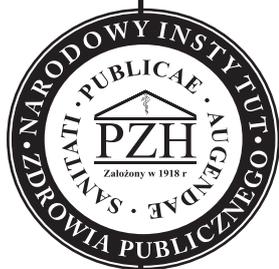


ISSN 0035-7715



ROCZNIKI PAŃSTWOWEGO ZAKŁADU HIGIENY

ANNALS OF THE NATIONAL INSTITUTE OF HYGIENE



**Quarterly
2015
Volume 66
Number 4**

EDITOR and PUBLISHER:
**NATIONAL INSTITUTE OF PUBLIC HEALTH
– NATIONAL INSTITUTE OF HYGIENE
Warsaw, Poland**

ROCZNIKI PAŃSTWOWEGO ZAKŁADU HIGIENY

[ANNALS OF THE NATIONAL INSTITUTE OF HYGIENE]

Volume 66

2015

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COFFEE CONSUMPTION VS. CANCER RISK - A REVIEW OF SCIENTIFIC DATA

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ABSTRACT

Coffee and its impact on health continue to be the topic of much heated debate. Until recently, coffee consumption has been believed to be associated with adverse effects, mainly cardiovascular problems. However, the vast majority of contemporary sources not only emphasize a lack of detrimental effect, but also suggest a beneficial effect of coffee intake. According to the current state of knowledge, coffee consumption is not associated with the majority of cancers although the results of studies on bladder and lung cancer remain conflicting. In case of colorectal, liver and breast cancers, coffee drinking may even have a protective effect. Coffee contains numerous compounds, potentially beneficial as well as harmful. The former include polyphenols which inhibit harmful oxidation processes in the body, while the latter include acrylamide, whose high intake in daily diet may have carcinogenic action. The impact of coffee on the human body is associated also with other factors, e.g. the rate of metabolism and other individual features.

Key words: *coffee, cancer, health*

STRESZCZENIE

Od lat trwa dyskusja na temat wpływu picia kawy na zdrowie. Jeszcze do niedawna przeważały poglądy o jej negatywnych skutkach, w tym przede wszystkim w postaci zwiększonego ryzyka chorób sercowo-naczyniowych. W ostatnich latach większość publikacji naukowych podkreśla jednak brak szkodliwego wpływu picia kawy na zdrowie, a niektóre sugerują nawet jej działanie prozdrowotne. W świetle aktualnego stanu wiedzy obecność kawy w diecie nie ma związku z zachorowaniem na większość nowotworów. Niejednoznaczne są dane dotyczące nowotworów pęcherza moczowego i płuc, natomiast w przypadku jelita grubego, wątroby i piersi nie wyklucza się jej działania ochronnego. Kawa zawiera szereg składników, zarówno potencjalnie korzystnych, jak i szkodliwych. Do pierwszej grupy należą przede wszystkim polifenole, hamujące szkodliwe procesy utleniania w organizmie. Do drugiej należy zaliczyć akryloamid, którego duże spożycie może mieć działanie kancerogenne. Wpływ kawy na organizm człowieka może zależeć także od innych czynników, w tym szybkości jej metabolizmu i innych cech osobniczych.

Słowa kluczowe: *kawa, nowotwory, zdrowie*

INTRODUCTION

Notwithstanding the popularity of tea, coffee is the most favored beverage in the world. Taking into account the enormous demand for coffee, the effect of its consumption on health is an important public health issue. A great number of studies on coffee and health have been conducted over the last decades. Until recently, coffee consumption has been believed to be associated

with adverse effects, mainly cardiovascular problems. Contrary to earlier beliefs, the results of recent research emphasize that coffee drinking is not only not harmful but may in fact be a beneficial element of a diet. Titles such as “*Coffee can protect against diseases*” and “*Is it time to write a prescription for coffee?*” have started to appear in scientific journals [14, 44]. In light of current knowledge, habitual moderate coffee intake may help prevent several chronic diseases, including type 2 dia-

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betes mellitus, coronary heart disease, and *Parkinson's* disease [27].

Over the last four decades, the relationship between coffee consumption and cancer has generated great interest. While earlier studies suggested that coffee drinking might increase the actual the risk of cancer [6], current findings suggests that coffee is associated with a reduced risk of some malignancies [1]. Despite the accumulating body of evidence for its safety, coffee intake remains controversial. According to 36% of health care professionals, coffee consumption increases the risk of cancer [6].

This article presents recent evidence for the association between coffee consumption and the risk of some types of cancer, based on meta-analyses of studies from that area.

COLORECTAL CANCER

Colorectal cancer is currently one of the most common cancers worldwide. For decades, the relationship between coffee consumption and the risk for colorectal cancer has been extensively examined. Some studies published in the 80s reported an adverse association between coffee consumption and colon cancer among people consuming ≥ 2 cups of coffee a day [38], whereas others did not show any relationship or suggest a beneficial effect of coffee on colorectal cancer risk [33]. Nevertheless, all studies emphasized that more data are needed in order to determine the exact nature of the relationship, if any, between coffee consumption and cancer risk.

Numerous case-control and cohort studies have been published since the 80s. In 1991, a Working Group of the International Agency for Research on Cancer reviewed the existing data and concluded that there is some evidence of an inverse relation between coffee drinking and cancer of the large bowel in man [10]. This suggestion was later confirmed in a meta-analysis of case-control studies based on data published up to 1997 [12]. Numerous meta-analyses have been undertaken recently and their results are also optimistic. A meta-analysis of prospective cohort studies in 2009 showed no significant effect of coffee consumption on colorectal cancer risk [16], whereas a meta-analysis of case-control studies in 2010 suggested a moderately favorable effect (17% lower risk of cancer) [10]. A beneficial effect of coffee on the risk of colorectal cancer was also confirmed by a meta-analysis of cohort studies in 2011 [52]. As many as three analyses and a review of data were published in 2013. One of them, including case-control studies, stated that the risk of colorectal cancer is reduced by 15% for heavy coffee drinkers as compared to low or non-drinkers, and that the risk of

colon cancer is reduced by 21% [23]. *Tian et al.*, in their analysis of observational studies, detected a significant association between coffee intake and decreased risk of colorectal and colon cancer among subjects consuming ≥ 4 cups of coffee a day [43], while a review of epidemiological evidence by *Bøhn et al.*, indicated that coffee may protect against colorectal cancer [6].

BREAST CANCER

In 1990, a Norwegian cohort study including over 14 000 women demonstrated that lean women who drank ≥ 5 cups of coffee a day were at a 50% lower risk of breast cancer as compared to their peers who drank ≤ 2 cups a day [47]. These optimistic findings were later confirmed by a Swedish study, where coffee intake was associated with a modest (20%) decrease in estrogen receptor (ER)-negative breast cancer among postmenopausal women drinking ≥ 5 cups coffee a day [24]. An 11-year French cohort study [9], and a 22-year follow-up American study [11] reported lack of relationship between coffee and breast cancer risk. Also, recently published meta-analyses of studies found no significant association between breast cancer risk and coffee consumption [18], either inverse [52], or only a borderline significant beneficial relationship between high coffee intake and the risk of breast cancer [41].

According to some authors, the effect of coffee intake on breast cancer risk can depend on caffeine metabolism, with cytochrome P450 CYP1A2 playing the essential role. Metabolites of caffeine are regarded as the best markers of the activity of this cytochrome in humans. CYP1A2 is also involved in the metabolism of estrogen and, therefore, is the key enzyme in the etiology of breast cancer [2, 4, 13, 21, 28]. Some data imply that the relation between coffee consumption and cancer risk can be modified by the *CYP1A2*1F* genotype. One study conducted in Sweden suggested that moderate to excessive consumption of coffee by patients with the *CYP1A2*1F* AA genotype may slow the growth of estrogen receptor-positive tumors [4]. Conflicting results were reported in another study from this country including healthy postmenopausal non-hormone users. According to that study, consumption ≥ 3 cups of coffee a day protects against breast cancer only in C genotype carriers [17]. However, a study by *Lowcock et al.*, has shown a significant reduction (29%) of breast cancer risk in heavy coffee drinkers (≥ 5 cups a day), independently of the CYP1A2 genotype [28]. The protective effect of coffee on women with the C genotype (AC or CC) but not the AA genotype was also observed in carriers of the BRCA1 mutation who are at high-risk of breast cancer [20]. Premenopausal women with the *BRCA1* or *BRCA2* mutation who ha-

bitually drank ≥ 6 cups of coffee a day experienced a statistically significant reduction (by 70%) in breast cancer risk also according to another study [32]. Finally, a meta-analysis of 37 studies by Jiang et al., published in 2013 demonstrated an inverse association of coffee/caffeine intake with breast cancer risk in carriers of the BRCA1 mutation [18].

LIVER CANCER

Data on potentially beneficial effects of coffee on liver function and liver diseases have accrued over the last two decades. Since 2007, all published data in this area indicate that coffee consumption can protect against liver cancer. A meta-analysis of cohort and case-control studies by *Larsson* and *Wolk* [22] reported an inverse association between coffee consumption and liver cancer among individuals with and without a history of liver disease. Their conclusion was also confirmed by a meta-analysis of cohort studies by *Yu* et al., who suggested a significant inverse relation between coffee intake and hepatocellular cancer [52]. Two independent meta-analyses were published in 2013. One of them stated the risk of liver cancer for high coffee drinkers was 50% lower than for no/almost never drinkers both, in European and in Asian studies [37]. The second reported that the risk of hepatocellular carcinoma for coffee consumption vs. no consumption was lower by 40% [5].

On the basis of epidemiological evidence it seems safe to conclude that coffee drinking not only does not increase the risk of liver cancer but may in fact protect from it. According to some experts, moderate daily intake of unsweetened coffee is a responsible addition to the main therapy for non-alcoholic fatty liver disease patients [44].

BLADDER CANCER

Bladder cancer is the most common cancer of the urinary tract, of unknown etiology. Since the early 1970s, coffee consumption has been considered to be related with an increased risk of bladder cancer [51]. Despite a large number of studies published since then, the relation between coffee and bladder cancer remains highly controversial [42]. A meta-analysis of cohort studies in 2011 found coffee to be inversely associated with bladder cancer in men, whereas that trend was not observed in women [52]. A meta-analysis of case-control studies, published a year later, provides opposite data, suggesting a linear increase in the risk of bladder cancer along with the amount of coffee intake (15-29% increase for 2-4 cups of coffee a day, respectively).

On the other hand, a meta-analysis of cohort studies in that publication failed to confirm such a correlation [53]. However, the results of the latest meta-analysis of observational studies in 2015 postulate an increased risk between coffee consumption and bladder cancer, especially among male coffee drinkers and non-smoking coffee drinkers [51].

PROSTATE CANCER

The results of studies relating to coffee consumption and prostate cancer remain inconsistent, despite numerous meta-analyses undertaken recently. A meta-analysis of case-control studies in 2010 reported a harmful association between coffee consumption and prostate cancer risk, whereas cohort studies failed to confirm it [34]. The meta-analyses of cohort studies in 2014 and 2015, which support the hypothesis that coffee consumption may even decrease the risk of prostate cancer, provided more optimistic conclusions [7, 26].

OTHER CANCERS

Regardless of the findings of the meta-analysis from 2011 that coffee consumption may reduce the total cancer incidence [52], data about lung cancer are less optimistic. In one study, an elevated lung cancer risk was observed for drinkers of ≥ 2 cups of coffee a day [3]. In another report, a linear relationship was found between coffee consumption and increased risk of lung cancer, especially for consumers of ≥ 3 cups coffee a day [48]. A meta-analysis on this topic indicated that high coffee consumption may increase the risk of lung cancer but, according to the authors, these results should be interpreted with caution due to other confounding factors, e.g. smoking [40]. As far as pancreatic cancer is concerned, two meta-analyses were published recently. The first suggests the existence of an inverse relationship between coffee drinking and the risk of pancreatic cancer [8], whereas according to the second coffee consumption is not appreciably related to pancreatic cancer, even at high intakes [46].

SUGGESTED ACTION OF COFFEE ON CANCER RISK

Despite a great number of studies on the relationship between coffee consumption and health, the protective mechanism of coffee against cancer remains elusive. Coffee can potentially impact the etiology of cancer by multiple pathways. One of them is connected with polyphenols which are abundant in coffee. Polyphenols

have strong antioxidant properties and can inhibit oxidative stress and oxidative DNA damage [6, 54]. In such countries as Finland and Norway, where that drink is extremely popular, coffee provides more than 50% of the total dietary antioxidants [6, 45]. The chlorogenic acid, which may slow intestinal glucose absorption and support insulin sensitivity in the body, is the most known among coffee polyphenols. Chronic hyperinsulinemia and insulin resistance are confirmed markers of high risk for some cancer sites [52].

Coffee is also a source of diterpenes – cafestol and kahweol, which can modulate multiple enzymes involved in carcinogenic detoxification, especially in the process of hepatic detoxification [19, 22, 44, 51]. Drinking coffee has been associated with a reduced risk of hepatic injury and cirrhosis and, via that pathway, coffee can protect against liver carcinogenesis [5, 22, 29]. With reference to colon cancer, specific possible mechanism include reduction of synthesis and secretion of bile acids, known promoters of colon cancer [10, 23], whereas in case of breast cancer the anti-carcinogenic properties of coffee can result from altered estrogen metabolism [4].

It is important to note that coffee is a primary source of caffeine. Based on the current evidence, it is suggested that moderate caffeine intake by healthy adults at a dose level of 400 mg a day is not associated with adverse effects, including incidence of cancer. Composition of coffee is determined by strength of the brew and brewing methods. Stronger brews have higher levels of caffeine, but also lots of beneficial polyphenols [15, 31, 49].

Considering the influence of coffee on health it is important to take into consideration various genetic factors, mainly determined by the CYP1A2 genotype, which play a role in metabolism of caffeine [2].

ACRYLAMIDE IN COFFEE

Acrylamide is an industrial monomer which has been manufactured for over 50 years and used in many fields of industry. This substance is also formed during the process of cooking, principally by the *Maillard* reaction between the amino acid asparagine and reducing sugars [30, 35]. Acrylamide is produced during roasting of coffee beans in high temperatures [6, 30]. Numerous studies have shown coffee to be a significant dietary source of acrylamide. In adult diet, coffee may deliver up to 39% of the total daily intake of this substance [19, 30]. A study by *Mojška* et al., found that one cup of coffee contained on average 0.45 µg of acrylamide [30].

A lot of animal studies have shown that acrylamide is carcinogenic [30, 36]. In 1986, an American study revealed a report on the mortality rate among 371 em-

ployees who had had potential exposure to acrylamide during monomer production and polymerization operations at an industrial facility [39]. Finally, in 1994 acrylamide was evaluated by the International Agency for Research on Cancer as “probably carcinogenic to humans” (IARC Group 2A) [30, 36]. Nevertheless, epidemiological studies and retrospective re-analyses of data published so far failed to provide sufficient evidence that dietary acrylamide increases the risk of any type of cancer in humans, including kidney, large bowel, bladder, oral cavity, breast, and ovarian cancer [25, 36, 50].

SUMMARY

Results of recently published studies on the effect of coffee on health are surprisingly positive for coffee consumers. An accumulated body of scientific evidence confirmed a lack of correlation between coffee intake and development of cancer. Furthermore, some authors suggest that coffee may in fact have pro-health properties. However, bearing in mind many factors affecting the risk of cancer in humans, the assumption that habitual coffee drinking can prevent carcinogenesis should be interpreted with caution.

Also, it is important to note that the impact of coffee on health may depend on the type and strength of the brew, and serving size. Most studies failed to provide accurate information on that matter. Therefore, the question whether every kind of coffee has the same impact on human body and which coffee is potentially the best remains unanswered. In Poland, it is very popular to pour hot water directly over the ground coffee in a cup. However, to the best of our knowledge, the Polish literature offers no data on the effect of such method of brewing on human health. In Western countries, where most scientific data come from, coffee is often prepared using paper filter. On the other hand, optimistic scientific findings come from various regions of the world, including America, Japan, and Europe, what may be proof that coffee is not harmful and support the hypothesis that coffee may be recommended in the future as an element of a pro-health diet.

REFERENCES

1. *Arab L.*: Epidemiologic evidence on coffee and cancer. *Nutr Cancer*. 2010; 62(3): 271-283.
2. *Ayari I., Fedeli U., Saguem S., Hidar S., Khlifti S., Pavanello S.*: Role of CYP1A2 polymorphisms in breast cancer risk in women. *Mol Med Rep*. 2013; 7(1): 280-286.
3. *Baker J.A., McCann S.E., Reid M.E., Nowell S., Beehler G.P., Moysich K.B.*: Association between black tea

- and coffee consumption and risk of lung cancer among current and former smokers. *Nutr Cancer*. 2005; 52(1): 15-21.
4. *Bågeman E., Ingvar C., Rose C., Jernström H.*: Coffee consumption and CYP1A2*1F genotype modify age at breast cancer diagnosis and estrogen receptor status. *Cancer Epidemiol Biomarkers Prev*. 2008; 17(4): 895-901.
 5. *Bravi F., Bosetti C., Tavani A., Gallus S., La Vecchia C.*: Coffee reduced risk for hepatocellular carcinoma: an updated meta-analysis. *Clin Gastroenterol Hepatol*. 2013; 11(11): 1413-1421.
 6. *Bøhn S.K., Blomhoff R., Paur I.*: Coffee and cancer risk, epidemiological evidence, and molecular mechanisms. *Mol Nutr Food Res*. 2014; 58: 915-930.
 7. *Cao S., Liu L., Yin X., Wang Y., Liu J., Lu Z.*: Coffee consumption and risk of prostate cancer: a meta-analysis of prospective cohort studies. *Carcinogenesis*. 2014; 35(2): 256-261.
 8. *Dong J., Zou J., Yu X.F.*: Coffee drinking and pancreatic cancer risk: a meta-analysis of cohort studies. *World J Gastroenterol*. 2011; 17(9): 1204-1210.
 9. *Fagherazzi G., Touillaud M.S., Boutron-Ruault M.C., Clavel-Chapelon F., Romieu I.*: No association between coffee, tea or caffeine consumption and breast cancer risk in a prospective cohort study. *Public Health Nutr*. 2011; 14(7): 1315-1320.
 10. *Galeone C., Turati F., La Vecchia C., Tavani A.*: Coffee consumption and risk of colorectal cancer: a meta-analysis of case-control studies. *Cancer Causes Control*. 2010; 21(11): 1949-1959.
 11. *Ganmaa D., Wiolett W.C., Li T.Y., Feskanich D., van Dam R.M., Lopez-Garcia E., Hunter D.J., Holmes M.D.*: Coffee, tea, caffeine and risk of breast cancer: a 22-year follow-up. *Int J Cancer*. 2008; 122, 9: 2071-2076.
 12. *Giovannucci E.*: Meta-analysis of coffee consumption and risk of colorectal cancer. *Am J Epidemiol*. 1998; 147(11): 1043-1052.
 13. *Goodman M.T., Tung K.H., McDuffie K., Wilkens L.R., Donlon T.A.*: Association of caffeine intake and CYP1A2 genotype with ovarian cancer. *Nutr Cancer*. 2003; 46(1): 23-29.
 14. *Hermansen K., Krogholm K.S., Bech B.H., Dragsted L.O., Hyldstrup L., Jørgensen K., Larsen M.L., Tjønneland A.M.*: Coffee can protect against disease. *Ugeskr Laeger*. 2012; 174(39): 2293-2297.
 15. *Jarosz M., Wierzejska R., Siuba M.*: Maternal caffeine intake and its effect on pregnancy outcomes. *Eur J Obstet Gynecol Reprod Biol*. 2012; 160: 156-160.
 16. *Je Y., Liu W., Giovannucci E.*: Coffee consumption and risk of colorectal cancer: a systematic review and meta-analysis of prospective cohort studies. *Int J Cancer*. 2009; 124(7): 1662-1668.
 17. *Jernström H., Henningson M., Johansson U., Olsson H.*: Coffee intake and CYP1A2 *1F genotype predict breast volume in young women: implications for breast cancer. *Br J Cancer*. 2008; 99(9): 1534-1538.
 18. *Jiang W., Wu Y., Jiang X.*: Coffee and caffeine intake and breast cancer risk: an updated dose-response meta-analysis of 37 published studies. *Gynecol Oncol*. 2013; 129(3): 620-629.
 19. *Kosicka T., Kara-Perz H., Gluszek J.*: Kawa – zagrożenie czy ochrona. *Przewodnik lekarza*. 2004; 69(9): 78-83.
 20. *Kostopoulos J., Ghadirian P., El-Sohemy A., Lynch H.T., Snyder C., Daly M., Domchek S., Randall S., Karlan B., Zhang P., Zhang S., Sun P., Narod S.A.*: The CYP1A2 genotype modifies the association between coffee consumption and breast cancer risk among BRCA1 mutation carriers. *Cancer Epidemiol Biomarkers Prev*. 2007; 16(5): 912-916.
 21. *Landi M.T., Sinha R., Lang N.P., Kadlubar F.F.*: Human cytochrome P4501A2. *IARC Sci Publ*. 1999; 148: 173-195.
 22. *Larsson S.C., Wolk A.*: Coffee consumption and risk of liver cancer: a meta-analysis. *Gastroenterology*. 2007; 132(5): 1740-1745.
 23. *Li G., Ma D., Zhang Y., Zheng W., Wang P.*: Coffee consumption and risk of colorectal cancer: a meta-analysis of observational studies. *Public Health*. 2013; 16(2): 346-357.
 24. *Li J., Seibold P., Chang-Claude J., Flesch-Janys D., Liu J., Czene K., Humphreys K., Hall P.*: Coffee consumption modifies risk of estrogen-receptor negative breast cancer. *Breast Cancer Res*. 2011; 13(3): 49.
 25. *Lipworth L., Sonderman J.S., Tarone R.E., McLaughlin J.K.*: Review of epidemiologic studies of dietary acrylamide intake and the risk of cancer. *Eur J Cancer Prev*. 2012; 21(4): 375-386.
 26. *Liu H., Hu G.H., Wang X.C., Huang T.B., Xu L., Lai P., Guo Z.F., Xu Y.F.*: Coffee consumption and prostate cancer risk: a meta-analysis of cohort studies. *Nutr Cancer*. 2015; 67(3): 392-400.
 27. *Lopez-Garcia E., Rodrigues-Artalejo F., Li T.Y., Mukamal K.J., Hu F.B., van Dam R.M.*: Coffee consumption and mortality in women with cardiovascular disease. *Am J Clin Nutr*. 2011; 94: 218-224.
 28. *Lowcock E.C., Cotterchio M., Anderson L.N., Boucher B.A., El-Sohemy A.*: High coffee intake, but no caffeine is associated with reduced estrogen receptor negative and postmenopausal breast cancer risk with no effect modification by CYP1A2 genotype. *Nutr Cancer*. 2013; 65(3): 398-409.
 29. *Masterton G.S., Hayes P.C.*: Coffee and liver: a potential treatment for liver disease? *Eur J Gastroenterol Hepatol*. 2010; 22(11): 1277-1283.
 30. *Mojska H., Gielecińska I.*: Studies of acrylamide level in coffee and coffee substitutes: influence of row material and manufacturing conditions. *Rocz Panstw Zakl Hig*. 2013; 64(3): 173-181.
 31. *Mostofsky E., Rice M.S., Levitan E.B., Mittleman M.A.*: Habitual coffee consumption and risk of heart failure: a dose-response meta-analysis. *Circ Heart Fail*. 2012; 5: 401-405.
 32. *Nkondjock A., Ghadirian P., Kostopoulos J., Lubinski J., Lynch H.T., Kim-Sing C., Horsman D., Rosen B., Isaacs C., Weber B., Foulkes W., Ainsworth P., Tung N., Essen A., Friedman E., Eng C., Sun P., Narod S.A.*: Coffee consumption and breast cancer among BRCA1 and BRCA2 mutation carriers. *Int J Cancer*. 2006; 118(1): 103-107.

