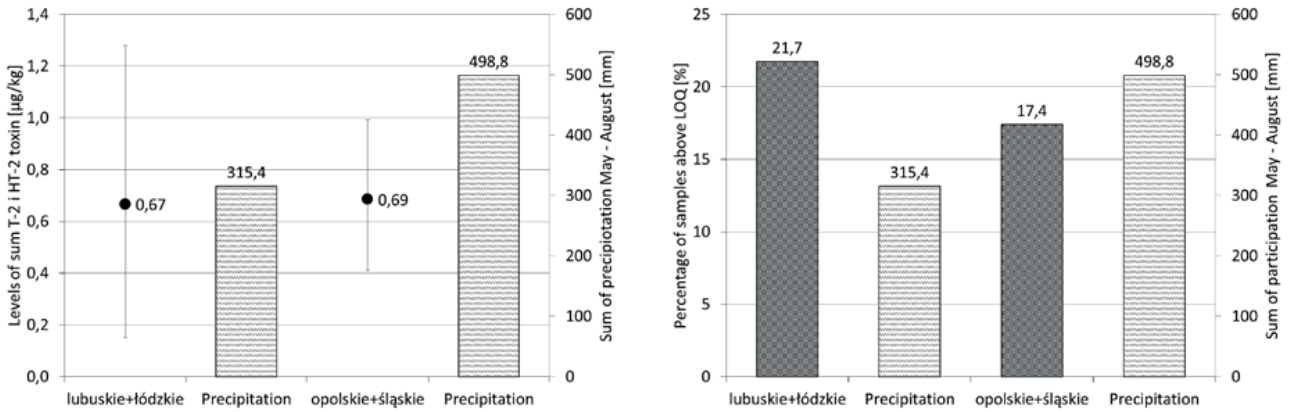
a) deoxynivalenol



b) zearalenone



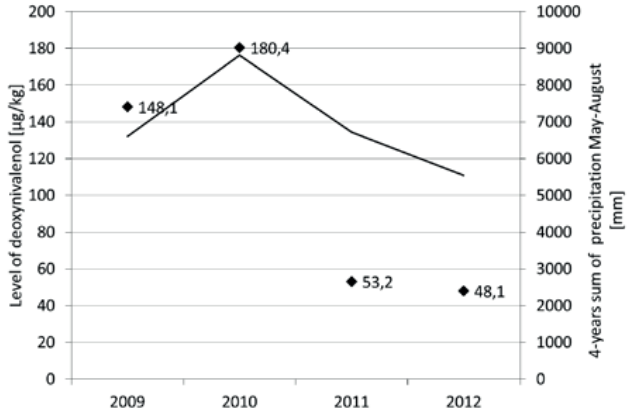
c) ochratoxin A

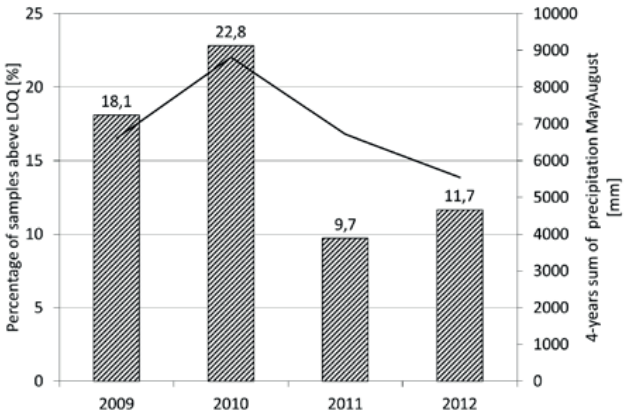


Data on presence of the investigated mycotoxins were collected in years 2009-2012, differing considerably in precipitation levels. Years 2009 and 2010 reported plentiful precipitation in the May to August period, whereas years 2011 and 2012 were more arid. Precipitation levels and mycotoxin presence results above the quantification limit for the entire Poland were compared over successive years and presented in Figure 3 and Table 4.

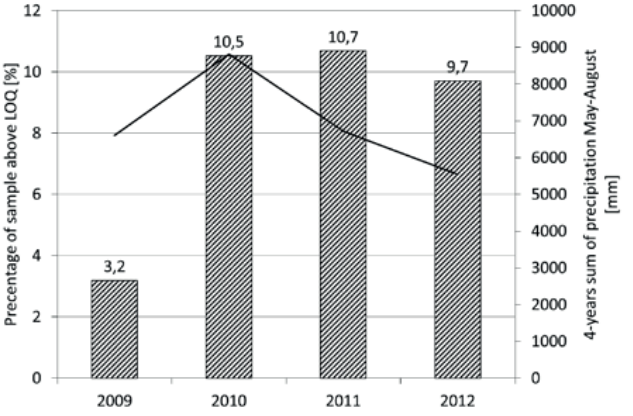
Figure 3. Mean values of occurrence a) deoxynivalenol, b) zearalenone and c) ochratoxin A in the samples above the limit of quantification in subsequent years to the sum of the four-year average precipitation in 2009-2012. Percentage of samples above the limit of quantification against the amount of precipitation discussed.

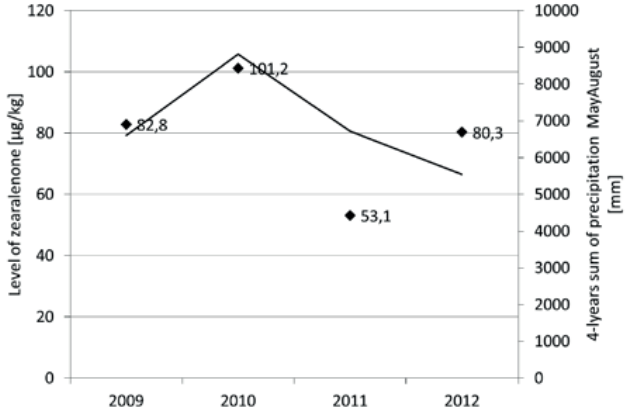
a) deoxynivalenol



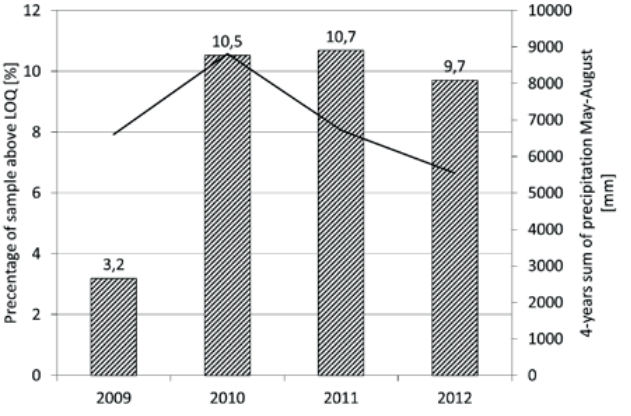


b) zearalenone





c) ochratoxin A



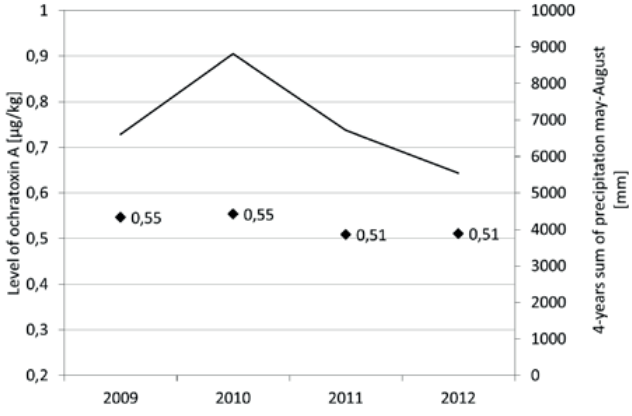


Table 4. Number of samples above and below the LOQ for each of the mycotoxins tested and average levels of total precipitation in May-August for both subpopulations of samples

Samples	Deoxynivalenol		Zearalenone		Σ Toxins T-2 and HT-2		Ochratoxin A	
	Qty (relative qty) of samples	Average precipitation (mm)	Qty (relative qty) of samples	Average precipitation (mm)	Qty (relative qty) of samples	Average precipitation (mm)	Qty (relative qty) of samples	Average precipitation (mm)
> LOQ	52 (14.6%)	355.3	30 (8.4%)	340.9	21 (5.9%)	331.8	88 (24.6%)	330.5
< LOQ	305 (85.4%)	337.7	327 (91.6%)	340.2	336 (94.1%)	340.8	269 (75.4)	343.5

A distinct variability of deoxynivalenol and zearalenone contamination is visible, corresponding with the changing precipitation levels and well reflecting the increased deoxynivalenol and zearalenone contents in the rainy years 2009-2010 relative to the more arid years 2011-2012. Variability of average ochratoxin A levels is not statistically significant. The relatively higher content of mycotoxins observed in 2009 may be a consequence of the heavy rain and floods of 2007-2008. Dependence has been observed for deoxynivalenol also between the precipitation levels and number of samples above the quantification limit. No significant dependence has been found in similar analysis for zearalenone and ochratoxin A. Data analysis for total of T-2 and HT-2 toxins was not possible due to insufficient number of samples. However, it should be noted that 21% investigated samples contained total T-2 and HT-2 toxin levels above the quantification limit, with average contamination levels at 8.9 µg/kg, whereas in 2010-2012 just one sample in 263 was reported to be contaminated with those toxins at level exceeding the quantification limit.

Use of mathematical models for quantification and forecasting microbiological behaviors. Predictive microbiology for forecasting presence of pathogens transferred through foodstuffs has been under development for some 20 years, notwithstanding primary application of such tools to bacteria. Prognostic mycology focused on food safety is much less advanced [1, 7, 17].

Mycotoxins present in agricultural commodities constitute a safety threat to foodstuffs during transport, storage and distribution [20]. The specific variability of factors responsible for generation of mycotoxins continues to pose a challenge, with the existing research referring either to laboratory or global scale models of forecasting changes. In summary, forecasting levels of mycotoxins present in foodstuffs and animal fodder is difficult due to the divergence of factors affecting their generation.

Table 5. Mean values of occurrence of mycotoxins in samples above the limit of quantification (LOQ) and the percentage of samples above the LOQ in each year to the sum of the 4-year average rainfall in 2009-2012

Year	Number of samples	Deoxynivalenol		Zearalenone		Ochratoxin A (OTA)		4-year total rainfall (mm)
		Number of samples > LOQ	Mean (µg/kg)	Number of samples > LOQ	Mean (µg/kg)	Number of samples > LOQ	Mean (µg/kg)	
2009	94	17 (18.1%)	148.1	3 / 94 (3.2%)	82.83	31 (33.0%)	0.55	6602
2010	57	13 (22.8%)	180.4	6 (10.5%)	101.2	8 (14.0%)	0.55	8812
2011	103	10 (9.7%)	53.2	11 (10.7%)	53.1	28 (27.2%)	0.51	6717
2012	103	12 (11.6%)	48.1	10 (9.7%)	80.3	21 (20.4%)	0.51	5541
2009-2012	357	52 (14.6%)	114.8	30 (8.4%)	79.4	88 (24.6%)	0.53	

CONCLUSIONS

1. The model for forecasting presence of mycotoxins in cereals does not allow its practical use during the routine of establishing official control and monitoring plans on the national scale.
2. Although adverse weather conditions prevailed during these investigations, exceeding of highest permitted contamination levels happened just incidentally.
3. Further systematic collection of data on mycotoxin contamination of agricultural crops is required for effective continued investigations.

Acknowledgments

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Conflict of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

SELECTED DETERMINANTS OF EATING BEHAVIOURS AMONG PRESCHOOL CHILDREN FROM THE KRAKÓW ENVIRONMENT

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ABSTRACT

Background. One of the factors determining the nutritional behaviour of children and adolescents is family socio-economic status.

Objective. The aim of the study was to assess the nutritional behaviour of preschool children from the Kraków environment depending on the sex of the child and the mother's level of education.

Material and methods. The study was carried out among a group of mothers of 480 (240 girls and 240 boys) 4-6-year-olds, using the author's questionnaire on dietary behaviours. Children of mothers with higher education accounted for 63.5%, and those with primary, vocational and secondary education constituted 36.5% of the group. Statistical analysis was carried out using the PQStat package 1.6.6.246 version, applying *Pearson's Chi*-squared test ($p<0.05$).

Results. The girls consumed a significantly greater amount of: vegetables ($p<0.01$), fruit ($p<0.05$), wholemeal bread ($p<0.001$) as well as milk and dairy products ($p<0.001$), and boys: meat and cold-cuts from poultry ($p<0.001$) and sweets ($p<0.05$). Children of mothers with higher education more frequently consumed: vegetables ($p<0.001$), fruit ($p<0.001$), wholemeal bread ($p<0.001$), fish ($p<0.01$) and eggs ($p=0.01$), and children of mothers with secondary and vocational education: milk and dairy products ($p<0.05$), meat and cold-cuts from poultry ($p<0.001$) and sweets ($p=0.001$), salted snacks ($p<0.001$) and sweetened fizzy beverages ($p<0.05$).

Conclusions. Diversity in some dietary choices of preschool children from the Kraków environment has been demonstrated, depending on the sex of children and the mother's level of education. Furthermore, it is indicated that girls and the children of mother's with higher education are characterised by a more favourable diet.

Key words: *preschool children, nutritional behaviour, mother's level of education, Poland*

STRESZCZENIE

Wprowadzenie: Jednym z czynników warunkujących zachowania żywieniowe dzieci i młodzieży jest status społeczno-ekonomiczny rodziny.

Cel. Celem badań była ocena zachowań żywieniowych dzieci przedszkolnych ze środowiska krakowskiego w zależności od płci dziecka oraz poziomu wykształcenia matki.

Materiał i metody. Badania przeprowadzono w grupie matek 480 dzieci (240 dziewcząt i 240 chłopców) w wieku 4-6 lat z zastosowaniem autorskiego kwestionariusza zachowań żywieniowych. Dzieci matek z wykształceniem wyższym stanowiły 63.5%, a z zasadniczym zawodowym i średnim 36.5% grupy. Analizę statystyczną przeprowadzono w pakiecie PQStat wersja 1.6.6.246. z zastosowaniem testu *Chi*-kwadrat ($p<0,05$).

Wyniki. Dziewczęta istotnie częściej spożywały: warzywa ($p<0.01$), owoce ($p<0.05$), pieczywo razowe ($p<0.001$) oraz mleko i jego przetwory ($p<0.001$), a chłopcy: mięso i wędliny drobiowe ($p<0.001$) oraz słodycze ($p<0.05$). Dzieci matek z wykształceniem wyższym z większą częstością spożywały: warzywa ($p<0.001$), owoce ($p<0.001$), pieczywo razowe ($p<0.001$), ryby ($p<0.01$) i jaja ($p=0.01$), a dzieci matek z wykształceniem nie-wyższym (średnim i zawodowym): mleko i jego przetwory ($p<0.05$), mięso i wędliny drobiowe ($p<0.001$) oraz słodycze ($p=0.001$), słone przekąski ($p<0.001$) i słodkie napoje gazowane ($p<0.05$).

Wnioski. Wykazano zróżnicowanie niektórych wyborów żywieniowych dzieci przedszkolnych ze środowiska krakowskiego w zależności od płci dzieci oraz poziomu wykształcenia ich matek, ze wskazaniem na korzystniejszy sposób żywienia dziewcząt niż chłopców oraz dzieci matek z wykształceniem wyższym niż średnim i zasadniczym zawodowym.

Słowa kluczowe: *dzieci przedszkolne, zachowania żywieniowe, poziom wykształcenia matki*

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INTRODUCTION

A correct, balanced way of feeding children and adolescents promotes the optimisation of development processes and the prevention of diet-related diseases, including obesity and its complications at later stages of ontogenesis [16, 18]. Improving the health potential of children and adolescents is favoured through a varied diet, rich in products with high nutritional density, including vegetables and fruit, whole-grain cereals, milk and dairy products, lean meat and fish as well as nuts, with limited consumption of low-density products, including sweets and confectionery products, sweetened fizzy beverages and fast food [10, 14]. The new Polish proposal within this aspect is the Pyramid of Healthy Nutrition and Lifestyle for Children and Youth (age 4-18) of the Institute of Food and Nutrition, published in January 2019. The nutritional part of the pyramid, at the base, starts with vegetables and fruits, and at the top, the pyramid is closed by vegetable oils and nuts. The intermediate levels are successively: whole-grain cereal products, milk and dairy products and other protein products (legume seeds, white meat, fish, eggs). It is also recommended to drink water and other non-sugary drinks, to not eat sweets or consume sugary drinks, limiting salt to herbs and other spices. The element of health creation for children and adolescents is also daily physical activity for at least one hour, sleep hygiene and counteracting body height and mass [13].

The specific nutritional needs of preschool children include a balanced diet, covering energy needs, protein, vitamins (including D3) and minerals (including calcium and iron). The proper supply of proteins and B group vitamins affects the normal course of metabolic processes, the normative intake of vitamin D3 and calcium optimises the building of peak bone mass, and the correct intake of iron prevents anaemia, one of the most frequently occurring paediatric problems [10, 13, 14].

Nutritional behaviours of children and adolescents are a derivative of the influence of family and preschool or the school environment, while the attitudes and nutritional habits shaped at this age influence eating habits in later life. Research has shown that the socio-economic status of a family is a factor influencing the health behaviour of children and teenagers, apart from demographic and cultural conditions [1, 6, 19].

The premise for undertaking research was assuming the importance of the family environment in shaping children's eating habits. The aim of the study was to assess the nutritional behaviours of preschool children from the Kraków environment depending on sex and the mother's level of education (higher education vs. non-higher: secondary and vocational).

MATERIAL AND METHODS

The study was conducted using the auditorium questionnaire method among a randomly selected group of 480 parents of preschool age children in Kraków using the author's original validated questionnaire. The survey was prepared on the basis of current recommendations and subject-related literature [10, 13, 14, 42]. The questionnaire addressed to mothers included metric questions concerning sociometric characteristics of the family (place of residence, age, education and occupational activity of parents, financial situation and family income, number of people in the household, number of children in the family) and concerning preschool children (age, gender, body mass and height). The main part of the questionnaire concerned the manner of feeding children (the number and regularity of eating meals, the frequency of consuming selected products, the number and type of preferred beverages). Statistical analysis was carried out using the PQStat, 1.6.6.246 version statistical package, applying *Pearson's Chi*-squared test, assuming test probability at the level of $p<0.05$.

The sociodemographic characteristics of the group show that the majority of subjects lived in the city (93.5%), and a small percentage (6.5%) lived in the outskirts. The mothers of the studied children were in majority, women between the age of 25 and 35 (65.0%), those with higher education (63.5%) and those professionally active (79.3%). Almost half of the subjects (44.0%) estimated their average, monthly family income to be above PLN 5,000, and a small percentage (6.5%) stated the amount to be below PLN 1,500. More than half of the subjects (58.9%) assessed the family's financial situation as good, and a small percentage (6.5%), as bad. The number of people in the household ranged from 2 to 7 individuals, 4-person families dominating (53.8%). The number of children in families ranged from 1 to 3, while families with 2 children dominated (53.8%).

The studied group included 240 girls (50%) and 240 boys (50%) aged 4 to 6 years, the majority being 5-year-olds (63.5%). The children covered by the examination, in addition to home nutrition, also used mass nutrition at a preschool institution. The group was dominated by children remaining in preschool for 7-8 h (79.3%), less often, 9-11 h (20.7%). Children of mothers with higher education accounted for 63.5% (N = 308), and those with non-higher education (secondary and vocational) totalled 36.5% of the group (N = 172). On the basis of the BMI index (with reference to Polish standards for children) [21], it was found that the majority of boys (55.0%) and girls (72.1%) were within the norm. At the same time, 17.9% of girls and 45.0% of boys were underweight. Overweightness and obesity occurred only in girls (respectively: 7.9% and 2.1%).

RESULTS

The preschool children in the study group were dominated by those who regularly consumed (93.5%) 5 meals a day (65.0%), eating meals together with their parents (87.5%) and snacking between main meals (86.4%) (Table 1). Analysis of the qualitative aspects of the discussed nutritional habits showed that the sex of children significantly differentiates the standard number of meals during the day and consumption of meals together with parents. In this regard, it was found that boys more often consumed at least 6 meals a day (12.1% vs 7.9%, $p<0.05$), and a greater percentage of girls e consumed meals together with their parents (95.0% vs. 80.0%, $p<0.001$). It was also shown that the level of the mother's education significantly differentiates all of the discussed aspects. Children of mothers with higher education significantly more regularly ($p<0.001$) consumed a larger number of meals during the day ($p<0.01$), together with their parents (p=0.001), while a greater percentage of children of mothers with non-higher (secondary and vocational) education snacked between main meals more often ($p<0.001$) (Table 1).

Table 1. Selected qualitative aspects of the diet of preschool children depending on sex and mother's level of education (percentage of subjects)

Evaluated indicators		Total N=480	Sex of the child			Mother's level of education		
			G n=240	B n=240	*p*	H n=308	S+V n=172	*p*
Number of meals during the day	≥6	10.0	7.9	12.1	0.023	12.5	5.8	0.004
	5	65.0	62.1	67.9		65.9	62.3	
	4	25.0	30.0	20.0		21.6	31.9	
Regularity of eating meals	Yes	93.5	92.1	95.0	0.193	96.1	88.1	0.000
	No	6.5	7.9	5.0		3.9	11.9	
Eating together (children and parents)	Yes	87.5	95.0	80.0	0.000	90.9	80.8	0.001
	No	12.5	5.0	20.0		9.1	19.2	
Snacking between main meals	Yes	86.4	87.9	85.0	0.350	81.8	94.8	0.000
	No	13.6	12.1	15.0		18.2	5.2	

Sex: G - girls, B - boys; Education: H - higher, S + V - secondary + vocational

Assessment of the frequency of consuming selected groups of food products showed that preschool children, in their total daily diets, included the largest percentage of: fruit (79.3%), milk and dairy products (64.3%) and vegetables (44.0%). They frequently consumed, several times a week: poultry meat and cold-cuts (93.5%), eggs (88.1%), fish (67.15), wholemeal bread (58.9%), sweets/confectionery products (56.8%) and vegetables (50.9%). At the same time, less than once a month or never, they consumed: wholemeal bread (25.5%) and fish (12.1%), but also salted snacks/fast food (37.1%) and sweets/confectionery products (21.9%). Statistical analysis confirmed variation in the frequency of consuming the majority of products included in relation to the sex of children and the level of education of their mothers. Girls consumed vegetables at a higher frequency ($p<0.01$), fruit (p<0.05), wholemeal bread ($p<0.001$) as well as milk and dairy products ($p<0.001$), while boys consumed poultry meat and cold-cuts ($p<0.001$) as well as sweets/confectionery products ($p<0.05$). In turn, children of mothers with higher education consumed vegetables ($p<0.001$), fruit ($p<0.001$), wholemeal bread ($p<0.001$), fish ($p<0.01$) and eggs ($p=0.01$) more frequently, and the children of mothers with non-higher education (secondary and vocational) consumed the following more often: milk and dairy products ($p<0.05$), poultry meat and cold-cuts ($p<0.001$), sweets/confectionery products ($p=0.001$) and salted snacks/fast food ($p<0.001$) (Table 2).

Assessment of the amount of consumed liquids and the type of preferred beverages showed that preschool children generally drank 1.0-1.5 and 0.5-1.0 litres of liquids a day, usually reaching for: mineral water (33.5%) and tea (20.4%). Statistical analysis confirmed diversity in the amount of beverages consumed depending on the sex of children and preferences depending on the mother's level of education. The boys consumed a greater volume of liquids than girls ($p<0.001$), and the children of mothers with non-higher (secondary and vocational) education preferred a higher percentage of consuming sweetened fizzy beverages ($p<0.05$) (Table 3).

Table 2. Frequency of consuming selected product groups among preschool children depending on sex and the mother's level of education (percentage of subjects)

Food products	Frequency of consumption	Total N=480	Sex of the child			Mother's level of education		
			G n=240	B n=240	*p*	H n=308	S+V n=172	*p*
Vegetables	Every day	44.0	48.0	40.0	0.005	34.2	26.2	0.000
	A few times a week	50.9	48.2	53.7		52.9	62.8	
	Once a month	2.9	3.8	2.1		12.9	6.9	
	Rarely / never	2.2	0.0	4.2		0.0	4.1	
Fruit	Every day	79.3	80.8	77.9	0.035	86.2	69.8	0.000
	A few times a week	19.6	17.1	22.1		12.9	30.2	
	Once a month	1.1	2.1	0.0		0.9	0.0	
	Rarely / never	0.0	0.0	0.0		0.0	0.0	
Wholemeal bread	Every day	8.5	12.1	5.0	0.000	12.4	1.9	0.000
	A few times a week	58.9	62.9	55.0		63.9	51.7	
	Once a month	7.1	7.1	7.1		4.9	8.7	
	Rarely / never	25.5	17.9	32.9		18.8	37.7	
Milk and dairy products	Every day	64.3	65.8	62.9	0.000	62.9	69.8	0.015
	A few times a week	28.5	32.1	25.0		27.9	27.9	
	Once a month	4.7	2.1	7.1		5.3	1.7	
	Rarely / never	2.5	0.0	5.0		3,9	0.6	
Poultry meat and cold-cuts	Every day	2.9	2.9	2.9	0.000	0.9	6.9	0.000
	A few times a week	93.5	90.0	97.1		92.9	93.1	
	Once a month	2.5	5.0	0.0		4.3	0.0	
	Rarely / never	1.1	2.1	0.0		1.9	0.0	
Fish	Every day	0.0	0.0	0.0	0.396	0.0	0.0	0.002
	A few times a week	67.1	70.0	64.2		71.1	58.1	
	Once a month	20.8	18.7	22.9		21.8	22.7	
	Rarely / never	12.1	11.3	12.9		7.1	19.2	
Eggs	Every day	1.5	0.5	2.1	0.159	0.9	0.0	0.010
	A few times a week	88.1	88.7	87.9		91.9	83.7	
	Once a month	5.0	5.0	5.0		3.9	8.8	
	Rarely / never	5.4	5.8	5.0		3.3	7.5	
Sweets	Every day	1.3	0.5	2.1	0.011	0.9	0.0	0.001
	A few times a week	56.8	62.9	50.8		51.9	66.9	
	Once a month	20.0	17.9	22.1		25.0	12.2	
	Rarely / never	21.9	18.7	25.0		22.2	20.9	
Salted snacks / fast food	Every day	0.0	0.0	0.0	0.145	0.0	0.0	0.000
	A few times a week	34.4	37.9	30.8		25.9	51.2	
	Once a month	28.5	25.0	32.1		25.9	31.9	
	Rarely / never	37.1	37.1	37.1		48.2	16.9	

Sex: G - girls, B - boys; Education: H - higher, S + V - secondary + vocational

Table 3. Amount of consumed liquids and preferred beverages among preschool children depending on sex and the mother's level of education (percentage of subjects)

Evaluated indicators		Total N=480	Sex of the child			Mother's level of education		
			G n=240	B n=240	*p*	H n=308	S + V n=172	*p*
Amount of fluids / 24 h (l)	>1.5	8.8	5.5	12.1	0.000	8.2	8.9	0.573
	1-1.5	59.4	53.7	65.0		61.0	55.8	
	0.5-1	31.8	40.8	22.9		30.8	35.3	
Preferred beverages (*percentages do not add up to 100)	Mineral water	33.5	32.9	34.2	0.771	31.8	26.2	0.170
	Tea	20.4	20.0	20.8	0.200	22.1	19.8	0.552
	Milk and dairy beverages	13.9	12.9	15.0	0.510	14.9	18.0	0.376
	Juice	9.6	9.2	10.0	0.756	10.1	12.8	0.360
	Sweetened fizzy beverages	2.5	2.1	2.9	0.558	0.1	4.1	0.022

Sex: G - girls, B - boys; Education: H - higher, S + V - secondary + vocational

DISCUSSION

The discussed research in the group of Kraków preschool children showed nutritional deficiencies (particularly concerning the insufficient frequency of consuming some recommended products: vegetables, fruit, whole-grains, milk and dairy products and the relatively frequent consumption of sweets and confectionery products), and the diversity of nutrition depending on the sex of children as well as the level of the mother's education, with an indication of more rational dietary choices among girls and children of mothers with higher education. The described nutritional deficiencies may limit the nutritional and health value of food rations, and in particular, cause an imbalanced supply of certain nutrients, reducing the potential developmental possibilities of children.