33. Nomura A., Heilbrun L.K., Stemmermann G.N.: Prospective study of coffee consumption and risk of cancer. *J Natl Cancer Inst.* 1986; 76(4): 587-590.
34. Park C.H., Myung S.K., Kim T.Y., Seo H.G., Jeon Y.J., Kim Y.: Coffee consumption and risk of prostate cancer: a meta-analysis of epidemiological studies. *BJU Int.* 2010; 106(6): 762-769.
35. Pelucchi C., La Vecchia C., Bosetti C., Boyle P., Boffetta P.: Exposure to acrylamide and human cancer – a review and meta-analysis epidemiologic studies. *Ann Oncol.* 2011; 22(7): 1487-1499.
36. Rice J.M.: The carcinogenicity of acrylamide. *Mutation Research.* 2005; 580: 3-20.
37. Sang L.X., Chang B., Li X.H., Jiang M.: Consumption of coffee associated with reduced risk of liver cancer: a meta-analysis. *BMC Gastroenterol.* 2013; 13, 34.
38. Snowdon D.A., Phillips R.L.: Coffee consumption and risk of fatal cancers. *Am J Public Health.* 1984; 74(8): 820-823.
39. Sobel W., Bond G.G., Parsons T.W., Brenner F.E.: Acrylamide cohort mortality study. *Br. J. Ind. Med.* 1986; 43: 785-788.
40. Tang N., Wu Y., Ma J., Wang B., Yu R.: Coffee consumption and risk of lung cancer: a meta-analysis. *Lung Cancer.* 2010; 67(1): 17-22.
41. Tang N., Zhou B., Wang B., Yu R.: Coffee consumption and risk of breast cancer: a meta-analysis. *Am J Obstet Gynecol.* 2009; 200(3): 290-299.
42. Tavani A., La Vecchia C.: Coffee and cancer: a review of epidemiological studies 1990-1999. *Eur J Cancer.* 2000; 9(4): 241-256.
43. Tian C., Wang W., Hong Z., Zhang X.: Coffee consumption and risk of colorectal cancer: a dose-response analysis of observational studies. *Cancer Causes Control.* 2013; 24: 1265-1268.
44. Torres D.M., Harrison S.A.: Is it time to write a prescription for coffee? Coffee and liver disease. *Gastroenterology.* 2013; 144(4): 670-672.
45. Tuomilehto J.: Coffee and Heath. *Duodecim.* 2013; 129(13): 1398-1405.
46. Turati F., Galeone C., Edefonti V., Ferraroni M., Lagiou P., La Vecchia C., Tavani A.: A meta-analysis of coffee consumption and pancreatic cancer. *Ann Oncol.* 2012; 23(2): 311-318.
47. Vatten L.J., Solvoll K., Løken E.B.: Coffee consumption and risk of breast cancer. A prospective study of 14,593 Norwegian women. *Br J Cancer.* 1990; 62(2): 267-270.
48. Wang Y, Yu X, Wu Y.: Coffee and tea consumption and risk of lung cancer: a dose-response analysis of observational studies. *Lung Cancer.* 2012; 78: 167-170.
49. Wierzejska R.: Kofeina - powszechny składnik diety i jej wpływ na zdrowie. *Rocz Panstw Zakl Hig* 2012; 63(2): 141-147.
50. Wilson K.M., Giovannucci E., Stampfer M.J., Mucci L.A.: Dietary acrylamide and risk of prostate cancer. *Int J Cancer.* 2012; 131(2): 479-487.
51. Wu W., Tong Y., Zhao Q., Yu G., Wei X., Lu Q.: Coffee consumption and bladder cancer: a meta-analysis of observational studies. *Sci Rep.* 2015; doi: 10.1038/srep09051.
52. Yu X., Bao Z., Zou J., Dong J.: Coffee consumption and risk of cancers: a meta-analysis of cohort studies. *BMC Cancer.* 2011; 11: 96.
53. Zhou Y., Tian C., Jia C.: A dose-response meta-analysis of coffee consumption and bladder cancer. *Prev Med.* 2012; 55(1): 14-22.
54. Żukiewicz-Sobczak W., Krasowska E., Sobczak P., Horach A., Wojtyła A., Piątek J.: Wpływ spożycia kawy na organizm człowieka. *Medycyna Ogólna i Nauki o Zdrowiu.* 2012; 18(1): 71-76.

Received: 31.07.2015

Accepted: 08.09.2015

BISPHENOL A (BPA) IN FOOD CONTACT MATERIALS – NEW SCIENTIFIC OPINION FROM EFSA REGARDING PUBLIC HEALTH RISK

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ABSTRACT

The wide use of bisphenol A (BPA) as a monomer in plastics manufacture or epoxy resins intended for food contact materials (FCM) has triggered numerous concerns due to toxicological findings indicating possible endocrine disrupting properties. This article traces the evolution of the scientific opinions since 1986 when the Tolerable Daily Intake (TDI) for BPA and its specific migration limit (SML) from plastic FCM into food were proposed for the first time by the Scientific Committee for Food (SCF). Recent extensive scientific studies concerning refined data on toxicity and exposure to BPA from food and non-food sources (eg. dust, cosmetics, thermal paper), including the most vulnerable groups of population, allowed the European Food Safety Authority (EFSA) to reduce the TDI of BPA from previously 50 µg/kg bw/day to now 4 µg/kg bw/day. EFSA's latest scientific opinion published in 2015 concludes that basing on the current estimations of total exposure to BPA from dietary and non-dietary sources for infants, children and adolescents is below the temporary TDI of 4 µg/kg bw/day. EFSA has also underlined that BPA poses no health risk at the estimated exposure levels of any population age group, including unborn children and the elderly. However, EFSA has indicated that some data on exposure and toxicological effects still require clarifications.

Key words: *bisphenol A, BPA, food contact materials, toxicology, exposure, toxicity, TDI, specific migration limit, EFSA*

STRESZCZENIE

Szerokie zastosowanie bisfenolu A (BPA) jako monomeru w produkcji tworzyw sztucznych i żywic epoksydowych przeznaczonych do kontaktu z żywnością wywołało wiele obaw wynikających z badań toksykologicznych wskazujących na możliwe szkodliwe działanie, szczególnie odnoszące się do efektów endokrynych. W artykule przedstawiono ewolucję podejścia do BPA oraz kolejnych opinii naukowych od 1986 roku, kiedy Naukowy Komitet ds. Żywności (SCF) po raz pierwszy zaproponował dla BPA wartość tolerowanego dziennego pobrania (TDI) i limit migracji specyficznej (SML) tego związku do żywności z materiałów z tworzyw sztucznych przeznaczonych do kontaktu z żywnością. Obszerne piśmiennictwo naukowe dotyczące pogłębionych badań toksycznego działania i narażenia na BPA, zarówno z żywności, jak i ze źródeł poza żywnościowych (kurz, kosmetyki, papier termiczny), uwzględniające najbardziej wrażliwe grupy populacji, umożliwiły EFSA obniżenie TDI z 50 µg/kg mc/dzień do 4 µg/kg mc/dzień. EFSA w swojej naukowej opinii z 2015 roku podkreśla, że na podstawie aktualnych oszacowań całkowite narażenie niemowląt, dzieci i młodzieży na BPA ze źródeł żywieniowych i poza żywieniowych jest poniżej tymczasowego TDI, wynoszącego 4 µg/kg mc/dzień. W opinii tej EFSA podkreśliła, że BPA nie stwarza ryzyka dla zdrowia, przy oszacowanych poziomach narażenia, dla żadnej z grup populacji, włączając również nienarodzone dzieci i osoby starsze. EFSA wskazała jednak na potrzebę wyjaśnienia niektórych danych dotyczących narażenia i badań toksykologicznych.

Słowa kluczowe: *bisfenol A, BPA, materiały do kontaktu z żywnością, narażenie, toksyczność, TDI, limit migracji specyficznej, EFSA*

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INTRODUCTION

Bisphenol A [2,2-bis(4-hydroxyphenyl)propane, CAS No. 80-05-7, EEC packaging material Ref. No. 13480] commonly known as BPA is widely used as a monomer in the manufacture of polycarbonates (PC) and epoxy resins and as an additive in other polymeric materials. Due to their rigidity and transparency, polycarbonates are used in food contact materials, such as tableware, infant feeding bottles and reservoirs for water dispensers, and also in other applications such as toys and pacifiers. BPA-based epoxy resins can be used as internal protective coatings in cans for food and beverages and in drinking water storage tanks. BPA is also used in a number of non-food applications, e.g. epoxy resin-based paints, medical devices, dental materials, surface coatings, printing inks, thermal paper (eg. for cash receipts), flame retardants and common plastic products (eg. CDs, DVDs) [20, 22, 38].

In the last decade several objections concerning BPA-related delayed adverse health effects have been raised following the worldwide intensive discussion triggered by toxicological findings, mainly based on its endocrine disrupting properties [17, 20, 21, 24, 25]. The use of BPA in food contact materials (FCM) may thus cause a potential consumer exposure of this substance through food. A large number of research studies on toxicity and endocrine activity of BPA in animals have been published. However, there have been discrepancies in outcomes from different studies. This has led to the controversy about the BPA safety in the opinion of scientists and has resulted in different decisions concerning risk management being undertaken by the various national authorities [22, 23, 25].

Legal status related to BPA in FCM

The use of BPA in materials intended into contact with food is regulated at the European Union level. BPA was first evaluated in 1986 by the Scientific Committee on Food (SCF) for use in manufacturing of plastic FCM. The SCF allocated a Tolerable Daily Intake (TDI) for BPA at the level 0.05 mg/kg bw/day [52]. BPA was also placed on the list by the Commission Directive 90/128/EEC as a permitted substance which may be used in plastic food contact materials with a specific migration limit (SML) of 3.0 mg/kg food [9].

In 2002, the SCF [53] changed the status of BPA by setting a temporary TDI of 0.01 mg BPA/kg bw/day, and applying a 500-fold uncertainty factor (UF) (comprising 10 for interspecies differences, 10 for inter-individual differences and 5 for uncertainties in the toxicity database), due to the lack of complete toxicological data. The SCF recommended that the TDI should be reviewed when any significant new data

becomes available [53]. This high UF was applied in the NOAEL (No-Observed-Adverse-Effect-Level) of 5 mg/kg bw/day identified in a three-generation study in the rat by Tyl et al. [59]. SML for BPA was accordingly reduced to 0.6 mg/kg of food which was reflected by the Commission Directive 2004/19/EC [11], amending Commission Directive 2002/72/EC [10].

In 2006, EFSA based on an extensive literature survey reduced the uncertainty factor to 100 and established a full TDI of 0.05 mg/kg bw/day. In the same evaluation the SML for BPA remained at the level of 0.6 mg/kg [20]. In 2008, EFSA re-confirmed the TDI (0.05 mg/kg bw/day) stating that the new data available did not provide convincing evidence to establish a lower value for TDI [21].

In 2011, the Commission Directive 2011/8/EU [12] prohibited, as a precautionary measure, the manufacture of polycarbonate infant feeding bottles with BPA as from 1 March 2011 and the placing on the market and import into the EU of such feeding bottles as from 1 June 2011.

Some European Union Member States banned the use of BPA in containers and packaging for food intended for children up to 3 years old and some of them extended this ban for other applications.

Denmark in 2010 banned the use of BPA in infant feeding bottles and cups and all containers for food products, such as breast milk substitutes and mixed substitutes intended for children for 0-3 years of age [2]. Austria in 2011 published a decree forbidding the use of BPA in pacifiers and soothers [63]. Belgium in 2012 banned the marketing and putting on the market and manufacture of containers for food products, containing BPA, particularly intended for children between 0-3 years of age [44]. France in 2012 adopted the law suspending the manufacturing, import, export and putting on the market of all food contact materials containing BPA and also introduced labelling requirements for pregnant women, breastfeeding women and small children [48]. Sweden in 2013 banned the use of BPA or compounds containing BPA in varnishes or coatings in the packaging for food intended for children aged 0-3 years old [57].

Since 2006 much additional data including exposure and toxic aspects of BPA became available that justified refining previous assessments.

In 2015 EFSA published a new scientific opinion based on the assessment of health-related risks associated with human exposure to BPA [23, 23]. The external dietary and non-dietary exposure and internal exposure (absorbed dose of conjugated and unconjugated BPA) was included in this assessment and expressed as oral human equivalent dose (HED) referring to unconjugated BPA only. In this opinion based on new toxicological data EFSA adopted a total uncertainty factor of 150-

fold and the lowered previous TDI (50 µg/kg bw/day) to a temporary TDI of 4 µg/kg bw/day. This substantial change was made by EFSA because of new data and a refined risk assessment together with uncertainties in the database regarding mammary glands, reproductive, metabolic, neurobehavioral and immune systems [22]. Taking into account the t-TDI and the exposure and toxicity estimates EFSA concluded that there is no health risk from BPA dietary or aggregated exposure (diet, dust, cosmetics and thermal paper) for any age group of consumers, including unborn children, infant and adolescents. Dietary exposure and from the combined sources is considerably below the new t-TDI. [22, 23]. The t-TDI remains temporary pending the results of a long-term animal study, which will allow to reduce these uncertainties.

EFSA maintained the same specific migration limit (0.6 mg/kg food) with the restriction on the use of BPA in the infant feeding bottles.

The evolution history of the reference values: tolerable daily intakes and specific migration limits related to bisphenol A in plastic food contact materials is summarized in Table 1.

Table 1 Evolution of the reference values: TDI and SML related to BPA in plastic food contact materials

Year	TDI ¹ (mg/kg bw/day)	SML ² (mg/kg food or food simulant)	Reference
1986	0.05	3.0	[9, 52]
2002	0.01 (t-TDI)	0.6 SML(T)	[11, 53]
2006	0.05	0.6 SML(T)	[11, 20]
2010	0.05	0.6	[14, 21]
2011	0.05	0.6*	[12, 13]
2015	0.004 (t-TDI) (4 µg/kg bw/day)	0.6*	[13, 22]

* **Restriction:** BPA not to be used for the manufacture of polycarbonate infant feeding bottles [12, 13]

¹ TDI (Tolerable Daily Intake) is an estimate of the amount of a substance, expressed in milligrams on a body weight that can be ingested daily over a lifetime without appreciable risk. The TDI has been set to protect all human populations for lifetime exposure, including the most vulnerable groups such as pregnant and lactating women, infants and young children.

t-TDI (temporary Tolerable Daily Intake) is allocated if there are uncertainties in the data that may be resolved by further studies and it is known that significant new data will be available in the near future.

² SML - specific migration limit for individual substance fixed on the basis of a toxicological evaluation. It is set according to the TDI established by the SCF/EFSA. To set the limit, it is assumed that, every day throughout lifetime, a person of 60 kg body weight consumes 1kg of food packed in plastics containing the substance at the maximum permitted quantity. SML is expressed in mg/kg food or food simulant [14].

SML(T) - specific migration limit (total) in food or food simulant expressed as total of a substance indicated.

DIETARY AND NON-DIETARY EXPOSURE TO BPA

Sources of BPA and migration

The general population can be exposed to BPA from dietary (food, drinking water) and non-dietary (dust, air, thermal paper, cosmetics, toys etc.) sources.

The studies on the exposure to BPA showed that diet is the main source in all population groups. This is due to migration of BPA into the food from food contact materials such as polycarbonate (PC) plastics and epoxy resins. Food contact materials as a potential source of exposure to endocrine disruptors, including BPA were discussed by many authors [16, 34, 37, 40, 46]. Specifically, BPA can be released from PC into food products as residual monomer present in the plastic and epoxy resins, as well as by hydrolysis of ester bonds of the polymer, a reaction that is catalysed by hydroxide when the polymer is in contact with aqueous food [15, 37, 45].

Epoxy resins are low molecular weight pre-polymers or higher molecular weight polymers which normally contain at least two epoxide groups. Since the epoxy resins are produced by O-alkylation of BPA with epichlorohydrin to form BPA-diglycidyl ether (BADGE) they may also contribute to the external exposure to BPA *via* food and water. The applications for epoxy-based materials are extensive and include coatings, adhesives, multilayer packaging and plastic components for direct food and beverage containers and composite materials such as those using carbon fibre and fiberglass reinforcements [38].

The wide use of polycarbonate plastics and epoxy resins triggers common concerns on the possible BPA migration into canned foods and into food having the contact with tableware [5, 15, 27, 28, 33, 39, 64]. Another source of concern may be the potential migration of BPA from vessels into food during microwave heating or potential migration of BPA into drinking water due to the use of PC and of epoxy-phenolic resins in water pipes and in water storage tanks [38].

The migration of BPA from commonly used food packaging and PC feeding bottles into food simulants was studied by many authors [6, 15, 27, 41, 43, 45, 50, 54, 55, 56, 65]. *Simoneau et al.* [54] reported BPA below limit of determination (0.1 µg/kg) in 32 out of 40 baby bottles made from PC sold in the European market when tested with 50% ethanol (used as a simulant for milk) for two hours at 70 °C after boiling for five minutes. The highest migration value was 1.83 µg/kg and most of the bottles did not release detectable levels of BPA in the second or third migration test carried out with this simulant. Also *Santillana et al.* [50] tested 72 baby bottles, taken from the market in Spain, for BPA migration into 50% ethanol and 3% acetic acid, for two hours at

70 °C followed by 24 hours at 40 °C by. In this study the highest value found in the third migration test into 3% acetic acid was 18 µg/kg and it occurred in only one of all tested bottles.

Brede et al. [6] found that brushing and boiling polycarbonate baby bottles causes increased BPA migration into food simulants. The effect of washing procedures on BPA migration into water simulants was also investigated by Hoekstra and Simoneau [37] who did not confirm that brushing polycarbonate bottles may increase BPA migration or that the migration from older bottles may be elevated as compared to the new ones. The studies generally show that under typical use conditions, the potential BPA migration from polycarbonate plastic articles intended into contact with food is rather low [45, 55, 56]. It depends on the food simulants used in the experiment, temperature and contact time. Most literature studies report a release of BPA into food simulant (3% acetic acid) below the specific migration limit (0.6 mg/kg).

Food contact articles made from polycarbonates such as kettles, coolers and filters for water may be the source of the additional dietary exposure to BPA. Literature data retrieved by EFSA reported BPA migration from such articles as follows: for coolers with PC reservoir - 0.81 µg/L, PC water kettles - 0.11 µg/L, PC filters - 0.04 µg/L in water [23].

Dietary exposure

Based on the literature data [24, 47, 51] EFSA estimated that average exposure to BPA for breastfed infants aged (1-5 days), (6 days-3 months) and (4-6 months) is 0.225, 0.165 and 0.145 µg/kg bw/day and the high exposure is 0.435, 0.600 and 0.528 µg/kg bw/day, respectively [22]. In the case of formula fed infants aged 0-6 months dietary exposure was considerably lower (0.030 µg/kg bw/day for average exposure and 0.080 µg/kg bw/day for the high exposure) compared to breastfed children. These estimates were based on the assumption that non-PC feeding bottles and water containing low level of BPA were used to reconstitute the formula product. Potential dietary exposure to BPA

estimates in different age groups of the general population is presented in Table 2.

For the population aged over 6 months and up to 10 years of age the estimated dietary exposure was considerably higher: ranging from 0.290 to 0.375 µg/kg bw/day (for average exposure) and from 0.813 to 0.857 µg/kg bw/day (for high exposure) (Table 2). This was mainly due to higher consumption of food and beverages per kilogram body weight. Additionally, the highest assessed dietary exposure for infants and toddlers from food contact articles was 0.086 µg/kg bw/day (0.014 µg/kg bw/day from PC tableware, 0.046 µg/kg bw/day from PC cookware and 0.026 µg/kg bw/day - from water coolers and PC filters into the drinking water. The contribution of BPA from non-dietary sources such as dust and toys for infants and toddlers was 0.015 µg/kg bw/day (Table 4).

The modelled dietary exposure for adolescents (10-18 years of age), adults (including women of childbearing age) and elderly ranged from 0.116 to 0.159 µg/kg bw/day (average exposure) and from 0.335 to 0.388 µg/kg bw/day (high exposure) (Table 2).

The above dietary exposure estimations show considerably lower exposure as compared to previous EFSA estimations in 2006 [20], where a very conservative approach was applied due to the lack of data for consumption of canned food levels and the estimated BPA concentration in these foods.

The FAO/WHO Expert Meeting [25] which estimated international exposure to BPA, considered a variety possible scenarios of model diets, combining consumption from the best-case scenario (25% consumption from packaged food) to the worst-case scenario (100% of consumption from packaged food). The 'best-case estimate' refers to the scenario that results in the lowest realistic exposure and the 'worst-case estimate' refers to such scenario that results in the highest exposure, representing the most conservative estimate.

The results of the estimated potential international dietary exposure to BPA according to different possible scenarios for different population groups is presented in Table 3.

Table 2. Dietary exposure to BPA estimates for different age groups of the general population [22]

Population	Average exposure (µg/kg bw/day)	High exposure 95% percentile (µg/kg bw/day)
Infants (1 - 5 days) - <i>breastfed</i>	0.225	0.435
Infants (6 days - 3 months) - <i>breastfed</i>	0.165	0.600
Infants (4 - 6 months) - <i>breastfed</i>	0.145	0.528
Infant (0-6 months) - <i>formula fed, non-PC bottle</i>	0.030	0.080
Infants (6 - 12 months)	0.375	0.857
Toddlers (1-3 years)	0.375	0.857
Children (3-10 years)	0.290	0.813
Adolescents (10-18 years)	0.159	0.381
Adults (18-45 years)	0.132	0.388
Adults (45-65 years)	0.126	0.341
Elderly (65 years and over)	0.116	0.375

Table 3. International dietary exposures to PBA estimates from model diets for different age groups of the population [25, 26]

Population	Mean exposure (µg/kg bw/day)	High exposure (95th percentile) (µg/kg bw/day)
Infants (0-6 months) <i>exclusively breastfed</i>	0.3	1.3
Infants (0-6 months) <i>Formula (powder-liquid), PC bottle (best case - worst case)^a</i>	2.0 - 2.4	2.7- 4.5
Infants (0-6 months) <i>formula (powder-liquid), no PC bottle (best case - worst case)^a</i>	0.01 - 0.5	0.1-1.9
Toddlers (6-36 months) <i>breastfed + solid food (best case - worst case)^a</i>	0.1	0.3-0.6 ^c
Toddlers (6-36 months) <i>formula, PC bottle + solid food (best case - worst case)^b</i>	0.5 - 0.6	1.6 - 3.0 ^c
Toddlers (6-36 months) <i>formula, no PC bottle + solid food (best case - worst case)^b</i>	0.01-0.1	0.1-1.5 ^c
Children (over 3 years old) <i>(fruits, vegetables, meat, soups, carbonated drinks etc.) (best case - worst case)^b</i>	0.2-0.7	0.5-1.9 ^c
Adults <i>(fruits, vegetables, grains, meat, soups, carbonated drinks, tea, coffee, alcoholic beverages etc.) (best case - worst case)^b</i>	0.4-1.4	1.1-1.2 ^c

^a Formula only, no breast milk

^b Best case scenario - 25% of the food consumed was in the packaging manufactured with BPA and worst case scenario - 100% of the food consumed was in the packaging manufactured with BPA.

^c Budget method scenario was used: maximum consumption is reported in these upper range of exposure estimates.

The average exposure to BPA of infants (0-6 months) exclusively fed with breast milk was estimated 0.3 µg/kg bw/day and the high exposure (at 95% percentile) was estimated to be 1.3 µg/kg bw/day. However, when for infants 6-36 months of age solid food was introduced exposure to BPA decreased relative to body weight. Generally, exposure to BPA was higher for infants fed with liquid formula compared with powdered formula and for infants fed using polycarbonate bottles with non-polycarbonate bottles [26].

More refined dietary exposure assessment for infants applied by the EFSA in 2015 was possible because of much better data availability than in 2006. This resulted from the use, at that time, of very conservative assumptions on BPA concentration in infant formula and to BPA migration from PC feeding bottles to account for the lack of data [19, 20].

Expert opinion draws attention to the fact that food is the major contributor of total exposure to BPA for most population groups.

Non-dietary exposure

The non-dietary sources of BPA considered in the assessment of exposure were air (indoor and outdoor), dust, cosmetics, thermal paper, toys and other articles which may be put into the mouth [3, 22, 26, 40].

The data on the migration of BPA from these sources is relatively small: for air 1 ng/m³, for dust 1460 µg/kg, for cosmetics (eg. body wash, body lotions) – 31 µg/kg. Migration of BPA from toys into saliva over 24 h period – 0.14 µg/toy (for rattles) and 0.98 µg/toy (for pacifiers with PC shields) [22, 25, 32, 42]. The transfer of BPA from thermal paper to fingers was estimated to be 1.4 µg/finger considering 10 seconds of contact with such paper [22]. BPA from thermal paper, cosmetics and dust can be absorbed through the skin and by inhalation. In the European Union countries BPA is

Table 4. Non-dietary exposure to BPA (µg/kg bw/day) in different age groups of the general population [22, 26]

Source and route of exposure	Age group of population	Average exposure (µg/kg bw/day)	High exposure (µg/kg bw/day)
Thermal paper (dermal)	Infants (0-1 year)	not applicable	not applicable
	Toddlers (1-3 years)	not applicable	not applicable
	Children (3-10 years)	0.069	0.550
	Adolescents (10-18 years)	0.094	0.863
	Adults	0.059	0.542
Cosmetics (dermal)	Infants	0.005	0.009
	Toddlers	0.003	0.005
	Children	0.002	0.004
	Adolescents	0.003	0.005
	Adults	0.002	0.004
Dust (oral/ingestion)	Infants	0.009	0.015
	Adults	0.0006	0.001
Toys (oral/ingestion)	Infants	0.0002	0.0006
	Toddlers	0.00001	0.00001
Air (inhalation)	Infants & toddlers	0.0007	0.0014
	Adults	0.0002	0.0003

not permitted in cosmetics and is placed on the list of substances prohibited in such products [49]. However, if their packaging contains BPA it can migrate into the cosmetic products.

For non-dietary sources of BPA inhalation is a relevant route for air, ingestion and inhalation for dust and dermal exposure for thermal paper and cosmetics.

Data on the modelled estimates of non-dietary exposure to BPA for infants, toddlers, children, adolescents and adults according to source and route of exposure are presented in Table 4.

Thermal paper was the largest external non-dietary exposure to BPA in all population groups above 3 years of age (children, adolescents, adults) ranging from 0.094 to 0.863 $\mu\text{g}/\text{kg}$ bw/day for average and high exposure, respectively. However, in children under 3 years of age dust was the largest source of exposure to BPA, ranging from 0.009 to 0.015 $\mu\text{g}/\text{kg}$ bw/day for average and high exposure, respectively. Estimated the highest exposure to BPA for children under 3 years of age from cosmetics was from 0.005 to 0.009 $\mu\text{g}/\text{kg}$ bw/day for average and high exposure, respectively and from toys less than 0.001 $\mu\text{g}/\text{kg}$ bw/day [22, 26].

Taking into account the external exposure to BPA from all dietary and non-dietary sources it was showed that diet is the main source of exposure in all population groups. The second largest source is the thermal paper in all population groups above 3 years of age and dust for the children below 3 years of age.

Comparing the highest estimates for aggregated exposure from dietary and non-dietary sources show that the total exposure will be below the t-TDI (4 $\mu\text{g}/\text{kg}$ bw/day).

TOXICOLOGICAL DATA

The controversy over the toxicity of BPA has been reflected in the reports of numerous organisations [17, 18, 20, 26] and critical reviews [35, 40]. Hengstler et al. [35] in his critical review of key evidence on the human health hazards of exposure to bisphenol A wrote: "Despite the fact that more than 5 000 safety-related studies have been published on Bisphenol A there seem to be no resolution of the apparently dead-locked controversy as to whether exposure of the general population to BPA causes adverse effects due to its estrogenicity". More recent studies in mice have shown that *in utero* exposure to small doses of the oestrogen-like BPA will result in an enlarged prostate and a reduced sperm count [58, 65]. Higher doses of BPA resulted in the opposite effects on the prostate. However, these 'low-dose' results were negated by Cagen et al. [7] and by Ashby et al. [1] leaving doubts on this mode of action and by Ho et al. [36] who concluded that exposure to environmentally

relevant doses of BPA did not result in the induction of prostatic hyperplasia. The combined exposure to BPA and X-rays and BPA to somatic cells of the bone marrow and liver of mice showed that exposure to X rays may magnify the genotoxic effect measured in the bone marrow lymphocytes by the comet assay [30].

The results of another study performed by Chevrier et al. [8] suggested that exposure to BPA during pregnancy was related to reduced total T4 hormone in pregnant women and decreased TSH in male neonates. The maternal BPA concentrations was associated with reduced TSH in boys ($p < 0.01$) but not in girls. This association was stronger when BPA was measured in the third trimester of pregnancy. Overall EFSA has noted some clinical relevancy of the study as a cause of concern but not for qualifying them as critical for establishing a reference dose. Fujimoto et al. [29] did not find associations between serum BPA and oocyte fertilization and embryo cell number [4]. Also Galloway et al. [31] study on daily BPA excretion and possible associations with sex hormone concentration did not shed more light on the potential endocrine effects; rather showing weak associations for all observed effects.

For hazard identification, the effects of BPA on kidney and liver weight reported in rats and mice in multi-generation studies [59, 60] have been regarded by EFSA [22, 23]. In these studies on male mice, the increased kidney weight was associated with nephropathy at the highest BPA dose and mild changes in kidney in female mice but not associated with nephropathy. The possibility of the low-dose effects of BPA, based on *in vitro* and *in vivo* experiments and epidemiological studies [61, 62] have been taken into account in the assessment.

CONCLUSIONS

EFSA concluded that based on the current estimations of exposure to BPA for infants, children and adolescents, which constitute the highest exposure groups, is below the temporary TDI of 4 $\mu\text{g}/\text{kg}$ bw/day. This means that no health concern may be expected at the estimated levels of exposure to BPA, including prenatal and elderly exposure. This opinion has also been extended to consider exposure to BPA from non-dietary sources (thermal paper, dust, cosmetics and toys). However, considerable uncertainties and data gaps were indicated, resulting in the following suggested recommendations for the future.

Exposure data:

- data on BPA concentrations in unpackaged foods,
- data on the use of food contact materials containing BPA, including specific geographical differences,
- the contribution of dermal exposure to overall exposure,

- studies on the frequency and extent of dermal contact with materials containing BPA.
Toxicology data:
- refining the Human Equivalent Dose approach to improve extrapolation of the results in experimental animals to humans, including the toxicokinetics of BPA,
- studies on the toxicokinetics of BPA following dermal absorption in humans and experimental animals,
- studies in the kidney to determine the mode of action of BPA in this organ,
- further research on the significance of proliferative and morphological changes in mammary glands.

Despite the fact that many research studies on risk assessments have been done, there is still not yet full agreement on the impact of bisphenol A on human health.

Conflict of interest

The author declares no conflict of interest.

REFERENCES

1. *Ashby J., Tinwell H., Haseman J.*: Lack of effects for low dose levels of bisphenol A and diethylstilbestrol on the prostate gland of CF1 mice exposed 'in utero'. *Reg Toxicol Pharmacol* 1999; 30(2):156–166.
2. Bekendtgørelse om fødevarerkontaktmateriale 579/2011 (§ 8, stk. 2): Available from: <https://www.retsinformation.dk/Forms/R0710.aspx?id=136917&exp=1>.
3. *Biedermann S., Tschudin P., Grob K.*: Transfer of bisphenol A from thermal printer paper to the skin. *Anal Bioanal Chem* 2010;398:571-576
4. *Bloom M.S., Vom Saal F.S., Kim D., Taylor J.A., Lamb J.D., Fujimoto V.Y.*: Serum unconjugated bisphenol A concentrations in men may influence embryo quality indicators during in vitro fertilization. *Environ Toxicol Pharmacol* 2011; 32:319-323.
5. *Bradley E.L., Read W.A., Castle L.*: Investigation into the migration potential of coating materials from cookware products. *Fd Addit Contam* 2007; 24: 326–335.
6. *Brede C., Fjeldal P., Skjevraak I., Herikstad H.*: Increased migration levels of bisphenol A from polycarbonate baby bottles after dishwashing, boiling and brushing. *Fd Addit Contam* 2003; 20:684-689.
7. *Cagen S. Z., Waechter J. M., Dimond S. S., Breslin W. J., Butala, J. H., Jekat F. W., Joiner R. L., Shiotsuka R. N., Veenstra G. E., Harris, L. R.*: Normal reproductive organ development in CF-1 mice following prenatal exposure to bisphenol A. *Toxicol Sci* 1999; 50 (1):36–44.
8. *Chevrier J., Gunier R.B., Bradman A., Holland N.T., Calafat A.M., Eskenazi B., Harley K.G.*: Maternal Urinary Bisphenol A during Pregnancy and Maternal and Neonatal Thyroid Function in the CHAMACOS Study. *Environ Health Perspect* 2012; 121:138-144.
9. Commission Directive 90/128/EEC of February 1990 relating to plastics materials and articles intended to come into contact with foodstuffs. *Off J Eur Com L* 75 21.03.1990.
10. Commission Directive 2002/72/EC of 6 August 2002 relating to plastic materials and articles intended to contact with foodstuffs. *Off. J Eur Union L* 220 18-58.
11. Commission Directive 2004/19/EC of 1 March 2004 amending Directive 2002/72/EC relating to plastic materials and articles intended to come into contact with foodstuffs. *Off J Euro Union L* 71, 8-21, 10.3.2004
12. Commission Directive 2011/8/EU of 28 January 2011 amending Directive 2002/72/EC as regards the restriction of use of Bisphenol A in plastic infant feeding bottles. *Off J Eur Union L* 26, 11–14; 29.1.2011
13. Commission implementing Regulation (EU) No 321/2011 of 1 April 2011 amending Regulation (EU) No 10/2011 as regards the restriction of use of Bisphenol A in plastic infant feeding bottles. *Off J Eur Union L* 87:1-2, 2.04.2011.
14. Commission Regulation (EU) 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food. *Off J Eur Union L* 12:1-88, 15.1.2011
15. *Cooper J.E., Kendig E.L., Belcher S.M.*: Assessment of bisphenol A released from reusable plastic, aluminium and stainless steel water bottles. *Chemosphere* 2011; 85:943-947.
16. *Ćwiek-Ludwicka K., Ludwicki J.K.*: Endocrine disruptors in food contact materials: is there a health threat? *Rocz Panstw Zakl Hig* 2014; 65(3):169-177.
17. EEA Technical report (2012) European Environment Agency No 2/2012. The impacts of endocrine disruptors on wildlife, people and their environments. ISBN 978-92-9213-307-8, ISSN 1725-2237, doi:10.2800/41462.
18. EEA Report (2013) European Environment Agency. Environment and human health. Joint EEA-JRC report No 5/2013. Report EUR 25933 EN. ISBN 978-92-9213-392-4, ISSN 1725-9177. doi:10.2800/9092.
19. EFSA. Guidance of the Scientific Committee on a request from EFSA related to uncertainties in dietary exposure assessment. *EFSA Journal* 2006; 438:1–54.
20. EFSA. Opinion of the Scientific Panel on Food Additives, Flavourings, Processing Aids and Materials in Contact with Food (AFC) related to 2,2-bis(4-hydroxyphenyl) propane (Bisphenol A). *EFSA Journal* 2006; 428:1-75.
21. EFSA. EFSA Panel on Food Contact Materials Enzymes Flavourings and Processing Aids (CEF): Scientific Opinion on bisphenol A: Evaluation of a study investigating its neurodevelopmental toxicity, review of recent scientific literature on its toxicity and advice on the Danish risk assessment of Bisphenol A. *EFSA Journal* 2010; 8(9):1829; doi: 10.2903/j.efsa.2010.1829.
22. EFSA: Scientific opinion on the risks to public health related to the presence of bisphenol A (BPA) in foodstuffs: Part I - Exposure assessment. *EFSA Journal* 2015;13(1):3978, 396 pp.; doi:10.2903/j.efsa.2015.3978.
23. EFSA: Scientific opinion on the risks to public health related to the presence of bisphenol A (BPA) in foodstuffs: Part II - Toxicological assessment and risk characterisation. *EFSA Journal* 2015;13(1):3978. 621 pp.; doi:10.2903/j.efsa.2015.3978.

24. EPA (US Environmental Protection Agency), 2011: Exposure factors handbook. Available from: <http://cfpub.epa.gov/ncea/risk/recordisplay.cfm?deid=236252>
25. FAO/WHO. Joint FAO/WHO expert meeting to review toxicological and health aspect of bisphenol A. 1-5 November 2010, Ottawa, Canada.
26. FAO/WHO. Background Paper on Bisphenol A Exposure Assessment. FAO/WHO Expert Meeting on Bisphenol A (BPA), Ottawa, Canada, 2-5 November 2010. WHO/HSE/FOS/11.1 WHO 2011.
27. Fasano E., Bono-Blay F., Cirillo T., Montuori P., Lacorte S.: Migration of phthalates, alkylphenols, bisphenol A and di(2-ethylhexyl)adipate from food packaging. *Food Control* 2012; 27:132–138.
28. Food Standards Agency. UK Survey of bisphenols in canned foods. Food Surveillance Information Sheet 13/1, 2001.
29. Fujimoto V.Y., Kim D., vom Saal F.S., Lamb J.D., Taylor J.A., Bloom M.S.: Serum unconjugated bisphenol A concentrations in women may adversely influence oocyte quality during in vitro fertilization. *Fertility and Sterility* 2011; 91:1816-1819.
30. Gajownik A., Radzikowska J., Dobrzyńska M.: The influence of bisphenol A and of combined exposure to X-rays and bisphenol A to somatic cells of the bone marrow and liver of mice. *Rocz Panstw Zakl Hig.* 2011; 62:439-444.
31. Galloway T., Cipelli R., Guralnik J., Ferrucci L., Bandinelli S., Corsi A.M., Money C., McCormack P., Melzer D.: Daily bisphenol A excretion and associations with sex hormone concentrations: results from the In CHIANTI adult population study. *Environ Health Perspectives.* 2010; 118:1603-1608.
32. Geens T, Roosens L, Neels H and Covaci A.: Assessment of human exposure to bisphenol-A, triclosan and tetrabromobisphenol-A through indoor dust intake in Belgium. *Chemosphere* 2009;76: 755–760.
33. Goodson A., Summerfield W., Cooper I.: Survey of bisphenol A bisphenol F in canned foods. *Food Addit Contam* 2002;19:796-802.
34. Grob K., Biedermann M., Scherbaum E., Roth M., Rieger K.: Food contamination with organic materials in perspective: packaging materials as the largest and least controlled source? A view focusing on the European situation. *Crit Rev Food Sci Nutr* 2006; 46:529-535.
35. Hengstler J.G., Foth H., Gebel T., Kramer P.J., Lillienblum W., Schweinfurth H., Völkel W., Wollin K.M., Gundert-Remy U.: Critical evaluation of key evidence on the human health hazards of exposure to bisphenol A. *Crit Rev Toxicol* 2011;(41(4):263–291.
36. Ho S. M., Leung Y. K., Chung I.: Estrogens and antiestrogens as etiological factors and therapeutics for prostate cancer. *Estrogens and Human Diseases.* 2006; 1089:177-193.
37. Hoekstra E.J., Simoneau C.: Release of bisphenol A from polycarbonate: a review. *Crit Rev Food Sci Nutr* 2013;53(4):386–402. Doi: 10.1080/10408398.2010.536919.
38. KEMI (Swedish Chemicals Agency), Emission of bisphenol A (BPA) from restored drinking water pipes. Report from a governmental assignment. 7/13. KEMI, Sundbyberg, Sweden, 2013;86 pp.
39. Kawamura Y., Sano H., Yamada T.: Migration of bisphenol A from can coatings to drinks. *J. Food Hygienic Society of Japan* 1999;42:13-17.
40. Konieczna A, Rutkowska A, Rachoń D.: Health risk of exposure to Bisphenol A (BPA). *Rocz Panstw Zakl Hig* 2015; 66(1):5-11.
41. Kubwabo C., Osarac I., Stewart B., Gauthier B.R, Lalonde K., Lalonde P.J.: Migration of bisphenol A from plastic baby bottle, baby bottle liners and reusable polycarbonate drinking bottles. *Food Addit Contam.* 2009;26(6):928-937.
42. Lassen C., Mikkelsen H.S., Brandt U.K.: Migration of bisphenol A from cash register receipts and baby dummies. Survey of Chemical Substances in Consumer Product, 110 2011 Danish Ministry of the Environment, Environmental Protection Agency, Copenhagen, Denmark, 2011, 67 pp.
43. Lopez-Cervantes J., Paseiro-Losada P.: Determination of bisphenol A in and its migration from PVC stretch film used for food packaging. *Food Addit Contam* 2003;20(6):596-606.
44. Moniteur Belge 2012 Loi du 4 septembre 2012 modifiant la loi du 24 janvier 1977 relative à la protection de la santé des consommateurs en ce qui concerne les denrées alimentaires et les autres produits, visant à interdire le bisphénol A dans les contenants de denrées alimentaires publiée au le Moniteur Belge 24 Septembre 2012.
45. Mountfort K.A., Kelly J., Jickells S.M. and Castle L.: Investigations into the potential degradation of polycarbonate baby bottles during sterilization with consequent release of bisphenol A. *Food Addit Contam* 1997;14:737-740.
46. Muncke J.: Endocrine disrupting chemicals and other substances of concern in food contact materials: An updated review exposure, effect and risk assessment. *J Steroid Biochem Mol Biol.* 2011; 127:118-127.
47. Neville M.C., Keller R., Seacat J., Lutes V., Neifert M., Casey C., Allen J. and Archer P.: Studies in human lactation: milk volumes in lactating women during the onset of lactation and full lactation. *American J. Clin Nutr* 1988;48:1375–1386.
48. Regulation No 1442/2012 of 24 December 2012 aiming at banning the manufacture, import, export and commercialisation of all forms of food packaging containing bisphenol A. OJ of the French Republic (OJFR), 26.12.2012, text 2 of 154.
49. Regulation (EC) No 1223/2009 of the European Parliament and of the Council of 30 November 2009 on cosmetics products. Off. J L 342, 22.12.2009.
50. Santillana M.I., Ruiz E., Nieto M.T., Bustos J., Maia J., Sendón R. and Sanchez J.J.: Migration of bisphenol A from polycarbonate baby bottles purchased in the Spanish market by liquid chromatography and fluorescence detection. *Food Addit Contam. Part A*, 2011;28:1610-1618.
51. Santoro W.J., Martinez F.E., Ricco R.G. and Moyses J. S.: Colostrum ingested during the first day of life by exclusively breastfed healthy new-born infants. *J Pediatr* 2010; 156:29-32.