Rational nutrition is a key determinant in the proper development of children, while negative nutritional choices may increase the risk of developing diet-related diseases at later stages of ontogenesis [14, 18]. It is recommended to regularly eat 4-5 meals a day, which has a positive effect on the rate of energy metabolism, preventing the development of obesity, regulating appetite and delaying the occurrence of fatigue [14]. The results of this study showed that all of the children consumed at least 4-5 meals a day, this number increased due to eating between main meals. The parents' declarations show that they made sure children ate meals regularly. Other studies have also confirmed the dominance of the 5-meal model of nutrition for preschool children [41], however, regularity of eating meals was emphasised to a lesser extent [8]. Also, in new studies among preschool children from Białystok county, at least 4 meals a day were consumed (84.9% for girls and 93.8% in the case of boys) [43]. The results showing that 87% of the children ate between main meals corresponded with the results of previous research conducted among preschool children from Kraków (86.5%) [8]. In other Kraków-based studies, it was found that only 26% snacked in-between meals every day, while 52.8% of the group snacked sporadically [17]. Preschool children from Pabianice most frequently chose sweets and fruit [4], while children from Biała Podlaska snacked on fruit and vegetables (44% girls and 39% boys) [43].

An important role in shaping the model of a child's nutrition is played by parents who are their role models. Common meals [6, 14, 48] are a good form of consolidating proper eating habits. In the author's research, it was shown that 92% of children consumed meals together with their parents (most often supper). Supper, as the meal most often consumed by children together with their parents, has also been noted in other studies [20].

The recommended diversity in the diet is ensured by the inclusion of products from various food groups. According to the Pyramid of Healthy Nutrition and Lifestyle for Children and Youth, the basis of a daily diet for children and teenagers should be vegetables and fruit as a source of dietary fibre as well as vitamins and minerals [13]. The author's research showed that less than half of the children consumed vegetables every day. The insufficient intake of vegetables among children was also confirmed by other authors [4, 6, 8, 17, 20, 31, 37, 41, 43]. The results of the aforementioned research, indicating almost twice as many children consuming fruit every day rather than vegetables, corresponded with the tendencies described by *Harton* et al. [11], whereas in earlier Kraków studies, the daily consumption of vegetables and fruit concerned a similar percentage of children (about 30%) [8]. The limited implementation of the recommendations for the consumption of vegetables and fruit is also described in the case of American preschoolers [23]. A low intake of vegetables and fruits may generate a risk of deficits in the supply of potassium and fibre in the food rations of preschool children, as confirmed by research conducted among preschools in Lublin [22]. Diets lacking in fruit and vegetables are poor in bioactive components, including vitamins, minerals, polyphenols, carotenoids, dietary fibre, which may increase the risk of various illnesses in the future, including cardiovascular- and cancer-related diseases.

An important group of products includes cereals as basic energy sources, indicating the importance of whole-grains with higher nutritional value. The recommended daily consumption of whole-grain cereal products in this study concerned a small percentage of children. In other studies, a similar amount of consuming whole-grain cereal products was demonstrated [4, 8, 37, 44]. In another group of children, wholemeal bread was regularly consumed by about 30% of the subjects [33]. The low frequency of consuming whole-grain cereal products has also been described among preschoolers from Białowieża county [43]. A low intake of wholemeal cereal products may generate a risk of fibre supply deficiencies in food rations, as confirmed by studies conducted in Lublin [22], and also Mexican kindergartens [15].

During the period of a child's intensive growth and development, there is a high demand for wholesome proteins originating from meat, poultry, fish, eggs and dairy products. Some studies have confirmed the normative [35], and others the supra-normative supply of protein [22, 39] in the diet of preschool children. This study proved that among protein products, children most often chose: milk and dairy products, meat and poultry, eggs and fish.

A particularly important group of food products for preschool children constitutes milk and dairy products, because they provide wholesome protein and calcium necessary for proper bone growth. Calcium intake, due to meeting growing needs, should be high [5] - especially to achieve the so-called peak bone mass, while some studies have shown calcium deficiencies in children's food rations [5, 39]. Children should consume 3-4 glasses of milk per day, and part of the recommended consumption can be replaced by fermented milk beverages and dairy products [13, 14, 40]. This research indicated a low level of consuming dairy products. Other studies also confirmed the observed trends in the preferred frequency of consuming dairy products by children [4, 8, 17, 37]. Insufficient consumption of dairy products, including fermented ones, was also demonstrated among preschoolers from Białowieża county [43] and children from 231 Polish kindergartens [31]. The low intake of milk and its products may generate the risk of calcium supply deficits, which has been confirmed by studies among preschool children [23, 32, 35].

Another group of food products included in the pyramid of nutrition for children and teenagers includes meat, eggs, fish and legume seeds that provide proteins necessary for the normal growth of children. Preschoolers should consume 2 portions of these products daily, with lean meats and cold-cuts, as well as oily sea fish. Fish, as a valuable source of mineral salts and omega 3 fatty acids, should be consumed twice a week [13, 14]. In the discussed research, it was shown that preschool children mostly ate fish several times a week. In earlier studies, a group of Kraków preschool children recorded lower intake of fish (16.7% several times a week and 50% once a week) [8]. The low consumption of fish by children was also noted in other groups of preschoolers from the Kraków [20] and Bialski [43] populations. Low intake of fish can lower the supply of omega 3 PUFA acids and heme iron and vitamin D, also described in other studies among children [5, 24, 38, 39, 46].

Children and adolescents constitute a population group excessively consuming sweets and confectionery as well as fast food products, low nutritional density and high energy products [3], with high content of simple sugars, salts, fats and trans fatty acids, which may increase the risk overweightness and obesity, which was also confirmed among Kraków kindergarten children [17]. The author's research showed the rather occasional consumption of fast food products and frequent consumption of sweets/confectionery. In earlier Kraków studies, preschool children also reported lower consumption of fast food than sweets [8]. Excessive consumption of sweets and sweetened beverages has been described among preschoolers from Białowieża county [43] and Pabianice [4].

An important aspect of children's nutrition is also proper fluid replenishment [14]. It is recommended that pres-choolers drink about 1,000-1,400 ml/day, with an indication of much water and other unsweetened beverages [14, 42]. The diet should eliminate sweetened fizzy beverages, which due to the high content of simple sugars, may increase the risk of excessive body mass and tooth decay [10, 30, 34, 42]. In the author's research, it was demonstrated that the children usually drank 1.0-1.5 litres of fluids a day, most often choosing mineral water and tea, less frequently fruit juices, and the least, sweetened fizzy beverages. Previous studies have shown that preschool children from the Kraków community consumed fruit juice (62.7%) and tea (45.2%) most often [8]. Other studies confirmed that preschool children preferred: fruit juices, mineral water and sweetened fizzy beverages [45], as well as fruit juices and mineral water [7]. Therefore, the research indicates a variety of taste preferences among children and perhaps an increase in the health awareness of parents.

The discussed research shows diversification in some dietary choices of preschool children depending on gender, with an indication of more frequent consumption of recommended vegetables and fruit, wholemeal bread, dairy products among girls, and sweets/confectionery among boys who also consumed more meals during the day. Therefore, it was found that the consumption of products with high nutritional density, conditioning the proper course of development processes among girls, was more widespread. The established regularities corresponded with the results of studies by other authors, confirming the diversity of some dietary choices depending on gender. In the Kraków group of teenagers, the consumption of sweetened fizzy beverages was more frequently noted among boys than girls [9]. Also, in the study by *Merkiel* and *Chalcarz* [28], a differentiated supply of some macronutrients in preschool children's food rations depending on gender was noted, including a higher sucrose consumption by boys than girls (21.2% vs. 19.7% energy).

The discussed research has also shown the association of some dietary choices of preschool children with the level of their mothers' education. There was a tendency for more rational dietary behaviours associated with more regular consumption of more meals and more frequent consumption of recommended products (vegetables and fruit, whole-grain cereals, milk and dairy products, fish and eggs), and less frequent consumption of non-recommended products (sweets/confectionery products and fast food, and a smaller preference for sweetened fizzy beverages) by the children of mothers with higher education. The described, more favourable dietary choices of children whose mothers had higher education favoured

a greater supply of certain nutrients, including vitamins and mineral salts (antioxidants, potassium, magnesium and iron), components essential for the development and health of children. The tendency to undertake more rational dietary behaviours among preschool children, along with the increase in the level of education of mothers, one of the indicators of socio-economic status of families, also corresponded with the results of other authors in the Polish and world literature. In the research by *Łoś-Rycharska* and *Niecławska* [25], it was found that children of mothers with higher education were less likely to consume fast-food products, and more often chose vegetables and fruit than those of mothers with lower education (primary, vocational and secondary). European surveys covering 7 countries also showed that a higher level of the mother's education was conducive to more pro-health behaviours among children [12]. Relationships between socio-economic status and health behaviours of children and adolescents are also described in other studies [1, 19, 48]. Earlier Kraków studies on the socio-demographic determinants of nutritional behaviour among preschool children revealed relationships between the children's eating behaviours and the level of parents' education and family income [19]. A Brazilian study also confirmed the predictive importance of socio-economic factors on the development of indicators regarding nutritional status among children aged 0-3, with an indication of more favourable rates for children of mothers with higher socio-economic status [2]. Diversity in the nutritional value of the diet depending on living environment has been described among Mexican preschool children, with an indication of more favourable results among urban children than in rural areas [15]. Other Polish studies on diet structure and body mass index among preschool children in relation to place of residence showed differences in anthropometric indicators and diet structure depending on region (children from the western region of Poland had a significantly higher BMI than those from other regions) [36].

There is a need for further research and to monitor children's nutritional behaviour, promoting the nutritional education of children and their parents as well as the preschool staff, assuming that eating habits are shaped from the earliest possible age, bearing in mind that a varied and balanced diet is an important element in raising health potential and prevention of chronic diseases [19, 26, 27, 28, 29, 31, 43, 47].

CONCLUSIONS

1. Irregularities in the nutrition of preschool children from the Krakow environment have been found, particularly concerning the insufficient frequency of consuming recommended products, including: vegetables, fruits, whole-grain cereal products, dairy products and fish.
2. Diversification of some nutrition choices among preschool children from the Kraków environment, depending on the sex of children and the mother's level of education, was indicated, suggesting more favourable dietary behaviours of girls than boys and regarding children of mothers with higher education rather than secondary and vocational education.
3. The described tendencies confirmed that there is a need to research and monitor the nutritional habits of preschool children and their conditions, as well as the nutritional education of children and their parents, taking the level of mothers' education into account.

Conflict of interest

The author declare no conflict of interest.

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ORIGINAL ARTICLE

COMPARISON OF THE PREVALENCE OF BODY MASS DISORDERS IN 7-YEAR-OLD CHILDREN LIVING IN RURAL AND URBAN AREAS OF LOWER SILESIA IN POLAND

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ABSTRACT

Background. Body height and weight are somatic qualities largely determined by genetic factors. These qualities are also modified by the factors of external environment which have a higher impact on body mass rather than height.

Objective. The aim of the research was to identify the prevalence of disorders related to body mass / height ratio in children residing in areas of diverse population numbers. A reconnaissance of cross-environmental diversification of the BMI value was also conducted.

Material and Methods. The sample consisted of 593 healthy children (314 boys; 279 girls) aged 7 from large city (Wrocław), small city (Polkowice) and rural environment (villages in the Lower Silesia) in Poland. Body height and weight were measured using standard procedures and body mass index (BMI) was calculated. Children's BMI categories were defined using IOTF cut-off points. Statistical analysis was carried out using ANOVA. Differences were considered significant at $p < 0.05$.

Results. The data analysis showed a general lack of significant cross-environmental and cross-gender differences in mean values of BMI among the studies girls and boys. Prevalence of children with abnormal body mass residing in areas of diverse degree of urbanisation varies from 20% to 28%. Prevalence of underweight in 7-year-old children is intensified particularly in urban environment where it occurs in a degree comparable to overweight (9.4% vs 10.7%).

Conclusions. The observed not significant differences in BMI means in the 7-year-old children, indicate the disappearing of disproportions in basic somatic parameters between children from environments of different urbanisation degree. Underweight is found in 6%-12% children, which is particularly intensified in urban environment where it occurs with prevalence comparable to the phenomenon of overweight. This suggests the need to introduce intervention measures aimed at increasing the consciousness of parents in terms of effects of malnutrition in the contexts of health risks for a developing child.

Key words: *children, underweight, overweight, obesity, rural and urban areas*

STRESZCZENIE

Wprowadzenie. Wysokość i masa ciała to cechy somatyczne w znacznym stopniu determinowane przez czynniki genetycznie. Cechy te są modyfikowane także przez czynniki środowiskowe, które wywierają większy wpływ na masę ciała niż wysokość ciała.

Cel. Celem badań było rozpoznanie częstości występowania zaburzeń w relacji masy do wysokości ciała u dzieci zamieszkujących obszary zróżnicowane pod względem liczby mieszkańców. Przeprowadzono także rozpoznanie zróżnicowania międzyśrodowiskowego wartości wskaźnika masy ciała BMI.

Materiał i metody. Badaną grupę stanowiło 593 dzieci (314 chłopców i 279 dziewcząt) w wieku 7 lat pochodzących z dużego miasta (Wrocław), małego miasta (Polkowice) i obszarów wiejskich (wsie Dolnego Śląska). U badanych dokonano pomiarów wysokości i masy ciała, które posłużyły do wyliczenia wskaźnika masy ciała BMI. W celu określenia częstości występowania niedowagi, nadwagi i otyłości, użyto wartości graniczne wskaźnika BMI dla dzieci i młodzieży zaproponowane przez *Cole'a* i wsp. oraz zalecane przez IOTF. Analizę statystyczną przeprowadzono przy użyciu ANOVA. Różnice uznano za istotne statystycznie dla $p < 0,05$.

Wyniki. Największy procentowy udział dzieci z rozpoznaną otyłością i nadwagą (łącznie ponad 20%) zaobserwowano w środowisku wiejskim. Największe nasilenie zjawiska niedowagi wśród dzieci badanych w poszczególnych środowiskach, zaobserwowano wśród polkowickich dziewcząt (11,9%), a najmniejszy wśród wiejskich chłopców (5,6%). Analiza danych wykazała na ogół brak istotnych różnic międzyśrodowiskowych i międzypłciowych w przeciętnych wartościach wskaźnika masy ciała BMI badanych dziewcząt i chłopców.

Wnioski. Różnice międzyśrodowiskowe dotyczące wskaźnika masy ciała BMI badanych dzieci 7-letnich są słabo uwidocznione, co wskazuje na zanikanie dysproporcji w podstawowych parametrach somatycznych między dziećmi ze środowisk o różnym stopniu urbanizacji. Niedowagę stwierdzono u 6% -12% dzieci, co jest szczególnie nasilone w środowisku

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miejskim, gdzie występuje z częstością porównywalną ze zjawiskiem nadwagi. Sugeruje to potrzebę wprowadzenia środków interwencyjnych mających na celu zwiększenie świadomości rodziców w zakresie skutków niedożywienia w kontekście zagrożeń dla zdrowia dziecka.

Słowa kluczowe: *dzieci, niedowaga, nadwaga, otyłość, wiejskie i miejskie obszary*

INTRODUCTION

Dynamic increase of number of people with abnormalities in terms of body height / weight ratio constitutes one of the main problems of prevention of diseases of affluence. Particularly the phenomena of overweight and obesity among the population of different countries have become the main subject analysed in numerous epidemiology research, since the excess of fat tissue accumulated in the organism is often accompanied by numerous diseases such us arterial hypertension, diabetes, degenerative changes of motor system and some types of cancer [1, 2, 35].

According to the Central Statistical Office (Statistics Poland, GUS) [12, 13, 14], prevalence of adults with identified obesity systematically increases. In the 1990s, the rate of obese men was at 10.3% of Polish population, and 12.4% for women. In 2004, the number of obese men increased to 12.6% while the percentage of obese women remained on a level comparable to previous years - 12.5%. The results of studies conducted in the following years - 2009 and 2014, show a steady and continuous increase of number of people with obesity [13, 14]. In 2009, 16.6% of obese men were noted, while in 2014 this group constituted 18.1% of male Polish population, whereas among women the percentage of obesity increased from 15.2% to 15.6%.

The problem related to the increasing number of people with excessive body weight in Poland is far more exposed in summaries concerning the identification of the phenomenon of overweight understood as a state leading to obesity. The analysis of data received in the years of 1996 - 2014 indicates that the percentage of overweight people increased in men from 18.7% to 44.1%, and in women from 14.2% to 30.1%. The presented data identifies men as a group of a higher risk of excess body weight prevalence. These observations seem to find confirmation also in the population of children and youth, since the results of HBSC's studies conduced in Poland in 2014 showed that the problem of increased body weight more often concerns boys (overweight - 15-16.3%, obesity - 3.0-4.2%) than girls (overweight - 5.5-13.6%, obesity - 0.8-1.5%) [29]. Among the leading factors contributing to the increasing number of people with excess body weight indicated are the following: increased consumption of high-calorie foods and a low level of physical activity [3, 4, 19, 22, 31, 32, 34]. In less numerous cases, excessive body mass is conditioned genetically (e.g. leptin deficiency), is endocrine-related (e.g. hypothyroidism, growth hormone deficiency) or is related to intake of a certain group of medications [23, 32]. Among issues concerning body mass, the phenomena of overweight and obesity are widely commented on and arise significant interest of researchers, whereas less attention is given to the problem of an insufficient body mass.

Underweight in children and youth most often results from deficiency of nutritional, energy and structural substances, and is related to the risk of disorders in psychophysical development. In children with malnutrition we often observe a significant delay of growth rate, hormonal changes in the body, delayed development, or increased risk of infections [5, 21]. Malnutrition in childhood can leave negative health effects observable also later in life.

On a global scale, the problem of insufficient body mass is exposed mainly in the context of malnutrition resulting from socio-economic conditions, an occurrence observed in people living in the countries of a low economic growth index. In highly developed countries, the problem of insufficient body mass is conditioned mainly by cultural factors, such as value system or traditions, customs and social models [5, 28]. One of the reasons behind a significant body thinness is thought to be a set of risky health behaviour inspired by current fashion related to excessive care of body, including self-perception of body mass and the resultant decisions such as reduction diets without specialist assistance, conscious and timely cessation of food consumption (so-called starvation diet), as well as reaching for pharmaceuticals assisting weight loss [8, 9, 10, 25, 26, 28].

In the country-wide research conducted in the years of 2007-2009 among children and youth aged 6-19, body mass deficiency was found in 13.7% of girls and 10% of boys [15]. A similar percentage of underweight children is also indicated by the results of studies conducted in the years of 2005-2006 among children and youth of Warsaw schools, which show that insufficient body mass occurs in 13.9% of girls and 6.4% of boys (similarly to previous years of 1990-2000, respectively: 7.9% and 13.6%) [5].

Many researchers working with identifying the significance of environmental factors on developing body highlight that larger agglomerations create more favourable conditions for the processes of growth of young generations [17, 18, 21, 30]. Dynamic economic growth observable in Poland and digitalisation can contribute to decrease of multi-aspect cross-environmental diversification.

The goal of the research was to identify the prevalence of disorders related to body mass/height ratio in children residing in areas of diverse population

numbers. A reconnaissance of cross-environmental diversification of the BMI value was also conducted.

MATERIAL AND METHODS

The collected research material was used to conduct comparative analysis of the results of 593 children (314 boys and 279 girls) aged 7 ($\bar{x}$ = 7,07 ± 0,25 years), in public education facilities within the Lower Silesia region in Poland.

After detailed discussions with the management, applications of educational institutions for taking part in the research were accepted. The randomness of sampling was conditioned by the consent of parents or legal guardians to the participation of children in research. The research group representative of a large city comprises of children from 17 educational institutions different districts of Wrocław, whereas the representatives of small-city environment are pupils of all first grades in primary schools located in Polkowice. The third comparative group comprises of first grade pupils of primary schools located in the villages of Legnica-Głogów Copper Belt (LGOM) such as: Brzeg Głogowski, Kotla, Kromolin, Nielubia, Rosochata, Rzeszotary, Spalona.

The results of basic somatic measurements were subjected to analysis - body height and weight, values of which were used to calculate the Body Mass Index (BMI). Children studied were dressed in light clothing and during the measurements did not wear shoes. Height was measured with anthropometer, and results were read with accuracy of 0.1 cm. Body weight measurement were made with the use of an electronic scale, and data were recorded with the accuracy of 0.1 kg. The results of somatic measurements are presented in Table 1. The research was conducted at the beginning of a school year and took place during the first half of the day (before noon).

Table 1. Somatic characteristic of studied children grouped according to the place of residence and gender

Gender groups	Place of residence	N	Body height [cm]		Body weight [kg]		BMI [kg/m^2]	
			$\bar{x}$	sd	$\bar{x}$	sd	$\bar{x}$	sd
Boys	Big city	83	124.37	5.20	24.57	3.61	15.84	1.73
	Small town	160	125.10	5.83	25.64	5.51	16.25	2.45
	Villages	71	123.72	5.49	25.68	5.67	16.66	2.08
Girls	Big city	76	122.68	4.53	24.35	4.01	16.12	2.05
	Small town	143	123.50	5.79	24.67	5.11	16.04	2.25
	Villages	60	123.20	5.60	24.42	4.29	16.02	2.14

BMI value was subjected to classification taking into account international norms developed by *Cole* et al. [6, 7, 11] and those recommended by IOTF; International Obesity Task Force (Table 2).

Identifying 6 weight-height ratio categories (3 degrees of thinness, normal body mass, overweight, obesity), enabled conducting cross-environmental comparison of children with abnormal mass proportions in relation to body height. In order to statistically characterise the chosen somatic parameters, the following values were determined: arithmetic average, standard deviation, coefficient of deviation, minimal and maximal value. A summary of mean values of the analysed somatic parameters and the BMI was made between the gender and environment groups (analysis of variance, *Wilks'* lambda test, post-hoc comparisons: NIR test). The determined level of result significance was α=0.05. Calculations were conducted in the Department of Statistical Analyses of the Central Science and Research Laboratory of the University of Physical Fitness in Wrocław, with the use of Statistica software version 13 (StatSoft Polska).

Table 2. Classification of children's Body Mass Index (BMI) by age and gender

International classification of BMI for children Recommended by International Obesity Task Force (IOTF)						
Age (years)	Thinness grade 3	Thinness grade 2	Thinness grade 1	Normal range	Overweight	Obesity
BMI cut-off points for boys						
6.5	12.45	13.10	14.04	14.05 – 17.70	17.71	20.23
7.0	12.42	13.08	14.04	14.05 – 17.91	17.92	20.63
7.5	12.41	13.09	14.08	14.09 – 18.15	18.16	21.09
BMI cut-off points for girls						
6.5	12.28	12.90	13.82	13.83 – 17.52	17.53	20.08
7.0	12.26	12.91	13.86	13.87 – 17.74	17.75	20.51
7.5	12.27	12.95	13.93	13.94 – 18.02	18.03	21.01

RESULTS

The analysis of values of the BMI in 7-year-old children in categories of underweight and overweight showed the highest percentage of subjects with excessive body weight in countryside environment (Figure 1); both in boys (21.1%) as well as in girls (20.0%).

The highest intensity of overweight among the children studied in each environment, was observed among girls from Polkowice (11.9%), and the lowest among countryside boys (5.6%).

Detailed analysis of BMI values (6 categories), enabled, among others, to observe the occurrence of obesity. The highest percentage of children studied in this category, i.e. 8.5% was found in village boys (Table 3), however an individual value of BMI - 27.77 kg/m^2 (significant obesity was noted in the group of Polkowice boys (Table 3). Comparisons conducted among other studied children with higher body mass showed, similarly as in the category of obesity, the highest percentage of overweight children in village environment (18.3% of girls and 12.7% of boys).

Table 3. Numeric and percentage characteristic of 7-year-old children in individual categories of BMI

BMI Classification		Thinness grade 3		Thinness grade 2		Thinness grade 1		Normal weight		Overweight		Obesity	
Place of residence		n	%	n	%	n	%	n	%	n	%	n	%
	Boys												
	Big city	0	0	1	1.2	7	8.5	68	81.9	5	6.0	2	2.4
	Small town	1	0.6	3	1.9	10	6.3	124	77.5	11	6.9	11	6.9
	Villages	0	0	0	0	4	5.6	52	73.2	9	12.7	6	8.5
	Girls												
	Big city	0	0	1	1.3	6	7.9	59	77.6	7	9.2	3	4.0
	Small town	0	0	5	3.5	12	8.4	99	69.2	20	14.0	7	4.9
	Villages	1	1.7	0	0	5	8.3	42	70.0	11	18.3	1	1.7
	Overall sample												
	Big city	0	0	2	1.3	13	8.2	127	79.9	12	7.6	5	3.1
	Small town	1	0.3	8	2.6	22	7.3	223	73.6	31	10.2	18	5.9
	Villages	1	0.8	0	0	9	6.9	94	71.8	20	15.3	7	5.3

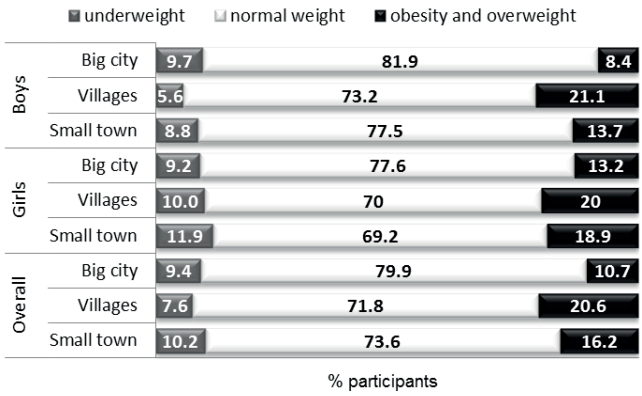

Figure 1. The structure of studied groups of 7-year-old children, taking into account the assumed main categories of BMI (underweight: combined categories of thinness 1, 2, 3; overweight: combined in categories of obesity and underweight)

The lowest BMI value at 12.07 kg/m^2 (extreme thinness of third degree) was noted in the group of countryside girls. Whereas the highest percentage of children with low not-recommended body mass was observed in the category of the first degree of thinness (Table 3), depending on the place of residence it ranged between 5.6% (countryside boys) to 8.4% (Wrocław boys and Polkowice girls).

Data analysis showed no cross-environment and cross-gender differences in BMI values of studied girls and boys (Figure 2), while statistically significant differences were observed only between countryside and Wrocław boys (NIR test; p=0.0263).

Neither were statistically significant differences obtained in the analysis of the body mass value both between environmental as well as gender groups (Figure 3), whereas body height is significantly different only between girls and boys from Polkowice (test NIR; p=0.0118), but is not a significant parameter differentiating subjects in terms of the place of residence (Figure 4).

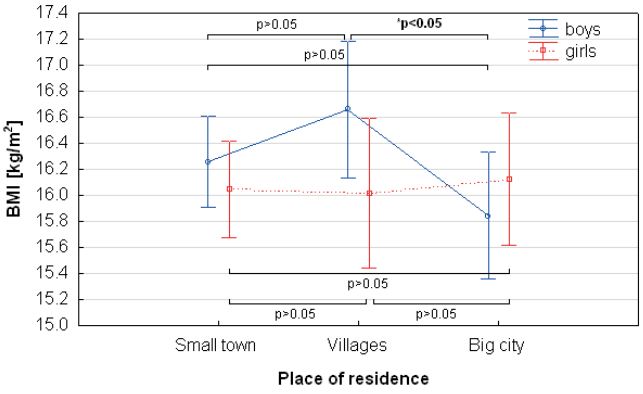

Figure 2. Body Mass Index values of 7-year-old children in the categories of gender and environment (vertical bars signify the confidence intervals of 0.95; ***p<0.05** – statistically significant difference; p>0.05 – no statistically significant difference)

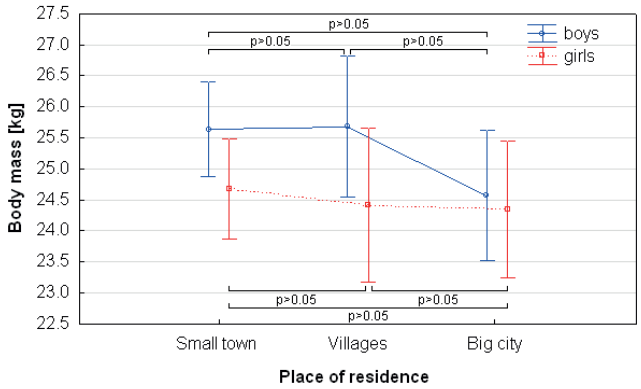

Figure 3. Body mass values of 7-year-old children in the categories of gender and environment (vertical bars signify the confidence intervals of 0.95; p>0.05 – no statistically significant difference)

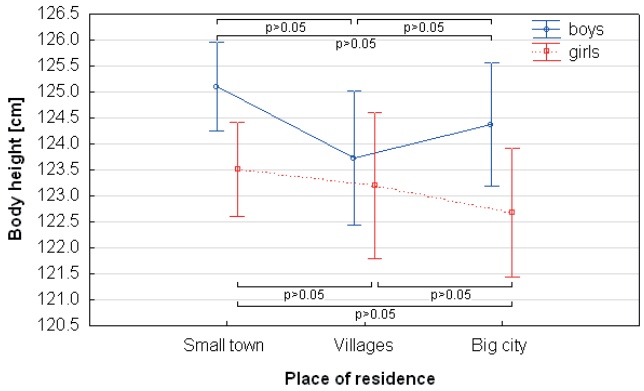

Figure 4. Body height values of 7-year-old children in the categories of gender and environment (vertical bars signify the confidence intervals of 0.95; p>0.05 – no statistically significant difference)

DISCUSSION

The research conducted in Poland concerning the basic somatic parameters such as body weight and height and evaluation of their corresponding proportions with the use of the popular BMI, focus on aspects related to differences between gender groups [5] and broadly-understood environmental factors [21, 27] including the studied person's identification with a specific region of Poland [21, 15] or area of diverse urbanisation level [16].

The conducted analysis of weight to height proportions of 7-year-old children at the very beginning of school education, indicated prevalence of insignificant cross-environmental diversification of studied children residing in areas differing in terms of population density.

Boys from countryside environments, compared to urban groups (Polkowice, Wrocław), are characterised by a smaller height and higher body weight, which eventually has affected statistically significant differences in average values of BMI which were observed only between countryside and a city group (Wrocław).

The reasons behind such a state of affairs can be found in widely observable tendency for a decreased level of physical activity, in 7-year-old countryside children conditioned perhaps by a limited access to sport and leisure facilities or spaces facilitating engagement in diverse forms of movement [24]. It is commonly known that there are less possibilities of participation in organised sport classes due to difficulties related to the necessity to commute to larger centres. The reason can also be lack of possibility for participation in movement activities for schools and local environment for children of lower grades, and consequently spending free time passively, most often with multimedia devices commonly used for entertainment purposes [20].

The observable blurring of cross-environmental differences in Poland is visible also in the results of studies by *Oblacińska* et al. [27] conducted among 15-year-old children. On the basis of the results of the studies, the place of residence was not indicated as a differentiating factor for occurrence of excessive body mass. It was determined, however, that excessive body thinness is more visible in the urban rather than rural environment, which corresponds to the results of our analysis which points to the prevalence of underweight in circa 10% of children studied from urban environment (Polkowice, Wrocław) and 7% from rural environment.

On the basis of results of *Szponar* and *Ołtarzewski* [33], a forecasted direction of changes in prevalence of underweight in further years of life presumes that we will see an increasing tendency in girls before puberty (ca. 12-years-old), whereas in boys together with advance of physiological maturing and growth processes, number of children with body mass deficiency will decrease.

Among the 7-year-olds studied, the highest percentage of the most desired (mainly for health reasons) body mass / height proportions was observed in children residing in a large city area (Wrocław). Almost 82% of boys and over 77% percent of girls in the studied development period (early school years) are characterised by the normal body mass. As shown by the results of studies by *Gurzkowska* et al. [16], it is the group of city boys who in the following years of life, i.e. the period of school education, will be exposed to the risk related to excessive body weight, and thus will require increased attention in taking up preventive measures.

CONCLUSIONS

1. In each of the Lower Silesia environments (Polkowice, LGOM villages, Wrocław) there were children characterised by abnormal body mass not-recommended for health reasons. These

children, both in the scope of increased body mas (overweight and obesity) as well as in very low values thereof (not-recommended thinness) comprised from 20% to 28% of studied population. The scale of observed occurrence indicates the need for education among parents and teachers about the objective methods of evaluation of human body proportions and importance of the children's body proportions for current and future health condition.

2. The phenomenon of underweight is particularly intensified in urban environment where it occurs with prevalence comparable to the phenomenon of overweight, which suggests the need to introduce intervention measures aimed at increasing the consciousness of parents in terms of effects of malnutrition in the contexts of health risks for a developing body.
3. Cross-environmental differences (large city, small city, village) concerning of medium values of the body mass index of the studied 7-year-old children are not prominent.

Conflict of interest

The author declare no conflict of interest.

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ORIGINAL ARTICLE

STUDY AND EVALUATION OF PHYSICAL ACTIVITY OF YOUTH FROM THE VISEGRAD COUNTRIES IN RELATION TO THE WHO RECOMMENDATIONS

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ABSTRACT

Background. In recent years, the subject literature has provided concrete recommendations concerning health with regard to specific parameters. Therefore, it is necessary to indicate appropriate physical activity standards for proper development at various stages of human ontogenesis.

Objective. The aim of the work was knowledge of the level of physical activity of high school youth in the Visegrad countries, including gender indications, to demonstrate whether the WHO recommendations are fulfilled.

Material and methods. The research was conducted in students from four Visegrad countries: the Czech Republic, Poland, Slovakia and Hungary. As the research method, the International Physical Activity Questionnaire − IPAQ in the extended version was used.

Results. Boys seem to do much better and have largely fulfilled the WHO recommendation for high-intensity efforts performed 3 times for 20 minutes, and medium and high efforts − 7 times for 60 minutes, which is particularly crucial for the effectiveness of the level of physical activity.

Conclusions. It is indispensable to continue monitoring the physical activity of young people using modern research techniques. It seems intentional to intensify promotion and educational activities, which should be aimed at motivating young people to undertake physical activity in accordance with world-wide recommendations.

Key words: *physical activity, IPAQ, youth, Visegrad countries*

STRESZCZENIE

Wprowadzenie. Literatura zagadnienia dostarcza na przestrzeni ostatnich lat konkretne rekomendacje z uwzględnieniem wskazanych parametrów. Potrzebne jest zatem wskazanie odpowiednich norm aktywności fizycznej dla prawidłowego rozwoju na różnych etapach ontogenezy człowieka.

Cel. Celem pracy było poznanie poziomu aktywności fizycznej młodzieży szkolnej z państw wyszehradzkich, z uwzględnieniem płci i wykazanie wypełnienia rekomendacji WHO.

Materiał i metody. Badania przeprowadzono wśród uczniów z czterech państw wyszehradzkich: Czechy, Polska, Słowacja, Węgry. Jako metodę badań wykorzystano Międzynarodowy Kwestionariusz Aktywności Fizycznej - IPAQ w wersji długiej.

Wyniki. Obraz aktywności fizycznej jawi się korzystniej u chłopców, którzy w dużym stopniu wypełnili rekomendację WHO dla wysiłków o intensywności wysokiej 3 razy po 20 min. oraz średniej i wysokiej 7 razy po 60 min., co ma szczególne znaczenie dla efektywności poziomu aktywności fizycznej.

Wnioski. Nieodzownym jest dalsze monitorowanie aktywności fizycznej młodzieży z wykorzystaniem nowoczesnych technik badawczych. Za celowe wydaje się zintensyfikowanie działań promujących i edukacyjnych, których zadaniem powinno być motywowanie młodzieży do podejmowania aktywności fizycznej zgodnie ze światowymi rekomendacjami.

Słowa kluczowe: *aktywność fizyczna, IPAQ, młodzież, państwa wyszehradzkie*

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INTRODUCTION

The effects of civilizational change increasingly lead to a sedentary lifestyle in which people do not see the necessity of maintaining health through physical activity. It should be remembered though that physical activity is measured by such parameters as duration (volume) and its type, frequency and intensity. Physical effort will be effective only if it is taken as often and with as much intensity as possible and for a sufficiently long time.

It is assumed that a serious change concerning the role of physical activity took place when it started to be regarded as a crucial element of a healthy lifestyle [20, 26]. In the last years, the subject literature has provided numerous requirements and recommendations with regard to concrete parameters. It has, therefore, become necessary to indicate appropriate physical activity standards for proper development at various stages of human ontogenesis. And so, *Strong* et al. [22] indicate, the US youth should spend no longer than 60 minutes for medium and high intensity daily. There is also a regular recommendation on an amount of exercise by an American College of Sport Medicine [1], which proposes moderate intensity effort at least 30 minutes daily, not less than 5 times a week, or high-intensity effort at least 20 minutes daily three times a week. In turn, the European Union [8] forwards the following three standards of physical activity to comply with: a) 20 minutes of high intensity effort 3 times a week, b) 30 minutes of medium intensity five times a week, c) 30 minutes of low intensity (walking) five times a week. In addition, the Healthy People 2020 program [24], beside the requirements for appropriate physical activity, points to the need of reducing the amount of the time spent on watching TV to two hours a day.

Furthermore, the recommendations of reducing work have been supplemented with a variant of getting involved in medium and high intensity-effort 7 times a week for 60 minutes. As a criterion of a healthy lifestyle, the number of steps performed daily is also given, which is 11,000 for adolescents [23], with 9,000 steps for girls and 11,000 for boys [9]. On the other hand, among the undesirable changes in the lifestyle of school youth, an increase in the time spent sitting has been indicated [6, 14, 21]. An all-too-common sedentary lifestyle leads to overweight and obesity. Therefore, the aim of the study was knowledge of the level of physical activity of high school youth in the Visegrad countries, including gender considerations, to demonstrate whether the young people comply with the WHO recommendations.

MATERIAL AND METHODS

The research on lower and upper secondary school students aged 15 to 17 four Visegrad countries: the Czech Republic, Poland, Slovakia and Hungary was conducted in April 2015. Overall, were examined 2425, out of which 499 (20.6%) were eliminated, due to their incompleteness. As the research method, the International Physical Activity Questionnaire − IPAQ in the extended version was used in on-line INDARES system. The number of respondents considering gender and age is presented in Table 1.

Table 1. Characteristics of the respondents by gender and age

Age (in years)	Boys (%)	Girls (%)
15	191 (23.7)	280 (25.0)
16	249 (31.0)	341 (30.4)
17	365 (45.3)	500 (44.6)
Total	**805 (41.8)**	**1121 (58.2)**

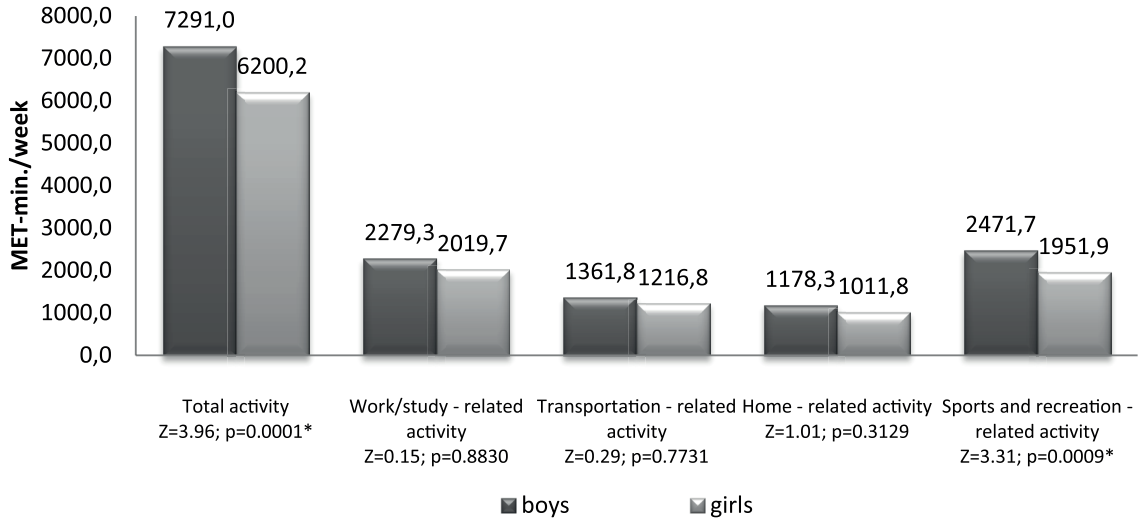
The extended version of IPAQ consists of five parts containing 27 questions in such domains as work/study, transportation, housework, recreation and sport, and time spent sitting. Each type of physical activity was expressed in three energy dimensions: vigorous, moderate, walking. The total physical activity was calculated by estimating the data in MET-min./times in particular domains, multiplying the duration in minutes by the number of days and the corresponding intensity factor: walking - 3.3, moderate - 4.0, vigorous - 8.0. At the same time, 1 MET corresponds to the consumption of oxygen at rest and amounts to 3.5 ml 02 / kg of body weight per minute.

The statistical analysis was performed in the STATISTICA programme v. 10. The level of physical activity was presented in the form of arithmetic means and standard deviations. To detect statistically significant differences between boys and girls, the *Mann-Whitney* U test was applied. If they belonged to a given recommendation groups, the data were presented in percentages and the *Pearson Chi-square* test was used. In all analyzed cases, the significance level was assumed at $p = 0.05$.

RESULTS

The level of physical activity of students by gender

The level of weekly total physical activity in boys was 7.291 MET and was substantially higher than in girls 6,200 MET. Significantly higher physical activity in boys was also demonstrated in the sports activity domain, i.e. 2,471 MET, with 1.951 MET in girls. No significant variation was detected in other domains: school-, transportation- and home-related activity (Figure 1).



* - significant variation at p <0.05; Z-value of the *Mann-Whitney* U test

Figure 1. The level of total physical activity and its areas (domains) by gender

A detailed analysis of the time data of physical activity (in minutes) within particular domains and the intensity of efforts showed a large variation between in girls and boys. The boys devote significantly more time to vigorous efforts in the domain of home-related activity, i.e. 44.7 minutes vs. - 29.4 minutes in girls (p = 0.0000) and sports and recreation-related activity, with 51.5 minutes and 40.2 minutes (P = 0.0000) respectively. However, there was no significant difference in the domain of school activity. The boys are also significantly more active in the domain of transportation, doing cycling − 33.9 minutes and 22.4 minutes respectively (p = 0.0000), while girls in walking, 48.1 minutes and 41.2 minutes respectively, i.e. an effort of relatively low intensity (Table 2).

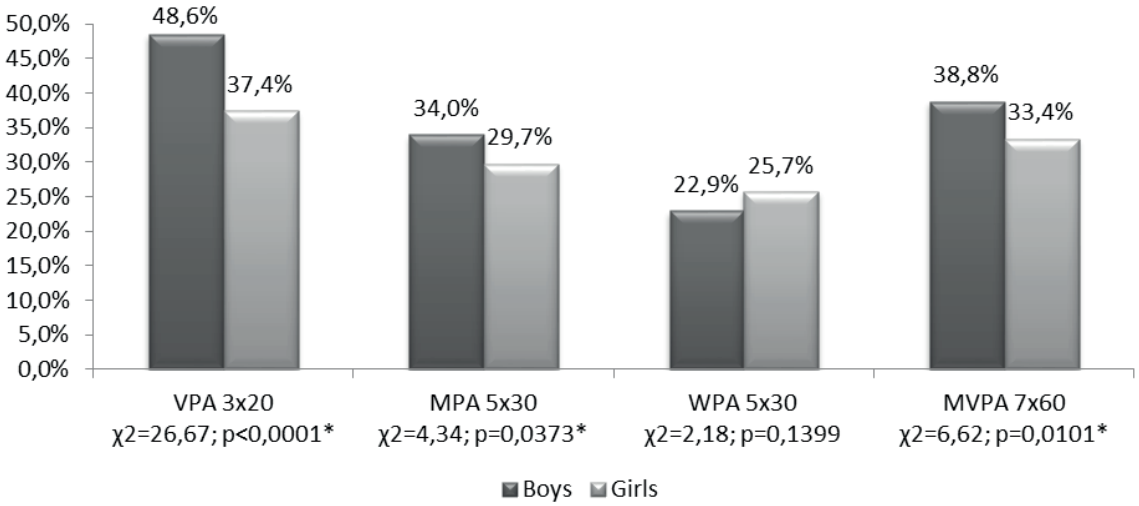
An unfavourable phenomenon visible in girls, less so in boys, is a significantly low amount of free time spent sitting in the means of transport, 70.9 minutes and 63.6 minutes respectively (p = 0.0004) and in other places on working days, 432.1 minutes and 392.7 minutes respectively (p = 0.0000) (Table 2).

Table 2. Weekly quantitative dimension of physical activity in particular domains by gender (in minutes)

No.	Domain	Girls		Boys		Test	
		mean	SD	mean	SD	z	p
1.	*School-related activity*						
	Vigorous	38.6	56.1	43.6	61.2	-1.16	0.2453
	Moderate	34.5	51.8	40.3	55.6	-1.70	0.0892
	Walking	**46.0**	59.4	**41.7**	58.1	2.08	0.0375*
2.	*Transportation-related activity*						
	Cycling	**22.4**	44.5	**33.9**	53.8	-6.06	0.0000*
	Walking	**48.1**	56.4	**41.2**	55.9	49.3	0.0000*
3.	*Home-related activity*						
	Vigorous around home	**29.4**	51.5	**44.7**	61.2	-6.83	0.0000*
	Moderate around home	39.8	51.3	41.7	54.3	0.10	0.9226
	Moderate at home	**47.7**	50.6	**35.1**	47.7	7.68	0.0000*
4.	*Sport and recreation-related activity*						
	Vigorous	**40.2**	50.7	**51.5**	56.8	-4.63	0.0000*
	Moderate	**28.8**	45.7	**37.0**	51.4	-4.03	0.0001*
	Walking	**52.8**	55.3	**49.1**	55.5	2.57	0.0102*
5.	*Sitting*						
	a) In means of transport	**70.9**	57.7	**63.6**	55.7	3.51	0.0004*
	b) In public places on working days	**432.1**	200.9	**392.7**	237.3	4.89	0.0000*
	During the weekend	296.6	198.5	312.9	231.6	-0.57	0.5707

* - significant variation at p <0.05; Z-value of the *Mann-Whitney* U test

The majority of boys undertake efforts of high intensity and perform them 3 times a week for 20 minutes (48.6%) and of medium and high intensity 7 times for 60 minutes (38.8%). In contrast, girls do that mainly with regard to high intensity efforts three times a week for 20 minutes (37.4%) and to high and medium efforts 7 times a week for 60 minutes (33.4%). Significant differences in the percentage of persons representing groups with recommended levels of physical activity were shown in relation to all groups except for WPA 5x30 (Figure 2).



VPA 3x20 – High-intensity AP performed 3 x 20 minutes a week
MPA 5x30 - Medium-intensity AP performed 5 x 30 minutes per week
LPA 5x30 – Low-intensity AP performed 5 x 30 minutes a week
MVPA 7x60 – Moderate and vigorous intensity AP completed 7 x 60 minutes a week

* -a significant differentiation at p <0.05; χ2-value of *Pearson's Chi*-square test

Figure 2. WHO recommendations of physical activity with gender mainstreaming

Recommendations of physical activity with regard to gender

The level of weekly physical activity shows statistically significant differences with varying intensity of efforts in boys and girls. These differences concern high-intensity efforts undertaken 3 times a day for 20 minutes each week (VPA 3x20), with a moderate intensity − 5 times a week for 30 minutes (MPA 5x30) and moderate and high intensity − 7 times a week for 60 minutes (MVPA 7x60). On the other hand, there were no significant differences within the particular gender at low-intensity efforts undertaken 5 times a week for 30 minutes (LPA 5x30) (Figure 2).

DISCUSSION

It is almost universally believed that proper physical activity is crucial for health maintenance in contemporary generations. Research conducted in high school students from different countries shows their insufficient activity [5, 7, 10, 11, 18, 25].

The essence of the International Physical Activity Questionnaire − IPAQ [4] is the possibility of comparing the results among respondents from different states. The obtained values of the total weekly PA of the youth of the Visegrad countries (Czech Republic, Poland, Slovakia, Hungary) at the level of 7,291 MET in boys and 6,200 MET in girls is much higher than the ones found in the youth surveyed by the same questionnaire in Lithuania [2], Czech Republic [13] or Croatia [12]. Similar high values as the ones obtained in the respondents from the Visegrad countries were demonstrated only in young people from Spain [5], which allows for assessing the level of total weekly physical activity both in the boys and in girls as good.

The findings in the study on physical activity in high school youth obtained with the extended version of IPAQ show higher values in boys than in girls in Latvia [2], 4,895 MET and 4.404 MET respectively, and in the Czech Republic [13] - 5,220 MET and 2,372 MET. The same pattern is visible in the studies on the Spanish youth [5], though they were calculated on one day, not a week. The values in boys amounted to 855 MET, and 656 MET in girls.

Own research confirms that it has become almost a norm that boys demonstrate higher physical activity in each of four countries: the Czech Republic, Poland, Slovakia and Hungary and the values in individual countries range from 4.546 MET to 10,280 MET in boys, and from 4.079 MET to 7.287 MET in girls.

The research in other studies has also confirmed much regularity in the higher level of physical activity

demonstrated in boys [4, 5, 13, 15, 16, 17, 19], which is mainly explained by less interest in motor activities in girls at this age. There might be another reason that could explain the results − the offer of physical activities for girls and the way they are run is not very attractive.

Still, it is particularly essential to follow the WHO recommendations on physical activity for the youth of the Visegrad countries. As indicated, this image appears to be more beneficial for boys who have largely fulfilled the recommendations for high-intensity efforts 3 times 20 minutes and medium and high-intensity efforts − 7 times for 60 minutes, which is particularly crucial for the effectiveness of the overall level of physical activity.

CONCLUSION

It is indispensable to continue monitoring the physical activity of young people using modern research techniques. It seems intentional to intensify promotion and educational activities, which should be aimed at motivating young people to undertake physical activity in accordance with world-wide recommendations.

Conflict of interset

The authors declare no conflicts of interest.

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ORIGINAL ARTICLE

TICK EXPOSURE AND PREVALENCE OF *BORRELIA BURGDORFERI* ANTIBODIES AMONG HUNTERS AND OTHER INDIVIDUALS EXPOSED TO VECTOR TICKS IN EASTERN POLAND

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ABSTRACT

Background. Lyme borreliosis is the most frequent tick-borne disease in Europe and North America, and the number of registered cases is on the increase. Frequent presence in the habitats of ticks enhances the risk of tick bites and possible infection with *Borrelia burgdorferi* spirochetes.

Objective. The aim of the study was to assess the risk of *B. burgdorferi* infection posed to hunters and other individuals exposed to activity-related contact with ticks.

Material and methods. The study was carried out in the northern part of the Lublin Province (eastern Poland) and involved 150 individuals exposed to tick bites (110 hunters and 40 individuals exposed to activity-related contact with ticks). The analysis of sera for the presence of *B. burgdorferi* IgM and IgG antibodies was carried out. All 150 individuals were tested with the ELISA assay, and positive and borderline results of the assay were verified with the Western blot test. All study participants completed a questionnaire, which provided information about exposure to ticks, application of prophylactic measures, and awareness of Lyme borreliosis.

Results. The ELISA assay revealed a positive or borderline result in at least one of the classes of *B. burgdorferi* antibodies in 63.3% (95/150) of the individuals (IgM 14.0%, IgG 63.3%). Verification carried out with the Western blot test showed a positive or borderline result in at least one of the antibody classes in 38.0% (57/150) of the examined persons (IgM 2.7%, IgG 36.7%). Abdomen (56.0%) and legs (53.7%) were the most frequently bitten body regions. Tick bites on the abdomen were significantly more frequently declared by hunters. Inspection of the body after returning from natural areas was more popular prophylactic method than use of repellents. Inspection of the body was significantly more often used in the group of the hunters.

Conclusions. The risk of *B. burgdorferi* infection among hunters and other individuals undertaking activities associated with exposure to tick bites in the study area is high.

Keywords: *Lyme borreliosis, Borrelia burgdorferi, ticks, prophylaxis, hunters*

STRESZCZENIE

Wprowadzenie. Borelioza z Lyme jest najczęstszą chorobą przenoszoną przez kleszcze w Europie i Ameryce Północnej, a liczba rejestrowanych przypadków zachorowań wzrasta. Częsta obecność w siedliskach kleszczy zwiększa ryzyko ukłucia przez kleszcze i możliwe zakażenie krętkami *Borrelia burgdorferi*.

Cel badań. Celem badań była ocena ryzyka zakażenia *B. burgdorferi* wśród myśliwych oraz innych osób podejmujących aktywności narażające na kontakt z kleszczami.

Materiał i metoda. Badania przeprowadzono na terenie północnej części województwa lubelskiego (wschodnia Polska) wśród 150 osób narażonych na pokłucia przez kleszcze (110 myśliwych i 40 osób narażonych na kontakt z kleszczami w związku z podejmowaniem innych aktywności). Zbadano surowice w kierunku obecności przeciwciał IgM i IgG anty-*-Borrelia burgdorferi*. U wszystkich 150 osób wykonano test ELISA, a pozytywne i wątpliwe wyniki tego testu zweryfikowano stosując test Western blot. W badaniach zastosowano również autorski kwestionariusz ankiety do oceny ekspozycji na kleszcze, podejmowania działań profilaktycznych oraz samooceny poziomu wiedzy na temat boreliozy z Lyme.

Wyniki. Stosując test ELISA, pozytywny lub graniczny wynik w co najmniej jednej z klas przeciwciał anty-*Borrelia* stwierdzono u 63,3% (95/150) badanych (IgM 14,0%, IgG 63,3%). Po weryfikacji testem Western blot, pozytywny lub graniczny wynik w co najmniej jednej z klas przeciwciał uzyskano u 38,0% (57/150) badanych (IgM 2,7%, IgG 36,7%). Najczęściej

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deklarowanym miejscem pokłucia przez kleszcze był brzuch (56,0%) oraz kończyny dolne (53,7%). Pokłucie w okolicy brzucha istotnie częściej deklarowali myśliwi. Oglądanie ciała po powrocie z terenów zielonych okazało się popularniejszą metodą profilaktyki niż stosowanie repelentów. Oglądanie ciała istotnie częściej stosowane było wśród myśliwych.
Wnioski. Ryzyko zakażenia *B. burgdorferi* wśród myśliwych i innych osób podejmujących czynności związane z narażeniem na ukąszenia kleszczy na badanym obszarze jest wysokie.

Słowa kluczowe: *borelioza z Lyme, Borrelia burgdorferi, kleszcze, profilaktyka, myśliwi*

INTRODUCTION

Lyme borreliosis is one of the newly emerging or re-emerging diseases. It is the most frequent tick-borne disease in Europe and North America, and the number of registered cases is on the increase [24]. In Poland, cases of Lyme disease have had to be reported and registered since 1996 and they are characterised by a growing incidence according to the National Institute of Public Health. The highest number of cases (21 514) was reported in 2017, and the incidence rate of the disease reached 56.0/100 000 individuals [9].

Bacteria *Borrelia burgdorferi* sensu lato transmitted by ticks from the genus *Ixodes* are the aetiological agents of Lyme borreliosis. In Central Europe, including Poland, *Ixodes ricinus* is the most common tick species and plays the most important role in transmission of spirochetes, which cause Lyme borreliosis. Frequent presence in the habitats of these arthropods enhances the risk of tick bites and possible infection with *B. burgdorferi* spirochetes. The particularly high risk is posed to foresters, farmers, hunters, and those who collect groundcover fruits or visit tick habitats for recreational purposes (e.g. survival) [21].

The available literature provides many reports analysing the exposure to infection with *B. burgdorferi* spirochetes. Foresters are examined most frequently, while farmers, who are occupationally exposed to tick-borne diseases, are analysed less often [7, 16, 19, 25]. Few studies have been conducted on individuals exposed to other activity-related contact with ticks. Although hunting is popular in Europe, there hed been relatively few studies heretofore that addressed serological exposure of hunters to *B. burgdorferi* s.l. [5, 10].