52. SCF (Scientific Committee on Food). Certain monomers and other starting substances to be used in the manufacture of plastic materials and articles intended to come into contact with foodstuffs. Reports of the Scientific Committee for Food (Seventeenth series), EUR 10778 EN, Commission of the European Communities, Luxembourg 1986. Available from: http://ec.europa.eu/food/fs/sc/scf/reports/scf_reports_17.pdf
53. SCF. Opinion of the Scientific Committee on Food on Bisphenol A. European Commission, SCF/CS/PM/3936 Final, 3 May 2002, 1-22 Available from: http://ec.europa.eu/food/fs/sc/scf/out128_en.pdf
54. Simoneau C., Valzacchi S., Morkunas V., Van den Eede L.: Comparison of migration from polyethersulphone and polycarbonate baby bottles. *Food Addit Contam. Part A*, 2011; 28:1763-1768.
55. Simoneau C., Van den Eede L., Valzacchi S.: Identification and quantification of the migration of chemicals from plastic bottles used as substitutes for polycarbonate. *Food Addit Contam. Part A*, 2012;29:469-480; doi: 10.1080/19440049.2011.644588.
56. Simoneau C., Valzacchi S., Morkunas V., Van den Eede L.: Comparison migration from polyethersulphone and polycarbonate baby bottles. *Food Addit Contam* 2011; 28:1763-1768.
57. Svensk författningssamling Regulation No 991/2012 of 20 December 2012 amending the Food Regulation No 813/2006, (SFS), 4.1.2013, p. 1.
58. Timms, B. G., Howdeshell, K. L., Barton, L., Bradley, S., Richter, C. A. and vom Saal, F. S.: Estrogenic chemicals in plastic and oral contraceptives disrupt development of the foetal mouse prostate and urethra, *Proceedings of the National Academy of Sciences of the United States of America*. 2005; 102:7014-7019.
59. Tyl R.W., Myers C.B., Marr M.C., Thomas B.F., Keimowitz A.R., Brine D.R., Veselica M.M., Fail P.A., Chang T.Y., Seely J.C., Joiner R.L., Butala J.H., Dimond S.S., Cagen S.Z., Shiotsuka R.N., Stropp G.D., Waechter J.M.: Three-generation reproductive toxicity study of dietary Bisphenol A in CD Sprague-Dawley rats. *Toxicol Sci* 2002; 68:121-146.
60. Tyl R.W., Myers C.B., Marr M.C., Sloan C.S., Castillo N.P., Veselica M.M., Seely J.C., Dimond S.S., Van Miller J.P., Shiotsuka R.N., Beyer D., Hentges S.G., Waechter J.M.: Two-generation reproductive toxicity study of dietary bisphenol A in CD-1 (Swiss) mice. *Toxicol Sci* 2008; 104:362-384.
61. Vandenberg L.N., Colborn T., Hayes T.B., Heindel J.J., Jacobs D.R., Lee D-H, Shioda T., Soto A.M., vom Saal F.S., Welshons W.V., Zoeller R.T. and Myers J.P.: Hormones and endocrine-disrupting chemicals: Low-dose effects and nonmonotonic dose-responses. *Endocrine Reviews*. 2012; 33:378-455.
62. Vandenberg L.N., Ehrlich S., Belcher S.M., Ben-Jonathan N., Dolinoy D.C., Hugo E.R., Hunt P.A., Newbold R.R., Rubin B.S., Sali K.S., Soto A.M., Wang H.S. and vom Saal F.S.: Low dose effects of bisphenol A: An integrated review of in vitro, laboratory animal, and epidemiology studies. *Endocrine Disruptors*. 2013;1, e26490.
63. Verordnung. Verbot der Verwendung von Bisphenol A in Beruhigungssaugern und Beißringen. Bundesgesetzblatt für die Republik Österreich, 327 Verordnung, 2011, 6 October 2011, teil II. Available from: http://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2011_II_327/BGBLA_2011_II_327.pdf.
64. Viñas P., Campillo N., Martínez-Castillo N. and Hernández-Córdoba M.: Comparison of two derivatization-based methods for solid-phase microextraction-gas chromatography-mass spectrometric determination of bisphenol A, bisphenol S and biphenol migrated from food cans. *Anal Bioanal Chem*. 2010; 397:115-125.
65. Vom Saal F. S., Cooke P. S., Buchanan D. L., Palanza P., Thayer K. A., Nagel S.C., Parmigiani S., Welshons W.V.: A physiologically based approach to the study of bisphenol A and other estrogenic chemicals on the size of reproductive organs, daily sperm production, and behaviour. *Toxicol Indust Health* 1998; 14:239-260.

Received: 20.08.2015

Accepted: 15.10.2015

RISK ASSESSMENT FOR PESTICIDES' MRL NON-COMPLIANCES IN POLAND IN THE YEARS 2011-2015

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ABSTRACT

Background. Human exposure to trace levels of pesticide residues present in food of plant origin is inevitable as long as pesticides continue to be applied in agriculture. Since Maximum Residue Levels (MRL) are not toxicological endpoint values, their violation is not by default equivalent to health risk for consumers. However, it is essential to provide a health-based risk assessment for each case of MRL non-compliance reported during monitoring and official control of foodstuffs.

Objective. To assess the potential short-term risk associated with consumption of food products of plant origin containing pesticide residues above MRL values based on notifications forwarded by the National Contact Point for RASFF in Poland during 2011-2015.

Material and Methods. 115 notifications including 127 analytical results non-compliant with respective MRL values were forwarded to provide risk assessment. An internationally accepted deterministic approach based on conservative model assumptions for short-term exposure assessment was applied. The risk was characterized by comparing an estimated dietary intake with respective acute reference dose (ARfD).

Results. Black currant, tea, lettuce, Chinese cabbage and carrot were among the most frequently notified products in years 2011-2015. Among pesticides exceeding respective MRL values, over 90% belonged to fungicides and insecticides/acaricides such as acetamiprid, chlorpyrifos, dimethoate, imidacloprid, dithiocarbamates and procymidone. For 15 and 6 results non-compliant with respective MRL value, a predicted short-term intake exceeded ARfD for children and adults, respectively.

Conclusions. Residue levels that could potentially pose a health threat are found incidentally. The science-based and transparent risk assessment process with regard to the data, methods and assumptions that are applied is essential to risk management authorities.

Key words: *risk assessment, pesticide residues, MRL, dietary intake, RASFF, food safety*

STRESZCZENIE

Wprowadzenie. Narażenie człowieka na śladowe poziomy pozostałości pestycydów obecnych w żywności pochodzenia roślinnego jest nieuniknione tak długo jak środki ochrony roślin są stosowane w rolnictwie. Ponieważ wartości najwyższych dopuszczalnych poziomów pozostałości pestycydów w żywności (NDP) nie są toksykologicznymi wartościami odniesienia, ich przekroczenie nie jest równoznaczne z zagrożeniem dla zdrowia konsumentów. Jednakże dla każdego przypadku niezgodności z NDP stwierdzonej w monitoringu i urzędowej kontroli żywności należy dokonać naukowej oceny ryzyka zdrowotnego.

Cel badań. Ocena potencjalnego ryzyka związanego z krótkoterminowym narażeniem na pozostałości pestycydu na poziomie powyżej wartości NDP na podstawie powiadomień przekazywanych przez Krajowy Punkt Kontaktowy system RASFF w Polsce w latach 2011-2015.

Materiał i metody. Do oceny ryzyka przekazano 115 powiadomień zawierających 127 wyników powyżej wartości NDP. W celu oszacowania wielkości narażenia krótkoterminowego zastosowano model deterministyczny wykorzystujący konserwatywne scenariusze najgorszego przypadku. Ryzyko charakteryzowano porównując oszacowaną dawkę pozostałości pestycydu z odpowiednią wartością ostrej dawki referencyjnej (ARfD).

Wyniki. W latach 2011-2015 najczęściej zgłaszanymi produktami z powodu przekroczenia wartości NDP były czarna porzeczka, herbata, sałata, kapusta pekińska i marchew. Ponad 90% przypadków przekroczenia NDP dotyczyło fungicydów

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oraz insektycydów/akarycydów takich jak np. acetamipryd, chlorpiryfos, dimetoat, imidaklopryd, ditiokarbaminiany czy procymidon. W przypadku 15 przekroczeń NDP, oszacowane krótkoterminowe pobranie pozostałości przekraczało wartość ARfD dla dzieci. Dla dorosłych odnotowano 6 takich przypadków.

Wnioski. Poziomy pozostałości pestycydów, które mogą teoretycznie zagrażać zdrowiu konsumentów stwierdza się bardzo rzadko. Transparentny i oparty na wynikach badań naukowych proces oceny ryzyka dostarcza niepodważalne argumenty urzędowi odpowiedzialnym za zarządzanie ryzykiem.

Słowa kluczowe: ocena ryzyka, pozostałości pestycydów, NDP, pobranie z diety, RASFF, bezpieczeństwo żywności

INTRODUCTION

Hundreds of plant protection products (PPPs), commonly called as pesticides, are widely used in agriculture. They safeguard crops from pests and diseases in the field and during storage and transportation. There are numerous, unquestionable benefits of pesticide application such as assuring high crop yields during cultivation and prolonging their post-harvest storage. On the other hand they are increasingly feared for their potential health risks for general population related to exposure to pesticide residues in food as well as their effects on ecosystems [3, 22, 23, 33]. Due to the strict authorization and Maximum Residue Levels (MRLs) setting procedures in the European Union (EU), pesticide residues in food of plant origin resulting from correct application of PPPs according to Good Agriculture Practice (GAP) rules may be regarded as acceptable from the human health point of view. To achieve this, the pre-registration risk assessment procedures apply a set of unfavorable scenarios to adopt high safety margins [2, 29, 31]. However, there are numerous reasons that may cause pesticide residues levels above the legally binding MRLs which potentially lead to unnecessary consumers' exposure over health-based limits. These include i.a. failure of post-harvest interval (PHI) established in the authorization procedure, inappropriate or illegal use of PPPs, or finally import of food from the third countries where pesticide legislation differs from that in the EU.

Over a dozen years, pesticide residues are the subject of particular interest of the food safety inspection services in the EU Member States. The EU-coordinated programme (EUCP) and the national surveillance programmes are continuously extended for new products and further pesticides [1, 8, 10, 12, 15, 16, 19, 26, 33]. Food products which do not comply with the MRL cannot be marketed in the EU area. They should be rejected during control at the border or withdrawn when non-compliance is found during inspection of the retail market.

In Poland, the State Sanitary Inspection (SSI) subordinated to the Minister of Health (MH) is responsible for the official control and monitoring of pesticide residues in food present on the market. The supervision

of the proper regulatory compliance in the use of plant protection products is under auspices of State Plant Health and Seeds Inspection Service (SPHSIS) subordinated to Minister of Agriculture and Rural Development (MARD) [35]. The former refers to domestic and imported foodstuffs available on retail market, while the latter covers raw agricultural commodities (RACs) grown in Poland.

In the EU, a Rapid Alert System for Food and Feed (RASFF) has been established to protect consumers and to respond quickly to any potential concerns regarding food and feed safety. In Poland, all threats regarding safety of foodstuffs available on retail market, including violations of MRLs, are reported to the Chief Sanitary Inspectorate (CSI) under the MH which was assigned the role of National Contact Point (NCP) for RASFF. In cases where the MRL non-compliance is found in RACs which have entered the market and could be traced there, the NCP is notified by the sub-point located in the General Veterinary Inspectorate subordinated to the MARD. NCP forwards those notifications with all necessary documents, including laboratory and sampling reports, to the Risk Assessment Team established in 2004 by the Chief Sanitary Inspector in the National Institute of Public Health – National Institute of Hygiene (NIPH-NIH). To evaluate whether a MRL violation can lead to an unacceptable risk to the consumer, an estimated dietary intake calculated according to the worst-case scenario is compared to the appropriate toxicological reference value (TRV), that is acute reference dose (ARfD) for the short-term exposure [11, 12, 17, 24, 31, 34]. The scientific risk assessment output is transparent with regard to the data, methods and assumptions that are applied in the process [13]. Depending on the risk assessment outcome, CSI – the risk managing authority – undertakes follow-up actions aiming to withdraw product from the market provided that it was not sold out before the laboratory issued the final analytical report. In justified cases the CSI transmits a relevant notification to the European RASFF system. The inspection may also provide information to SPHSIS to implement procedures aiming to investigate the possible reasons of non-compliance.

The aim of the study was to assess the potential risk associated with consumption of food products conta-

ining pesticide residues above MRL values based on notifications forwarded by the National Contact Point for RASFF in Poland during 2011-2015.

MATERIAL AND METHODS

Notifications from the National Contact Point for RASFF

A total of 124 notifications regarding MRL non-compliance have been forwarded between January 2011 and August 2015 to the NIPH-NIH by the NCP for RASFF for providing science-based risk assessment. In 9 cases a quantitative risk characterization could not be performed due to such reasons like inappropriate residue definition used by the laboratory, applying own uncertainty (instead of default 50%) to the result above MRL value for non-compliance checking or lack of respective TRVs. Thus, a quantitative risk assessment outcome has been provided for 115 food samples, including fruit (n=47), vegetables (n=49) and other products (n=19). Since in some cases MRL non-compliances concerned two, and even more pesticides, a risk was characterized for total of 127 analytical results exceeding respective MRL values. The number of notifications sent to the Risk Assessment Team in the particular years is presented in Table 1.

Table 1. Number of notifications concerning MRL non-compliances for which risk assessments were performed on request of the National Contact Point for RASFF during the period of 2011-2015

Year	Total number of notifications	Number of notifications for which risk assessment was performed
2011	22	17
2012	30	30
2013	27	23
2014	22	22
2015*	23	23
Total	124	115

* until 31.08.2015

Short-term dietary exposure and acute risk characterization

In this study we applied an internationally accepted deterministic approach based on conservative model assumptions which is commonly used for post-regulation risk assessment purposes to evaluate whether the MRL violation for given pesticide/product combination may pose a risk for consumer. In case of MRL violations an acute exposure assessment is performed which aims to estimate the worst realistic scenario based on high-level and short-term intakes that can happen within a period of 24 hours. It is assumed that one would eat a large portion (LP) of that product that is defined as the

97.5th percentile consumption of the food product among eaters only. It is also assumed that the residues are not evenly distributed in the individual units analysed in the composite sample. Such an approach should better represent an acute situation in which a consumer is eating a large portion of the commodity within a short period of time (one day or meal) [11, 12, 17, 34]. An estimated intake is then compared to the most recent ARfD value established or recommended by the European Food Safety Authority (EFSA).

According to the latest European Commission requirements [5], a revised version of the model for calculating the acute and chronic consumer exposure developed by EFSA [9], so-called PRIMo model rev.2, was used. For the short-term exposure assessment it uses the most critical, large portion consumption data among 19 national diets collected (including children and adults) provided to EFSA by the Member States. Calculation of so-called Predicted Short-Term Intake (PSTI) is based on the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) International Estimated Short-Term Intake (IESTI) equations [14, 34]. Depending on the commodity unit weight (U) and large portion (LP) consumed, three cases are distinguished in the model:

- case 1: unit weight < 25 g; no variability of residue levels among units is expected; PSTI is calculated according to the formula:

$$PSTI = \frac{LP \times OR}{bw}$$

where: LP – large portion, OR – observed residue level, *bw* – body weight

- case 2: unit weight >25 g, variability of residue levels among units is expected;
- 2a: unit weight < large portion; PSTI is calculated according to the formula:

$$PSTI = \frac{(U \times OR \times v) + (LP - U) \times OR}{bw}$$

where: U – unit weight, OR – observed residue level, *v* – variability factor, LP – large portion, *bw* – body weight

- 2b: unit weight ≥ large portion; PSTI is calculated according to the formula:

$$PSTI = \frac{LP \times OR \times v}{bw}$$

where: LP – large portion, OR – observed residue level, *v* – variability factor, *bw* – body weight

- case 3: processed/bulked/blended commodities; no variability of residue levels is expected; PSTI is calculated according to the formula for case 1.

For sub-cases 2a and 2b variability factors (v) defined as the ratio between the 97.5 percentile and the average of pesticide residues in individual units are used to account for the unit-to-unit variability in composite samples. Depending on unit weight of a product and its relation to the amount consumed, default variability factors of 3, 5, 7 and 10 are currently used [14, 20]; PRIMo model rev.2 applies factors of 5 and 7 [9]. For cases 1 and 3 a factor of 1 is applied.

Calculated PSTI values are then compared to the most recent ARfD values established or recommended by the EFSA. Intakes that exceed the TRV applied are considered as potentially associated with possible health implications. In case where ARfD is not defined, the predicted short-term intake is checked against the acceptable daily intake (ADI) knowing that this approach generally leads to an overestimation of the risk.

The following model assumptions are additionally applied in the calculations in a transparent and open way:

- a result is regarded as non-compliant if the result of confirmatory analysis exceeds the MRL by more than the default expanded uncertainty of 50% [4, 6];
- the current residue definition for risk assessment purposes, as set by EFSA, is used. If it was not set or when it differs from residue definition established for monitoring purposes and the conversion factor between two definitions was not set, the result reported by the laboratory compliant with residue definition for monitoring is used. In some cases laboratory was asked for providing additional analysis allowing to perform risk assessment;
- no processing factors reflecting theoretical reduction of residue due to washing, cooking or peeling are taken into account;
- for dithiocarbamates, the worst-case scenario is applied assuming that the quantified carbon disulfide

(CS₂) originated from the dithiocarbamate with the lowest ARfD among these fungicides listed in the EU MRL legislation was a potential origin of residue [8]. When ARfD values are the same, then the active substance with the highest conversion factor from CS₂ is chosen;

- in case of MRL non-compliances in rapeseed, consumption of rapeseed oil and rapeseed oil-based margarines was taken into account in exposure estimation.

RESULTS AND DISCUSSION

In contrast to previous years [25], the recent notifications received through the national RASFF system were practically not dominated by any products. The only exception was black currant – notifications concerning this product accounted for almost half of all notifications on fruit with acaricide fenazaquin being the most frequent reason of MRL non-compliances. Other frequently notified products in years 2011-2015 included: tea, lettuce, Chinese cabbage and carrots. It is worth mentioning that tea samples, in addition to the pesticide residues above the MRL, contained up to dozen pesticides below the respective MRL values. Products of plant origin, for which a risk assessment due to MRLs violation was performed on request of NCP for RASFF are shown in Figure 1.

Among products where number of MRL non-compliances has been substantially reduced as compared to the previous study [25] one should mention apples (28 vs 5) and spinach (12 vs 3). Illegal use of carbendazim in the cultivation of fungi (champignons) has been permanently eliminated, hence during the last few years, no sample of this mushroom has been questioned because

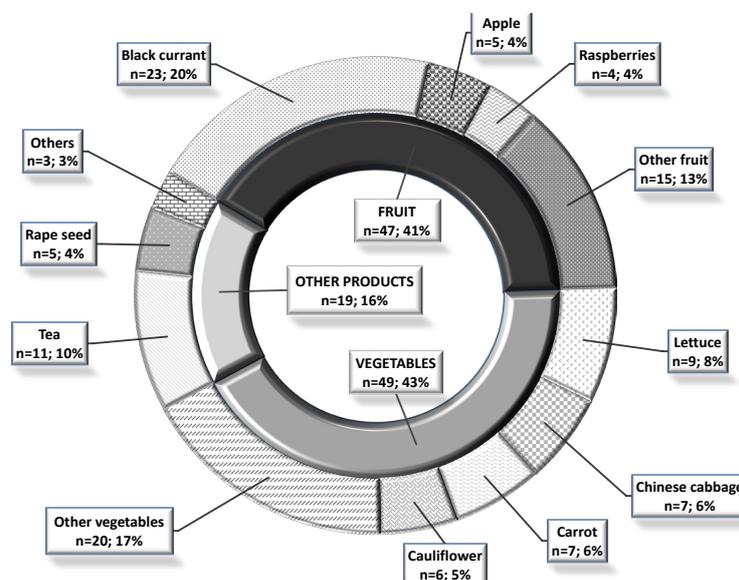


Figure 1. Products for which risk assessment was performed on request of NCP for RASFF due to MRL non-compliances

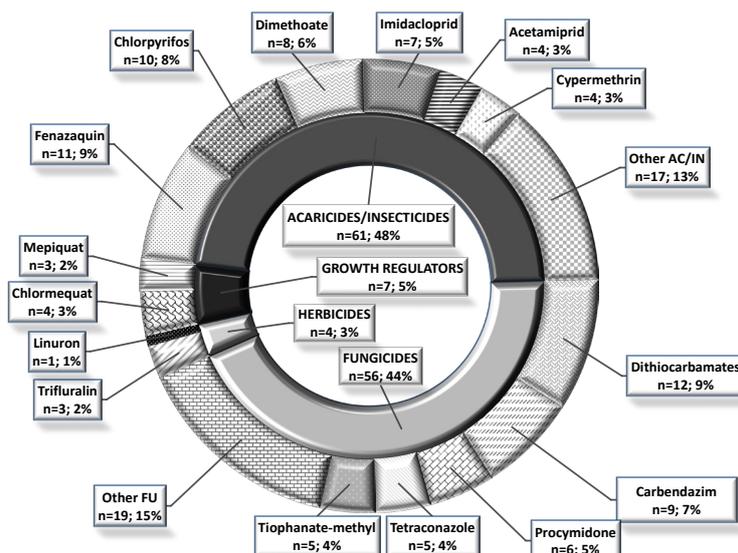


Figure 2. Active substances the most frequently notified in Poland due to MRL non-compliances divided into their mode of biocidal action (AC/IN – acaricides/insecticides, FU – fungicides)

Table 2. A list of food products/pesticide combinations with MRL non-compliances notified through the NCP for RASFF

Commodity	Pesticide residues exceeding particular MRL values
Apple	Carbendazim (NA) ^a , diazinon (NA) ^a , dimethoate, flusilazole (NA) ^a , mepiquat
Aubergine	Procymidone (NA) ^a
Black currant	Cypermethrin, difenoconazole, fenvalerate/esfenvalerate, fenazaquin, flusilazole (NA) ^a , carbendazim (NA) ^a , propargite (NA) ^a , thiophanate-methyl
Broccoli	Dithiocarbamates
Carrot	Chlorpyrifos, diazinon (NA) ^a , tetraconazole, trifluralin (NA) ^a ,
Cauliflower	Chlorpyrifos, dimethoate, dithiocarbamates
Celery (leaves)	Linuron
Chinese cabbage	Acetamiprid, chlorothalonil, chlorpyrifos, dimethoate, pyrimethanil, propamocarb
Cucumber	Chlorfenapyr (NA) ^a , dieldrin (NA) ^a
Oyster mushroom (cultivated fungi)	Mepiquat
Dill	Chlorpyrifos, chlorpyrifos-methyl
French bean	Procymidone (NA) ^a
Gooseberry	Difenoconazole, propiconazole
Grape	Chlormequat, penconazole
Kiwi	Folpet, pyraclostrobin
Lettuce	Chlorothalonil, chlorpyrifos, dimethoate, dithiocarbamates, fenvalerate/esfenvalerate, carbendazim (NA) ^a , thiophanate-methyl
Peach	Carbendazim (NA) ^a
Pear	Chlormequat, mepiquat
Pepper	Thiophanate-methyl
Plum	Dimethoate
Radish	Dimethoate
Rape seed	Pyrimifos-methyl, tetraconazole
Raspberry	Dithiocarbamates, spirodiclofen
Rice	Piperonyl butoxide ^b
Spinach	Chlorpyrifos, cyfluthrin (NA) ^a , iprodione
Strawberry	Procymidone (NA) ^a
Tea	Acephate (NA) ^a , acetamiprid, dithiocarbamates, imidacloprid, tolfenpyrad (NA) ^a , triazophos (NA) ^a

^a Currently not approved under Regulation (EC) No 1107/2009

^b Not listed as active substance of plant protection products

of any MRL violation. On the other hand a number of tea samples with residues above MRL increased from 1 to 11 [25]. According to data from RASFF Portal [30] over half cases of border rejections because of MRL

violations in food reported by Poland between 1.01.2011 and 31.08.2015 were batches of tea.