The aim of the study was to assess the risk of *B. burgdorferi* infection posed to hunters and other individuals exposed to activity-related contact with ticks by analysis of tick exposure, presence of anti-*B. burgdorferi* antibodies, preventive measures taken to reduce the risk of contracting Lyme disease, as well as awareness and knowledge of the disease.

MATERIALS AND METHODS

The investigations involved 150 respondents exposed to tick bites; 73.3% (110/150) were represented by hunters and the other 26.7% (40/150) were tick bite-exposed individuals undertaking different activities (agriculture, collecting groundcover fruits, recreational activity in forested areas).

The study was carried out in the northern part of the Lublin Province, in eastern Poland. The residents of the city and the countryside accounted for 52.0% and 48.0%, respectively. They were aged 17 - 80 years (mean: 53; SD=11). Males, representing 82.7% of the total number, were a majority of the examined group.

The analysis of sera for the presence of *B. burgdorferi* IgM and IgG antibodies was carried out with a routine two-stage serological diagnosis of Lyme disease. The first stage consisted in determination of anti-*B. burgdorferi* sensu lato IgG and IgM antibodies with the ELISA method (Anti-*Borrelia* ELISA IgM and Anti-*Borrelia* plus VlsE ELISA IgG, Euroimmun). The wells were coated with mixed antigens of *B. burgdorferi* sensu stricto, *B. afzelii*, *B. garinii* and recombinant protein VlsE. In accordance with the producer's recommendations, a result above 22 RU/ml was considered positive, whereas a result within 16-22 RU/ml was regarded as borderline. The positive and borderline results obtained were confirmed using the Western blot method (Wb) (Anti-*Borrelia* EUROLINE-WB IgM/IgG; Euroimmun). Test stripes comprised immobilized antigens of *B. afzelii* (p83, p41, p39/BmpA, p31/OspA, p30, p25/OspC, p21, p19, p17/DbpA) as well as a chip with recombinant antigen VlsE. The results were read using the EuroLinescan software (Euroimmun).

After obtaining informed consent, the subjects were asked to fill in a questionnaire including data about the age, sex, number of tick bites, body regions of tick bites, methods for tick removal, frequency of application of repellents, frequency of inspection of the body after returning from tick habitats and self-assessment of the level of knowledge of Lyme borreliosis.

The results were statistically analysed with *Pearson's Chi*^{2} test. The analyses were performed using STATISTICA v. 7.1 (StatSoft, Poland). The 0.05 level of significance was adopted for statistical inference.

Consent for the study was obtained from the Bioethics Committee at the Medical University in Lublin (No. KE-0254/12/2013).

RESULTS

The ELISA assay revealed a positive or borderline result in at least one of the antibody classes in the case of 63.3% (95/150) of the examined individuals. In the IgM class, a positive result was found for 10.0% (15/150) of the respondents and a borderline result was noted in 4.0% (6/150). In turn, in the IgG antibody class, positive and borderline results were was obtained among 53.3% (80/150) and 10.0% (15/150) of the respondents, respectively (Figure 1).

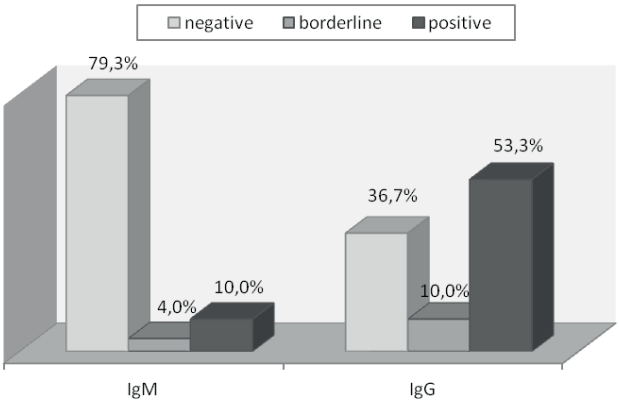

Figure 1. Results of ELISA test with division into IgM and IgG class antibodies

Positive and borderline results of the ELISA assay were verified with the Western blot test. In the IgM class, there were 0.7% (1/150) of positive results and 2.0% (3/150) of borderline results, and in the IgG class the positive and borderline results accounted for 26.0% (39/150) and 10.7% (16/150), respectively (Figure 2). Ultimately, a positive or borderline result in at least one of the antibody classes was noted in 38.0% (57/150) of the individuals. A detailed summary of the results is shown in Table 1.

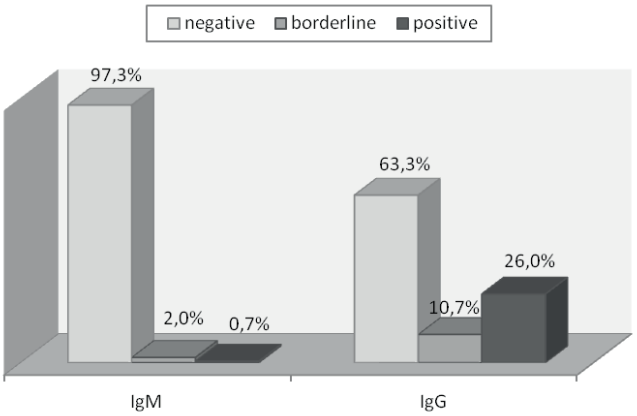

Figure 2. Results of Western blot test with division into IgM and IgG class antibodies

89.3% (134/150) of the examined individuals reported having been bitten by a tick. A majority of the respondents (58.0%) declared more than two bites, 8.7% two bites and 22.7% single bite. Tick bites were declared by 90.0% in the group of the hunters and by 87.5% of the respondents undertaking other activities related to tick exposure (agriculture, collecting groundcover fruits, outdoor recreation).

Table 1. Results of ELISA and Western blot tests

Study group N=150		Antibodies against *B. burgdorferi*					
		ELISA		N=150		Western blot	
n	%	IgM	IgG	n	%	IgM	IgG
15	10.0	positive	positive	1	0.7	positive	negative
				1	0.7	borderline	positive
				3	2.0	negative	positive
				1	0.7	borderline	negative
				1	0.7	negative	borderline
				8	5.3	negative	negative
6	4.0	borderline	positive	1	0.7	borderline	positive
				3	2.0	negative	positive
				2	1.3	negative	negative
59	39.3	negative	positive	30	20.0	*	positive
				13	8.7	*	borderline
				16	10.7	*	negative
15	10.0	negative	borderline	1	0.7	*	positive
				2	1.3	*	borderline
				12	8.0	*	negative
55	36.7	negative	negative	55	36.7	*	*

* - test not performed (the result of ELISA test was negative)

Abdomen (56.0%) and legs (53.7%) were the most frequently bitten body regions reported by the respondents bitten by ticks (N=134); in turn, the lowest frequency of tick bites was found for the head (4.5%) and neck (9.7%). Detailed data are presented in Figure 3.

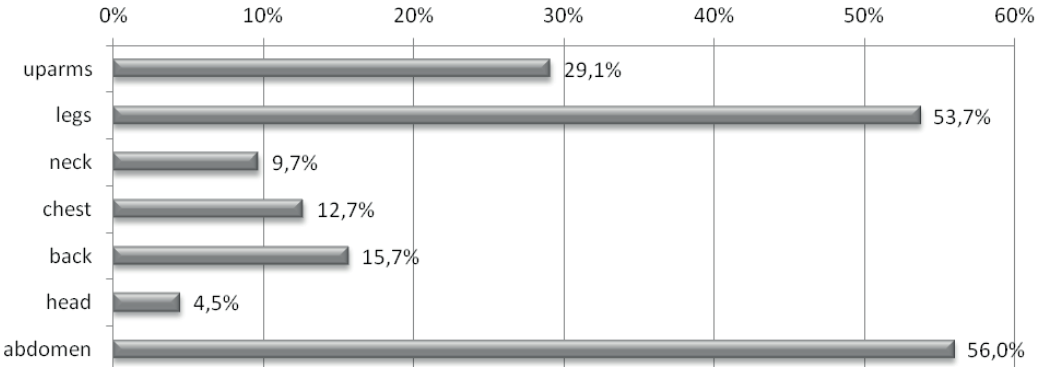

Figure 3. Body regions of tick bites (N=134)

The hunters reported significantly greater numbers of bites on the abdomen than the respondents exposed to contact with ticks through other activities, 62.6% and 37.1%, respectively (Chi^2=6.8; p=0.09). Additionally, they reported higher frequency of bites on the arms (32.3%), chest (13.1%), and head (5.1%), but the differences were not statistically significant.

Different methods for removal of the tick were used by the respondents bitten by ticks (Figure 4), and pulling the tick out with the fingers was the most frequent method (36.6%). Comparative analysis of the groups of the hunters and the other respondents exposed to ticks through their activities showed no statistically significant differences in the frequency of the application of the tick removal methods. Disinfection of the parasite attachment site after the removal was declared by 24.6% of the individuals.

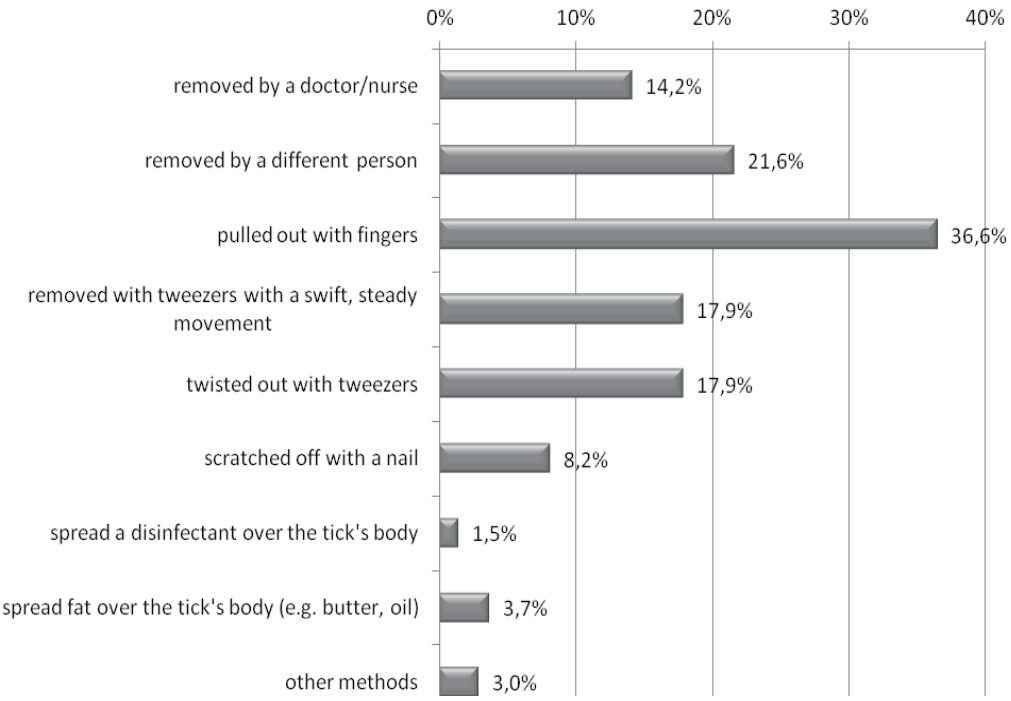

Figure 4. Methods for tick removal applied by the respondents (N=134)

Two Lyme borreliosis prophylactic methods were analysed in the study: the use of tick-repelling agents (repellents) and inspection of the body after returning from tick habitats in order to remove ticks.

As for the use of repellents, the largest group (42.8%) of respondents declared that they frequently used this form of prophylaxis (Figure 5). There were no statistically significant differences in the frequency of the use of repellents between the hunters and the other respondents exposed to contact with ticks.

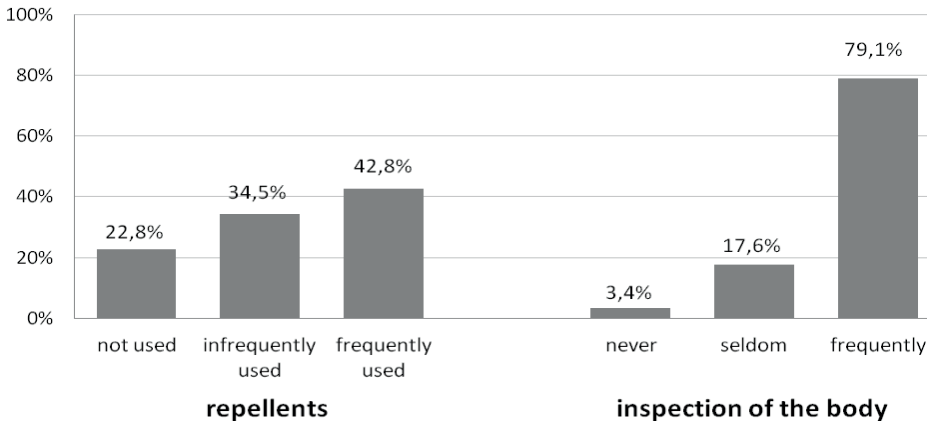

Figure 5. Frequency of application of tick repellents and frequency of inspection of the body after returning from tick habitat

Inspection of the body after returning from natural areas was the most popular prophylactic method. Frequent application of this method was declared by as many as 79.1% of the respondents (figure 5). The method was significantly more often used in the group of the hunters (86.1%) than in the group of the individuals exposed to activity-related contact with ticks (60.0%) (Chi^2=14.4; p<0.01).

Comparison of the declared frequencies of the use of the two analysed methods reveals that the higher rate of application of repellents by the respondents was accompanied by more frequent inspection of the body (Chi^2=17.3; p<0.01).

The self-assessment of the knowledge of Lyme borreliosis demonstrated that a majority of the respondents evaluated their awareness of the disease at a medium (52.3%) or minimal (33.6%) level. In this aspect, there were no statistically significant differences between the group of the hunters and the other respondents exposed to tick bites. Individuals that declared inspection of the body after returning from tick habitats assessed their knowledge as medium- or high-level significantly more frequently (Chi^2=11.8; p<0.01). There were no significant correlations between the self-assessment of the level of knowledge of Lyme disease and the frequency of application of repellents. The need to broaden their knowledge of Lyme disease and other tick-borne diseases was declared by 75.7% of the respondents.

DISCUSSION

Frequent presence in the habitats of ticks enhances the risk of tick bites and possible infection with *B. burgdorferi* spirochetes. In the analysed groups of hunters and individuals occupied with activities involving exposure to ticks, there was a high proportion of respondents declaring tick bites (89.3%). Simultaneously, a majority of the respondents declared having experienced more than two bites (58.0%). In a study conducted in the Lublin macroregion, tick bites were reported by 66% of individuals from an occupationally tick bite-exposed group of foresters and farmers and merely 26% of occupationally non-exposed individuals [2]. In turn, 58.9% of secondary school pupils from the analysed region reported tick bites [14].

In our study, the body regions reported most frequently by the individuals who had experienced tick bites included abdomen (56.0%) and legs (53.7%). Tick bites on the abdomen were significantly more frequently declared by the hunters (62.6%). Only 37.1% of the respondents exposed to contact with ticks through other activities reported this site of tick bites. Tick bites on the abdomen are specific to hunters, as the extremities, in particular the legs, are usually the most commonly reported body region bitten by ticks [1, 12, 15, 20, 22, 23]. In the studies among adolescents, performed in the analysed region (northern part of Lublin Province), tick bites on the abdomen and on the legs were declared by 34.4% and 59.4% of respondents, respectively [15]. Patients reporting to health facilities in the Lublin Province due to tick bites were most often bitten by ticks on the arms (28.8%) and legs (27.1%) [4].

In our study, the ELISA assay revealed positive or borderline results in at least one of the classes of *B. burgdorferi* antibodies in 63.3% of the analysed respondents (IgM 14.0%, IgG 63.3%). Verification by the Western blot test confirmed a positive or borderline result in at least one of the antibody classes in 38.0% of the respondents (IgM 2.7%, IgG 36.7%).

Most publications assessing the presence of *B. burgdorferi* antibodies presented examinations of Lyme disease patients or individuals occupationally exposed to contact with ticks. There are especially many reports of foresters. The investigations, however, were carried out with different diagnostic methods (ELISA, IFA, WB) and in different regions of the individual countries; they are therefore hard to compare. The percentage of foresters having specific antibodies increased in France from 14.1% to 20.2%,

in Italy from 5.4% to 23.2%, in Germany in the range of 0 - 43%, in Holland to 19.3%, in Slovenia to 23.8%, in Romania to 9.4%, in Turkey to 10.9%, and in Hungary to 37%. In Poland, the examination results are highly diverse. They range from 19.2% to 61.5% in analyses performed with the ELISA test, depending on the region [16]. In examinations of foresters from the same area as in this study, the ELISA assay showed a positive or borderline result in at least one class of antibodies in 75% individuals, whereas verification with the Western blot test confirmed the results in 55% (IgM 15%, IgG 46%) [19].

In examinations of farmers from the Lublin region (ELISA test), the presence of antibodies from at least one class (IgM or IgG) was detected among 27.3% of the individuals [6]. Further reports from the same region demonstrated the presence of specific antibodies detected using the Western blot method in 33.0% of farmers [7]. Examinations of farmers from the same area as in this study revealed a positive or borderline result in at least one of the antibody classes in 42% of individuals examined using the ELISA test and in 28% of farmers after verification with the Western blot test (IgM 14%, IgG 18%) [19].

In the literature, there are few studies relating to hunters. In examinations in Hokkaido (Japan's northernmost island), the presence of antibodies against *B. burgdorferi* was detected among 16.0% of hunters [13]. In Austria, *B. burgdorferi* antibodies were detected among 7% of hunters in the IgM class and 42% in the IgG class [10]. Further reports from Austria demonstrated the presence of IgG antibodies against *B. burgdorferi* in 54% of hunters. Seropositivity was clearly related to age and duration of hunting activity; it was 33% among persons younger than 29 years and 83% in those older than 70 years. The nearly linear increase of seroprevalence with age and duration of hunting activity reflects repeated tick exposure [5]. In rural parts of western Turkey, only 1 of 29 (3.4%) serum samples from hunters were positive for IgG *B. burgdorferi* antibodies [11].

Since no vaccine is currently available, protection against tick bites is the best Lyme borreliosis prophylactic method [19]. In our study, we analysed two methods for Lyme disease prophylaxis: inspection of the body after leaving tick habitats and the use of tick repellents. Inspection of the body was the more popular prophylactic method. A frequent use of this method was declared by as many as 79.1% of the respondents, and 42.8% of them reported a frequent use of repellents. Inspection of the body after returning from tick habitats was particularly popular with the hunters. This method was also more frequently applied by individuals who assessed their knowledge of Lyme disease to be at a high level.

In a study conducted in the Lublin macroregion, inspection of the body after leaving tick habitats was declared by 43% and application of repellents by 38% of the examined individuals [2]. In other studies in south-eastern Poland, 13% of patients presenting to a doctor to have a tick removed reported the use of repellents and only 4% declared inspection of clothes after leaving forests and other tick habitats [3]. The principle of inspection of the body after returning from tick habitats was declared by as many as 92% of forestry workers and the use of repellents was reported by 76% [8]. Forest Service employees are well informed about tick-borne diseases, which undoubtedly is related to educational and knowledge dissemination actions provided in this occupational group [26].

An important element of Lyme borreliosis prophylaxis is prompt removal of a skin-attached tick in a proper way. The sooner the tick is removed the greater the chances are that infection does not develop. It is recommended that the tick should be grasped with tweezers as close to the skin as possible and pulled out with a swift, steady, and strong movement. After removal of the tick, the skin should be disinfected [17, 21]. In our study, the most frequent method applied involved pulling the tick out with fingers (36.6%). Tick removal with a swift movement using tweezers was declared by 17.9% of the respondents. Similarly, in other studies conducted in the Lublin macroregion, the most common method for removal of ticks was pulling them out with fingers (44%). Only 17% of the respondents declared removing ticks with tweezers [2].

CONCLUSIONS

The risk of *Borrelia burgdorferi* infection among individuals undertaking activities associated with exposure to tick bites in eastern Poland is high and spirochete infections confirmed by the positive results of the Western blot test are highly probable. The examined individuals reported most frequent tick bites in the region of the abdomen and legs. Bites on the abdomen were noted with particular frequency in the group of the hunters. The respondents usually evaluated their knowledge of Lyme borreliosis at a medium level. A majority of them declared a need for extension of their knowledge of Lyme borreliosis and other tick-borne diseases.

Acknowledgements

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Conflict of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

RELATIONSHIPS BETWEEN DIETS AND THE QUALITY OF LIFE TO WOMEN AGED 50 TO 64

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ABSTRACT

Background. Adverse effects of numerous environmental factors, including improperly balanced diets, may accelerate the onset of ailments related to the climacteric period.

Objective. The aim of the study was to examine the relationships between diets and the quality of life of working women aged 50-64 years.

Material and methods. The study included 274 working women aged 55.4±4.0 years living in Biała Podlaska and the surrounding area. These were women working in various positions (teaching, administrative, economic department) at the State School of Higher Education in Biała Podlaska, Poland and patients of the Health and Rehabilitation Centre in Biała Podlaska. The study was conducted by means of a popular tool used to diagnose quality of life i.e. SF-36 questionnaire (Short Form Health Survey) and the Questionnaire of Eating Behaviour (QEB).

Results. In all categories of quality of life (SF-36), apart from pain and general health, there were statistically significant differences between the results of the respondents and the norm for Polish women aged 50 to 60 years. Fruit, vegetables and wholemeal bread were the most frequently consumed products in the healthy diet group, while legumes, fish and curd cheese were the least frequently consumed by the respondents. Of the unhealthy products, the women most often chose sweets (at least once a week), cheese and fried food. Analysis of the effect of a healthy diet on the quality of life showed that a statistically significant correlations were observed in the case of mental health, functioning in society, emotionality, vitality, and well-being.

Conclusions. A positive correlation with the application of a healthy diet was observed in all the categories of quality of life. This means that the respondents with healthy diets had a higher quality of life.

Key words: *nutrition, quality of life, women, menopause*

STRESZCZENIE

Wprowadzenie. Niekorzystne oddziaływanie licznych czynników środowiskowych, w tym stosowanie niewłaściwie zbilansowanej diety może przyspieszać pojawienie się dolegliwości związanych z okresem klimakterium.

Cel badań. Celem badań była weryfikacja zależności pomiędzy spożywaną dietą a jakością życia kobiet w wieku 50-64 lata aktywnych zawodowo.

Materiał i metody. Badaniami objęto 274 kobiety w wieku 55,4±4,0 lat, aktywne zawodowo zamieszkujące Białą Podlaską i okolice. Były to osoby pracujące na różnych stanowiskach (dydaktycznych, administracyjnych, działu gospodarczego) w Państwowej Szkole Wyższej w Białej Podlaskiej oraz pacjentki korzystające z usług Centrum Zdrowia i Rehabilitacji w Białej Podlaskiej. Badania dokonano za pomocą narzędzia używanego do diagnozy jakości życia - kwestionariusza SF-36 Short Form Health Survey oraz kwestionariusza QEB do badania zachowań żywieniowych i opinii na temat żywności (QEB – Questionnaire of Eating Behaviour).

Wyniki. We wszystkich kategoriach jakości życia (SF-36), poza „bólem" i „zdrowiem ogólnym", odnotowano różnice istotne statystycznie pomiędzy wynikami respondentek i normą dla polskich kobiet w wieku 50-60 lat. Najczęściej spożywanymi przez badane kobiety produktami z grupy prozdrowotnej są owoce, warzywa i pieczywo razowe, natomiast najrzadziej potrawy z nasion strączkowych, ryby oraz sery twarogowe. Z produktów niezdrowych najczęściej badane kobiety sięgają po słodycze, sery żółte i potrawy smażone. Analizując wpływ diety prozdrowotnej na jakość życia respondentek odnotowano istotną statystycznie zależność w przypadku zdrowia psychicznego, funkcjonowania w społeczeństwie, emocjonalności, witalności oraz samopoczucia.

Wnioski. We wszystkich ww. kategoriach jakości życia odnotowano dodatnią korelację ze stosowaniem prozdrowotnej diety. Oznacza to, że respondentki, które odżywiają się zdrowo posiadają wyższą jakość życia.

Słowa kluczowe: *odżywianie, jakość życia, kobiety, klimakterium*

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INTRODUCTION

Improving the health-related quality of life (HRQoL) and promoting successful ageing have become important points in policies and programmes targeting populations of older adults [4, 17]. Health depends to a large extent on diets, which, if properly selected and balanced, have a positive effect on health status, while poor nutrition has a negative impact on the body. In recent years, this problem has been addressed more and more frequently in scientific research [6, 7, 8, 19, 22, 23, 24, 25]. A change in the diet to eliminate nutritional mistakes significantly improves the health and quality of life of women, especially in the perimenopausal period [6, 7, 22, 23].

Research on quality of diets focuses mainly on the relationship between adherence to healthy dietary patterns and cardiometabolic risk factors [15], cancer [30], mortality [15], and physical and mental functions (e.g. depression) [16]. Many studies presented in the literature have emphasized the adverse effects of climacteric symptoms on quality of life of women [1, 7, 22, 23]. Adverse effects of numerous environmental factors, including improperly balanced diets, may accelerate the onset of ailments related to the climacteric period.

The aim of the study was to examine the relationships between diets and the quality of life of working women aged 50-64 years.

MATERIAL AND METHODS

The study included 274 working women aged 55.4±4.0 years living in Biała Podlaska and the surrounding area. These were women working in various positions (teaching, administrative, economic department) at the State School of Higher Education in Biała Podlaska, Poland and patients of the Health and Rehabilitation Centre in Biała Podlaska. The youngest woman studied was 50 years old, whereas the oldest was 64 years old. The inclusion criteria were: female, age 50 to 64 years, working person and the consent for examinations. The characteristics of the subjects are given in Table 1.

For the purpose of the analysis, the respondents were categorized according to biological factors (age, BMI value) and socio-demographic factors (education, material status, place of residence).

Each participant was informed about the aim of the study, research procedure and the potential use of the results.

The study was conducted by means of a popular tool used to diagnose quality of life i.e. SF-36 questionnaire (Short Form Health Survey) and the Questionnaire of Eating Behaviour (QEB). The SF-36 questionnaire, due to the criterion of control, is numbered among self-assessment methods and allows for evaluation of eight indicators of quality of life i.e.: physical functioning, limitations in performing roles due to worse physical health, pain, general sense of health, vitality, social functioning, emotional problems, and sense of mental health. According to the Polish version of the SF-36 questionnaire, the highest point score means the lowest level of the quality of life, while the lowest point score means the highest level of quality of life [32].

Table 1. Characteristics of the subjects

Participants			
		n	%
Education level	primary or secondary	115	42.0
	tertiary	159	58.0
Age	50-54 years	120	43.8
	55-59 years	107	39.1
	60-64 years	47	17.2
Place of residence	rural areas	106	38.7
	city	168	61.3
Financial status	below average	17	6.2
	average	213	77.7
	above average	44	16.1
BMI	normal BMI	130	47.4
	overweight	88	32.1
	obesity	56	20.4
Age		Mean	55.4
		SD	4.0
BMI		Mean	26.3
		SD	5.8

Based on the answers to the QEB questionnaire (QEB - Questionnaire of Eating Behaviour), it was possible to determine whether a person's diet is healthy (healthy diet index - pHDI-8) or shows unhealthy characteristics (unhealthy diet index - nHDI-8). In order to facilitate the interpretation of both indices, it is recommended to compute the total frequency of consumption and express it on a scale from 0 to 100 points. Healthy diet index (pHDI-8, in point) = (100/16) × total frequency of consumption of eight groups of foods (times/day). Unhealthy diet index (nHDI-8, pt.) = (100/16) × total frequency of consumption of eight groups of foods (times/day) [33]. Products belonging to pHDI-8 are: wholemeal bread, milk and fermented milk drinks, curd cheese, fish dishes, legumes, vegetables and fruits. Products belonging to nHDI-8 are: fast foods, fried foods, cheese, sweets, canned meat, fish, vegetable and meat, sweetened carbonated drinks, energy drinks, alcoholic beverages. The mean healthy diet index (pHDI-8) was computed by summation of the daily frequency of consumption of specific food groups, expressed in times/day, on a scale from 0 to 100, reaching 17.13 in the women studied. The higher the index value, the greater the intensity of health benefits.

Table 2. Comparison of the results of the quality of life of female respondents (SF-36v2) with the norms for Polish women aged 50-60

Variable	Mean	Standard deviation	Minimum	Maximum	Reference	t	p
Physical functioning	55.4	6.4	33.1	62.9	48.0	19.20	0.0000*
Limitations of the role: ailments	53.3	6.0	43.6	59.1	49.0	11.84	0.0000*
Pain	48.2	7.4	29.0	60.6	48.0	0.51	0.6075
General health	48.3	6.1	32.9	63.4	48.0	0.92	0.3582
Limitations of the role: emotionality	62.8	11.7	26.7	85.6	42.0	29.36	0.0000*
Social functioning	66.5	13.7	20.1	85.1	50.0	19.89	0.0000*
Vitality	51.4	5.6	39.8	55.2	54.0	-7.75	0.0000*
Well-being	64.2	10.6	27.1	81.4	50.0	22.29	0.0000*
Physical health	51.9	8.9	28.1	68.7	46.0	11.04	0.0000*
Mental health	78.8	14.6	25.3	107.1	51.0	31.47	0.0000*

t- value of the *Student's t*-test for a single sample; *-significant differences at p<0.0

Statistical analysis was conducted using the STATISTICA v.10 software. Arithmetic means and standard deviations were calculated for quantitative data. In order to detect statistically significant differences, the *Mann Whitney* U-test and the *Kruskall-Wallis* test were used. The *Student's* t-test was used to compare the results of the quality of life with the Polish norms. The level of correlations was calculated using the *Spearman's* r rank correlation coefficient. In all analysed cases, the level of significance was set at p=0.05.

RESULTS

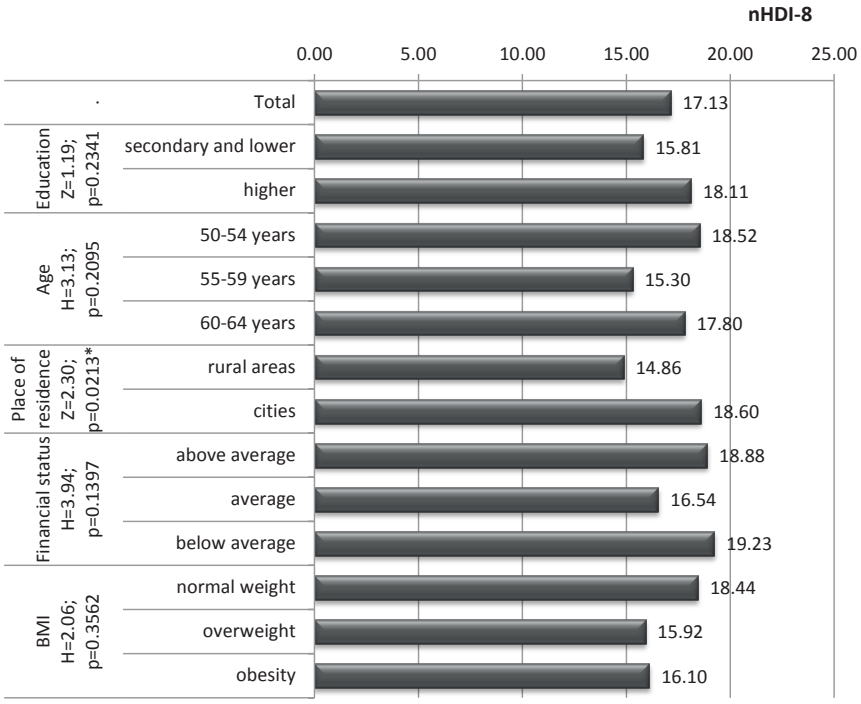
In all categories of quality of life (SF-36), apart from pain and general health, there were statistically significant differences between the results of the respondents and the norm for Polish women aged 50 to 60 years. In the case of vitality, the women tested had lower values compared to the norms, with higher values observed in other cases. According to the Polish version of the SF-36 questionnaire, the highest point score means the lowest level of the quality of life, while the lowest point score means the highest level of quality of life [32]. The highest coefficient was achieved for mental health (78.8), social functioning (66.5), and well-being (64.2). Furthermore, the lowest values were found for pain (48.2), general health (48.3), and vitality (51.4), (Table 2).

Fruit, vegetables and wholemeal bread were the most frequently consumed products in the healthy diet group, while legumes, fish and curd cheese were the least frequently consumed by the respondents. Of the unhealthy products, the women most often chose sweets (at least once a week), cheese and fried food. The remaining products from the unhealthy category were consumed once every 3 weeks, (Table 3).

Table 3. Weekly frequency of consumption of products from healthy and unhealthy groups

Food products consumed		Mean	Standard deviation
Healthy	wholemeal bread	3.03	4.61
	milk	2.12	3.46
	fermented milk beverages	1.41	2.41
	curd cheese	1.19	2.06
	fish dishes	0.66	0.67
	dishes made from legumes	0.45	0.68
	fruit	5.33	5.51
	vegetables	5.23	5.32
Unhealthy	fast food	0.34	1.52
	fried foods	1.04	1.93
	cheese	1.08	2.20
	sweets	2.08	3.42
	canned meat, canned fish, canned vegetables and meat	0.33	0.78
	sweetened carbonated beverages	0.38	1.34
	energy drinks	0.26	1.46
	alcoholic beverages	0.33	0.87

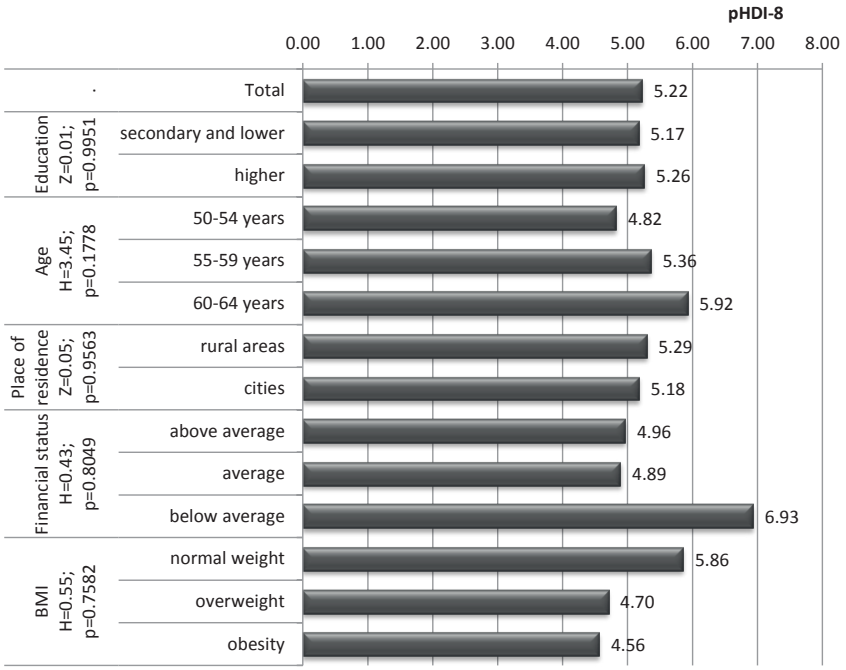
The highest healthy diet index was achieved by women with above-average financial status (19.23), living in the city (18.60) and aged 50-54 (18.52). A statistically significant relationship was recorded in relation to the place of residence, in favour of women living in the city, (Figure 1).



Z- value of the *Mann-Whitney* test, H- value of the *Kruskal-Wallis* test, *-significant differences at p<0.05

Figure 1. Healthy diet index pHDI-8 (in points) and selected biological and socio-demographic characteristics

The mean score of the unhealthy diet index (nHDI-8) was as above and it reached the level of (5.22). The higher the index value, the greater the intensity of unfavourable health characteristics. The highest index was achieved by women with the best financial status (6.93), aged 60 - 64 (5.92) and having a normal BMI (5.86). The lowest coefficient, indicating low intensity of characteristics of unhealthy diet index, was recorded in the case of obese (4.56) or overweight women (4.70), and respondents aged 50-54 (4.82), (Figure 2).



Z- value of the *Mann-Whitney* test, H- value of the *Kruskal-Wallis* test

Figure 2. Unhealthy diet index nHDI-8 (in points) and selected biological and socio-demographic characteristics of the respondents

Analysis of the effect of a healthy diet on the quality of life showed that a statistically significant correlations were observed in the case of mental health (p=0.0002; r=0.22), functioning in society (p=0.0010; r=0.20), emotionality (p=0.0122; r=0.15), vitality (p=0.0215; r=0.14), and well-being (p=0.0447; r=0.12). A positive correlation with the application of a healthy diet was observed in all the above mentioned categories of quality of life. This means that the women who eat healthily have a higher quality of life.

Analysis of research results leads to the conclusion that unhealthy diets negatively affect the quality of life of the respondents. A statistically significant relationship was recorded in the case of well-being (p=0.0064), (Table 4).

Table 4. The effect of healthy and unhealthy diets on the quality of life

		Spearman's R	t(N-2)	p
Unhealthy diet index	Physical functioning	-0.06	-1.05	0.2945
	Limitations of the role: ailments	-0.03	-0.46	0.6445
	Pain	-0.01	-0.09	0.9319
	General health	0.00	0.05	0.9601
	Limitations of the role: emotionality	-0.06	-0.95	0.3426
	Social functioning	-0.05	-0.86	0.3908
	Vitality	-0.03	-0.50	0.6174
	Well-being	**-0.16**	**-2.75**	**0.0064***
	Physical health	-0.05	-0.80	0.4222
	Mental health	-0.11	-1.76	0.0803
Healthy diet index	Physical functioning	0.10	1.63	0.1047
	Limitations of the role: ailments	0.07	1.09	0.2750
	Pain	0.00	0.07	0.9405
	General health	0.04	0.59	0.5584
	Limitations of the role: emotionality	**0.15**	**2.52**	**0.0122***
	Social functioning	**0.20**	**3.32**	**0.0010***
	Vitality	**0.14**	**2.31**	**0.0215***
	Well-being	**0.12**	**2.02**	**0.0447***
	Physical health	0.09	1.42	0.1581
	Mental health	**0.22**	**3.72**	**0.0002***

t - value of *the Student's t*-test; *-significant differences at p<0.05

DISCUSSION

The presented material constitutes one of the few studies concerning the relationships between dietary patterns and the quality of life of women aged 50-64 and comparative studies of healthy diet index (pHDI-8) and unhealthy diet index **(**nHDI-8) with selected biological and socio-demographic characteristics.

The results of our study are consistent, among others, with the research studies by *Muñoz* et al.[19], who found that positive self-rated mental and physical health is directly related to the Mediterranean diet, which is consistent with the healthy diet index. *Bonaccio* et al. [3], in their study covering 24,325 inhabitants of the Molise region in Italy, demonstrated that there is a positive link between following healthy diets and the self-rated mental and physical health. Ford et al. [9] found that poor quality of diets is linked to lower health-related quality of life (HRQOL) assessed by the health and activities limitation index (HALex) in older adults.

Researchers from universities in Spain, *Henríquez-Sánchez* et al. [12] conducted an analysis in a group of 11,015 participants with a 4-year observation period and observed a significant direct correlation between healthy diets and all areas of physical and mental health (vitality, social functioning and emotional role). The highest coefficients were found for vitality and general health status. In our studies, we also observed significant statistical differences in mental health, social functioning, emotionality, vitality and well-being.

The explorations conducted by *Gopinath* et al. [10] in Sydney, Australia, in groups of 1,305 and 895 participants (aged ≥ 55 years) demonstrated that a higher quality of diet is prospectively associated with a better quality of life and functional abilities. This was also confirmed by the results of our examinations.

The meta-analysis of cross-sectional study by *Jacka* et al. [13] covering 5,731 people showed that respondents on a high-nutrient diet with better quality

were less susceptible to depression, while higher consumption of processed and unhealthy foods was associated with increased anxiety.

The results of some studies suggest a relationship between diets rich in fruit and vegetables and subjective well-being [5, 11]. Furthermore, *Blanchflower* et al. [2] showed that there is a link between the consumption of large amounts of fruit and vegetables and life satisfaction (LS).

CONCLUSIONS

The problem of the effects of healthy and unhealthy diets on the quality of life of working women aged 50-64, is topical and important from the social point of view, because with the ageing society, it is extremely important not only to extend the life expectancy but also to maintain its quality. Therefore, further research to this problem is needed.

1. Taking into consideration the results of our research, it would be recommended to carry out prospective studies on a larger population of professionally active women aged 50-65.
2. Based on the results of the prospective studies, indicate the direction of education and health promotion in the group of middle-aged and elderly women, which will contribute to their health improvement and extension of a good quality life expectancy.

Conflict of interest

The Authors declare no conflict of interest.

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ORIGINAL ARTICLE

POLYPHENOL-RICH DIET IS ASSOCIATED WITH DECREASED LEVEL OF INFLAMMATORY BIOMARKERS IN BREAST CANCER PATIENTS

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ABSTRACT

Background. The study investigated the relationship between dietary intake of polyphenols and inflammatory markers: CRP, neutrophil/lymphocyte ratio (NLR), platelet/lymphocyte ratio (PLR), medium platelet volume/lymphocyte ratio (MPVRL), in newly-diagnosed breast cancer patients.

Objectives. The aim of this work was to verify whether diet rich in plant polyphenols affects inflammatory markers in breast cancer patients.

Materials and methods. 78 patients (55.3±14.5 years) treated surgically for breast cancer were studied. A modified FFQ and authorial worksheet based on the *Phenol Explorer* database was used to measure the amount of plant polyphenols in a diet. Basing on the median of polyphenols intake (1780 mg/day), the group was divided into two subgroups: low- and high- dietary intake of polyphenols (LDIP and HDIP, respectively). Plasma CRP level was measured and NLR, PLR and MPVLR were calculated using results from peripheral blood morphology.

Results. LDIP was associated with significantly higher CRP (elevated in 34.5% LDIP patients vs. 8.3% HDIP, $p<0.003$), NLR (elevated in 46.2% LDIP patients vs. 25.6% HDIP, $p<0.006$) and PLR level (elevated in 25.6% LDIP patients vs. 12.8% HDIP, $p<0.03$). MPVLR was not significantly different between both the subgroups.

Conclusion. High dietary intake of polyphenols remarkably reduced process of inflammation in breast cancer patients, which has important clinical implications. The study demonstrated also an usefulness of simple, cheap and commonly available biomarkers for monitoring anti-inflammatory effects of diet.

Keywords: *polyphenols, diet, breast cancer, inflammation, inflammatory markers*

STRESZCZENIE

Wprowadzenie. Badano zależność pomiędzy pobraniem polifenoli wraz z dietą a poziomem markerów stanu zapalnego: CRP, wskaźnika neutrofile/limfocyty (NLR), płytki/limfocyty (PLR) oraz średnia objętość płytek/limfocyty (MPVLR) wśród nowo zdiagnozowanych pacjentek z rakiem piersi.

Cel. Celem pracy było zweryfikowanie czy dieta bogata w polifenole roślinne wpływa na parametry stanu zapalnego u pacjentek z rakiem piersi.

Materiały i metody. Do badania włączono 78 pacjentek (55.3±14.5 lat) klasyfikowanych do leczenia chirurgicznego raka piersi. Do oszacowania zawartości polifenoli w diecie użyto zmodyfikowanego zwalidowanego FFQ i autorskiego arkusza opartego na bazie *Phenol Explorer*. Po wyliczeniu median spożycia polifenoli (1780mg/dobę), podzielono pacjentki na dwie grupy: niskiego i wysokiego spożycia polifenoli (odpowiednio LDIP I HDIP). Zmierzono stężenie CRP oraz na podstawie wyników morfologii krwi obwodowej wyliczono wskaźniki NLR, PLR oraz MPVLR

Wyniki. W grupie z niższym pobraniem polifenoli zaobserwowano znacząco wyższe wartości CRP (podwyższone u 34.5% vs grupa wysokiego spożycia 8.3%, $p<0.003$), NLR (podwyższone w 46.2% vs 25.6%, $p<0.006$) oraz poziom PLR (podwyższone u 25.6% vs 12.8%, $p<0.03$). Wartości MPVLR nie różniły się istotnie pomiędzy podgrupami.

Wnioski. Wysokie spożycie polifenoli znacząco redukowało proces zapalny u pacjentek z rakiem piersi, co ma znaczące implikacje kliniczne. Badanie przedstawiło również użyteczność prostych, tanich i powszechnie dostępnych biomarkerów do monitorowania przeciwzapalnego wpływu diety.

Słowa kluczowe: *polifenole, dieta, rak piersi, stan zapalny, markery zapalenia*

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INTRODUCTION

Among females, breast cancer is the most commonly diagnosed cancer and the leading cause of cancer death [2], hence many scientists struggle to improve an effectiveness of breast cancer therapy and limit its side effects [33]. Major factors that increase the occurrence of that disease are alcohol consumption and overweight. Protective activity have lactation, physical activity and probably fruits, vegetable, soy and fish consumption. Nutrients as folate, calcium, vitamin D and fiber have also been taken into consideration [10]. A number of studies suggest that plant polyphenols play a protective role in carcinogenesis [9, 14, 24]. The risk of BC is significantly decreased among both pre- and post-menopausal women with high polyphenol intake [6, 9, 14]. The biological activity of polyphenols is manifested through several potential mechanisms: removing free radicals and increasing their dismutation to substances with lower activity [16, 19], modulation of immunological function and inhibition cancer initiation, promotion and progression, as well as platelet aggregation. There are studies indicating an anti-cancer activity of green tea and hawthorn fruit polyphenols as well as ellagic acid by performing cytostatic activity [16]. Concerning these potential activities, a diet rich in plant polyphenols can be very beneficial and may improve the treatment efficacy of cancer [5, 9, 14].

There are many publications reporting the positive effect that plant polyphenols have on reducing CRP level [3, 20, 23]. Low-grade inflammation is characterized by elevated concentrations of inflammatory markers: plasmatic (C-reactive protein) and cellular (leukocyte and platelet counts and in neutrophil/lymphocyte ratio - NLR) in the absence of any overt symptoms is recognized as a risk factor for a number of chronic diseases including cancer [1]. It is now widely accepted that chronic inflammation is closely associated with the process of cancer development. In the large study, effectiveness of inflammatory markers in predicting prognosis in 2374 women with BC was analysed, where NLR and PLR were found to be independent markers of prognosis in breast cancer, however further studies are needed in patients with overexpression of HER-2 [28].

In general, blood tests based on granulocyte, platelet and lymphocyte counts have identified a relationship between with poor prognosis in patients with BC and elevated NLR and PLR [29, 32]. Higher NLR correlates with decreased 5-year survival, greater tumour size, higher grading and metastasis occurrence. Higher PLR is known as a factor enhancing breast cancer risk. An preoperative PLR can be used as an independent prognostic marker for survival in breast cancer patients [12]. Additionally, when PLR was higher than 185, reduced 5-year survival was observed [11]. One recently-described factor is MPVLR (mean platelet volume/lymphocyte ratio). However, while it is assumed to be a prognostic factor in CVD, further data is required to confirm this fact [8]. A review by *Bonaccio* et al., including MOLI-SANI study data, found that dietary polyphenol intake may reduce NLR, PLR and CRP values and protect against cancer [1]. Currently, there is no data, however, on the suitability of those simple inflammatory markers to monitor anti-inflammatory action of polyphenol-rich diet in breast cancer patients.

In response to the growing body of evidence concerning the anti-cancer and anti-inflammatory properties of dietary polyphenols, the aim of the present study was to determine whether a high dietary intake of polyphenols reduces the level of inflammatory markers in breast cancer patients. We analysed and compared CRP, PLR, NLR and MPVLR in two subgroups of breast cancer patients having low- or high dietary intake of polyphenols.

MATERIAL AND METHODS

Patients

A group of 78 breast cancer patients was studied (55.3±14.5years). Patient recruitment was conducted in the Department of Surgical Oncology and Breast Diseases in Polish Mother's Memorial Hospital Research Institute. The inclusion criteria were as follows: the presence of loco-regional non-metastatic BC confirmed by histopathology; no previous oncological treatment. The exclusion criteria comprised the patient following an alternative diet (e.g. rigorous low-calorie diets, vegetarian diet, elimination diets) or taking medicines containing acetylsalicylic acid or other anti-platelets agents two weeks or shorter before the examination.

Patients were informed about the aim of the experiment and the potential risk associated with blood donation. All participants confirmed voluntary and conscious participation in the study.

For calculating cut off values of inflammatory markers, we used data coming from healthy reference group (n=102) from our previous study [18].

Laboratory tests

Blood morphology (Sysmex XN-2000 automated haematology analyser, Sysmex Corporation, Kobe, Japan) results and CRP concentration (VITROS CRP Slide method, Ortho-Clinical Diagnostics, Inc, Rochester, NY, USA) were obtained from the hospital laboratory. On the basis of blood morphology data, the following markers (indexes) were calculated: PLR (platelet/lymphocyte ratio), NLR (neutrophil/lymphocyte ratio) and MPVLR (medium platelet volume/lymphocyte ratio).

Dietary questionnaire and the estimation of phenolic compounds intake

To estimate the nutritional value of a diet, including the vegetable phenolic compound content,

a validated Food Frequency Questionnaire (FFQ) was used [7]. The data was entered into an authorial worksheet to estimate the content of the vegetable phenolic compounds. The worksheet was based on data from Phenol Explorer, a comprehensive database containing information about the quantity of 501 vegetable phenolic compounds (classified in six classes and 31 sub-classes) in 459 eatables. The products are classified into nine classes and 67 sub-classes. The common English name, French name, botanical family, scientific name, number of polyphenols and their medium quantity are given for each product, together with references for each substance.

The worksheet included the following classes: total quantity of vegetable phenolic compounds, flavonoids (alkylphenols, flavons, flavanols, catechins, procyanidins, antocyanins, teaflavins, dihydrochalcones, isoflavonoids), flavan-3-ols, phenolic acids (hydroxybenzoic acid, hydroxycynnamic acid), stilbenes and lignans.

Statistical analysis

Analyses were done with StatsDirect statistical software, version 2.7.8 (StatsDirect Ltd, Altrincham, UK). The results of inflammatory markers in patients are presented as the percentage of patients above the cut-off point (calculated separately for each inflammatory marker). Significance of differences were analysed using *Fisher's* exact test. *Cohen's* kappa coefficient was calculated as a measure of agreement. A kappa statistic value of <0.4 represents poor-to-fair agreement, a value of 0.41-0.60 reflects moderate agreement, a value of 0.61-0.80 is considered good agreement, and a kappa value of 0.81-1.0 is considered very good agreement.

RESULTS

Dietary intake of polyphenols

Using a validated FFQ, the dietary intake of polyphenols [7] was determined in the total of 78 middle-aged women with newly-diagnosed breast cancer. The median of total polyphenol intake was 1780 mg per day. Using this value as the cut-off, the whole group of breast cancer patients was divided into a high dietary intake of polyphenols (HDIP) group (n=39) and low dietary intake of polyphenols (LDIP) group (n=39). The most abundant polyphenol sources in total breast cancer population were tea (52.7%), coffee (18.4%), fruits (11.4%), vegetables (6.7%), juices (6.1%), cereal products (2.5%), chocolate (2.1%), seeds and oils (0.2%).

All the participants were receiving breast-conserving surgery or breast radical surgery as their first oncological treatment. The participating women were classified as follows: premenopausal (regular menstrual cycles in the past three months), postmenopausal (no menstrual period for over one year), were older than 55 years or had surgical menopause. Participants in both subgroups were well balanced according to age, BMI, smoking status, menopausal status, disease duration or family history of breast cancer. Breastfeeding was found to be significantly longer among the HDIP group of patients. No significant differences were found between HDIP and LDIP groups concerning the following tumour features: tumour grade, HER2 status, hormonal receptor status, Ki-67 status. The only differences between the HDIP and LDIP groups were in haemoglobin level and leukocyte count. The characteristics of the patients in HDIP and LDIP subgroups are shown in the Table 1.

Inflammatory markers: cut-off points

Cut-off values were defined based on inflammatory markers: plasmatic (C-reactive protein) and cellular (PLR, NLR and MPVLR) measured in the group of healthy volunteers not taking anti-inflammatory drugs (n=102) [18]. Cut-off values were defined as 95th percentile of CRP, NLR, PLR and MPVLR. The values exceeding cut-off values were regarded as 'elevated' (over the normal range indicating higher inflammatory status) (Table 2).

Inflammatory markers in breast cancer patients

Overall, a total group of breast cancer patients (HDIP and LDIP together) (n=78) was characterised by significant rise of all the inflammatory markers studied (CRP, NLR, PLR, MPVLR) in comparison with the control group (healthy subjects, n=102) (Figure 1).

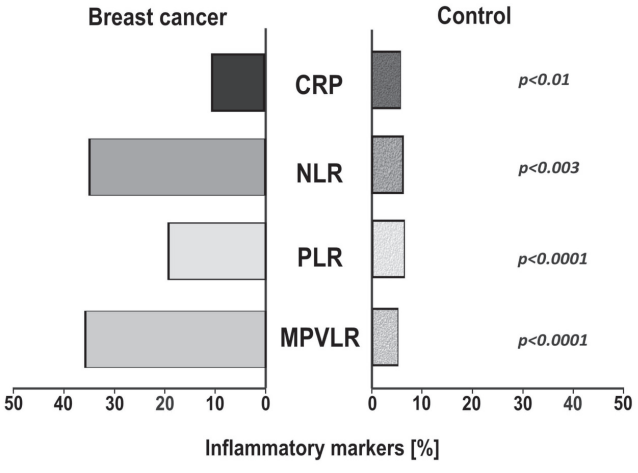

Figure 1. The comparison of plasma inflammatory markers (CRP) and cellular inflammatory markers (NLR, PLR, MPVLR) between breast cancer patients (n=78) and control group (n=102).

The results of inflammatory markers are presented as the percentage of individuals above the cut-off point. Cut-off values: CRP>0.5 mg/L, NLR>3.0, PLR>207.0, MPVLR>6.8. Significance of differences were analysed using Fisher's exact test. CRP: C-Reactive Protein, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio, MPVLR: mean platelet volume-to-lymphocyte ratio.

Table 1. Characteristics of breast cancer patients (n=78) divided into subgroups with high- and low dietary intake of polyphenols

Variable		High dietary intake of polyphenols n=39	Low dietary intake of polyphenols n=39	*P* value
Dietary intake of polyphenols [mg/day]		2230 (1923-2394)	1275 (988-1541)	<0.001
Age (years)		56.9±14.1	53.8±14.9	ns
BMI		26.9±3,97	27.1±4.64	ns
Tumour grade	G1	3	2	ns
	G2	16	18	ns
	G3	7	4	ns
	Unknown	13	15	ns
HER2 status	Positive	2	4	ns
	Negative	15	15	ns
ER status	Positive	14	15	ns
	Negative	6	3	ns
PR status	Positive	13	14	ns
	Negative	7	4	ns
Ki-67 [%]		40	36	ns
Menopausal status	Postmenopausal	27	26	ns
	Pre-menopausal	12	13	ns
Breast cancer in family	Yes	12	15	ns
	No	27	24	ns
Haemoglobin (g/dL)		14.09±4.37	13.02±1.37	ns
Leukocyte count (x 10^9/L)		6.88±1.69	7.67±2.03	ns
Granulocyte count (x 10^9/L)		4.34±1.40	5.08±1.80	<0.04
Lymphocyte count (x 10^9/L)		1.96±0.72	1.78±0.71	ns
Platelets count (x 10^9/L)		236.5±59.5	251.2±36.7	ns
Mean platelet volume (fL)		11.03±1.02	10.99±0.83	ns

Continuous data are presented as mean ±SD or median (interquartile range).
Categorical data are presented as absolute numbers of patients.
Significance of differences were analyzed using *Mann-Whitney* U test (continuous data) or *Fisher's* exact test (categorical data).

The elevation of the three parameters: CRP, NLR and PLR was found in LDIP subgroup in comparison with HDIP subgroup of breast cancer patients (Figure 2). The values for MPVLR were 7.1±2.7 for LDIP vs. 6.7±3.9 for HDIP (NS).