The differences between products (and pesticide residues) notified by the NCP for RASFF may be, ho-

wever, explained by numerous reasons, like differences in the annual sampling plans, development of analytical capabilities of laboratories, better compliance with GAP among farmers or improved border control which prevents getting imported products which do not meet health quality requirements to the market.

Among pesticides notified by the NCP for RASFF due to MRL violation, over 90% belonged to fungicides and insecticides/acaricides. Acetamiprid, chlorpyrifos, dimethoate, imidacloprid, dithiocarbamates and procymidone were the most frequently reported residues, similarly to the data from recent RASFF report [7]. The profile of the most frequently notified active substances in Poland (2011-2015) divided into their mode of biocidal action is presented in Figure 2. The pesticide/product combinations for which risk assessments were provided are presented in Table 2. It is worthy to note that substantial number of notifications concerned pesticides not approved in the EU.

MRLs are the upper legal levels of a concentration for pesticide residues in or on food or feed based on GAPs and to ensure the lowest possible consumer exposure [8, 18]. Results over the MRL values do not by default pose a risk for health, however for each MRL violation risk assessment must be provided. For 15 out of 127 analytical results non-compliant with respective MRL value, an estimated short-term exposure exceeded ARfD for children who are the most vulnerable subpopulation of consumers (range from 102% to 2258%). This represents 11.8% of MRL non-compliances, and this value is almost the same like in the previous study (11.5%) of Ludwicki and Kostka [25]. In adults, the exposure expressed per kg bw is lower than in children, thus the estimated exposure exceeded ARfD value in 6 cases only (range from 100,2% to 2171%). The highest intake was reported for combination chlorpyrifos/Chinese cabbage. Among above cases, none of the pesticide/product combinations had a dominant share. A distribution of potential short-term dietary exposure calculated for all MRL violations

for children and adults is presented in Figure 3. A list of MRL non-compliances which potentially pose a health risk with detailed description of input data and output of risk characterization expressed as percentage of ARfD is presented in Table 3.

A total of about 2800 samples, including over 500 EUCP samples and almost 2300 national control samples per year are currently analyzed by the SSI [10, 12]. Number of RACs samples analyzed annually in the frame of supervision of the proper regulatory compliance in the use of plant protection products is about 2000-3000 [21, 27, 28]. Both monitoring systems cover up to over 260 pesticide residues, depending on the particular laboratory capabilities. All analyses are carried out in the accredited laboratories of two afore mentioned inspection services. Undoubtedly, 115 notifications on MRL exceedances forwarded by the NCP for RASFF during almost five years represent a very small percentage of all samples analyzed for presence of pesticide residues in food of plant origin in Poland. Additionally, only every tenth was associated with potential health threat. It should be stressed, however, that MRL non-compliances found in RACs were notified only for those cases where the product could be traced on the market, therefore the total number of MRL non-compliances in RACs was undoubtedly somewhat higher.

Considering that a worst case scenario approach was applied in the assessment, a potential risk is likely to overestimate the actual exposure situation that occurred in practice. On the other hand, prevention of being exposed to pesticide residues exceeding concentrations that may lead to adverse health effects is one of the fundamental rules of public health protection.

CONCLUSIONS

Residue concentrations in food of plant origin, even those above respective MRL values, are generally safe

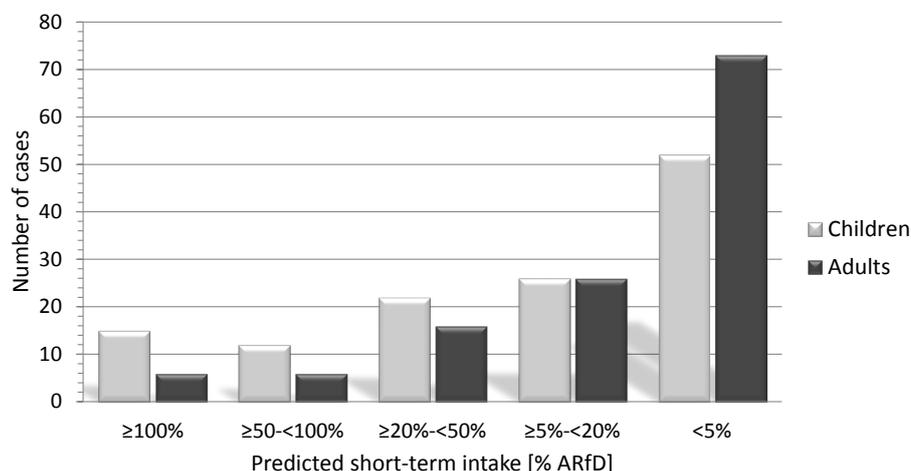


Figure 3. A distribution of potential short-term dietary exposure for children and adults calculated for all MRL violations

Table 3. A list of MRL non-compliances resulting in Predicted Short-Term Intake (PSTI) values exceeding relevant ARfD, therefore evaluated as posing potential risk for consumers' health (MRLs, residue definitions and ARfD values were applicable at the time of sampling)

Commodity, year (country of origin)	Pesticide (residue definition for enforcement)	Residue level (MRL value) [mg kg ⁻¹]	Residue definition for risk assessment	ARfD [mg kg ⁻¹ bw day ⁻¹] (source, year)	v (case)	PSTI [mg kg ⁻¹ bw day ⁻¹] (% ARfD)	
						Children	Adults
Chinese cabbage, 2015 (Poland)	Chlorpyrifos (chlorpyrifos)	3.04 (0.5)	As for enforcement ^a	0.005 (EFSA 2014)	5 (2b)	0.1129 (2257.8%)	0.1086 (2171.4%)
Cauliflower, 2015 (Poland)	Chlorpyrifos (chlorpyrifos)	0.71 (0.05)	As for enforcement ^a	0.005 (EFSA 2014)	5 (2b)	0.0470 (939.7%)	0.0226 (451.4%)
Peach, 2012 (Spain)	Carbendazim and benomyl (sum of benomyl and carbendazim expressed as carbendazim)	2.83 (0.2)	As for enforcement	0.02 (EC 2006)	7 (2a)	0.1679 (839.5%)	0.0495 (247.3%)
Pears, 2014 (Poland)	Chlormequat (chlormequat)	4.6 (0.1)	Sum of chlormequat and its salts expressed as chlormequat chloride ^b	0.09 (EFSA 2008)	7 (2a)	0.4189 (465.5%)	0.0987 (109.7%)
Pears, 2012 (Poland)	Chlormequat (chlormequat)	4.2 (0.1)	Sum of chlormequat and its salts expressed as chlormequat chloride ^b	0.09 (EFSA 2008)	7 (2a)	0.3825 (425.0%)	0.0902 (100.2%)
Lettuce, 2012 (Poland)	Dimethoate (sum of dimethoate and omethoate expressed as dimethoate)	1.28 (0.01)	As for enforcement	0.01 (EFSA 2006)	5 (2b)	0.0336 (336.3%)	0.0137 (137.4%)
Apple, 2014 (Poland)	Dimethoate (sum of dimethoate and omethoate expressed as dimethoate)	0.084 (0.02)	Toxicologically adjusted sum of dimethoate and omethoate, expressed as dimethoate ^c	0.01 (EFSA 2013)	7 (2a)	0.0288 (288.0%)	0.0066 (66.0%)
Apple, 2015 (Poland)	Flusilazole (flusilazole)	0.12 (0.02)	As for enforcement	0.005 (EC 2006)	7 (2a)	0.0118 (235.1%)	0.0027 (53.9%)
Orange, 2015 (Turkey)	Fenvalerate (fenvalerate (any ratio of constituent isomers (RR, SS, RS & SR) including esfenvalerate))	0.26 (0.02)	Esfenvalerate	0.0175 (EFSA 2014)	7 (2a)	0.0359 (205.4%)	0.0069 (39.6%)
Apple, 2011 (Poland)	Carbendazim and benomyl (sum of benomyl and carbendazim expressed as carbendazim)	0.41 (0.2)	As for enforcement	0.02 (EC 2006)	7 (2a)	0.0402 (200.8%)	0.0092 (46.0%)
Lettuce, 2014 (Poland)	Dithiocarbamates (dithiocarbamates expressed as CS ₂ , including maneb, mancozeb, metiram, propineb, thiram and ziram)	28.8 (5)	Mancozeb ^{d,e}	0.6 (EC 2005)	5 (2b)	1.0829 (180.5%)	0.4423 (73.7%)
Cucumber, 2012 (Poland)	Aldrin and dieldrin (aldrin and dieldrin combined expressed as dieldrin)	0.08 (0.02)	As for enforcement	0.003 (EFSA 2007)	5 (2b)	0.0045 (150.1%)	0.0015 (50.0%)
Tomato, 2012 (Poland)	Vinclozolin (vinclozolin, sum of vinclozolin and all metabolites containing the 3,5-dichloraniline moiety, expressed as vinclozolin)	1.24 (0.05)	As for enforcement	0.06 (SCoFCAH 2006)	7 (2a)	0.0721 (120.2%)	0.0189 (31.5%)
Lettuce, 2011 (Poland)	Carbendazim and benomyl (sum of benomyl and carbendazim expressed as carbendazim)	0.84 (0.1)	As for enforcement	0.02 (EC 2006)	7 (2a)	0.0227 (113.5%)	0.0093 (46.4%)
Lettuce, 2013 (Poland)	Dithiocarbamates (dithiocarbamates expressed as CS ₂ , including maneb, mancozeb, metiram, propineb, thiram and ziram)	13.0 (5)	Mancozeb ^{d,e}	0.6 (EC 2005)	5 (2b)	0.6121 (102.0%)	0.2500 (41.7%)

^a Two separate plant residue definitions for risk assessment were set: 1) chlorpyrifos and 2) TCP (3,5,6-trichloropyridinol) and its conjugates expressed as TCP. For PSTI calculation, the first one was applied.

^b No conversion factor (from monitoring to risk assessment) established; quantified level of chlormequat applied for PSTI calculation.

^c Toxicologically adjusted sum of dimethoate and omethoate, expressed as dimethoate (0.294 mg kg⁻¹) for the acute exposure was calculated as: $C_{\text{dimethoate}} + 6 \times C_{\text{omethoate}}$; potency factor of 6 on a short-term basis is derived taking into account that omethoate has a 6 times higher acute toxicity than dimethoate

^d Origin of the residue according to Regulation 396/2005 (and amending Regulations): mancozeb.

^e For risk assessment, concentration of CS₂ was recalculated to mancozeb using conversion factor of 1.78.

from the toxicological point of view. However, there are cases, where pesticide residues' levels in food could potentially pose a threat to human's health. Even though substantial overestimation of exposure provides a large margin of safety for consumers, it is justified to continuously perform official controls and monitoring surveys to check the compliance of products with MRLs and look for potential threat for consumers' health. The science-based and transparent risk assessment process with regard to the data, methods and assumptions that are applied is essential to risk management authorities maintaining and building trust and credibility of food regulation and the wider food system.

Acknowledgements

This study was financially supported by the National Institute of Public Health – National Institute of Hygiene, Warsaw, Poland in frame of public health protection activities, project numbers 2014/4/ZŚM and 2015/4/ZŚM and by the Chief Sanitary Inspectorate (contract No 62/14/GIS/NISP/BŻ).

The Authors would like to thank the staff of the National Contact Point for RASFF located in the Chief Sanitary Inspectorate for good past, current and future cooperation.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. Claeys W.L., De Voghel S., Schmit J.-F., Vromman V., Pussemier L.: Exposure assessment of the Belgian population to pesticide residues through fruit and vegetable consumption. *Food Addit Contam Part A* 2008;25(7): 2014;160:851-863
2. Czaja K., Góralczyk K., Struciński P., Hernik A., Korcz W., Snopczyński T., Ludwicki J.K.: Analiza podstaw naukowych ustalania definicji najwyższych dopuszczalnych poziomów pozostałości pestycydów (NDP) [Analysis of scientific background of establishing definitions for Maximum Residue Levels (MRLs)]. *Rocz Panstw Zakł Hig* 2009;60(3):207-212 (in Polish)
3. Damalas C.A., Eleftherohorinos I.G.: Pesticide exposure, safety issues, and risk assessment indicators. *Int J Environ Res Public Health* 2011;8:1402-1419
4. EC (European Commission) 2002. Commission Directive 2002/63/EC of 11 July 2002 establishing Community methods of sampling for the official control of pesticide residues in and on products of plant and animal origin and repealing Directive 79/700/EEC. *Off J Eur Comm L*187:30-43
5. EC (European Commission) 2011. Draft guidance document on notification criteria for pesticide residue findings to the Rapid Alert System for Food and Feed (RASFF). SANCO/3346/2001 rev 12, Brussels, 12 May 2011
6. EC (European Commission). 2013. Guidance document on analytical quality control and validation procedures for pesticide residues analysis in food and feed. SANCO/12571/2013, 19 November 2013 rev. 0
7. EC (European Commission) 2015. RASFF for safer food – The Rapid Alert System for Food and Feed – 2014 annual report. Luxembourg, Publications Office of the European Union, 2015
8. EC (European Commission) 2005. Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending Council Directive 91/414/EEC. *Off J Eur Comm L*70:1-16, as amended
9. EFSA (European Food Safety Authority) 2013. EFSA calculation model: Pesticide Residue Intake Model “PRIMO” revision 2. Available from: <http://www.efsa.europa.eu/en/mrls/mrlteam.htm> (accessed 30.07.2015).
10. EFSA (European Food Safety Authority) 2015. National summary reports on pesticide residue analysis performed in 2013. EFSA supporting publication 2013:EN-755, 162 pp. Available from: http://www.efsa.europa.eu/sites/default/files/scientific_output/files/main_documents/755e.pdf (accessed 30.07.2015)
11. EFSA (European Food Safety Authority) 2007. Reasoned opinion on the potential chronic and acute risk to consumers' health arising from proposed temporary EU MRLs according to Regulation (EC) No 396/2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin, 15 March 2007. Available from: <http://www.efsa.europa.eu/en/efsajournal/doc/32r.pdf> (accessed 30.07.2015)
12. EFSA (European Food Safety Authority) 2015. The 2013 European Union report on pesticide residues in food. *EFSA J* 2015;13(3):4038, 169 pp., doi:10.2903/j.efsa.2015.4038
13. EFSA (European Food Safety Authority) 2009. Transparency in risk assessment. Guidance of the Scientific Committee in the Scientific Aspects of Risk Assessment carried out by EFSA. Part 2: General principles. *EFSA J* 2009;1051:1-22.
14. FAO 2009. FAO manual on the submission and evaluation of pesticide residues data for the estimation of maximum residue levels in food and feed, Second Edition, Rome, 2009. Available from: http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/JMPR/FAO_manual2nded_Oct07.pdf (accessed 30.07.2015)
15. Góralczyk K., Struciński P., Hernik A., Czaja K., Korcz W., Ludwicki J.K.: Monitoring i urzędowa kontrola pozostałości pestycydów w żywności w Polsce w 2004 roku [Monitoring and official control of pesticide residues in foodstuffs in Poland in 2004]. *Rocz Panstw Zakł Hig* 2005;56(4):307-316 (in Polish)
16. Góralczyk K., Struciński P., Korcz W., Czaja K., Hernik A., Snopczyński T., Ludwicki J.K.: Badania pozostałości pestycydów w żywności pochodzenia roślinnego w Polsce w latach 2004 – 2007 [The survey of pesticide residues in food of plant origin in Poland, 2004-2007]. *Rocz Panstw Zakł Hig* 2009;60(2):113-119 (in Polish)

17. Hamilton D., Ambrus A., Dieterle R., Felsot A., Harris C., Petersen B., Racke K., Wong S.-S., Gonzalez R., Tanaka K., Earl M., Roberts G., Bhula R.: Pesticide residues in food – acute dietary exposure. *Pest Manag Sci* 2004;60:311-339
18. Hamilton J.H.: MRL calculations based on both intra- and inter-trial residue variability. *Regul Toxicol Pharmacol* 2015;72:1-7
19. Hjorth K., Johansen K., Holen B., Andersson A., Christensen H.B., Siivinen K., Toome M.: Pesticide residues in fruits and vegetables from South America – A Nordic project. *Food Control* 2011;22(11):1701-1706
20. IGHRC (The Interdisciplinary Group on Health Risks from Chemicals). 2010. Current approaches to exposure modeling in UK Government Departments and Agencies (cr15). Institute of Environment and Health, Cranfield University, UK. Available from: [http://ieh.cranfield.ac.uk/ighrc/pdf/cr%20reports/cr15\[1\].pdf](http://ieh.cranfield.ac.uk/ighrc/pdf/cr%20reports/cr15[1].pdf) (accessed 30.07.2015)
21. Instytut Ogrodnictwa. Analiza pozostałości środków ochrony roślin w płodach rolnych. Sprawozdanie za rok 2012 [Analysis of pesticide residues in raw agricultural commodities. Report 2012], Skierniewice, grudzień 2012 (in Polish). Available from: http://www.inhort.pl/files/program_wieloletni/wykaz_publicacji/obszar5/2012_Analiza%20pozostalosci.pdf (accessed 30.07.2015)
22. Karabelas A.J., Plakas K.V., Solomou E.S., Drossou V., Sarigiannis D.A.: Impact of European legislation on marketed pesticides – A view from the standpoint of health impact assessment studies. *Environ Int* 2009;35:1096-1107
23. Kjeldsen L.S., Ghisari M., Bonfeld-Jørgensen E.C.: Currently used pesticides and their mixtures affect the function of sex hormone receptors and aromatase enzyme activity. *Toxicol Appl Pharmacol* 2013;272:453-464
24. Low F., Lin H.-M., Gerrard J.A., Cressey P.J., Shaw I.C.: Ranking the risk for pesticide dietary intake. *Pest Manag Sci* 2004;60:842-848
25. Ludwicki J.K., Kostka G.: Przekroczenia dopuszczalnych poziomów pozostałości pestycydów w żywności zgłaszane do oceny ryzyka zgodnie z procedurami RASFF w Polsce [Violations of MRLs for pesticide residues in food reported for risk assessment according to RASFF procedures in Poland]. *Roczn Panstw Zakl Hig* 2008;59(4):389-396 (in Polish)
26. Matt D., Pehme S., Peetsmann E., Luik A., Meremäe K.: Pesticide residues in Estonian local and imported food in 2008-2011. *Acta Agr Scand, Sect B – Soil Plant Sci* 2013:sup1;78-85
27. Miszczak A., Research Institute of Horticulture, Skierniewice, personal communication, 20.07.2015
28. Nowacka A., Gnusowski B., Walorczyk S., Drożdżyński D., Raczkowski M., Hołodyńska A., Frąckowiak D., Wójcik A., Ziółkowski A., Przewoźniak M., Swoboda W. et al.: Pozostałości środków ochrony roślin w płodach rolnych (rok 2011) [Pesticide residues in Polish crops (2011)]. *Prog Plant Prot* 2012;52(4):1106-1116 (in Polish)
29. Noworyta-Głowacka J., Bańkowski R., Wiadrowska B., Ludwicki J.K.: Ocena toksykologiczna środków ochrony roślin w procesie rejestracyjnym UE [Toxicological evaluation of crop protection chemicals in the EU registration proces]. *Rocz Panstw Zakl Hig* 2010;61(1):1-6 (in Polish)
30. RASFF Portal website 2015. <https://webgate.ec.europa.eu/rasff-window/portal/> (accessed on 30.07.2015)
31. Struciński P., Góralczyk K., Czaja K., Hernik A., Korcz W., Ludwicki J.K.: Ocena ryzyka dla konsumenta przy przekroczeniach najwyższych dopuszczalnych poziomów pozostałości (NDP) w żywności [Consumer risk assessment in case of maximum residue levels (MRLs) violations in food]. *Rocz Panstw Zakl Hig* 2007;58(2):377-388 (in Polish)
32. Struciński P., Góralczyk K., Czaja K., Hernik A., Korcz W., Ludwicki J.K.: Ocena ryzyka związana z narażeniem na pozostałości pestycydów w żywności pochodzenia roślinnego na etapie rejestracji środka ochrony roślin [Dietary risk assessment for pesticide residues in food of plant origin during plant protection product's registration process]. *Rocz Panstw Zakl Hig* 2006;57(4):303-315 (in Polish)
33. Struciński P., Morzycka B., Góralczyk K., Hernik A., Czaja K., Korcz W., Matuszak M., Minorczyk M., Łyczewska M., Pruss B., Ludwicki J.K.: Consumer risk assessment associated with intake of pesticide residues in food of plant origin from the retail market in Poland. *Hum Ecol Risk Assess* 2015; 21(8): 2036-2061
34. Tucker A.J.: Pesticide residues in food – Quantifying risk and protecting the consumer. *Trends Food Sci Technol* 2008;19:S49-S55
35. Wojtyła A., Biliński P., Jaworska-Luczak B.: Regulatory strategies to ensure food and feed safety in Poland – update review. *Ann Agric Environ Med* 2010;17:215-220.

Received: 31.07.2015

Accepted: 06.10.2015

FLAVONOIDS INTAKE AMONG POLISH AND SPANISH STUDENTS

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ABSTRACT

Background. Flavonoids are a group of bioactive compounds that are extensively found in foodstuffs of plant origin. Their regular consumption plays an important role in the prevention of degenerative diseases, particularly cardiovascular disease, and cancer.

Objective. The purpose of the study was to estimate dietary flavonoid intake among Polish and Spanish students and to establish the main dietary sources of flavonoids.

Material and Methods. This study included 91 Polish and 60 Spanish students.

Dietary data were collected using a food frequency questionnaire. The dietary USDA Database for the flavonoid content of selected foods was used to calculate daily and weekly flavonoid intakes by the subjects.

Results. The average flavonoid consumption in the Polish students was 801 mg/day, and in Spanish students 297 mg/day. Food categories such as beverages, vegetables and fruits were found to be significant sources of flavonoids, of which tea, oranges, orange juice, dried parsley and oregano were the main contributors among Polish students and oranges, tea, chick-peas, orange juice and dried parsley were the main sources of flavonoids among Spanish students.

Conclusions. Flavonoid consumption in Polish students was more than two times higher than in Spanish students. Compared to other population studies consumption of flavonoids in both students groups was adequate.

Key words: *flavonoids, flavonoid intake, patterns of consumption*

STRESZCZENIE

Wprowadzenie. Flawonoidy to grupa antyoksydantów występująca powszechnie w roślinach. Substancje te wykazują wielokierunkowe działanie protekcyjne na organizm człowieka, budząc tym samym zainteresowanie naukowców, którzy w licznych pracach badają pobranie tych związków u ludzi.

Cel. Celem badań była ocena spożycia wybranych flawonoidów spożywanych wraz z dietą przez polską i hiszpańską młodzież akademicką oraz wskazanie głównych źródeł tych substancji w diecie badanych.

Materiał i Metody. W badaniach wzięło udział łącznie 151 osób: 91 Polaków oraz 60 Hiszpanów. Studenci zostali poproszeni o podanie tygodniowego spożycia produktów spożywczych będących istotnym źródłem flawonoidów. Spożycie tych związków obliczono na podstawie informacji zawartych w bazie danych opracowanej przez Departament Rolnictwa USA (USDA United States Department of Agriculture).

Wyniki. Średnie spożycie flawonoidów przez polskich studentów wynosiło około 801 mg/dzień, podczas gdy wśród hiszpańskich studentów wyniosło około 297 mg/dzień. Napoje, warzywa, oraz owoce były głównymi grupami produktów dostarczających flawonoidów wśród badanych z obydwu grup. Najistotniejszym źródłem tych związków wśród polskich ankietowanych była czarna herbata, a wśród hiszpańskich pomarańcze.

Wnioski. Analiza udzielonych odpowiedzi wykazała, że polscy studenci spożywali ponad dwukrotnie więcej flawonoidów niż hiszpańscy badani. Konsumpcja flawonoidów w obu grupach była zadowalająca, na tle danych z innych badań populacyjnych.

Słowa kluczowe: *flawonoidy, spożycie flawonoidów, wzory konsumpcji*

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INTRODUCTION

Flavonoids are one of the most abundant group of biochemical substances found in plants. Several reviews about flavonoids have shown a wide spectrum of potential health benefits, such as antioxidant, anticarcinogenic, anti-inflammatory and cardiovascular disease prevention [7, 8, 9, 10, 11, 16]. Molecular mechanisms of these substances have not been fully understood [11]. Their beneficial effects on the cardiovascular system are suspected to involve the inhibition of low-density lipoprotein (LDL) oxidation, reduction of atherosclerotic lesion formation, inhibition of platelet aggregation, reduction of vascular cell adhesion molecule expression, amelioration of endothelial function and reduction of the blood pressure [7, 16]. The consumption of flavonoids in a plant-based diet can be several times higher than the consumption of other phytochemicals and vitamins, including ascorbic acid (vitamin C), α -tocopherol (vitamin E) or carotenoids [9].

The eating habits of populations living in the Mediterranean region, including the Spanish population, arouse the interest of many researchers. The typical Mediterranean diet is characterized by high consumption of plant products rich in flavonoids [2, 14, 18]. It is estimated that inhabitants of the Western Europe consume on average 100-1000 mg flavonoids/day/person [10, 17]. This study aimed to estimate the level of intake of these compounds by people living in different countries, with different dietary habits and with different availability of specific foods.

Winter-spring period is characterized by the limited access to certain foodstuffs. Interesting is the level of flavonoid consumption at that time. The populations for which it is important are not only people with chronic diseases, but also other groups – e.g. young people, including students. The purpose of the study was to estimate dietary flavonoid intake among Polish and Spanish students and to establish the main dietary sources of flavonoids.

MATERIALS AND METHODS

Information about food intake during February, March and April 2013, was collected in the anonymous on-line survey in Polish and Spanish academic students. Both groups received the same questionnaire including questions about flavonoid-rich foods intake during 7 preceding days. The questionnaire aimed to the Spanish students was translated into Spanish.

The selection of food items that were included in the questionnaire was based on the database of flavonoid and flavonoid subclasses content of foods that was published by the US Department of Agriculture (USDA) in 2011 [1]. From among more than 500 specified products, 126 considered as effective flavonoid sources have been selected. In the case of several varieties of a product, contents of flavonoids were averaged. When the content of flavonoids in related products was similar, respondents were asked to report the total size of their consumption, e.g. the total amount of consumption red/black grapes in the preceding week.

To analyze the results the participants were grouped according to students' nationality: Polish (P) and Spanish (H) students. One hundred and sixty persons, 97 Poles and 63 Spaniards, signed in the website survey. Due to the incorrect filling a total of 9 questionnaires were excluded: 6 Polish and 3 Spanish. The final statistical analysis involved 91 questionnaires completed by Polish and 60 by Spanish students. In the group of Polish students there were 74 women and 17 men. In the Spanish group there were 36 women and 24 men. Among both groups dominated the female respondents. The differences in the percentage of men and women surveyed were statistically significant ($P < 0.05$). Polish respondents were 21-28 years old, their average age was 23.5 years. Spanish students were 19-46 years old, their average age was equal to 22.73 years. One of Spanish respondents did not specify her age. The average age of men and women did not show statistically significant differences within the groups surveyed and between them.

Table 1. Mean weekly flavonoid, flavone and flavonol intakes in Spanish and Polish students (mean, SD, median, minimal, 25%, 75% and maximum)

Class of flavonoids		Mean (mg)	SD	Min.	25%	Median	75%	Max.	P-value
Total flavonoids	P	5605.26	4150.77	328.80	2003.69	4706.63	8667.72	18220.13	P<0.001
	H	2080.26	1851.83	145.12	973.81	1563.90	2530.42	10970.94	
Flavones	P	115.99	153.71	0.1	24.14	59.07	143.74	923.91	NS
	H	133.20	153.51	0.31	42.22	70.09	152.25	626.52	
Flavonols	P	302.32	189.12	29.72	147.20	267.80	414.09	844.09	NS
	H	213.26	196.08	7.89	97.19	141.02	242.44	1056.92	

P – Polish students, H – Spanish students, SD – standard deviation

Statistical analysis was performed using Statistica and Epi Info programmes (Student's t-test, Fisher's exact test, ANOVA). The level of statistical significance was $P < 0.05$.

RESULTS

The weekly flavone, flavonol, and total flavonoid intakes in the both groups under study are shown in Table 1. Statistical analysis showed statistically significant differences between the two groups ($P < 0.001$) in the average amount of total flavonoids consumed with the diet. No differences were found between consumption of two subclasses of flavonoids: flavones and flavonols.

Polish students consumed more than twice the amount of total flavonoids compared to the respondents from Spain. The mean and median of the total flavonoid intakes among Polish students were 5605 and 4707 mg/week respectively. The mean and median of total flavonoid intakes among Spanish students were 2080 and 1564 mg/week respectively. The average daily flavonoid consumption among Polish students was 801 mg, and among Spanish students 297 mg. The daily intake of flavonoids exceeding 1.2 g were found in 25% of Polish respondents. The maximum weekly intake of these substances in the group P was about 18.2 g, while in the group H about 11 g. The minimum weekly intake in Spanish students was a little over 145 mg and in Polish students almost 329 mg.

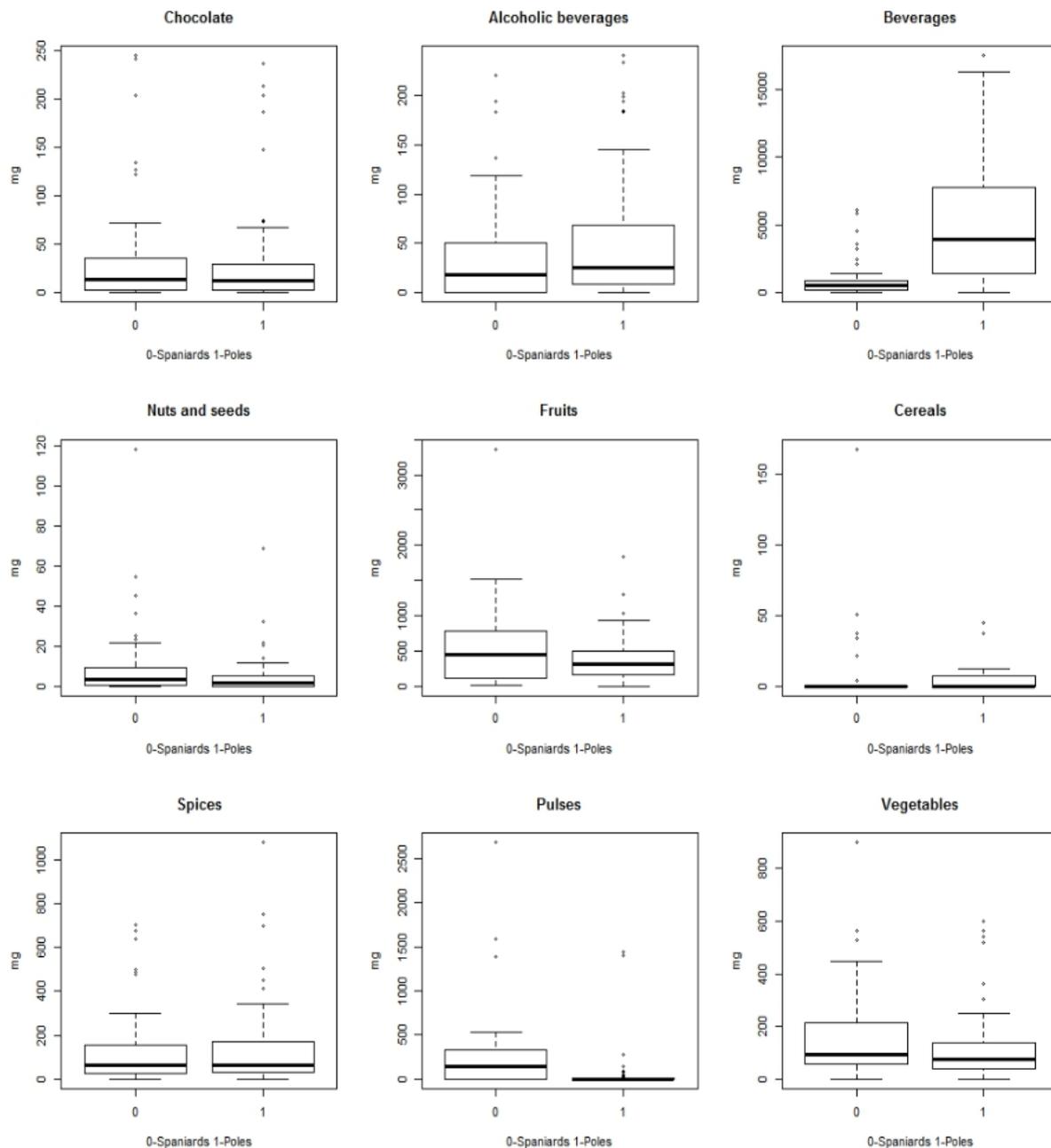


Figure 1. Mean weekly flavonoid intakes with different kinds food in Polish and Spanish student groups

Table 2. Mean weekly flavonoid intakes with different food categories in Polish and Spanish student groups

Food categories	Mean weekly flavonoid intake (mg ± SD)			P-value
	Poles (N=91)	Spaniards (N=60)	Both (N=151)	
Chocolate	29 ± 46	34 ± 55	31 ± 49	0.521
Alcoholic beverages	52 ± 67	36 ± 51	46 ± 61	0.110
Non- alcoholic beverages	4855 ± 4026	906 ± 1298	3286 ± 3761	<0.001
Nuts and seeds	3.9 ± 8.6	9.2 ± 18.1	6 ± 13.4	0.017
Fruit	371 ± 304	533 ± 553	436 ± 427	0.022
Cereals	3.6 ± 6.9	5.6 ± 23.4	4.4 ± 15.7	0.443
Spices	130 ± 176	130 ± 171	130 ± 174	0.993
Pulses	49 ± 212	270 ± 459	137 ± 349	<0.001
Vegetables	113 ± 118	156 ± 166	130 ± 140	0.061

SD – standard deviation

THE MAIN SOURCES OF FLAVONOIDS IN POLISH AND SPANISH STUDENTS' DIET

The main food categories related to the flavonoid intake were also studied (Figure 1, Table 2). There were statistically significant differences between consumption of flavonoids from such groups of products as beverages, nuts and seeds, fruits and pulses. The Poles consumed higher amounts of flavonoids than the Spaniards with non-alcoholic beverages. On the other hand, the Spaniards consumed higher amount of these substances with nuts and seeds, fruits and pulses.

Table 3 illustrates the main flavonoid sources in the Polish group of participants. The main sources of total flavonoid intake were: black tea (~2901 mg/ week) green tea (~1520 mg /week), followed by oranges (~164 mg / week), orange juice (~160 mg/ week) and fruit tea (~100 mg /week). Dried parsley and oregano effectively enriched the diet of Polish students with these substances. The declared amount of consumption of dried parsley, supplied weekly about 56 mg of these compounds, and dried oregano about 52 mg, both altogether slightly more than 100 mg. Alcoholic beverages, such as beer, provided

43 mg of these substances. The average of 30 mg of total flavonoid consumption was derived from the following sources: white tea, blackcurrant juice, onion and lemon.

The analysis of the answers given by the Spanish academic youth enabled to identify the main products being a source of flavonoids in their weekly diet (Table 4). The main contributors were oranges (~270mg/ week) and green tea (~265 mg/week). In the vegetable group chickpeas (~250 mg/week) were by far the richest source of flavonoids.

The main sources of flavonoids in Spanish and Polish diets were different. For example, black tea in the Spanish group provided weekly about 236 mg of flavonoids, over 12 times less than in the Polish group. On the other hand, the Spaniards' diet was richer than Poles' diet in such sources of flavonoids as oranges, chickpeas, dried parsley, onions, strawberries, almonds or pomelo (Table 3, Table 4).

DISCUSSION

Flavonoids exert beneficial effects on human health. Their regular consumption is associated with reduced

Table 3. The main flavonoid sources in the Polish group of participants

Product	Mean weekly flavonoid intakes (mg)	SD	Min.	25%	Median	75%	Max.
Black tea	2901.05	3006.05	0	447.45	1789.8	6562.6	8352.4
Green tea	1520.85	2699.31	0	0	454.75	909.51	9398.27
Orange	164.49	200.87	0	0	88.05	220.12	1232.7
Orange juice	160.10	325.13	0	0	76.28	228.84	2135.84
Fruit tea	99.57	170.07	0	0	20.5	123.0	574.0
Parsley, dried	56.55	128.90	0	0	0	97.09	728.17
Oregano, dried	52.16	56.90	0	0	30.92	61.84	293.74
Apple	46.64	57.31	0	0	22.88	57.2	286.0
Beer	43.17	64.63	0	0	12.52	50.10	233.8
Chickpeas	41.15	208.30	0	0	0	0	1387.05
White tea	37.91	243.55	0	0	0	0	2238.0
Blackcurrant juice	33.23	94.49	0	0	0	0	585.3
Onion	30.45	40.10	0	6.77	27.1	27.1	243.9
Lemon	30.26	45.69	0	0	21.35	42.7	277.55
Banana	24.18	29.36	0	0	14.42	41.05	147.78

Table 4. The main flavonoid sources in the Spanish group of participants

Product	Mean weekly flavonoid intake (mg)	SD	Min.	25%	Median	75%	Max.
Orange	270.75	337.03	0	0	88.05	396.22	1232.7
Green tea	265.27	699.75	0	0	0	303.17	3638.04
Chickpeas	249.68	445.12	0	0	138.7	277.41	2635.39
Black tea	236.15	667.75	0	0	0	298.3	3579.6
Orange juice	218.67	272.50	0	0	114.42	457.68	915.36
Parsley, dried	72.82	128.75	0	0	0	97.09	533.99
Onion	58.38	79.14	0	10.16	27.1	67.75	379.4
Strawberries	55.13	68.38	0	0	49.22	88.60	344.57
White tea	49.73	205.64	0	0	0	0	1119.0
Oregano, dried	48.96	60.53	0	0	30.92	61.84	293.74
Banana	39.81	45.77	0	0	41.05	41.05	229.88
Almonds	36.38	6.03	0	0	0	3.3	29.70
Apple	34.51	57.39	0	0	17.16	57.2	320.32
Pomelo	28.15	167.75	0	0	0	0	1291.68
Beer	26.92	45.87	0	0	12.52	25.05	183.7

risk of a number of chronic diseases, including cancer, cardiovascular disease (CVD) and neurodegenerative disorders. Our study showed the estimated level of flavonoid intake and the main food sources of total flavonoids and also flavones and flavonols subgroups among Spanish and Polish students. There are few investigations aimed at assessment of flavonoid consumption in the Polish population. One of such studies included 13545 subjects aged 20 to 74 years from the whole Poland as a part of the Polish Multicenter National Health Survey (WOBASZ) that was performed in 2003-2005 [19]. Another study was carried out in 2005-2007 and included students from the Medical University of Wroclaw [6]. There are also data on consumption of flavonoids in the Spanish [18], Greek [3], American [5] and Dutch female populations [12].

The average estimated flavonoid intake in a group of 398 students of the Medical University of Wroclaw was 639.1 mg/day. This amount compared to our own results was lower than that in Polish students (about 801 mg/day) and higher than in Spanish students (about 297 mg/day) [6].

Based on the data from the WOBASZ study, the average estimated intake of flavonoids in Poles aged 20-74 years was 1172 mg/day in males and 1031 mg/day in females. Men aged 20-40 years consumed about 1251 mg of flavonoids per day, while women in the same age range 1054 mg [19]. Consumption of flavonoids in the WOBASZ study was higher than in our study. However, the main sources of flavonoids were similar: beverages, fruits and vegetables.

It is estimated that inhabitants of the Western Europe consume on average 100 to 1000 mg of flavonoids/day [10, 17]. Results of the European Prospective Investigation into Cancer and Nutrition (EPIC) study showed a lower intake of these substances among inhabitants of Greece and Spain compared with results of our own

study [3,18]. The median daily intake of flavonoids by Greek and Spaniard subjects equaled to 93 mg (n ~ 28000) and 126.1 mg (n = 40683) per person, respectively. The Greek survey was performed in 1992-1996 and thus the results may be underestimated as the database concerning flavonoid levels in foodstuffs was incomplete at that time [3,18].

The authors of another study, published in 2008, which covered a much smaller group of respondents (45 Dutch women) estimated that the daily average intake of flavonoids with diet was 166 mg, which also indicates a relatively large supply of these substances by Polish and Spanish students that took part in our study [12]. It should be emphasized that the information about the diet of our subjects was collected in the winter-spring period when the access to certain fruit and vegetables is limited.

The data collected in 2001-2002 by the US Department of Agriculture showed that Americans consumed about 132 mg of flavonoids per day, which is much less than in our own participants [5]. On the other hand, it is assumed that inhabitants of countries in the Far East, such as Japan, because of high intake of legumes, soy and tea, may consume up to 2 g of flavonoids daily [17].

The main sources of flavonoids in the diet of Spaniards, according to the data from the European Prospective Investigation into Cancer and Nutrition (EPIC) study, were successively: apples, red wine, oranges, beans, pears and peaches [18]. However, the main food contributors to the total flavonoid intake among the Spanish students who took part in our study were: oranges, green tea, chickpeas, black tea, orange juice and dried parsley. Different sequence of products which are the main source of flavonoids in adult Spaniards in the EPIC study and our group of Spanish students may indicate a change in eating habits which took place in Spain during the last 17 years. We should emphasize that in the group of 6 products which are the main

sources of flavonoids in the diet of Spanish students there was no red wine. Moreover, low consumption of this drink caused this product to be outside of the 15 the most important foods that supply flavonoids. An alcoholic beverage which provided the highest amount of flavonoids in the diet of Spanish students was beer. It should be emphasized that beer contains much less of these substances than red wine.

Black tea was a product which was the main contributor of flavonoids in students of the Medical University of Wrocław. In the daily diet it supplied as much as 93% of these compounds [6]. The results of our study are similar. Black tea supplied the Polish students with over 81% of these substances. Similarly, it is estimated that in the diet of Americans about 83% of flavonoids were derived from this source [15]. The authors of the Spanish study indicate that inhabitants of the Northern European countries and the United States habitually drink more tea than those living in the Mediterranean countries [18]. The results of the study concerning consumption of black and green teas by Polish inhabitants of the Mazovian Region show that black tea was drunk by 80% of them, of whom 39% did so daily [4].

The average consumption of spices in Europe is estimated to be 0.5 g/person/day, which is significantly less than in the inhabitants of the North Africa and Asia. These products are good sources of flavonoids. It is worth noting that in the recent years in Poland, there was an increase in the consumption of spices. A review describing the sources of natural antioxidants, published in 2008, pays attention to changes in the Polish diet. According to the authors, the growth in consumption of spices is probably due to increased availability of these food items and the possibility of buying them in fresh form and also popularity of cuisines from different parts of the world. This conduces to increasing supply of antioxidants with a daily diet [13]. In the present study, both Polish and Spanish students declared consumption of spices, which had a favorable impact on the level of consumption of flavonoids with their diet.