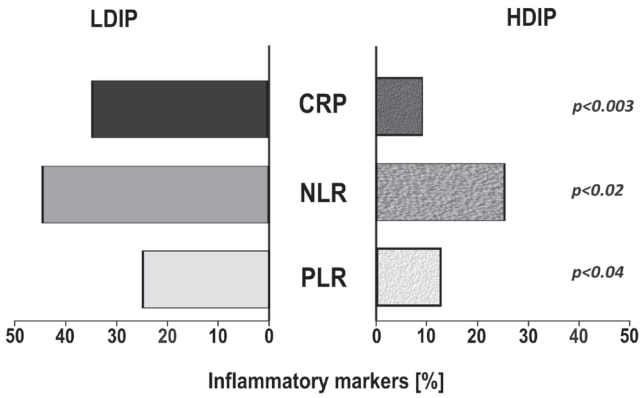

Figure 2. The comparison of plasma inflammatory markers (CRP) and cellular inflammatory markers (NLR, PLR, MPVLR) between breast cancer patients with high dietary polyphenols intake (HDIP) (n=39) and breast cancers with low dietary polyphenols intake (LDIP) (n=39).

The results of inflammatory markers are presented as the percentage of individuals above the cut-off point. Cut-off values: CRP>0.5 mg/L, NLR>3.0, PLR>207.0. Significance of differences were analysed using Fisher's exact test. CRP: C-Reactive Protein, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio. HDIP - high dietary polyphenols intake, LDIP - low dietary polyphenols intake.

Agreement between selected inflammatory markers and polyphenol dietary intake

A significant association was found between CRP, NLR, PLR but not MPVLR and total polyphenol intake. The highest agreement rate was found for CRP. Agreement between results was assessed using *Cohen's* kappa test and are presented in Table 3. Concordance between polyphenol intake and inflammatory markers was in the poor to fair range but reached a level of statistical significance.

DISCUSSION

The aim of this study was to find whether the high polyphenol intake can limit rate of inflammation in breast cancer (BC) patients. We measured CRP and calculated PLR, NLR, MPVLR on the basis of laboratory results of blood morphology and compared the values of these inflammatory markers in two subgroups of breast cancer patients with either low- or high- phenolic dietary intake. All the inflammatory markers studied, with the exception of MPVLR, were found to be remarkably reduced in the group receiving a high dietary intake of polyphenolic compounds.

Table 2. Cut-off values of inflammatory markers obtained from population of healthy subjects (n=102)

Marker	CRP	NLR	PLR	MPVLR
Cut-off value	>0.5 mg/L	>3.0	>207.0	>6.8

Cut-off values were calculated as 95th percentiles of the inflammatory markers in healthy subjects (control, n=102).
CRP: C-Reactive Protein, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio, MPVLR: mean platelet volume-to-lymphocyte ratio.

Table 3. Agreement between elevated inflammatory markers and low dietary polyphenol intake in breast cancer patients group (n=78)

Marker	Observed agreement [%]	Cohen's kappa	Confidence interval (95% CI)	P value
CRP	66.7	0,38	0.079 - 0.614	<0.006
NLR	60.0	0.20	-0.010 - 0.41	<0.04
PLR	57.7	0.19	0.026 - 0.359	<0.02
MPVLR	56.4	0.15	-0.061 - 0.354	NS

The inflammatory markers of breast cancer patients (n=78).
CRP: C Reactive Protein, NLR: neutrophil-to-lymphocyte ratio, PLR: platelet-to-lymphocyte ratio, MPVLR: mean platelet volume-to-lymphocyte ratio.

Our study shows for the first time that high polyphenol intake is associated with lower level of inflammatory markers in BC patients. The obtained results suggest also that these markers could be useful for estimating the anti-inflammatory effect of a diet. Interestingly, in our earlier work [26] based on the same group of patients, we found a significant difference in platelet aggregation between LDIP vs. HDIP group. In general, platelet aggregation induced in *vitro* with arachidonic acid, ADP or collagen was higher in LDIP group, which can be explained by pleiotropic activity of polyphenols [26].

NLR and PLR were proposed to be predictive markers in various tumours, including BC [15]. Liu et al. demonstrated that both increased NLR and PLR were associated with poor survival in hormone receptor-negative BC patients. However, NLR was independently correlated with overall survival and disease-free survival, but PLR was not [15]. A meta-analysis found high PLR to be associated with poor overall survival and disease-free survival [32]. In addition, PLR remains a significant prognostic marker for overall survival among patients receiving systemic treatment and patients receiving chemotherapy [31]. These findings suggest that PLR could serve as an indicator of poor prognosis in patients with BC [32]. The neutrophil lymphocyte ratio (NLR) is a good marker of inflammation, and one which plays an important role in tumour progression and metastasis. However, no association was found between NLR and overall survival in the luminal A and luminal B subtypes of breast cancer patients. Positive results have been obtained elsewhere in the analyses of human epidermal growth factor receptor 2 (HER2)-positive and triple-negative BC subtypes [29]. In another study, NLR and PLR were demonstrated to be independent markers of prognosis in BC [28].

Although, the comparison of inflammatory markers between breast cancer patients (HDIP and LDIP together) with control (reference group) was not the aim of our study, our results showed that all the inflammatory markers studied are significantly elevated in cancer patients support the usefulness of inflammatory markers in cancer prognosis.

Sun at al. reported that the mean values NLR, and PLR were significantly elevated in BC patients compared to the control group [25]. Moreover, MPV value was significantly higher in BC group ($p<0.0001$) and it was suggested that this parameter can be useful in evaluating Ki-67 proliferation index as well as axillary lymph node metastasis. It was proposed therefore, that MPV could serve as a newly described biomarker for prognosis evaluation amongst BC patients. *Losada* at al. found an association between low PLR and longer DFS (disease-free survival) in elderly breast cancer patients [17]. Furthermore, they observed longer 3 year overall survival in the low PLR group and longer disease-free survival and overall survival in low NLR subgroup with triple negative breast cancer.

Interestingly, the LDIP group in our study demonstrated a higher NLR value (3.0) than the cut-off point for poor cancer prognosis (2.5) [4, 30]. A lower polyphenol intake is frequently related to a higher CRP level. Similarly to the observations made in our study, previous reports found the greatest difference between cancer patients cohort and control group in respect to CRP level [30].

A large population-based study found the polyphenol content of the diet to be negatively associated with the INFLA-score of low-grade inflammation biomarkers (CRP, WBC, PLT, GrL) [22]. Although the total INFLA-score was not computed in the present study, the values being its components, including CRP, WBC and PLT, were found to be

lower in the HDIP group. Interestingly, CRP is the best described inflammatory marker [27] and the preoperative C-reactive protein level is an independent prognostic factor of disease-free survival and overall survival in breast cancer [21]. Our results confirm the key roles reported in the literature for CRP [27], NLR [4] and PLR [28]. The mean platelet volume/lymphocyte ratio (MPVLR) was described by *Hudzik* et al. as a good prognostic factor in CVD [8], in our study concerning breast cancer patients, however, it was not useful marker of polyphenol intake.

In this study, in the total group of breast cancer patients (HDIP and LDIP together), the greatest polyphenol sources were tea, dark chocolate, apples, pears, bananas, grapes, berries and whole grain products. This list of sources is similar to that reported for Polish population by *Grosso* et al., who found the main intake to derive from coffee, tea and chocolate [7] and by *Zujko* et al., who found it to come from non-alcoholic beverages, fruits, vegetables and cereal products [34]. Chocolate and cocoa products were not found to play such a significant role in the present study as sweets are commonly eliminated from the diet of cancer patients. An increased consumption of fruits and vegetables is commonly observed in cancer patients following diagnosis. Total polyphenol intake in our whole group was 1757 mg/day, which was similar to the findings of *Grosso* et al. (1741 mg/day); likewise, flavan-3-ol intake was 608.4 mg/day (our group), 637.3 mg/day [7]. Interestingly, the total consumption of polyphenols in our (Polish) population was found to be comparable to that reported for breast cancer patients in the Western Europe (UK: 1523 mg/day, Germany: 1056 mg/day, Denmark: 1354 mg/day) [13], which strengthen the importance of our findings, making them more universal.

CONCLUSIONS

Obviously, we are aware that our results, suggesting an association between diet rich in polyphenols and lower inflammatory markers, have been obtained from an small observational cross-sectional study and require further validation in randomized trials on the large cohorts of patients. Nevertheless, in our opinion, these preliminary findings indicate that an anti-inflammatory diet is effective in reducing inflammation in the breast cancer patients, which could be an innovative and promising trend in the modern dietetics. A novelty of this study is also showing an usefulness of simple, cheap and commonly available biomarkers for monitoring an anti-inflammatory effects of diet. It is very likely that these markers could be successfully applied to assess a rate of diet-reduced inflammation in other clinical settings where a process of subclinical inflammation poses a significant problem.

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Statement of ethics

The investigation received the approval of the Bioethical Committee of the Medical University of Lodz (RNN/21/16/KE).

Disclosure statement

The authors report no conflicts of interest.

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ORIGINAL ARTICLE

DIET AND NUTRITIONAL STATUS OF ELDERLY PEOPLE DEPENDING ON THEIR PLACE OF RESIDENCE

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ABSTRACT

Background. The main problems in nutrition among elderly people are insufficient consumption of high energy protein and deficiencies in vitamins and minerals. Obesity or malnutrition in this age group is also common. The character of the diet of the elderly is affected by many factors, including the place of residence.

Objective. The aim of this work was to compare the diet and nutritional status of elderly people living in nursing homes and in their family homes in West Pomeranian Voivodeship region.

Material and methods.The study was performed among 48 citizens of Drawsko Pomorskie (DP) and 79 residents of Nursery Home (NH) in Żabów. For the study we used a questionnaire containing questions about anthropometric data which served to assess nutritional state. The assessment of diets of the citizens of Drawsko Pomorskie was performed based on the menus collected using a 24-hour diet recall. Energy and nutritional value of the diets of NH residents were assessed on the basis of decade menus. Obtained results were compared to current recommendations.

Results. Two examined groups comprised of both underweight and obese people. The residents of NH in Żabów consumed more energy, protein, fat, cholesterol and carbohydrates, whereas people from DP – more dietary fibre. Diets of the citizens of DP were characterized by excessive consumption of sodium, phosphorus, iron, zinc, copper and vitamins: A, B_2, B_6, B_{12} and niacin, and insufficient consumption of potassium, calcium, magnesium and vitamins: D, E, C and folates. The diets of people living in family homes were excessive in sodium, phosphorus, iron, copper and vitamins: A, B_1, B_6, C and niacin, and contained too little calcium, magnesium and vitamins D, E and folates.

Conclusion. It was shown that the place of residence of examined people affected their diets and nutritional status. Both in case of people living in NH and in family homes there was a risk of underweight and obesity, which could be affected by improper way of nutrition.

Keywords: *nutrition, nutritional state, elderly people, nursing home*

STRESZCZENIE

Wprowadzenie. Do głównych problemów odżywiania osób w starszym wieku należą: niedostateczna ilość spożywanego wysokoenergetycznego białka, niedobory witaminowe i mineralne. Powszechna jest również otyłość lub niedożywienie występująca w tej grupie wiekowej. Na charakter i sposób odżywiania się osób starszych wpływa wiele czynników m. in. miejsce zamieszkania.

Cel badań. Celem pracy było porównanie sposobu żywienia oraz stanu odżywienia osób starszych zamieszkałych w domu pomocy społecznej oraz w warunkach domowych na terenie województwa zachodniopomorskiego.

Materiał i metody. Badania przeprowadzono wśród 48 mieszkańców Drawska Pomorskiego (DP) oraz 79 pensjonariuszy Domu Pomocy Społecznej (DPS) w Żabowie. Do badań użyto ankiety zawierającej dane antropometryczne, które posłużyły do oceny stanu odżywienia. Oceny sposobu żywienia mieszkańców Drawska Pomorskiego dokonano w oparciu o jadłospisy zebrane metodą wywiadu 24-godzinnego. Natomiast wartość energetyczną i odżywczą diet pensjonariuszy DPS oceniono na podstawie otrzymanych jadłospisów dekadowych. Otrzymane wyniki porównano z obowiązującymi normami.

Wyniki. W obu badanych grupach były osoby z niedowagą oraz nadmierną masą ciała. Pensjonariusze DPS w Żabowie spożywali więcej energii, białka, tłuszczu, cholesterolu oraz węglowodanów, natomiast osoby z DP – błonnika pokarmowego. Diety mieszkańców DPS charakteryzowała nadmierna ilość sodu, fosforu, żelaza, cynku, miedzi oraz witamin: A, B_2, B_6, B_{12} i niacyny, a niewystarczająca: potasu, wapnia, magnezu oraz witamin: D, E, C i folianów. Diety osób zamieszkałych w warunkach domowych miały zbyt dużo sodu, fosforu, żelaza, miedzi oraz witamin: A, B_1, B_6, C i niacyny, a zbyt mało wapnia i magnezu oraz witamin: D, E i folianów.

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Wnioski. Wykazano, że miejsce zamieszkania osób badanych ma wpływ na ich sposób żywienia i stan odżywienia. Zarówno u osób mieszkających w DPS, jak i domach wystąpiło ryzyko niedowagi i nadmiernej masy ciała, do których mógł przyczynić się nieprawidłowy sposób żywienia.

Słowa kluczowe: *odżywianie się, stan odżywienia, osoby starsze, dom pomocy społecznej*

INTRODUCTION

Ageing is a natural, irreversible process constantly happening to us for our whole adult life. Currently observed demographic changes are mainly caused by the development in medicine, improvement in the level of hygiene and vaccination but also by the decrease in fertility and birth rate [15]. Increasing percentage of elderly people, not only in Poland but throughout the world [12], results in growing interest in this social group among the researchers. Gerontology allows for a better care for the elderly, improves their life conditions and thus makes their future more decent.

One of the characteristics of this age group is multiple morbidities. Elderly people often suffer from such diseases as cardiovascular diseases, diabetes (especially type 2), tumours, various types of digestive problems (constipation, flatulence, eating disorder), urinary incontinence, but also insomnia, depression, dementia and hearing and sight disorders [15]. Considering that many of these diseases are diseases of affluence, one should put special attention to their prevention, which includes appropriate nutrition enabling to maintain a good physical and mental condition [2].

Proper feeding of elderly people is challenging due to gastric problems, economical situation or long-standing bad habits. Very important factors affecting the diets of the elderly are psychosocial factors, of which the most important is everyday stress. Emotional support of the family and surrounding people, satisfaction from life and the feeling of control over one's life are very important factors, which can significantly contribute to the improvement of last years of life [15].

Therefore, there is a need to develop and run educational programs directed to this social group which include proper nutrition [5]. One of them is a strategy developed by WHO, referring to the diet, physical activity and health, which establishes the means of implementation and evaluation of the activities promoting a healthy lifestyle [10]. The access to educational programs is determined by e.g. the place of residence of an elder, which will influence the diet and nutritional status. In this study we compared the diet and nutritional status of elderly people living in nursing home and in their family homes in West Pomeranian Voivodeship.

MATERIAL AND METHODS

The study was performed among the citizens of Drawsko Pomorskie (DP) and the residents of Nursing House (NH) in Żabów. The total number of the participants was 127, including 48 elders living in their family homes and 79 in NH. The details on the size of examined groups are presented in Table 1.

Table 1. Size of examined groups with respect to age

Age interval	Residents of NH in Żabów						Citizents of Drawsko Pomorskie					
	Women n =39		Men n = 40		Total n = 79		Women n = 33		Men n = 15		Total n = 48	
	n	%	n	%	n	%	n	%	n	%	n	%
51-65	6	15.4	17	42.5	23	29.1	0	0.0	0	0.0	0	0.0
66-75	6	15.4	14	35	20	25.3	20	60.6	8	53.3	28	58.3
>75	27	69.2	9	22.5	36	45.6	13	39.4	7	46.7	20	41.7

The participants of the study in the authors' questionnaire gave the basic anthropometric data, which were used to assess nutritional status. Quantitative analysis of daily food ratios (DFR) among the residents of Drawsko Pomorskie was performed based on the menus collected using a 24-hour dietary recall. The "Album of photographs of produce and meals" [29] was used to estimate the size of food portions. Energy and nutritional value of DFRs of the residents of the NH was assessed based on obtained decade menus. The contents of energy, basic nutrients, vitamins and minerals in the diets was calculated using a computer software Dieta 5.D (Institute of Food and Nutrition, Warsaw). Obtained results were compared with current standards at the level of estimated average requirement of the group (EAR) or adequate intake (AI) [13]. Required standard values for energy and particular components of the diet were established using weighted average method. Supplementation was not taken into consideration in the calculations.

All the results were statistically analysed using Statistica v. 13.0 (Statsoft). Due to the fact that the characteristics did not have normal distribution the significance of differences was calculated using a non-parametric *Mann-Whitney* U test. The significance level was $p < 0.05$.

RESULTS

BMI (Body Mass Index) was calculated based on obtained information concerning the weight and height and enabled the assessment of nutritional status of the examined. The average value of BMI of elderly people living in their family homes was 28.1±3.8 kg/m^{2}and was slightly higher than for the residents of NH (26.7±5.0 kg/m^2).The analysis of nutritional status of the elderly with respect to their place of residence is presented in Table 2.

According to WHO classification, every third person from Drawsko Pomorskie had proper body weight, which was a slightly lower percentage than in case of the examined residents of NH. The majority of examined elders were overweight or obese (71% and 60%, respectively). Taking into consideration the classification of Queensland Government [20], almost every sixth citizen of DP (17%) and every third resident of NH (33%) was underweight. Using QG interpretation, almost 45% of the examined people has a proper body weight and excessive weight was noted in every fifth person living in NH (20%) and in 42% people living in family homes. Obesity was not observed. Detailed information is presented in Table 2.

Table 2. Interpretation of BMI of examined people according to WHO and Queensland Government (QG) [23]

	WHO			QG		
	BMI range (kg/m^2)	people living in family homes (%)	people living in NH (%)	BMI range (kg/m^2)	people living in family homes (%)	people living in NH (%)
Underweight	<18.5	0	3.0	<23	17.0	33.0
Normalweight	18.5-24.99	29.0	37.0	24-30	42.0	47.0
Overweight	25.00-29.99	29.0	37.0	>30	42.0	20.0
Obesity	>30	42.0	23.0	-	-	-

The analysis of examined menus enabled to compare the average consumption of energy, basic nutrients, minerals and vitamins among the residents of NH and citizens of DP. Obtained results and realization of the norms are presented in Tables 3-4.

The residents of NH consumed significantly more energy (2036.3±134.8 kcal) than people living in family homes (1602.9±519.1kcal), which contributed to higher percentage of norm realization (92,9% and 79.8%, respectively). Among the residents of NH, a significantly higher consumption of all analysed nutrients was observed, with the exception of dietary fibre, whose intake was slightly higher for citizens of DP, but it was within the standards (Table 3).

Table 3. Average consumption of energy and nutrients among examined people (n=127)

Component	NH (n=79)		DP (n=48)	
	Average ± SD	% norm realization	Average ± SD	% norm realization
Energy [kcal]*	2036.3±134.8	92.9	1602.9±519.1	79.8
Protein [g]*	75.7±8.1	152.3	59.5±15.5	117.9
Fat [g]*	79.1±11.5	108.2	51.6±20.9	77.2
Cholesterol [mg]*	313.6±91.4	104.5	213.2±110.8	71.0
Total carbohydrates [g]*	273.1±21.8	210.1	243.1±108.2	187
Dietary fibre [g]	19.5±3.3	94.1	20.5±9.0	102.3

*statistically significant differences at the level of $p<0.05$

The residents of NH consumed, on average, higher amounts of calcium, phosphorus, iron, zinc and copper. On the other hand, the diets of the citizens of DP were characterized by higher contents of sodium and potassium. In case of sodium the differences were statistically significant (Table 4).

The analysis of vitamins contents in daily food ratios showed that the realization of norms among the participants of the study differed significantly with respect to vitamins E, B_2, B_{12}, C and folates. The residents of NH consumed significantly more riboflavin and cobalamin, whereas the people living in family homes – more vitamin E, folates and vitamin C (Table 4).

Table 4. Average consumption of minerals and vitamins among examined people (n=127)

Component	NH (n=79)		DP (n=48)	
	Average ± SD	% norm realization	Average ± SD	% norm realization
Sodium [mg]*	2224.6±319.6	172.8	2787.8±979.1	232.3
Potassium [mg]	2750.3±488.0	78.6	3505.9±2126.5	100.2
Calcium [mg]*	665.7±180.5	69.7	446.4±181.9	44.6
Phosphorus [mg]*	1212.3±155.4	209.0	1129.4±557.0	194.7
Magnesium [mg]	260.6±52.0	84.6	261.4±118.3	89.6
Iron [mg]*	12.1±5.1	201.3	9.9±4.9	165.0
Zinc [mg]*	10.3±1.5	127.1	8.3±2.6	108.8
Copper [mg]*	1.1±0.2	153.2	0.96±0.4	137.8
VitaminA [µg]	1429.1±2121.1	252.6	852.4±525.8	157.7
Vitamin D [µg]	2.5±1.8	16.6	2.2±2.0	14.9
Vitamin E [mg]*	5.9±2.0	65.0	7.6±3.3	88.5
Thiamine [mg]	1.1±0.2	111.5	1.2±0.6	122.7
Riboflavin [mg]*	1.6±0.6	162.3	1.1±0.3	114.1
Niacin [mg]	14.4±4.1	124.9	19.9±14.3	176.6
Vitamin B_6 [mg]	1.8±0.4	133.9	1.9±0.7	143.0
Folate [µg]*	140.9±27.8	44.0	252.7±99.9	79.0
Vitamin B_{12} [µg]*	5.5±5.5	272.5	2.2±2.0	112.2
Vitamin C [mg]*	32.0±15.2	47.4	102.7±56.1	158.7

*statistically significant differences at the level of $p<0.05$

Figure 1 shows the share of macronutrients (A) and fatty acids (B) in energy supply. Among the examined people we observed small differences in the ratio of consumed nutrients. It was observed that in DFR of NH residents there was significantly higher percentage of energy from fat, which contributed to a lower intake of energy from carbohydrates in this group. The share of protein in energy supply was at a similar level in both examined groups. The residents from Żabów consumed the highest amounts of saturated fatty acids, which caused their higher intake in this group in comparison to the people living in family homes. On the other hand, the residents of Drawsko Pomorskie consumed less monounsaturated fatty acids and more polyunsaturated fatty acids than the residents of NH.

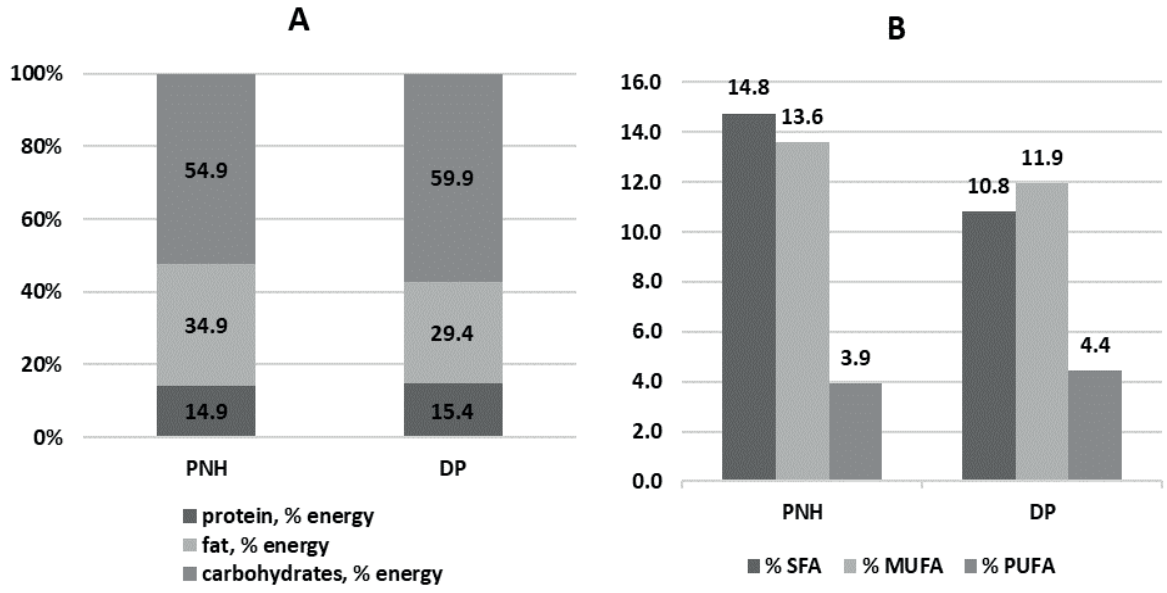

Fig. 1. Share of Energy from macronutrients (A) and fatty acids (B) in diets of the examined people.

DISCUSSION

Agrowing tendency for the ageing of the population is currently observed worldwide. One of the main factors contributing to improvement in longevity has been a better medical care in recent years. Maintaining a proper nutritional status in older age will positively contribute to improvement in the quality of life, despite the presence of many diseases typical for that age. One of the key elements used to assess nutritional status is BMI [1]. In the publication of Queensland Government [20] we find the information that the classification proposed by WHO may be inadequate for elderly people. It was shown that the lowest mortality in a group of people aged above 65 occurs in people with BMI within the range 24-31 kg/m^{2}and a separate classification for BMI of elderly people was proposed. Taking the above into consideration, in this study it was observed that almost half of the participants, irrespective of their place of residence, had appropriate value of BMI. In the publication of *Ene-Margit* and *Kai* [8], the results of the BMI index of older people from 17 European countries were collected, which showed a slightly higher percentage (60%) of participants with BMI assessed as proper for the elderly. A slightly smaller percentage (41%) of those with normal BMI was observed among nursing home residents in Nysa [3].

Too low body weight in case of the elderly (BMI <18.5 kg/m^2) is definitely unfavourable for the health, because it can result in quicker occurrence of malnutrition. Malnutrition affects 12-61% of the residents of long-term care facilities [31]. Own study also showed a slightly higher percentage of underweight people among the residents of NH (3% according to WHO and 33% according to QG) in comparison with the people living in own homes (0% and 17%, respectively). Although, in the studies of *Zołoteńka-Synowiec* et al. [32] among residents of nursing homes in Nysa, the percentage of people with underweight was 16.4 (15.7% in women and 20% in men).

Properly balanced diet is one of the crucial factors to maintain good health. With age the energetic demand of an organism decreases. Thus, in order to provide appropriate supply of all the necessary nutrients, the food consumed by elderly people should have high nutritional density, be low in calories and easy to digest [26, 29]. In this study it was shown that the average energy value of a food ratio for people living in family homes was 1602.9 kcal and was lower than for residents of NH, which resulted in that the demand on energy was covered in only 79.8%. Similar results were obtained by *Sygnowska* and *Waśkiewicz* [27], *Różańska* et al. [25], and *Włodarek* and *Głąbska* [30] where the average energetic value of daily food ratios was1756.6 kcal, 1539.6 kcal and 1830 kcal, respectively. Higher energy content in the home diets, but within the norm, were obtained in the study of *Malczyk* et al. [18] – 2066.2 kcal and *Włodarek* and *Głąbska* [30] – 2200 kcal. DFR of elderly people from nursing homes covered energy demand to a higher extend (93% of norm realization). Different results were obtained by *Grochowska-Niedworok* et al. [11] and *Gacek* [9], where the residents food ratios supplied on average 2835.2 kcal and 2746.9 kcal a day, i.e. 141% and 118.5% of the norm.

The ratio of macronutrients in energy supply is very important in proper feeding of elderly people. This study has shown that both in case of people living in NH and in family homes the ratio of macronutrients was correct. In the study of *Sygnowska* and *Waśkiewicz* [27] the percentage of energy from protein was within the norm, but the energy from fat exceeded recommended values and the energy from carbohydrates was insufficient. Similar ratio of nutrients in energy supply was noted by *Różańska* et al. [25]. In the study of *Całyniuk* et al. [3] a lower percentage of energy from protein and normal from fats and carbohydrates has been demonstrated.

In this study, the average consumption of carbohydrates was within the range of 243-273 g/day, which supplied recommended 45-60% of the energy in both examined groups. Similar results were obtained by *Grochowska-Niedworok* et al. [11] and *Orkusz* and *Gorla* [21], who showed that ca. 55% of energy came from carbohydrates. At the same time, higher consumption of total energy contributed to higher intake of this component in comparison with this study – from 338.8 to 385.8 g/day.