CONCLUSIONS

1. Flavonoids intake by Polish and Spanish students was similar or higher than in other Western populations studied by other authors.
2. Polish students consumed more than two times higher amount of flavonoids than Spanish students.
3. The main contributors of flavonoids in the diet was black tea in Polish, and oranges in Spanish students.
4. There is a need for further research on dietary intake of flavonoids among these groups taking into account the variability of consumption of these compounds in different seasons.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. *Bhagwat S., Haytowitz D. B., Holden J. M.*: USDA Database for the flavonoid content of selected foods. Nutrient Data Laboratory, Beltsville Human Nutrition Research Center Agricultural Research Service U.S. Department of Agriculture 2011; 1-159.
2. *Cichożka A.*: The Mediterranean diet in the prevention of coronary disease. *Endokrynol Otył Zab Przem Mat* 2005; 3:30-39 (in Polish).
3. *Dilis V., Trichopoulou A.*: Antioxidant intakes and food sources in Greek Adults. *J Nutr* 2010; 140:1274-1279.
4. *Drywień M., Podkowska J., Frąckiewicz J., Górnicka M.*: Consumption of black and green tea as a dietary source of polyphenols in Polish inhabitants of the Mazovian region. *Rocz Panstw Zakł Hig* 2015; 66(1):35-38.
5. *Haytowitz D.B., Bhagwat S., Harnly J., Holden J.M., Gebhardt S.E.*: Sources of flavonoids in the U.S. diet using USDA's updated database on the flavonoid content of selected foods, Agricultural Research Service, 2008; MD 20705.
6. *Iłow R., Regulska-Iłow B., Tangermann S., Róžańska D.*: Evaluation of dietary flavonoids among students of Wrocław Medical University in 2005-2007. *Bromat Chem Toksykol* 2011; 3:469-473 (in Polish).
7. *Jeong Y.J., Choi Y.J., Kwon. H.M., Kang S.W., Park H.S., Lee M., Kang Y.H.*: Differential inhibition of oxidized LDL-induced apoptosis in human endothelial cells treated with different flavonoids. *Br J Nutr*. 2005; 93:581-591.
8. *Kozłowska A, Szostak-Węgierek D*: Flavonoids--food sources and health benefits. *Rocz Panstw Zakł Hig* 2014; 65: 79-85.
9. *Lotito S.B., Zhang W., Yang C., Crozier A., Frei B.*: Metabolic conversion of dietary flavonoids alters their anti-inflammatory and antioxidant properties. *Free Radic Biol Med* 2011; 51(2):454-463.
10. *Majewska M., Cieczot H.*: The flavonoids in the prevention and treatment. *Terap Lek* 2009; 65(5): 369-377 (in Polish).
11. *Majewska-Wierzbicka M., Cieczot H.*: The flavonoids in the prevention and treatment of cardiovascular diseases. *Pol Merk Lek* 2012; 32: 50-54 (in Polish).
12. *Mullie P., Clarys P, Deriemaeker P., Hebbelinck M.*: Estimation of daily human intake of food flavonoids. *Inter J Food Sci Nutr* 2008; 59:291-298.
13. *Sikora E., Cieślak E., Topolska K.*: The sources of natural antioxidants. *ACTA Sci Pol Technol Aliment* 2008; 7(1):5-17.
14. *Sofi F., Cesari F, Abbate R., Gensini G.F., Casini A.*: Adherence to Mediterranean diet and health status: meta-analysis. *BMJ* 2008; 337(1344):1-7.
15. *Song W.O., Chung O.K*: Tea is the major source of flavan-3-ol and flavonol in the U.S. diet. *J Nutr* 2008; 138(8):1543S-1547S.
16. *Vauzour D., Rodriguez-Mateos A., Corona G. Oruna-Concha M.J., Spencer J.P.E.*: Polyphenols and human

- health: Prevention of disease and mechanisms of actions. *Nutrients* 2010; 2:1106-1131.
17. *Wilczyńska A., Retel M.*: Estimate of dietary phenolic compounds of honey. *Probl Hig Epid* 2011; 92(4): 709-712 (in Polish).
18. *Zamora-Ros R., Andres-Lacueva C., Lamuela-Raventos R., Berenquer T., Jakszyn P., Barricarte A., Ardanaz E., Amiano P., Dorronsoro M., Larranaga N., Martinez C., Sanchez M.J., Navarro C., Chirlaque M.D., Tormo M.J., Quiros J.R., Gonzalez C.A.*: Estimation of dietary sources and flavonoid intake in Spanish adult population (EPIC-Spain). *J Am Diet Assoc* 2010; 110:390-398.
19. *Zujko M.E., Witkowska A.M., Waśkiewicz A., Sygnowska E.*: Estimation of dietary intake and patterns of polyphenol consumption in Polish adult population. *Adv Med Sci* 2012; 57(2): 375-384.

Received: 11.05.2015

Accepted: 31.08.2015

METHODS USED BY ADOLESCENTS FOR REDUCING BODY MASS

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ABSTRACT

Background. During adolescence teenagers undergo dynamic physical and mental changes which are accompanied by an increasing interest in changes to their external appearance. Often teens are concerned about such changes, leading to attempts at managing body mass reduction. Adolescent slimming more commonly arises due to a subjective appraisal of body mass rather than using any objective BMI indicators.

Objective. To evaluate nutritional status of 13 year old boys and girls living in Szczecin, Poland and to analyse the methods used for achieving body mass reduction.

Materials and Methods. Subjects were 1,342 adolescents consisting of 679 girls and 663 boys. Nutritional assessment was performed by anthropometric measurements; calculated BMI (Body Mass Index) and WC (Waist Circumference index). A questionnaire was also used to determine how the subjects lost body mass, their satisfaction levels, mood changes and physical activity.

Results. Only 73% subjects had an adequate/normal nutritional status. It was found that half of those declaring that they had used various means of losing body mass (13.04%), of whom the majority were girls, had normal BMI indicators. The most frequently used method of losing body mass were; reducing foodstuff portions and dishes, abstaining from dinner, 1-3 starvation days, increasing physical activity, reducing sweets consumption, abstaining altogether from sweets and increasing fruit and vegetable consumption. Slimming diets were undertaken by 13.1% subjects, consisting mainly of 1000-1300 kcal diets, vegetarian diets or ones recommended by a physician.

Conclusions. Adolescents living in Szczecin showed similar rates of adopting slimming diets for reducing body mass when compared to other regions of Poland and the rest of Europe. The methods used for this purpose were mainly either anti- or pro-healthy nutritional behaviour, but less often using physical activity or through slimming diets. It thus appears that monitoring nutritional status in adolescents, as well as providing education in pro-healthy nutrition, is necessary.

Key words: adolescents, nutritional status, methods for reducing body mass, nutritional behaviour, slimming diets

STRESZCZENIE

Wstęp. U młodzieży w okresie dorastania zachodzą dynamiczne zmiany w sferze fizycznej i psychicznej, którym towarzyszy wzrost zainteresowania zmieniającym się wyglądem zewnętrznym. Częstym obserwowanym zjawiskiem jest brak akceptacji przez młodzież zachodzących zmian, która jest przyczyną podejmowania prób redukcji masy ciała.

Cel. Celem badań była ocena stanu odżywienia młodzieży (dziewcząt i chłopców) w wieku 13 lat w Szczecinie oraz analiza stosowanych przez nią sposobów redukcji masy ciała.

Material i Metody. Ocenie stanu odżywienia poddano 1342 osób w wieku 13 lat (dziewcząt, n = 679 i chłopców, n = 663) uczęszczających do 17 szkół w Szczecinie, na podstawie wykonanych pomiarów antropometrycznych i wyliczonych wskaźników BMI (*Body Mass Index*) i WC (*Waist Circumference*). Badania przeprowadzono w latach 2007 – 2010. Wśród młodzieży przeprowadzono również badanie ankietowe dotyczące stosowanych sposobów redukcji masy ciała, poczucia akceptacji, wahań nastroju oraz aktywności fizycznej.

Wyniki. Prawidłowym stanem odżywienia charakteryzowało się 73% młodzieży. 13.04% badanych (częściej dziewcząt) deklarowało stosowanie różnych sposobów redukcji masy ciała, pomimo że u ponad połowy badanych stwierdzono prawidłową wartość wskaźnika BMI. Najczęściej stosowanymi sposobami redukcji masy ciała były zmiany w zachowaniach żywieniowych: zmniejszenie porcji spożywanych produktów i dań, rezygnacja z posiłków, ograniczenie lub rezygnacja ze słodczy, zwiększenie spożycia owoców lub warzyw i stosowanie głodówek. Stosowanie diet odchudzających zadeklarowało 13.1% badanych, głównie: 1000-1300 kcal, vegetariańskiej i zaproponowanej przez lekarza.

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Wnioski. Wśród badanej młodzieży ze Szczecina odsetek osób stosujących różne sposoby redukcji masy ciała, w tym diety odchudzające, był zbliżony do stwierdzanego przez innych autorów w innych regionach Polski oraz w Europie. Redukcję masy ciała stosowały osoby nie tylko z nadwagą lub otyłością, ale również osoby z prawidłowym stanem odżywienia. Stosowanymi sposobami redukcji masy ciała były głównie anty- lub prozdrowotne zachowania żywieniowe, rzadziej zwiększenie aktywności fizycznej lub diety odchudzające. W świetle uzyskanych wyników badań koniecznym wydaje się monitorowanie stanu odżywienia młodzieży oraz prowadzenie prozdrowotnej edukacji żywieniowej.

Słowa kluczowe: młodzież, stan odżywienia, sposoby redukcji masy ciała, zachowania żywieniowe, diety odchudzające

INTRODUCTION

Improper state of nutrition in the period of adolescence is not only an increased risk of cardiovascular complication but also affects - decreases the quality of life by lack of acceptance of own looks, low self-esteem [39], feeling of isolation [31], difficult relationships with peers [34], teasing by others [37], even states of depression [12]. Especially disadvantageous is visceral accumulation of fat tissue correlated with insulin-resistance, secondary hyperinsulinemia, dysglycaemia, atherogenic dyslipidemia. Also in not obese people but with visceral accumulation of fat tissue referred to as MONW (*Metabolically Obese Normal-Weight*) the above mentioned disorder is more often found [2]. To evaluate the state of nutrition in children and teenagers the anthropometric measurements are being taken and based on them indicators such as BMI, WC are calculated because it was shown that they are strongly correlated with risk factors of cardiovascular diseases [18].

Adolescents nutrition behavior, demonstrated among others by applying various types of slimming diets, overeating, or absolutely rejecting food especially during this period of life is one of the important environmental factors modifying the development in accordance with genetic potential. Irregularities in nutrition methods in adolescents and low physical activity become a threat to health, which in the period of development shows through somatic disorder among others in content and distribution of fat tissue which predisposes development of malnutrition, overweight and obesity. Excessive increase of adipocytes at the time of pubertal spurt predisposes development and fixation of obesity during the adulthood. That is why it is reasonable to conduct screening tests in adolescents during the pubertal spurt in order to find people with improper state of nutrition and nutrition behavior and provide them with modifying pro-health education, encourage them to increase their physical activity in order to achieve standard weight [6].

Therefore the objective of this study is the evaluation the nutritional status of 13-year-old adolescents both sexes living in Szczecin, Poland and to analyse the methods used for achieving body mass reduction.

MATERIALS AND METHODS

The presented results are a part of the study constituting a unique 4-year program (2007-2010) co-funded by the Department of Health and Social Policy of the City of Szczecin, which evaluates nutritional status, the nutrition methods in Szczecin secondary schools, nutrition education and the effects of this education by means of a questionnaire.

After obtaining the approval of Local Ethical Commission (BN-001/93/07) the research was conducted in the years 2007-2010 among 1342 thirteen-year-old Polish adolescents (679 girls and 663 boys) of 68 first classes of randomly selected 17 junior high schools in Szczecin.

The children were anthropometrically examined, that is their body mass was measured with medical scales (legalized and standardized to 0.1 kg without shoes and in light clothes), body height in Frankfurt position with height meter attached to mobil stadiometr Seca 215 accurate to 0.1 cm. The waist circumference (WC) measurement was taken midway between the tenth rib and the iliac crest accurate to 0.1 cm a n anthropometric Gulick tape measure was employed with the subject in a standing position.

From the obtained measurements BMI (*Body Mass Index*) was calculated according to the formula: body mass (kg)/height (m²). The obtained values of the BMI index were referred (according to sex and age) to polish centile nets [21] and BMI value was assumed: ≤ 5 percentile as underweight; 10 – 75 percentile as normal weight, 85 – 90 as overweight, ≥ 95 percentile as obesity. The values of WC indexes were referred to polish centile nets [22] and for both indexes the assumed values were ≥ 90 percentile as a criterion of the location of the visceral fat tissue.

Questionnaire research has been conducted among adolescents regarding the application of body mass reduction methods including weight loss diets and feeling of acceptance, mood changes and physical activity. The results achieved were presented as arithmetic means and standard deviation computed in the Microsoft Excel program.

RESULTS

Analysis of the achieved numbers from the anthropometric features of adolescents (Table 1) shows that both in girls and in boys average body mass and height, BMI and WC indicators values were proper and within the limits of 10 – 75 percentile. Proper state of nutrition was found in nearly 73% of adolescents (Table 2), underweight (more often boys) 5%, overweight (more often girls) 12% and 15% obesity (more often girls).

Table 1. Values on anthropometric attributes and the BMI, WC, WHtR indicators in 13-year old adolescents, ($\bar{x} \pm SD$)

Attributes and indicators	Girls (n = 679)	Boys (n = 663)
Body weight, kg	52.2 ± 10.4	53.0 ± 12.0
Body height, cm	160.2 ± 6.5	162.1 ± 8.6
BMI, kg × m ⁻²	20.3 ± 3.3	20.0 ± 3.5
WC, cm/cm	70.0 ± 8.2	71.6 ± 9.2

Table 2. The value of the BMI indicator in 13-year old adolescents

Percentile level	BMI					
	Girls (n = 679)		Boys (n = 663)		Total (n = 1342)	
	n	%	n	%	n	%
≤ 5 th percentile (underweight)	33	4.9	41	6.2	74	5.5
10 th to 75 th percentile (normal)	464	68.3	509	76.8	973	72.5
85 th to 90 th percentile (overweight)	108	15.9	52	7.8	160	11.9
≥ 95 th percentile (obesity)	142	20.9	62	9.4	204	15.2

On the base of data from questionnaire tests it was shown that from the population under research – 1,342 people, 13.04% (175 adolescents) declared using various methods aiming at body mass reduction (Table 3), in this 9.69% girls and 3.35% boys. Taking into consideration the value of BMI indicator it was ascertained that more than a half of slimming adolescents (more often girls) had its proper value (10 – 75 percentile) and the rest of people had its over standard value (≥ 85 percentile). None of the slimming persons

Table 3. Percentage of 13 year old adolescents applying body mass reduction according to BMI value

Percentile level	BMI					
	Girls (n = 130)		Boys (n = 45)		Total (n = 175)	
	n	%	n	n	n	%
≤ 5 th percentile (underweight)	0	0	0	0	0	0
10 th to 75 th percentile (normal)	69	53.1	21	46.7	90	51.4
85 th to 90 th (overweight)	34	26.2	9	20.0	43	24.6
≥ 95 th percentile (obesity)	27	20.7	15	33.3	42	24.0

was malnourished. Taking into consideration the values of WC ≥ 90 percentile it has been found (Table 4) that nearly 33% of slimming adolescents had visceral obesity (more often boys).

Table 4. Percentage of 13 year old adolescents applying body mass reduction according to waist circumference (WC)

Range of WC	Girls (n = 130)		Boys (n = 45)		Total (n = 175)	
	n	%	n	%	n	%
< 10 th percentile (underweight)	0	0	0	0	0	0
10 th to 75 th percentile (normal)	11	8.5	2	4.4	13	7.4
90 th to 95 th percentile (overweight)	17	13.1	2	4.4	19	10.9
> 95 th percentile (obesity)	24	18.5	15	33.3	39	22.3

In the questionnaire tests adolescents mentioned as the most commonly applied methods of body mass reduction (Table 5) changes in nutrition behavior such as: decreasing the size of portions of consumed products and dishes, resigning from eating supper, 1 -3 days starvation, limiting or total resigning from eating sweets, increasing consumption of fruit and vegetables. Only few adolescents decided to increase physical activity as the method of reducing body weight.

Taking into consideration sex, girls more often than boys took the trials to reduce body weight by resigning from consumption of supper, applying 1 -3 days of starvation, limiting the portions of consumed products and dishes, increasing physical activity, limiting the amount of consumed sweets or elimination them from their diet and increasing fruit consumption. Boys tried to reduce their body mass by limiting portions of consumed products and dishes and increasing consumption of vegetables, increasing physical activity and limiting of sweets consumption.

Applying weight loss diets was declared in the questionnaire by 13.1% adolescents, these were mainly diets: 1000-1300 kcal, vegetarian and proposed by a physician. However, none of the adolescents under research declared using any pharmacological preparations for weight loss only girls (2.2%) used herbal teas for weight loss. We cannot exclude that in the group of 14% of people under research who declared slimming without saying anything about method could be people who used pharmacological preparations.

Analysis of the information from questionnaires of adolescents slimming down (Table 6) showed that 15.4% of them do not feel accepted in class by teenagers of the same age obese girls (37%) more often than boys (26.7%). The changes taking place during the puberty are not accept by 20% adolescents under research, most often overweight girls (44.1%) and overweight

Table 5. Methods used by 13 year old adolescents for reducing body mass

Kind of methods	Girls (n = 130)		Boys (n = 45)		Total (n = 175)	
	n	%	n	%	n	%
Limitation of the number of consumed meals	4	3.1	2	4.4	6	3.4
Resignation from consuming breakfast	3	2.3	0	0	3	1.7
Resignation from consuming dinner	3	2.3	1	2.2	4	2.3
Resignation from consuming supper	28	21.5	2	4.4	30	17.1
Reduction of portions of products	18	13.8	13	28.9	31	17.7
Applying (1 – 3 days) starvations	23	17.7	2	4.4	25	14.3
Limiting sweets consumption	16	12.3	5	11.1	21	12.0
Resignation from sweets consuming	21	12.0	0	0	21	12.0
Resignation from breads consuming	1	0.8	0	0	1	0.6
Resignation from meat and cold meats consumption	1	0.8	3	6.7	4	2.3
Resignation from potatoes consumption	1	0.8	0	0	1	0.6
Resignation from juices and fizzy beverages sweetened	0	0	3	6.7	3	1.7
Resignation from chips consumption	2	1.5	2	4.4	4	2.3
Resignation from fast food type dishes	0	0	1	2.2	1	0.6
Increasing water consumption	7	5.4	3	6.7	10	5.7
Increasing vegetables consumption	11	8.5	7	15.6	18	10.3
Increasing fruit consumption	16	12.3	3	6.7	19	10.9
Increasing yoghurt consumption	5	3.8	0	0	5	2.9
Food cooking	2	1.5	1	2.2	3	1.7
Applying slimming teas	2	1.5	0	0	2	1.1
Low calories diet (1000 – 1300 kcal)	10	7.7	1	2.2	11	6.3
Light food diet	0	0	1	2.2	1	0.6
“Eat according to your blood group” diet	1	0.8	0	0	1	0.6
Vegetarian diet	2	1.5	2	4.4	4	2.3
Mediterranean diet	1	0.8	0	0	1	0.6
Copenhagen diet	1	0.8	0	0	1	0.6
Diet prescribed by physician	1	0.8	1	2.2	2	1.1
Chrono biological diet	1	0.8	0	0	1	0.6
Dr Ducan diet	0	0	1	2.2	1	0.6
Increasing physical activity	17	13.1	7	15.5	24	13.7
Other methods	9	6.9	5	11.1	14	8.0

boys (26.7%). Mood changes occurring during the puberty period are felt by 88% adolescents, most often overweight girls (96.3%) and boys with proper state of nourishment (80.9%). However stress and emotional tension result in growing appetite for food in every third adolescent under research (35.4%), most often

in obese girls (44.4%) and boys with proper state of nourishment (28.6%).

Subjectively, 60% people under research defined their own way of nutrition as proper, mostly girls with obesity (63%) and boys with overweight (77.8%).

More than a half of adolescents defined their physical activity as average (51.4%) and only every third person as high. Small percentage of adolescents under research declared their activity as very high or low.

DISCUSSION

Non-invasive, simple and the most often applied methods in appraisal of state of nutrition of children and youths are anthropometrical measurements of mass and height which allow us to calculate the BMI indicator [36]. In our own study from the population of 1,342 percentage of overweight adolescents was 11.9%, but with obesity 15.2% and this problem more often concerned girls than boys.

During the puberty period physiologically in healthy conditions boys have tendency to increase their no-fat body mass and to decrease the percentage content of fat tissue in their general body mass which is the result of androgen concentration in blood. Estrogens in girls increase the fat tissue mass around breasts, hips and buttocks thus increase its percentage share in the general body mass [30]. However, revealing during the puberty period the abdominal location of fat tissue is a significant factor of development of metabolic syndrome. In the conducted research visceral obesity was characteristic, regardless of BMI indicator, for 33.2% of the general number of people under research, more often boys (37.7%) than girls (32.5%).

Accumulation of fat tissue in body might be for adolescents not only an aesthetic but also psychological and emotional problem because dynamical changes take place not only in physical but also in mental sphere along with growing interest in physical appearance at this stage of ontogenesis. Lack of acceptance of these changes by adolescents is also an often occurring phenomenon, which is confirmed by my own research because 20% of adolescents declared in the questionnaire that they do not accept the changes taking place in their body (more often girls) connected to puberty. It was shown that adolescents have problems with self-evaluation adequate to reality of the body mass [10, 25], which is caused by mass media, especially television and color magazines for teenagers and women which create the image of slim body (sometimes even skinny) as beautiful, attributing to it such features as: success, self-confidence, attractiveness and health [26]. The study conducted by *Kololo and Woynarowska* [20] showed that the decision of losing the weight by

Table 6. Percentage of 13 year old adolescents applying body mass reduction (on the base of the questionnaire)

Questions		Girls								Boys								Total (n=175)	
		BMI 10 - 75 pc (n = 69)		BMI 85 - 90 pc (n = 34)		BMI ≥ 95 pc (n = 27)		Total Girls (n=130)		BMI 10 - 75 pc (n = 21)		BMI 85 - 90 pc (n = 9)		BMI ≥ 95 pc (n = 15)		Total Boys (n = 45)			
		n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%		
Do you feel accepted in the class?	Yes	65	92.8	28	82.4	17	63.0	110	84.6	20	95.2	7	77.8	11	73.3	38	84.4	148	84.6
	No	4	7.2	6	17.6	10	37.0	54	15.4	1	4.8	2	22.2	4	26.7	7	15.6	27	15.4
Do you accept changes taking place in your body?	Yes	59	85.5	19	55.9	24	88.9	102	78.5	19	90.5	8	88.9	11	73.3	38	84.4	140	80.0
	No	10	14.5	15	44.1	3	11.2	28	21.5	2	9.5	1	11.2	4	26.7	7	15.6	35	20.0
Do you have mood changes?	Yes	65	94.2	30	88.2	26	96.3	121	93.1	17	80.9	6	66.7	10	66.7	33	73.3	154	88.0
	No	4	5.8	4	11.8	1	3.7	9	6.9	4	19.1	3	33.3	5	33.3	12	9.2	21	12.0
Does stress and tension result in desire to eat?	Yes	25	36.2	13	38.2	12	44.4	50	38.5	6	28.6	2	22.2	4	26.7	12	9.2	62	35.4
	No	44	63.8	21	61.8	15	55.6	80	61.5	15	71.4	7	77.8	11	73.7	33	73.3	113	64.6
Do you eat properly?	Yes	41	59.4	20	58.8	17	63.0	78	60.0	12	57.1	7	77.8	8	53.3	27	60.0	105	60.0
	No	28	40.6	14	41.2	10	37.0	52	40.0	9	42.9	2	22.2	7	46.7	18	40.0	70	40.0
What is your physical activity?	Low	3	4.3	2	5.9	4	14.8	9	6.9	0	0	0	0	3	20.0	3	6.7	12	6.9
	Midium	33	47.8	20	58.8	16	59.3	69	53.1	10	47.6	4	44.4	7	46.7	21	46.7	90	51.4
	High	24	34.9	9	26.5	6	22.2	39	30.0	7	33.3	2	22.2	3	20.0	12	26.7	51	29.1
	Very high	9	13.0	3	8.8	1	3.7	13	10.0	4	19.1	3	33.4	2	13.3	9	20.0	22	12.6

adolescents depends mostly on subjective evaluation of body mass than on objective BMI indicator. Twice as many girls (46%) than boys (23%) felt that they are too fat, which can explain the results of my own research. Slightly higher percentage (56%) got *Janiszewska* et al. [16] in the research conducted among 16 years old girls with proper BMI indicator.