Dietary fibre plays a veryimportant role in the diet of the elderly and its consumption in the examined groups was appropriate. Similar results were obtained in the studies of *Włodarek* and *Głąbska* [30].Lower supply of dietary fibrein home diets was observed in other studies [3, 18, 27].

The process of ageing is connected to higher protein catabolism and muscle mass loss (sarcopenia). In the menus of both NH residents and DP citizens there was too high average amount of protein (152.3% and 117.9% of the norm, respectively). The diets of the residents of the Lower Silesian Nursing Home contained more protein by almost 9 g, which, however, did not contribute to higher realization of the norm (117.2%) than in this study [21]. In the study of Leszczyńska et al. [16], related to the feeding of the residents of nursing homes, the norms on protein content were also exceeded.

In this study it was shown that the consumption of total fat was at a correct level only among the residents of NH and amounted to 79.1g/day, i.e. 108.2% of the norm. The citizens of DP consumed too little of this

nutrient. Their DFRs realized the norm at the level of 77.2%, which corresponded to 51.6 g/day. Such content of fat in the menus of examined people contributed to proper intake of cholesterol. Different results were noted in other studies, where the amounts of both total fat and cholesterol in home diets were too high and reached even 150% of the daily norm [18, 25, 27, 29]. The analysis of menus from NH in Krakow showed too much fat supply in both winter and summer [9].

The ratio of particular fatty acids in examined diets was not proper. Too high consumption of saturated fatty acids was observed, especially in the case of the residents of NH. Similar results were obtained by *Leszczyńska* et al. [16], who at the same time showed too low content of polyunsaturated fatty acids, which was in contradiction to the results obtained in this study, where their consumption was satisfactory. In other studies, the authors noted higher intake of polyunsaturated fatty acids, which delivered on average 9.4% of the energy [11].

The analysis of minerals and vitamins contents in examined diets showed numerous irregularities.

Excessive supply of sodium together with insufficient intake of potassium in elderly people may contribute to cardiovascular diseases, including high blood pressure [26], arrhythmia, renal impairment, disorders in sensorimotor excitation and in acid/base balance [18, 22].

In this study, too high intake of sodium was noted in both groups (172.8% and 232.2% of the norm. Moreover, the diets of NH residents contained too low amounts of potassium (78.6%). Higher content of sodium in DFR of elderly people in NH in Warsaw was shown by *Włodarek* and *Głąbska* [30]. Too high consumption of sodium was also confirmed by other authors [4, 18, 22]. Low intake of potassium observed in the group of NH residents is very common among the elderly, what was confirmed by the studies of *Włodarek* and *Głąbska* [30]. On the other hand, Pieter [22] showed that potassium consumption was at a similar level to that in the group of people living in Drawsko Pomorskie examined by us.

This study revealed insufficient consumption of calcium - it was within the range from 446.4 mg in the group from DP to 665.7 mg for the residents of NH, which covered the requirements in 44.6% and 69.7%. Low intake of this element with the home diet was confirmed in numerous studies in various regions of Poland, where the realization of the norm was from 26 to 67% [19, 22, 25, 26]. Insufficient consumption of Ca may cause muscle cramps, heart disorders, development or worsening of osteoporosis and more frequent bone fractures. Moreover, proper intake of this element will have a positive effect on the regulation of the blood pressure [18]. In contrast, the calcium content in the analyzed menus met the standard on average in 59.2% in the diets of NH from Silesia [23].

Excessive supply of phosphorusin this social grouphas been observed in many studies and also confirmed in this study [9, 22, 30]. Lower amount if this element in the diet was noted by *Całyniuk* et al. [4], but even there its intake was by ca. 33% higher than recommended. Too high consumption of phosphorus can lower the absorption of calcium, magnesium, iron, zinc and disrupt appropriate ratio of calcium to phosphorus, which in turn can lead to higher risk of osteoporosis [18].

The content of magnesium is often insufficient in the diets of the elderly. The norm on this element in this study was realized at the level of 84.6% in the diets of NH residents and 89.6% in the diets of DP citizens. In the study of *Pieter* [22] the supply of magnesium covered on average 88.5% of required amount. Other authors also confirmed too low content of this element in the diets of the elderly [25, 30]. Deficiency in magnesium leads to circulatory failure, arrhythmia, anaemia and may affect the development of atherosclerosis and osteoporosis in women after the menopause. Moreover, too high consumption of sodium increases the secretion of magnesium from the organism [22].

An excessive supply of iron was determined in the DFRs of the examined people, and it amounted to 12.1 mg in case of the residents of NH, which was significantly higher in comparison to that of the citizens of DP (9.9 mg) – that corresponded to 201.3% ad 165% of the norm, respectively. The results of the studies performed among the participants at the age above 65 taking part in PolSenior project were similar to those in this study. It was shown that the consumption of iron in this age group exceeded recommended values by ca. 68% [17]. A slightly lower intake of this element was noted by *Pieter* [22] and *Gacek* [9]. Other conclusions were drawn by *Kowalczuk-Vasilev* and *Klebaniuk* [14], who showed that the content of iron in the diets of the residents of NH in Lublin was too low and covered only 88.4% of recommended intake. Too high supply of iron increases the production of free radicals in the organism, which can result in higher risk of carcinogenesis and coronary disease [6].

This study showed that the consumption of zinc was at appropriate level, both in case of elderly people living in NH and in family homes. However, NH diets contained significantly more zinc than home diets. Obtained results are comparable to those presented in the study PolSenior [17], where the average demand on this component was realized in 112.5%. Different results were obtained by *Włodarek* and *Głąbska* [30], who noted that average consumption of zinc was by almost 10% higher than recommended. Insufficient intake of this element in diets of the elderly can contribute to the lack of appetite through distortion of taste and smell, and may also decrease the activity of immune system and impair cognitive functions [7].

In this study an excessive intake of copper was observed. Its consumption exceeded recommended levels by 52.2% in case of the residents of NH and by 37.8% in case of DP citizens. Excessive amount of copper was also noted in diets of NH in Warsaw, where the average intake was almost twice higher than recommended [30].

Too high consumption of vitamin A was observed in the diets of the two examined groups. DFRs of the residents of NH supplied on average 1429.1 µg of vitamin A (252.6% of the norm) whereas DFRs of DR citizens - 852.4 µg (157.7%). Obtained results were similar to those in other studies, where a higher intake of this vitamin was reported [9, 14, 22, 30], especially in case of the people living in NH.

Vitamin E as a strong antioxidant can prevent aging and carcinogenesis [22]. This study showed that both groups consumed insufficient amounts of tocopherol, whose amount was significantly lower in the diets of the residents of NH and amounted to 5.86 µg, i.e. the norm was realized in 65%. Too low intake of vitamin E with the diet was also reported by Całyniuk et al. [4], who observed that DFRs of citizens of Silesia aged above 65 realized the norm at the level of ca. 66%. Diets of NH residents in Kraków also contained insufficient amount of this component (68.8-83.8% of the norm) [24]. However, Gacek [9] noted that nursing home residents in Cracow consumed too much vitamin E, realizing the norm in 137.6%.

Performed analyses showed alarmingly low consumption of vitamin D, which for NH residents was at the level of 2.5 µg/day (16.6% of the norm). Diets of the citizens of DP supplied even less of this vitamin – on average 2.2 µg/day, i.e. 14.9% of the norm. Other authors also showed insufficient intake of this component with the diet – the requirements were covered in 13-23% [18, 22, 23, 27].

The analysis of the contents of group B vitamins showed correct or extensive intake in both groups irrespectively of the place of residence. Diets of NH residents were too abundant in vitamins B_{12} and B_2, and to a lesser degree in vitamin B_6 and niacin. DP citizens consumed too much niacin and vitamin B_6. Obtained results are in contradiction with the data reported by other researchers. Całyniuk et al. [4] observed too low consumption of group B vitamins. The analysis of the menus from NH in Lublin also showed insufficient coverage of the demand on vitamin B_1 (71.7%) and B_2 (55.3%) [14]. However, in studies in the NH in Cracow, the correct amounts of vitamins B_1 and B_2 and too high content of vitamin B_{12}were noted [30].

The demand on folates was not covered in DFRs of both groups – the norm was realized in 44% in case of NH residents and in 79% in case of DP citizens. The results of this study correlate with those obtained by other authors [18, 25, 27, 30].

The consumption of vitamin C varied among the examined people. The people living in NH consumed significantly less vitamin (47.4% of the norm) than the citizens of DP (158.7%). It should be noted that high doses of ascorbic acid are not harmful to the organism due to little bioavailability and secretion with urine. However, in some persons its excessive amount may lead to the formation of kidney stones [22]. In the study of Różańska et al. [25] the average supply of vitamin C was realized in 78.5%. On the other hand, Pieter [22] reported too high intake of ascorbic acid in DFR (ca. 283%). Such discrepancies may be caused by seasonal availability of this vitamin.

Obtained results indicated nutritional errors, which were reflected in the amount of particular nutrients in the diets of the elderly. Due to multiple morbidities often occurring in this age group a special attention should be paid to proper composition of the menus. This can be facilitated by the presence of qualified personnel in nursing homes and food education available for elderly people.

CONCLUSIONS

1. The obtained results indicate a lack of DFR's balance of both groups which could contribute to improper nutritional status of the examined people.
2. The daily food rations of the subjects were characterized by a high content of sodium and protein as well as low potassium which may disturb the functioning of the cardiovascular system.
3. The diets of both groups had too low amount of calcium, magnesium, vitamin D and too high content of phosphorus, which may increase the risk of osteoporosis.
4. Due to the irregularities in DFR it is justifiable to introduce food education for elderly people and the personnel in the audited Nursing Home in Żabów, on the prevention of diseases associated with older people.
5. The irregularities in the analyzed diets do not differ significantly from the diet of older people stated by other research centers in the country.

Conflict of interest

The authors declare no conflict of interest.

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ORIGINAL ARTICLE

THE INFLUENCE OF DIET ON GASTROINTESTINAL *CANDIDA* SPP. COLONIZATION AND THE SUSCEPTIBILITY OF *CANDIDA* SPP. TO ANTIFUNGAL DRUGS

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ABSTRACT

Background. *Candida* spp. has been identified as the most common member of human gut microbiota. This yeast-like fungus is recognized as an opportunistic organism due to its potential to cause diseases in all parts of the gastrointestinal tract.
Objective. The aim of the study was to investigate the relationship between diet and health of the study participants and the presence of gastrointestinal *Candida* spp. Susceptibility of *Candida* to antifungal drugs was determined.
Material and methods. Material comprised of oral swabs and fecal samples self-collected by the study participants. The participants filled in a nutritional questionnaire. A total of 30 people took part in the study, including 28 women and 2 men. The study was conducted in Wroclaw, Poland. Susceptibility of *Candida* to antifungal drugs was determined using Bio-Rad's FUNGITEST™ Kit designed for the susceptibility testing of yeasts to six antifungal drugs.
Results. In the group with negative *Candida* spp. cultures, healthier wheat flour substitutes were consumed significantly more frequently than in the group with positive *Candida* spp. cultures. Yellow cheeses and quark were eaten significantly more frequently in the group with negative *Candida* spp. cultures. No antifungal resistance was detected in the study group.
Conclusions. The increased consumption of purified wheat flour products was linked to the presence of gastrointestinal *Candida* spp. A higher consumption of cheese was observed in the group with negative *Candida* spp. cultures, which may indicate the inhibitory effect of saturated fatty acids on the growth of human *Candida* spp. Sensitivity of *C. albicans* to antifungal drugs may increase effectiveness of candidiasis treatment.

Key words: *Candida* spp., diet, fecal samples, antibiotics, drug resistance

STRESZCZENIE

Wprowadzenie. *Candida* spp. to najczęstszy element mikroflory przewodu pokarmowego. Ten grzyb drożdżopodobny jest oportunistą, ze względu na możliwość powodowania chorób we wszystkich odcinkach przewodu pokarmowego. Pomimo, że *Candida* spp. jest jedną z głównych przyczyn zakażeń oportunistycznych, to istnieje ograniczona liczba środków przeciwgrzybiczych stosowanych w terapii. Szerokie zastosowanie antybiotyków spowodowało zwiększenie oporności szczepów na stosowane leki.
Cel. Celem pracy było zbadanie zależności między dietą i stanem zdrowia osób biorących udział w badaniu, a obecnością *Candida* spp. w przewodzie pokarmowym. Ponadto oceniono wrażliwość wyizolowanych szczepów *Candida* spp. na najczęściej stosowane leki przeciwgrzybicze.
Materiał i metody. Materiałem do badania były wymazy z jamy ustnej i próbki kału, pobrane samodzielnie przez badanych. Badani wypełniali ankietę dotyczącą częstotliwości spożycia różnych grup produktów spożywczych oraz występowania czynników ryzyka kandydozy. Przebadano 30 osób, w tym 28 kobiet i 2 mężczyzn. Badanie przeprowadzono na terenie miasta Wrocław, w Polsce. Oznaczono wrażliwości uzyskanych Candida na leki przeciwgrzybicze z użyciem zestawu FUNGITEST firmy Biorad, który umożliwia badanie wzrostu drożdżaków w obecności 6 preparatów przeciwgrzybiczych.
Wyniki. Wykazano dodatnią korelację pomiędzy spożyciem produktów z oczyszczonej mąki pszennej, a występowaniem *Candida* spp. w przewodzie pokarmowym. Zaobserwowano wyższe spożycie serów w grupie osób z wynikiem ujemnym badania w kierunku *Candida* spp., co może wskazywać hamujący wpływ nasyconych kwasów tłuszczowych na wzrost *Candida* spp. w organizmie. Wśród badanych szczepów nie wykryto opornych na leki przeciwgrzybicze.
Wnioski. Duże spożycie produktów z pszennej, oczyszczonej mąki było związane z obecnością *Candida* spp. w przewodzie pokarmowym badanych. Konsumpcja produktów bogatych w nasycone kwasy tłuszczowe korelowała ze zmniejszoną liczebnością drożdżaków w przewodzie pokarmowym. *Candida albicans* wykazywał wrażliwość na wszystkie leki zastosowanie w teście, co może zwiększać skuteczność terapii kandydozy.

Słowa kluczowe: *Candida* spp., dieta, próbki kału, antybiotyki, lekooporność

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INTRODUCTION

Candida spp. is the most common member of human gut microbiota and estimated to be present in 40-60% of the general population [1, 2, 14]. It may be present as transient or permanent colonizer in the oral cavity and in the further parts of the gastrointestinal tract. This yeast-like fungus is considered an opportunistic microorganism capable of causing diseases in all parts of the gastrointestinal tract. The most important risk factors associated with *Candida* spp. infections include frequent use of antibiotics, chronic use of alcohol and immunosuppressive drugs, and high-carbohydrate diet [2, 14]. The increased incidence of fungal infections contributes to higher morbidity and mortality rates. This is due to increased antimicrobial resistance and a limited number of antifungal drugs that have many side effects. *Candida* spp. can cause infections of mucous membranes and deep tissues [6, 8, 11].

Although *Candida* spp. strains are mainly responsible for opportunistic fungal infections, they have acquired complex and multifaceted resistance to antifungal treatment. It may be induced in reaction to a compound or due to a genetic mutation resulting from prolonged drug exposure [11]. The rapidly increasing resistance of fungal pathogens to commonly used antifungal drugs is becoming a challenge for modern medicine. Increased drug-resistance is associated with the widespread use of antibiotics. The emergence of resistant strains have contributed to the increased mortality and therefore prompted search for novel antifungals. A thorough drug resistance control should be carried out in the case of treating *Candida* strains exhibiting reduced susceptibility to antifungals [4, 10, 13].

The aim of the study was to demonstrate the relationship between diet and the presence of risk factors associated with the growth of human *Candida* spp. The study was based on the analysis of oral swabs and fecal samples for the presence of *Candida* spp. The results obtained allowed us to indicate the correlation between particular elements of diet and the presence of *Candida* spp.

MATERIAL AND METHODS

Material consisted of oral swabs and fecal samples self-collected by the study participants who had been instructed about the appropriate method for sample collection and storage. Respondents filled in the questionnaire on the frequency of consumption of selected food groups, used drugs, diseases and infections, and the degree of physical activity. The investigation was performer in accordance with the Declaration of Helsinki for Human Research. The research was carried out from statutory founds of Wroclaw Medical University No. ST.E090.18.021.

A total of 30 people were examined, including 28 women and 2 men. The study was conducted in Wroclaw (Poland) from April to May 2017. The mean age of the study group was 23.8 ±1.98 years.

The material (feces and oral swabs) was cultured on Sabouraud dextrose agar with actidione (cycloheximide) by GRASO. The significant growth of *Candida* spp. on Sabouraud's medium in the form of white, oval colonies with a characteristic yeast smell was evaluated as a positive result. Then, for selective isolation of yeast, the material was cultured on the chromogenic substrate. The identification of individual species was carried out according to the color of colony growth. *Candida* spp. colonies were classified according to the guidelines of the manufacturer (GRASO Biotech). *Candida albicans* developed green colonies, *Candida krusei* pink, and *Candida glabrata* light purple. Collected samples underwent Gram's staining. Large oval cells arranged in clusters and/or individually indicated the presence of *Candida* spp. The susceptibility of *Candida* to antifungal drugs was determined using the Bio-Rad's FUNGITEST ™ Kit, which allows the susceptibility testing of yeasts to six antifungal agents at two different concentrations. The presence of a redox indicator allowed a colorimetric reading. The test included 5-fluorocytosine, amphotericin B, miconazole, ketoconazole, itraconazole and fluconazole.

RESULTS

The study involved 30 people, including 28 women and 2 men. Fecal samples and oral swabs were collected from the participants of the study. Isolates were cultured on Sabouraud's medium. Thirteen strains were obtained after incubation, most were identified as *Candida albicans*, but we also identified *Candida glabrata* and *Candida krusei* (Table 1). All strains demonstrated morphology typical for *Candida* species, and were differentiated on the CHROMagar Candida Medium.

Table 1. Type of strains in the group with positive *Candida* spp. cultures

Isolates	% (n=13)
Candida albicans	84.6
Candida glabrata	7.7
Candida krusei	7.7

In *Candida* spp. positive group, the yeast was reported in the oral cavity, feces and both (the oral cavity and feces). *Candida glabrata* strains were isolated only from feces and *Candida krusei* strains from the oral cavity and feces. We reported a low growth of *Candida* spp. cultures in over 50% of isolates. A significant growth (assessed at 3+) of *Candida* spp. cultures from the oral cavity occurred in two people (Table 2).

Table 2. Characteristic of isolates

Isolation	(n=30) %	Significant growth (3+) %	Moderate growth (2+) %	Low growth (1+) %
Total	43.3	15.4	30.8	53.8
Oral cavity	38.5	100.0	25.0	42.9
Feces	38.5	0	50.0	42.9
Oral cavity and feces	23.1	0	25.0	14.2

Respondents filled in questionnaires that included information on their lifestyle and diet. The questionnaire asked about the use of antibiotics, pregnancy, susceptibility to infections, and previous fungal infections or surgeries. There was no correlation between the incidence of *Candida* spp. risk factors in the study group and the presence of yeasts in the *Candida* spp. positive group.

In the group with positive *Candida* spp. cultures, the majority of respondents declared symptoms such as abdominal pain, flatulence and unrestrained appetite for sweets. The minority of respondents declared restless sleep, nausea and a metallic taste in the mouth. One person did not experience any symptoms listed in the questionnaire (Table 3).

Table 3. Frequency of symptoms in the group with positive *Candida* spp. cultures

Symptoms	%
Abdominal pain	69.2
Flatulence	53.8
Unrestrained appetite for sweets	53.8
Restless sleep	15.4
Nausea	15.4
Metallic taste in the mouth	15.4
Not experienced any symptoms	7.7

Respondents were asked about their diet taking into account particular groups of food products and the frequency of their consumption.

Most of respondents did not follow any elimination diet. Respondents could choose several variants of their diets. The most frequently mentioned diets were milk-free, lactose-free and gluten-free. Among the respondents from the group with positive *Candida* spp. cultures, the majority of them had not followed any elimination diet.

In the group with positive *Candida* spp. cultures, more than half declared they ate white and wholegrain flour. In the group with negative *Candida* spp. cultures, healthier wheat flour substitutes were consumed significantly more frequently (p=0.04) than in the group with positive *Candida* spp. cultures.

Over 50% of respondents consumed natural white quark regularly. Average consumption of yellow cheese (eg. Gouda) was comparable in the group with positive and negative *Candida* spp. cultures. Quark were eaten significantly more frequently (p=0.005) in the group with negative *Candida* spp. cultures.

The majority of respondents admitted using different types of vegetable oils to prepare both heated and cold food. Most frequently used were vegetable oils including olive oil. In the group with positive *Candida* spp. cultures, the majority of respondents used vegetable oils, the minority of respondents chose butter. In the group with negative *Candida* spp. cultures the results were comparable.

Frequency of consumption particular groups of food products was presented in Table 4.

Table 4. Description of population surveyed diet

Specification	% (the whole group, n=30)	% (the group with positive *Candida* spp. cultures, n=13)	% (the group with negative *Candida* spp. cultures, n=17)
Elimination diet			
Milk-free	10.0	15.4	5.9
Lactose-free	10.0	7.7	11.8
Gluten-free	13.0	7.7	17.6
Not followed any diet	76.7	76.9	76.5
Frequency of consumption particular groups of food products			
Wheat flour	23.3	15.4	29.4
Wholegrain flour	33.3	15.4	47.1 (p=0.04)
White and wholegrain flour	43.3	69.2	23.5
Natural white quark	66.7	53.9	76.5 (p=0.005)
Yellow cheese	39.9	38.5	41.2
Vegetable oils	70.0	69.2	70.6
Olive oil	20.0	23.1	17.6
Coconut oil	3.3	0	5.9
Butter	3.3	7.7	0
Clarified butter	3.3	0	5.9

The study included 16 *Candida* spp. isolates cultured on Sabouraud medium, including isolates from feces and from the oral cavity. Almost 100% isolates were susceptible to 5-fluorocytosine, amphotericin B, miconazole, ketoconazole, itraconazole, and fluconazole. A few isolates showed moderate susceptibility mainly to itraconazole. *Candida albicans* was the most susceptible to antifungal drugs. No antifungal resistance was detected in the study group (Table 5).

Table 5. Susceptibility of *Candida* spp. to antifungal drugs

Strains	Isolates from oral cavity (%)	Isolates from feces (%)	Susceptible strains (%)					
			5-fluoro-cytosine	Amphotericin B	Miconazole	Ketoconazole	Itraconazole	Fluko-nazole
Candida albicans	37.5 - 6.3	12.5 12.5 12.5	100.0 100.0 moderate	100.0 100.0 moderate	100.0 100.0 moderate	100.0 100.0 moderate	100.0 moderate moderate	100.0 100.0 moderate
Candida glabrata	-	6.3	100.0	100.0	100.0	100.0	moderate	100.0
Candida krusei	6.3	6.3	100.0	100.0	100.0	100.0	100.0	100.0

DISCUSSION

Diet significantly influences the composition and activity of intestinal microbiota, including fungi. High-fat and high-carbohydrate diets are of particular importance. Specific nutrients change the microbial composition and metabolic activity of the physiological flora [5]. Carbohydrates, proteins and individual fatty acids are most frequently studied compounds that influence the growth of *Candida* in the gastrointestinal tract. Scientific research proves that diet contributes to the growth of human *Candida* spp. [7]. Carbohydrates lead to the highest rated of *Candida* spp. growth in the digestive tract, whereas yeast growth is inhibited by saturated fatty acids [6, 7]. It has been reported that probiotics and flavonoids inhibit *Candida* spp. growth [9, 12].

The influence of diet on the development of *Candida* spp. has been proved by examining fecal samples taken from healthy adults as well as by analyzing their current diets. *Hoffmann* et al. [7] in 2013 reported a positive correlation between the presence of *Candida* spp. in the human gastrointestinal tract, high carbohydrate intake and a negative correlation between the presence of *Candida* spp. and saturated fatty acids intake. The study described the metabolic activity of *Candida* spp., which is capable of fermenting starch, especially after preliminary amylase digestion in saliva. Therefore, yeast may participate in the decomposition of starch from high carbohydrate products and contribute to the release of simple sugars which are a fermentation substrate for this type of fungus.

In this research the authors reported differences in the consumption of high carbohydrate foods between our respondents. People with positive *Candida* spp. cultures more frequently consumed cereal from purified than from whole-grain flour. The diet of people with negative *Candida* spp. cultures more often included healthier wheat flour substitutes (e.g. rye flour, oat flour, buckwheat flour). Potatoes, which are a rich source of starch, were more frequently found in the diet of people with *Candida* spp. There were no differences in the frequency of consumption and the type of sweets among the respondents of this study.

Gunsalus et al. [6] evaluated the effect of different types of food fats on gastrointestinal tract infestation by *C. albicans* and compared the role of beef tallow, soybean and coconut oils in the process of *C. albicans* multiplication in the intestines of mice. Beef tallow and soybean oil are rich in long-chain saturated fatty (C16:0 and C18:0) and unsaturated fatty acids (C18:1 and C18:2). Coconut oil is rich in medium- and short-chain fatty acids. Coconut oil used in in vitro conditions inhibited the growth of *C. albicans* and led to the death of strains. This effect was mainly attributed to short-chain fatty acids such as capric (C10:0) and lauric acids (C12:0). On the other hand, long-chain fatty acids contained in soybean oil and beef tallow enhanced the growth of *C. albicans*. The colonization with *C. albicans* was lower in mice fed with coconut oil than in mice fed with beef tallow or soybean oil. The researchers concluded that coconut oil inhibits *C. albicans* growth under in vivo conditions.

In this study, the highest percentage of respondents with positive *Candida* spp. cultures (69.2%) used vegetable oils (such as rapeseed oil or sunflower oil), whereas only 1 person used fat containing short chain fatty acids, such as coconut oil or butter. Comparable results were obtained in the group with negative *Candida* spp., therefore it can be concluded that in the studied material the type of chosen fat had no significant effect on the presence of gastrointestinal *Candida* spp. After analyzing the consumption of products containing a large amount of saturated fatty acids**,** authors of this research reported that people with negative *Candida* spp. cultures consumed significantly more yellow cheese and quark, which are the source of short-chain fatty acids.

Due to the increasing drug resistance of yeast-like fungi to fungistatic drugs, there have been many reports on the effectiveness of antifungal treatment. Researchers from the Department of Periodontology and Oral Mucosa Diseases at the Medical University of Gdansk (Poland) examined the antifungal resistance profile of isolated yeast-like strains in 197 patients. For this purpose, they used oral isolates obtained from the participants of the study and treated them with 7 fungistatic drugs (nystatin, amphotericin B, fluconazole, miconazole, ketoconazole, itraconazole and flucytosine). The most frequently isolated *Candida albicans* strains (70.4%) showed the highest susceptibility to all antifungals tested. The highest percentage (93.0%) of *C. albicans* strains was susceptible to amphotericin B and nystatin (91.7%). The highest resistance to antifungal agents was observed among *Candida krusei* (2.7%) and *Candida glabrata* (9.9%) strains. *C. krusei* showed 100% resistance to fluconazole and itraconazole. *C. glabrata* strains were most resistant to fluconazole (95.5%). Amphotericin B and nystatin were characterized by the highest probability of clinical efficacy for all isolated yeast-like fungi. Susceptibility to amphotericin was demonstrated in 92.9% of *C. albicans*, 81.8% of *C. glabrata*, and 100% of *C. krusei*. In the case of nystatin, the percentage of susceptible strains was lower and for *C. albicans*, *C. glabrata* and *C. krusei* amounted to 91.7%, 77.3%, and 66.7%, respectively. Azole derivatives were assessed as less effective than amphotericin B and nystatin.68.3% of *C. albicans* and 13.6% of *C. glabrata* strains showed susceptibility to azole antifungal drugs, whereas *C. krusei* isolates were resistant to all azole drugs tested [3]. Similarly in this study, *C. albicans* strains were most susceptible to the majority of antifungal drugs. 61.5% of strains were susceptible to 5-fluorocytosine, amphotericin B, miconazole, ketoconazole, itraconazole, and fluconazole. 15.4% showed susceptibility to 5 drugs and moderate susceptibility to itraconazole. 23.1% of isolates were moderately susceptible to all the drugs tested. *C. glabrata* isolates were susceptible to all drugs tested except for itraconazole, for which they showed moderate susceptibility. *C. krusei* strains were susceptible to all drugs used in the test.

CONCLUSION

Results of statistical analysis suggests a positive correlation between the consumption of high carbohydrate content foods (such as products made from wheat flour) and the presence of gastrointestinal *Candida* spp. and a negative correlation between the presence of gastrointestinal *Candida* spp. and the consumption of products rich in saturated fatty acids.

Use the Bio-Rad's FUNGITEST™ Kit which allows the susceptibility testing of yeasts to six antifungal agents at two different concentrations determines *Candida albicans* strains are most commonly susceptible to antifungal drugs.

Conflict of interest

The Authors declare no conflict of interest.

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ORIGINAL ARTICLE

FAT MASS INDEX AND DIETARY BEHAVIOURS OF THE POLISH BORDER GUARD OFFICERS

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ABSTRACT

Background. Due to specific requirements of service, Border Guard officers should be characterized by good health. Whereas there is lack of studies assessing nutritional status as well as dietary behaviours among Polish Border Guard officers.

Objective. The aim of the study was to assess the impact of dietary behaviours of the Polish Border Guard officers on the Fat Mass Index.

Material and methods. The study was carried out with participation of 250 Border Guard officers (187 men and 63 women), aged 37±6; years of service: 12±6. Nutritional status was determined with the electrical bioimpedance method using the TANITA MC-780 analyzer. According to the calculated Fat Mass Index value each person was qualified to one of the following groups: fat deficit, normal fat or excess fat. The Border Guard officers were asked to fill in the original questionnaire containing questions about nutritional behaviours in line with the recommendations of the Swiss Food Pyramid for Athletes in the basic version.

Results. The excessive amount of fat in every third officer of the Border Guard and numerous irregularities in eating behaviours were found. According to the food pyramid the smallest scale of rational dietary choices (especially regularity of meals, fruit and vegetable consumption) was characteristic of officers with excess fat. In addition, officers from the excess fat group obtained, on average, a lower sum of points for compliance of nutritional behaviours with the recommendations of the Swiss Food Pyramid than those from other groups (49% vs. 59% and 56%, p=0.002).

Conclusions. There is a need for nutritional education and further monitoring of both the nutritional status and dietary behaviours of Border Guard officers.

Key words: *nutritional status, Fat Mass Index, dietary behaviours, food pyramid, border guards*

STRESZCZENIE

Wprowadzenie. Z uwagi na specyfikę służby funkcjonariusze Straży Granicznej powinni charakteryzować się dobrym stanem zdrowia. Tymczasem brakuje badań na temat stanu odżywienia, jak również zachowań żywieniowych funkcjonariuszy Straży Granicznej w Polsce.

Cel. Celem badań była ocena wpływu zachowań żywieniowych na Wskaźnik Tkanki Tłuszczowej funkcjonariuszy Straży Granicznej pełniących służbę w Polsce.

Materiał i metody. Badania przeprowadzono w 2018 roku z udziałem 250 funkcjonariuszy Straży Granicznej (187 mężczyzn i 63 kobiet) w wieku 37±6 lat, pełniących służbę od 12±6 lat. Stan odżywienia oceniono metodą elektrycznej bioimpedancji z użyciem analizatora TANITA MC-780. Na podstawie obliczonej wartości Wskaźnika Tkanki Tłuszczowej każdą z osób zakwalifikowano do jednej z następujących grup: zbyt niska ilość tkanki tłuszczowej, prawidłowa ilość tkanka tłuszczowa lub nadmierna ilość tkanki tłuszczowej. Funkcjonariuszy poproszono o wypełnienie autorskiego kwestionariusza ankiety, zawierającego pytania na temat zachowań żywieniowych zgodnych z rekomendacjami szwajcarskiej piramidy żywienia dla sportowców w wersji podstawowej.

Wyniki. Stwierdzono nadmierną ilość tkanki tłuszczowej u co trzeciego funkcjonariusza Straży Granicznej oraz liczne nieprawidłowości w zachowaniach żywieniowych tych osób. W odniesieniu do piramidy żywienia najmniejszą skalą racjonalnych wyborów żywieniowych (w szczególności dotyczącą regularności posiłków oraz spożycia owoców i warzyw) charakteryzowali się funkcjonariusze z nadmierną tkanką tłuszczową. Ponadto, funkcjonariusze z nadmierną ilością tkanki

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tłuszczowej uzyskali średnio niższą sumę punktów za zgodność zachowań żywieniowych z zaleceniami szwajcarskiej piramidy żywienia niż badani z pozostałych grup (49% vs 59% i 56%; p=0.002).
Wnioski. Istnieje potrzeba edukacji żywieniowej oraz dalszego monitorowania zarówno stanu odżywienia jak i zachowań żywieniowych funkcjonariuszy Straży Granicznej.

Słowa kluczowe: *stan odżywienia, wskaźnik tkanki tłuszczowej, zachowania żywieniowe, piramida żywieniowa, straż graniczna*

INTRODUCTION

Proper nutrition along with appropriate level of physical activity are key factors for keeping good health. Irregularities in the diet are correlated with occurrence of diet-related metabolic diseases such as diabetes, dislipidemia, obesity and hypertension and other cardiovascular diseases [3, 16, 21]. Disorders in the nutrition manner have also been associated with an increased risk of osteoporosis and cancer [24, 36]. Diet-related metabolic diseases, although they do not manifest in a rapid course, can result in serious health consequences such as heart attack and stroke, which can not only lead to elimination of a patient from professional and social life, but often make a direct threat to life, as the main cause of death in Poland [35].

Keeping a good health condition is crucial, especially for officers of uniformed services, including officers of the Border Guard (BG). Numerous tasks of this formation created in 1991, defined by the Legislator in art. 1. of the Act of 12 October 1990 *on the Border Guard* [34] include varied activities for border protection and border traffic control in the Republic of Poland. Due to the shape of state borders, fulfillment of the above tasks is related to realization of activities in diverse geographical conditions, from sea activities to high-mountain ones, therefore BG officers should be characterized by good health and high level of physical fitness. Irregularities in nutrition of officers manifested in occurrence of overweight, obesity or underweight may result in difficulties in fulfillment of service tasks, and due to further health consequences, may be an indirect cause of early elimination from the service for health reasons [28].

The current issue of irregularities in the nutritional status of Border Guard officers and their possible health consequences may be provided by epidemiological data obtained from occupational medicine examinations. In the group of BG officers examined in 2012-2018 (n=54303), 23% were diagnosed with specific diseases, among which cardiovascular diseases, obesity and type 2 diabetes accounted for 20%, 28% and 1.7% of cases respectively (own data unpublished). These data indicate occurrence of health disorders associated most probably with abnormal nutritional behaviours of the examined officers.

Due to the limited number of scientific publications addressing the nutritional status of uniformed services officers, this publication attempts to assess the impact of dietary behaviours of Border Guard officers on the protein and energy nutritional status expressed as the Fat Mass Index (FMI). Association between value of the FMI index and degree of BG officers compliance with the principles of proper nutrition in relation to recommendations contained in the nutrition pyramid developed by the Swiss Society for Nutrition for athletes was also tested. [4]. Due to the nature of service, including need to maintain high level of psychophysical fitness by the BG officers, the work refers to the Swiss Pyramid of nutrition for sportsmen in the basic version.

MATERIAL AND METHODS

The research was conducted from June to October 2018 with participation of 187 male and 63 female officers of the BG, aged from 21 to 54. To carry out the tests approval of the Bioethics Committee at the Military Institute of Hygiene and Epidemiology in Warsaw was obtained (1/XXI/2016). All guards officers, after getting acquainted with the information about conducted research, voluntarily gave their written consent to participate in the study.

Nutritional status was determined using the electrical bioimpedance method with the TANITA MC-780 analyzer. In order to determine the correctness of fat content of the subjects, for each person the Fat Mass Index (FMI): FMI [kg/m^2]=fat mass/height^2 was calculated. Then, the subjects were qualified to one of the following groups: fat deficit: male <3, female <5; normal fat: male 3–6, female 5–9; excess fat: male >6, female >9, according to the Kelly et al. classification [17].

The subjects were asked to fill in the original questionnaire containing questions about nutritional behaviours in line with the recommendations of the Swiss Food Pyramid for Athletes in the basic version, i.e. intended for use in the general population, without taking into account additional portions of selected food products groups in connection with sport training taken above 5 hours per week [4]. During preparation of the survey, this questionnaire was modeled on research conducted in this field by other authors among various groups of athletes [8-12]. The Swiss Food Pyramid was validated using 168 menus prepared in accordance with established recommendations [23].

Table 1. Adherence of Border Guard officers to the recommendations of the Swiss Food Pyramid for Athletes (the basic pyramid) according to the Fat Mass Index classification

Recommendation	FMI [%]			p
	Fat deficit (n=31)	Normal fat (n=139)	Excess fat (n=80)	
1-2 liters of liquids a day	74	81	91	0.045**
Hydration with mineral water and other non-sweetened beverages	87	91	88	0.591
Hydration during exercise	90	92	90	0.857
Variable diet	55	50	36	0.134
Eating regularly (every 3-5 hours)	57	42	26	0.012**
At least 3 meals per day	87	89	79	0.164
At least 5 servings of fruits and vegetables per day	23	16	10	0.226
At least 2 servings of fruits per day	70	56	37	0.002**
At least 3 servings of vegetables per day	26	18	9	0.056*
Raw vegetables at least once a day	52	52	43	0.430
At least 3 servings of whole grain or legumes	39	40	33	0.571
Whole grain cereals at least twice a day	48	37	33	0.185
1 serving of meat, fish, eggs, cheese or tofu per day	77	79	70	0.307
Fish 2 times per week	33	24	18	0.104
3 servings of dairy products per day	29	42	41	0.383
3 servings of plant-based oils per day	48	53	35	0.042**
1 serving of nuts per day	32	14	10	0.013**
Reduced intake of animal fats	45	51	44	0.510
Reduced intake of sweets	61	47	50	0.380
Reduced intake of salted snacks	74	62	61	0.397
Reduced intake of fast-food products	74	76	60	0.047**
Reduced intake of carbonated beverages	81	84	78	0.590
Reduced intake of energy drinks	90	92	85	0.382
Average	59	56	49	0.002^{KW}

Fat deficit: male <3, female <5; normal fat: male 3–6, female 5–9; excess fat: male >6, female >9
* statistical tendency: Chi^2 test, $0.05 \leq p \leq 0.10$
** statistical significance: Chi^2 test, $p<0.05$
^{KW} statistical significance: *Kruskal-Wallis* test, $p<0.05$

The subjects were asked to answer "yes" or "no" to each of 23 selected statements describing dietary behaviours according to the pyramid of nutrition, such as: hydration methods and preferences, frequency and regularity of meals, frequency consumption of recommended food products, avoidance of foods that are non-recommended in rational diet. The next part of the questionnaire contained questions about personal information (sex, age, years of service and education).

The analysis of the results was carried out using the STATISTICA ver. 13 program. Compatibility of distribution of variables with normal distribution was assessed using the Shapiro-Wilk test, assuming the significance level of $\alpha=0.05$. Correctness of nutritional behaviours depending on correctness of the Fat Mass Index was assessed using the Kruskal-Wallis test. The *Mann-Whitney* U test was used to compare Fat Mass Index values depending on declaration of specific recommendations fulfillment. For specified statistically significant statements, a two-way analysis of variance was additionally performed in order to check whether there is an interaction of influence of two factors, i.e. compliance with the recommendation and gender of the subjects. The *Spearman's* correlation test was used to assess relationship between the Fat Mass Index values among the subjects and the sum of points obtained for statements consistent with the recommendations of the food pyramid. In the carried out analyzes, the significance level of $\alpha=0.05$ and the level of statistical tendency for p in the range from 0.05 to 0.10 were assumed.

RESULTS

The average age of examined Border Guard officers amounted to 37±6 years, and the average period of serving was 12±6 years. Over 3/4 of subjects (79%) were higher educated, while others – secondary

educated. The FMI values calculated for officers ranged from 1.3 to 13.0 kg/m^2 and for the fat deficit, normal and excess fat groups 12%, 56% and 32% of subjects were classified respectively.

The percentage of responses given by Border Guard officers, which were consistent with the principles of proper nutrition in relation to the Swiss Food Pyramid, varied widely and ranged from 15 to 91% (Figure 1). The subjects met the recommendations to the smallest extent for consuming 5 portions of fruit and vegetables every day (15%), as well as consuming one portion of nuts per day (15%), three portions of vegetables every day (16%) and fish twice a week (23%). The highest percentage of subjects implemented recommendations regarding hydration during training (91%), preference for water and unsweetened drinks for general hydration (90%) and reducing limiting consumption of energy drinks (90%). The majority of subjects consumed at least 3 meals a day (86%), but only 39% of officers consumed these meals regularly, maintaining a 3-5 hour interval. Only every second subject used a varied diet.

There were statistically significant differences for answers given to 6 out of 23 statements regarding nutritional behaviours and a summary of the average number of correct behaviours between groups distinguished due to the FMI classification (Table 1). The highest differences were noted in answers given to the question about consuming at least two portions of fruit per day (p=0.002), then eating meals regularly (p=0.012) and eating a portion of nuts daily (p=0.013). The affirmative answers to these questions were given by 70%, 57% and 32% of officers from the fat deficit group, 56%, 42% and 14% from the normal fat group and 37%, 26% and 10% from the excess fat group respectively. It was also shown that officers with excessive fat were less likely to eat 3 servings of plant-based oils per day (p=0.042) and to a lesser extent limited consumption of fast-food products (p=0.047), and more often than others drank 1-2 liters of liquids a day (p=0.045). In addition, officers from the excess fat group obtained, on average, a lower sum of points for compliance of nutritional behaviours with the recommendations of the Swiss Food Pyramid than those from other groups (49% vs. 59% and 56%, p=0.002).

A negative correlation was found between the FMI and the sum of points obtained for correctness of nutritional behaviours (p=0.015, R=-0.15). A detailed analysis, after separating new subgroups due to the sex of the subjects, confirmed statistical significance only among men (men: p<0.001, R=-0.24, women: p=0.479, R=-0.09).

Table 2. Fat Mass Index according to the adherence of Border Guard officers to the recommendations of the Swiss Food Pyramid for Athletes (the basic pyramid)

Recommendation	Not complying					Complying					p
	X	SD	Me	Min	Max	X	SD	Me	Min	Max	
1-2 liters of liquids a day	5.42	1.71	5.13	2.37	9.06	5.81	2.09	5.63	1.30	12.9	0.342
Hydration with mineral water and other non-sweetened beverages	5.85	2.07	5.44	2.59	11.4	5.73	2.04	5.58	1.30	12.9	0.778
Hydration during exercise	6.23	2.51	5.82	2.58	12.9	5.70	1.98	5.56	1.30	11.9	0.473
Variable diet	6.04	2.16	5.82	2.30	12.9	5.40	1.84	5.33	1.30	11.6	0.038**
Eating regularly (every 3-5 hours)	5.99	2.12	5.83	2.25	12.9	5.37	1.86	5.14	1.30	11.6	0.023**
At least 3 meals per day	6.21	2.13	6.15	2.25	11.4	5.67	2.02	5.48	1.30	12.9	0.114
At least 5 servings of fruits and vegetables per day	5.79	2.04	5.63	1.30	11.9	5.27	1.67	5.38	1.53	8.63	0.272
At least 2 servings of fruits per day	6.05	2.06	5.92	1.30	12.9	5.49	2.00	5.37	1.53	11.9	0.037**
At least 3 servings of vegetables per day	5.82	2.05	5.64	1.30	12.9	5.33	1.93	4.96	1.53	10.5	0.188
Raw vegetables at least once a day	5.74	1.98	5.70	1.30	11.4	5.74	2.15	5.38	1.53	12.9	0.711
At least 3 servings of whole grain or legumes	5.81	1.99	5.74	1.30	11.9	5.63	2.12	5.36	1.53	12.9	0.345
Wholegrain cereals at least twice a day	5.87	2.03	5.66	1.30	11.9	5.58	2.08	5.38	1.53	12.9	0.359
1 serving of meat, fish, eggs, cheese or tofu per day	5.82	2.06	5.89	2.25	11.2	5.72	2.03	5.51	1.30	12.9	0.553
Fish 2 times per week	6.00	2.04	5.78	2.25	12.9	4.99	1.86	4.77	1.30	9.38	0.001**
3 servings of dairy products per day	5.72	2.18	5.42	1.30	12.9	5.76	1.83	5.65	1.53	11.9	0.499
3 servings of plant-based oils per day	5.87	2.02	5.64	1.30	11.2	5.60	2.05	5.54	1.53	12.9	0.258
1 serving of nuts per day	5.81	1.97	5.66	1.30	12.9	5.37	2.36	4.68	1.53	11.9	0.053*
Reduced intake of animal fats	5.75	2.03	5.60	1.30	12.9	5.72	2.04	5.57	1.53	11.9	0.827
Reduced intake of sweets	5.83	1.95	5.57	2.25	11.9	5.66	2.12	5.58	1.30	12.9	0.464
Reduced intake of salted snacks	5.89	1.94	5.71	2.37	11.9	5.66	2.09	5.52	1.30	12.9	0.293
Reduced intake of fast-food products	5.94	1.91	5.95	2.30	11.4	5.66	2.09	5.35	1.30	12.9	0.131
Reduced intake of carbonated beverages	5.96	2.25	5.63	2.44	11.4	5.70	1.99	5.57	1.30	12.9	0.624
Reduced intake of energy drinks	5.81	2.05	5.98	2.59	10.2	5.74	2.04	5.55	1.30	12.9	0.807

X – arithmetic average, SD – standard deviation, Me – median, Min – minimum, Max – maximum
* statistical tendency: *Mann-Whitney U* test, 0.05≤p≤ 0.10
** statistical significance: *Mann-Whitney U* test, p<0.05

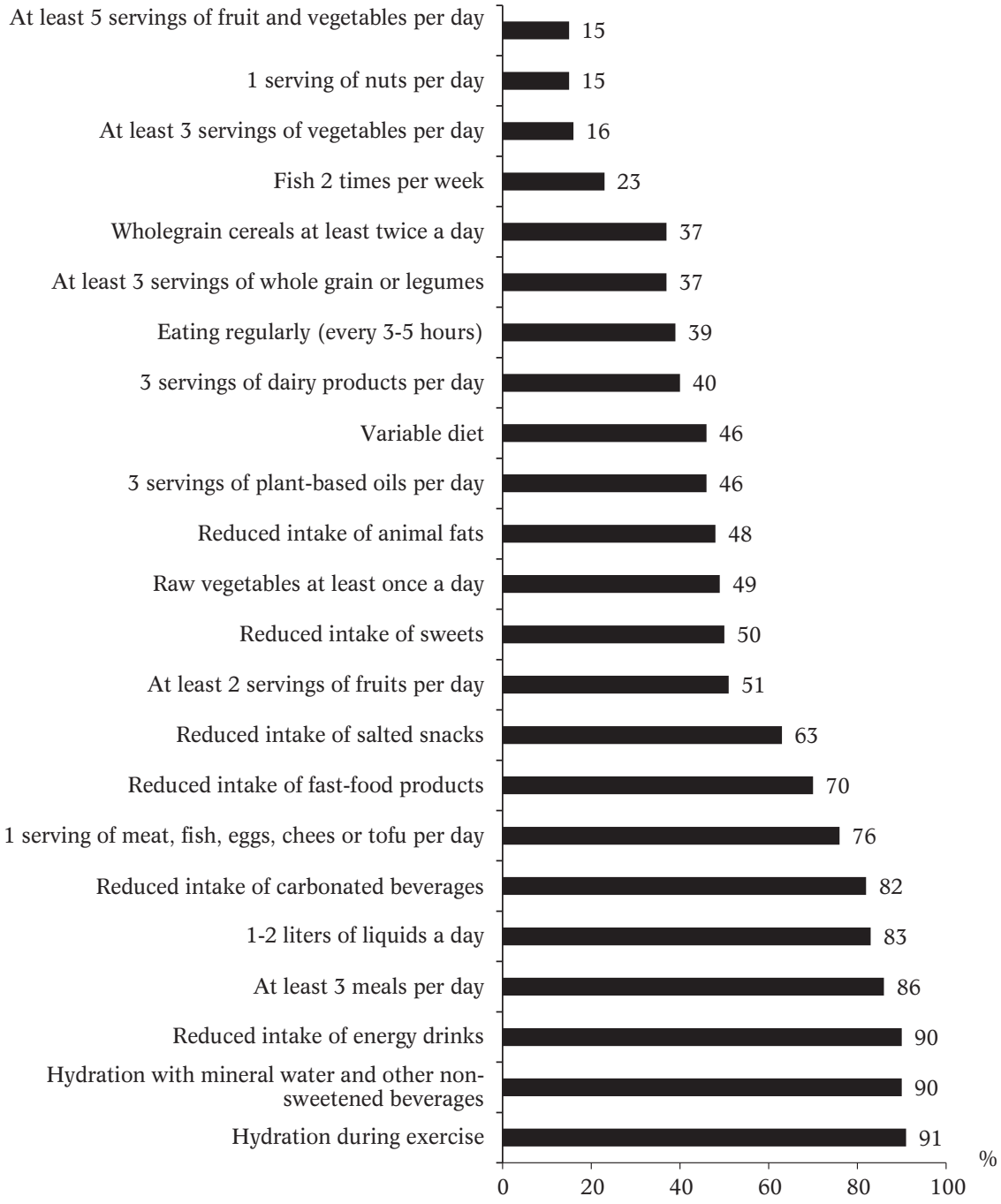

Figure. 1. Adherence of Border Guard officers to the recommendations of the Swiss Food Pyramid for Athletes (the basic pyramid)

Four out of 23 statements describing nutritional behaviours consistent with the food pyramid differentiated the FMI value depending on the subjects' compliance with these recommendations (Table 2). BG officers using a varied diet (p=0.038), eating meals regularly (p=0.023), consuming fruits at least twice a day (p=0.037) and consuming fish twice a week (p=0.001), as well as consuming nuts daily (p=0.053) were characterized by a smaller FMI value. A two-factor analysis of variance showed an interaction between the examined factors (sex and the recommendation fulfillment) only in one recommendation, i.e. two portions of fruit a day, which depending on the sex of the subjects varied the Fat Mass Index of these people (p=0.005). Using the Post hoc Tukey test statistically significant differences between the FMI of men and women fulfilling this recommendation (FMI of women eating fruit twice a day = 6.61 kg/m^2 and FMI for men eating fruit twice a day = 4.99 kg/m^2; p<0.001) were shown, as well as in the group of men due to the fulfillment of the recommendation (FMI for men eating fruit twice a day = 4.99 kg/m^2 and FMI for men who do not comply with this recommendation = 6.07 kg/m^2, p<0.001).

DISCUSSION

The carried out research revealed excessive amount of fat in every third officer of the Border Guard and numerous irregularities in the nutritional behaviours of these people. In recent years, as in general population, excessive body mass is more and more often observed among officers of other groups of uniformed services, e.g. soldiers [1, 19, 20, 27, 29], police officers [25, 31] and firefighters [2, 18].

A state of human health, in particular the nutritional status, depends to a large extent on a nutrition manner. That is why experts have been creating and publishing dietary recommendations in various forms - not only as nutrition standards but also as food pyramids that are present in various countries around the world. Their main task is to provide nutritional recommendations in an accessible way, as well as encouragement to physical activity [5]. Research carried out by other authors regarding evaluation of sportsperson nutrition in relation to the Swiss Food Pyramid showed differences in fulfillment of individual recommendations due to the sports level, indicating more rational dietary choices in competitive athletes than amateurs practicing volleyball [9] and long-distance runners [12], or tendency to fuller implementation of the recommendations of the Swiss Pyramid by women than by men [8, 11]. However, none of these studies considered the nutritional status of these people.

Due to the nature of the service of Border Guard officers and the requirements for general health, in particular high physical fitness, it seems justified to use the Swiss Pyramid also for this population group. General level of fulfillment of recommendations contained in the Swiss Food Pyramid by the Border Guard officers (49-59%) should be considered insufficient. The subjects implemented the recommendations regarding hydration of the body, eating at least 3 meals a day and eating one portion of meat, fish, eggs, cheese or tofu daily. However, more than half of the subjects declared not remaining on a variable diet. In addition, officers, regardless of the level of adipose tissue, fulfilled recommendations regarding consumption of 5 portions of fruit and vegetables (10-23% of subjects) to the smallest extent. Similar nutritional errors, i.e. insufficient consumption of cereal products, fish, fruit and vegetables and dairy products, as well as smaller than recommended number of meals were also observed in the total population [6] and among athletes [13, 30, 32, 33]. Research conducted with participation of another group of uniformed services also shown an insufficient frequency of eating fruit and vegetables and milk and its products among soldiers [14]. In addition, it has been shown that along with duration of the service, frequency of fruit and dairy products consumption by soldiers is reduced, and thus the Healthy Eating Index-2010 decreases [7]. According to the principles of proper nutrition, it is recommended to eat 4-5 properly balanced meals during a day in order to ensure maintenance of a constant level of glucose in the blood and regular supply of essential nutrients [15]. Insufficient consumption of fruit and vegetables can lead to unbalanced supply of some antioxidant vitamins, which are especially important in the increased oxidative stress condition associated with, for example, intensive exercise [26]. Moreover, low frequency of cereal products consumption, in particular from full milling, may promote deficiency of B vitamins and influence reduction of exercise capacity, as well as increase risk of fiber deficiency. And inadequate consumption of dairy products can lead to calcium deficiency. Calcium is the basic building material of bones and teeth and is involved in regulation of neuromuscular excitability and acid-base balance of the system [15]. Moreover, a properly balanced daily food intake secures the body, among others against a decrease in concentration, which is especially important among people whose work requires maintaining high psychophysical fitness and protects against fatigue [22].

The smallest scale of rational dietary choices was characteristic of officers with excessive adipose tissue (excess fat: male >6 kg/m^2, female >9 kg/m^2), which may explain their nutritional status. In the examined group, a negative correlation between the sum of points obtained for correctness of nutritional behaviours (according to the food pyramid) and the FMI value was found. In addition, nutritional behaviours differentiating level of the adipose tissue index among the subjects, such as regularity of eating meals, the varied diet, consumption of two portions of fruit a day, consumption of fish twice a week and daily consumption of nuts were distinguished. Officers complying with these recommendations were characterized by lower FMI values compared to the subjects who declared failure to fulfillment of these recommendations. More rational food choices favored maintaining the right amount of adipose tissue in Border Guard officers. Thus, the existence of relationship between the nutritional status and the nutrition manner of BG officers was confirmed.

CONCLUSIONS

1. The carried out research has shown excessive amount of fat in every third officer of the Border Guard and numerous irregularities in eating behaviours, including lack of variety and regularity of eating, as well as insufficient frequency of eating fruit and vegetables, whole grain products, dairy products, fish and nuts.
2. Dependencies between the Fat Mass Index and correctness of nutrition manner in relation to recommendations included in the Swiss Food Pyramid were revealed.

3. There is a need for nutritional education and further monitoring of both the nutritional status and dietary behaviours of Border Guard officers.

Conflict of interest

The authors declare no conflict of interest.

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3. *Shridhar G.*, *Rajendra N.*, *Murigendra H.*, *Shridevi P.*, *Prasad M.*, *Mujeeb M.A.*, *Arun S.*, *Neeraj D.*, *Vikas S.*, *Suneel D.*, *Vijay K.*: Modern diet and its impact on human health. J Nutr Food Sci 2015;5:6 doi:10.4172/2155-9600.1000430.
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Books and chapter in a book:

5. *Riley D.M., Fishbeck P.S.*: History of methylene chloride in consumer products. In: *Salem H.*, *Olajos E.J.* (eds.). Toxicology in Risk Assessment. London, Taylor & Francis, 2000.

Legislative acts:

6. Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs. Off J EU L 364, 20.12.2006.

Internet source:

7. The Rapid Alert System for Food and Feed (RASFF) Portal. Available https://webgate.ec.europa.eu/rasff-window/portal (accessed 18.10.2010)

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