Adolescents perception of their own bodies in the aspect of their attractiveness and discrepancy with the promoted by mass-media canons of beauty [23] often causes frustration. Omnipresent in media incentives for using preparations and weight loss diets contribute to formation of conviction of the need of their application [3] and induce decision about body mass reduction [20]. And what is more often under the influence of family and peers criticism adolescents become almost obsessed with controlling their body weight with differences between sexes. Boys have tendency to determine their weight as too low, which is synonymous with masculinity, because it is identified with big muscle mass, especially in the upper parts of body and high physical fitness [19]. That is why they use slimming preparations and/or laxatives rarely and rarely monitor their body mass. Their nutrition concentrates more on achieving through diet proper silhouette than on reducing directly body mass [35]. Girls more often connect appraisal of their looks with other features and with lack of satisfaction from the look of their body, lowering of self-esteem can be observed which lead to application of various methods of body mass reduction [14].

Safe way of reducing body mass should be pro-health change of nutrition behavior assisted by increase

of physical activity however use of preparations and application of weight reducing diets should be done only according to medical indication under the supervision of a nutritionist. The conducted research shows that 13% of adolescents have already tried to reduce their body weight and the percentage is close to (14%) presented in the HBSC (*Health Behavior in School-aged Children*) research [9]. Similarly *Kololo and Woynarowska* [20] stated that the percentage of slimming among Polish 13 years olds was 14.4%, in this 21.7% girls and 8.3% boys. The HBSC [9] research report presented data says that among the European 13 years olds girls and boys 18% and 11% are slimming down however as in the own research girls (20.57%) more often than boys (13.39%) slimmed down, which confirms the fact that the dissatisfaction with their bodies grows among the male sex.

As long as attempting by the teenagers with overweight or obesity trials to reduce their body mass might be justified, however own research shows that more than half of the slimming down adolescents (more often girls) were the persons with proper BMI indicator values. Lower percentage of slimming down girls with proper BMI indicator value were shown by *Janiszewska* et al. [16] among 16 year old girls (33%).

Most often used methods of reducing body mass applied by people under research were changes of the nutrition behavior, which are often reckless and in disorder, random and short termed and do not guarantee weight loss and long term maintenance of the new body mass. That is why we have to agree with other authors [8, 15], that anti health behavior aiming at reduction

of body mass used by adolescents under research are: resigning from basic meals (first breakfasts, dinners and suppers), starving, resigning from various groups of nutrient products (breads, potatoes and meat) and undertaking diets and slimming teas. Resigning from eating meals, lengthening the time between meals might result in adolescents bodies not only in fluctuations in concentration of glucose in blood, changes of metabolism pace and body saving the consumed energy by putting it away in the form of fat tissue, but also in formation of hunger, lowering of concentration, limiting mental and physical activity, negative impact on effectiveness in learning. Similar problems with resignation from meals by adolescents showed other authors in their research [29, 40]. The problem of resigning from meals does not only regard Polish teenagers but also European teenagers because the research conducted by HBSC [9] showed that on average only 57% of girls and 65% of 13 year old boys consumed first breakfast however in Poland the percentage was only slightly higher (similarly 56% and 63%). Starving themselves declared 14.3% of the adolescents under research (more often girls) however *Janiszewska et al.* [16] showed higher percentage (23.3%) of 16 year old girls starving themselves.

Resigning from the consumption of various groups of food products was also watched by *Pieszko - Klejnowska et al.* [29] and *Wołowski and Jankowska* [40]. In own research adolescents resigned from breads consumption, which is an unfavorable phenomenon because especially whole grain products supply body in complex carbohydrates and mineral components (Ca, Mg, Zn, Cr), B group vitamins and fiber, components essential in body mass reduction. However resignation from meat and cold meats consumption might be the reason of anemia, lowered physical activity, psychomotor and intellectual disorder because this element is an ingredient of hemoglobin and myoglobin which are responsible for oxygen transportation.

Many authors [4, 7, 8, 11] excluding from the diet many groups of food products treats as nourishment disorder, which by unbalanced diet during this period of life might lead to delay of growth and puberty, period disorder in girls, osteopenia development, states of depression and lowered self-esteem. The positive aspect of this was that 40% of adolescents under research were conscious that their method of nutrition is not proper.

Pro health behavior used by adolescents under research as a method of body mass reduction must also include limiting of eating snacks between meals which helps accumulating fat tissue. Limiting the size of eating products or dishes portions can be considered pro-healthy only in the situation when before had been consumed bigger portions than those which could appease the feeling of hunger. Especially valuable is bringing to the diet by adolescents fruit and vegetables

which are main source of fiber, minerals and vitamins, mainly C vitamin necessary to produce collagen, hormone and transmitters synthesis, as well as to absorb non-haem iron.

Limiting or resignation from consuming pastries and/or sweets by adolescents under research is a pro-health behavior, because these products with high glycaemic indexes and loads cause excess insulin release as an answer to glucose load, poor immune response and increase of production free oxygen radicals promoting oxidation of LDL-CH fraction to atherogenic oxLDL-CH [1]. Resignation by adolescents from consuming fast food type dishes characterized by high content of fat, sugar, salt and low content of vitamins, minerals and fiber might affect and regulate body mass.

It was shown in the HBSC [9] research that 23% of 13 years old (20% girls and 25% boys) consume beverages with sugar, however in Poland the percentage was higher (25% and 35%). Limiting consumption of this group of products, containing the additive phosphates, might have positive influence on achieving peak bone mass by the adolescents under research. Although resignation from chips consumption thus limitation of consumption of saturated fatty acids, not only has influence on body mass regulation but can prevent neurotoxic action of these products resulting from the acrylamide content [24].

Increasing water consumption by adolescents under research should also be included in favorable nourishment behavior because water is calorie free carrier of many mineral ingredients. During the pubertal spurt positive balance of water is a physiological phenomenon, which contributes to regulation of feeling of thirst, metabolism improvement, secretion of digestive juices improvement, increasing exertion of unnecessary metabolism products, improves defecation, prevents irritability, insomnia and physical weakness.

Positive aspect identified in own research is the fact that there were no persons among the adolescents using pharmacological slimming preparations as a method of weight loss, which is in line with general tendency observed among teenagers among whom application of laxatives, diuretic and slimming preparations is not an often encountered phenomenon [4].

Despite the fact, that recommended by WHO action in body mass reduction should be increasing of physical activity, however in the conducted research like in the research made by *Kołoto and Woynarowska* [20], such actions were more often undertaken by boys than girls.

While using weight loss diets as a method of body mass reduction, in own research, was declared by 13.1% of adolescents and these were mainly low calorie, vegetarian and offered by a physician diets. It is generally known that applying low calories diets. Low carbohydrates and low fat diets does not give effect in long

term maintenance of body weight [32]. Paradoxically teenagers' slimming without clear medical indications and without a dietician's supervision might not acquire the desired effects in the form of "healthy weight" and "cosmetically desirable weight" but can also bring increase of body weight [28]. It was shown that adolescents of both sexes who applied restrictive diets five years later showed three times more often obesity than in the group who did not applied diets [27]. Also teenagers, who applied slimming diets at the age of 16 years were more exposed to obesity at the age of 30 than persons who did not apply diets [38].

Short and long term diet application by adolescents might result in distraction, irritability, fatigue and even in losing self-esteem in case of little or totally ineffective body mass reduction [5]. Applying weight loss diets carries risk (5 to 18 times) of deepening the nourishment disorder leading to anorexia or bulimia, to unrestricted appetite, gluttony [13] and their psychological consequences. Application of weight loss diets is seen as an introduction to the above mentioned disorders.

The cause of adolescents' under research behavior which aims at body mass reduction might be found in the declared in the questionnaire feeling of lack of acceptance by peers in the class, in mood changes and "eating up stress". It was shown that teenagers (especially girls) who have experienced criticism from peers and emerging from this states of depression and fear, are more prone to engage themselves in extreme body weight loss practices [17]. Constant monitoring of the state of nutrition of adolescents is necessary and it should be done by school nurses while doing screening tests, by physicians while doing prophylaxis health care and physical activity teachers [33]. It gives possibility of early detection of any irregularities in the state of nutrition and modifying it by working on correct nourishing habits, increasing physical activity and forming proper self-esteem.

Taking into consideration the results of conducted research all adolescents (1,342 people) were subject to pro-health nourishment education in the form of "live" workshops with nourishing products during which the rules of proper nourishing in accordance with their developing age and sex in the aspect of further physical and intellectual development and preventing the development of civilization diseases were introduced to them. After the workshops adolescents received leaflets containing basic rules of proper nourishment.

The parents of adolescents who showed the signs of improper nourishment received proposal of individual diet correction, however only 13% answered the invitation which confirms parents' low interest in health and development of their children which was also pointed in several discussions with headmasters, teachers and school educators.

CONCLUSIONS

1. Among the adolescents from the city of Szczecin the percentage of people applying various methods of body mass reduction including slimming diets was similar to the percentage in other regions in Poland and in Europe.
2. Reducing body mass was not only done by overweight or obese adolescents but also with proper state of nutrition.
3. Methods used by adolescents for reducing body mass were mainly anti- or pro-health nutrition behaviour, less often as a result of the physical activity or using the slimming diet.
4. Taking into consideration above conclusions it seems that monitoring the state of nutrition of adolescents and providing pro-health nutrition education is necessary.

Acknowledgements

The authors would like to thank the Department of Health and Social Policy of the city of Szczecin, Poland for the co-financing of this study.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. *Barclay A.W., Petocz P., McMillan-Price J., Flood V.M., Prvan T., Mitchell P., Brand-Miller J.C.:* Glycemic index, glycemic load, and chronic disease risk—a meta-analysis of observational studies. *Am J Clin Nutr* 2008; 87(3): 627-637.
2. *Bell J.A., Kivimaki M., Hamer M.:* Metabolically healthy obesity and risk of incident type 2 diabetes: a meta-analysis of prospective cohort studies. *Obes Rev* 2014; 15(6): 504-515.
3. *Beneditto M.C., Tordera C., Bottela Arbona C.:* Body image and restrictive eating behavior in adolescents. *An Pediatr* 2003; 58(3): 268-272.
4. *Boutelle K., Neumark-Sztainer D., Story M., Resnick M.:* Weight control behaviors among obese, overweight and nonoverweight adolescents. *J Pediatr Psychol* 2002; 27(6): 531-540.
5. *Cameron J.W.:* Self-esteem changes in children enrolled in weight management programs. *Issues Compr Pediatr Nurs* 1999; 22(2-3): 75-85.
6. *Campbell K., Waters E., O'Meara S., Summerbell C.:* Interventions for preventing obesity in childhood. *A systematic review. Obes Rev* 2012; 2(30): 149-157.
7. *Chen M.Y., Fan J.Y., Jane S.W., Wu J.Y.:* Do overweight adolescents perceive the need to reduce weight and take healthy actions? *J Nurs Res* 2009; 17(4): 270-277.
8. *Croll J., Neumark-Sztainer D., Story M., Ireland M.:* Prevalence and risk and protective factors related to

- disordered eating behaviors among adolescents: Relationship to gender and ethnicity. *J Adolesc Health* 2002; 31(2): 166-175.
9. *Currie C., Zanutti C., Morgan A., Currie D., de Looze M., Roberts Ch., Samdal O., Smith O.F.R., Barnekow V.*: Social determinants of health and well-being among young people. *Health Behaviour In: School-Aged Children (HBSC) Study: International Report From The 2009/2010 Survey*. Copenhagen, WHO Regional Office for Europe (Health Policy for Children and Adolescents, No. 6), 2012.
 10. *Czaja K., Fiszer K., Kołodziej M.*: The relation between selected health behaviour and body mass index amongst adolescents living in urban and rural areas in south-western Poland. *Rocz Panstw Zakl Hig* 2013, 64(2): 135-141.
 11. *Davison K.K., Deane G.D.*: The consequence of encouraging girls to be active for weight loss. *Soc Sci Med* 2010; 70(4): 518-525.
 12. *Erermis S., Cetin N., Tamar M., Bukusoglu N., Akdeniz F., Goksen D.*: Is obesity a risk factor for psychopathology among adolescents? *Pediatr Int* 2004; 46(3): 296-230.
 13. *French S.A., Story M., Downes B., Resnick M.D., Blum R.W.*: Frequent dieting among adolescents: Psychosocial and health behavior correlates. *Am J Public Health* 1995; 85(5): 695-701.
 14. *Furnham A., Badmin N., Sneade I.*: Body image dissatisfaction: gender differences in eating attitudes, self-esteem, and reasons for exercise. *J Psychol* 2002; 136(6): 581-596.
 15. *Grigg M., Bowman J., Redman S.*: Disordered eating and unhealthy weight reduction practices among adolescent females. *Prev Med* 1996; 25: 748-756.
 16. *Janiszewska R., Pilch W., Makuch R., Mucha D., Palka T.*: Aspekty żywienia i odchudzania się dziewcząt. *Probl Hig Epidemiol* 2011; 92(2): 351-354 (in Polish).
 17. *Johnson J.G., Cohen P., Kotler L., Kasen S., Brook J.S.*: Psychiatric disorders associated with risk for the development of eating disorders during adolescence and early adulthood. *J Consult Clin Psychol* 2002; 70(5): 1119-1138.
 18. *Kahn H.S., Imperatore G., Cheng Y.J.*: A population-based comparison of BMI percentiles and waist-to-height ratio for identifying cardiovascular risk in youth. *J Pediatr* 2005; 146(4): 482-488.
 19. *Kilpatrick M., Ohannessian C., Bartholomew J.B.*: Adolescent weight management and perceptions: an analysis of the National Longitudinal Study of Adolescent Health. *J Sch Health* 1999; 69(4): 148-152.
 20. *Kololo H., Woynarowska B.*: Samoocena masy ciała i odchudzanie się młodzieży w okresie dojrzewania. *Przeegl Pediatr* 2004; 34(3/4): 196-201 (in Polish).
 21. *Kulaga Z., Litwin M., Tkaczyk M., Palczewska I., Zajęzkowska M., Zwolińska D., Krynicki T., Wasilewska A., Moczulska A., Morawiec-Knysak A., Barwicka K., Grajda A., Gurdzowska B., Napieralska E., Pan H.*: Polish 2010 growth references for school-aged children and adolescents. *Eur J Pediatr* 2011; 170(5): 599-609.
 22. *Kulaga Z., Litwin M., Zajęzkowska MM, Wasilewska A, Morawiec-Knysak A, Różdżyńska A., Grajda A., Gurdzowska B., Napieralska E., Barwicka K., Świąder S.A.*: Comparison of waist and hip circumferences ranges in children and adolescents in Poland 7–18 y of age with cardiovascular risk thresholds – initial results of OLAF project (PL0080). *Stand Med* 2008; 5(4): 473-485.
 23. *Maes L., Vereecken C., Johnston M.*: Eating and dieting. In: *Currie C., Samdal O., Boyce W., Smith B.*: *Health Behaviour in School-Aged Children: a World Health Organization Cross-National Study. Research Protocol for the 2001/02 Survey*. University of Edinburgh, Edinburgh, 2001.
 24. *Mojcka H., Gielecińska I., Szponar L., Chajewska K.*: Zawartość akryloamidu w chipsach ziemniaczanych w Polsce. *Rocz Panstw Zakl Hig* 2006; 57(3): 243-249 (in Polish).
 25. *Mulvihill C., Nemeth A., Vereecken C.*: Body image, weight control and body weight. In: *Settortobulte W., Samdal O., Barnekow Rasmussen Currie C., Roberts C., Morgan A., Smith R., V. Young*: *People's Health in Context. Health Behaviour in School-aged Children: a WHO crossnational collaborative study (HBSC). International Report from 2001/02 survey. Health Policy for Children and Adolescents No. 4*. WHO Regional Office for Europe, Copenhagen, 120-130, 2004.
 26. *Muris P., Meesters C., van de Blom W., Mayer B.*: Biological, psychological, and sociocultural correlates of body change strategies and eating problems in adolescent boys and girls. *Eat Behav* 2005; 6(1): 11-22.
 27. *Neumark-Sztainer D.R., Wall M.M., Haines J.I., Story M.T., Sherwood N.E., van den Berg P.A.*: Shared risk and protective factors for overweight and disordered eating in adolescents. *Am J Prev Med* 2007; 33(5): 359-369.
 28. *Neumark-Sztainer D., Wall M., Guo J., Story M., Haines J., Eisenberg M.*: Obesity, disordered eating, and eating disorders in a longitudinal study of adolescents: how do dieters fare 5 years later? *J Am Diet Assoc* 2006; 106(4): 559-568.
 29. *Pieszko-Klejnowska M., Stankiewicz M., Niedoszytko M., Kozanecka I., Łysiak-Szydłowska W.*: Ocena sposobu odżywiania się gimnazjalnej młodzieży zamieszkującej wieś i miasto. *Pediatr. Współcz Gastroenterol Hepatol Żywienie Dziecka* 2007; 9(1): 59- 62 (in Polish).
 30. *Power M.L., Schulkin J.*: Sex differences in fat storage, fat metabolism, and the health risk from obesity: possible evolutionary origins. *Br J Nutr* 2008; 99(5): 931-940.
 31. *Robinson S.*: Victimization of obese adolescents. *J Sch Nurs* 2006; 22(4): 201-206.
 32. *Shai I., Schwarzfuchs D., Henkin Y., et al.*: Weight loss with a low-carbohydrate, Mediterranean, or low-fat diet. *N Engl J Med* 2008; 359: 229-241.
 33. *Spear B.A., Barlow S.E., Ervin C., Ludwig D.S., Saelens B.E., Schetzina K.E., Taveras E.M.*: Recommendations for treatment of child and adolescent overweight and obesity. *Pediatrics* 2007; 120: 254-288.
 34. *Strauss R.S., Pollack H.A.*: Social marginalization of overweight children. *Arch Pediatr Adolesc Med* 2003; 157(8): 746-752.
 35. *Striegel-Moore R.H., Rosselli F., Perrin N.*: Gender difference in the prevalence of eating disorder symptoms. *Int J Eat Disord* 2009; 42(5): 471-474.

36. *Turconi G., Guarcello M., Maccarini L., Bazzano R., Zaccardo A., Roggi C.*: BMI values and other anthropometric and functional measurements as predictors of obesity in a selected group of adolescents. *Eur J Nutr* 2006; 45(3): 136-143.
37. *Van den Berg P., Wertheim E.H., Thompson J.K., Paston S.J.*: Development of body image, eating disturbance and general psychological functioning in adolescent females: A replication using covariance structure modeling in an Australian sample. *Int J Eat Disord* 2002; 32(3): 46-51.
38. *Viner R.M., Cole T.J.*: Who changes body mass between adolescence and adulthood? Factors predicting change in BMI between 16 years and 30 years in the 1970 British Birth Cohort. *Int J Obes* 2006; 30(9): 1368-1374.
39. *Witherspoon D., Latta L., Wang Y., Black M.M.*: Do depression, self-esteem, body-esteem, and eating attitudes vary by BMI among African American adolescents? *J Pediatr Psychol* 2013; 38(10): 1112-1120.
40. *Wołowski T., Jankowska M.*: Wybrane aspekty zachowań zdrowotnych młodzieży gimnazjalnej. Część I. Zachowania młodzieży związane z odżywianiem. *Probl Hig Epidemiol* 2007; 88(1): 64-68 (in Polish).

Received: 05.04.2015

Accepted: 02.10.2015

LIFESTYLE OF STUDENTS FROM DIFFERENT UNIVERSITIES IN WROCLAW, POLAND

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ABSTRACT

Background. Changes in the economic and political system that took place in Poland in recent decades had a significant impact on lifestyles of different social groups, especially in youngsters as vulnerable and open to all novelty and changes.

Objective. The aim of this study was to evaluate the healthy or non-healthy behaviours including physical activity, diet, time devoted for sleeping, leisure, stress and the use of drugs by students of four universities in Wrocław.

Material and Methods. The study involved 604 students (305 women and 299 men) from four universities in Wrocław: University of Wrocław - 25.0%, Wrocław University of Technology - 24.5%, University School of Physical Education (AWF) - 25.2% and Wrocław Medical University - 25.3%. A questionnaire developed for this study was used. The questions were both open and closed, one or multiple answers could be matched. The questions related to: physical activity, nutrition, time devoted for sleeping, leisure, stress and stimulants.

Results. On the basis of the results it was found that students mostly reported an average level of physical activity. The highest level of physical activity was presented by students of the University School of Physical Education and the lowest by students of the University of Wrocław. Just one in ten students consumed meals on a regular basis, including one in five studying in the AWF. Almost half of the respondents (48.7%) spent 5-7 hours sleeping. Every tenth student slept less than five hours. Most respondents preferred passive forms of recreation, only one in three practiced sports in their spare time (usually students of the AWF). Every fourth student declared smoking, and more than 90% consumed alcohol.

Conclusions. Lifestyle of majority of the students surveyed did not follow the recommendations of preventive care. The need for more efficient education of students is obvious, which will lead to the future positive changes in their lifestyle, reducing the risk of lifestyle diseases.

Key words: *lifestyle, health, students*

STRESZCZENIE

Wprowadzenie. Zmiany ekonomiczne i ustrojowe, jakie miały miejsce w Polsce w ostatnich dziesięcioleciach w sposób znaczący wpłynęły na styl życia różnych grup społecznych. Grupą niewątpliwie podatną i otwartą na wszelkie nowości i zmiany są młodzi ludzie

Cel badań. Celem pracy była ocena zachowań pro- i antyzdrowotnych – w tym: aktywności fizycznej, sposobu odżywiania, długości snu, spędzania czasu wolnego, stresu i stosowania używek przez studentów czterech uczelni wrocławskich.

Material i metody. W badaniach wzięło udział 604 studentów (305 kobiet i 299 mężczyzn) z czterech wrocławskich uczelni wyższych: Uniwersytetu Wrocławskiego -25,0%, Politechniki Wrocławskiej - 24,5%, Akademii Wychowania Fizycznego (AWF) - 25,2% i Uniwersytetu Medycznego - 25,3%. W badaniu wykorzystano autorski kwestionariusz ankiety.

Wyniki. Stwierdzono, że studenci w większości odznaczali się średnim poziomem aktywności fizycznej, najwyższy poziom cechował studentów Akademii Wychowania Fizycznego, najniższy - studentów Uniwersytetu Wrocławskiego. Tylko, co dziesiąty student odżywił się regularnie, w tym, co piąty z AWF. 48,7% badanych przeznaczała na sen 5 -7 godzin. Co dziesiąty student sypiał krócej niż 5 godzin. Większość badanych preferowała bierne formy odpoczynku, a co trzecia osoba uprawiała sport w czasie wolnym (najczęściej studenci AWF). Co czwarty student deklarował palenie papierosów, a ponad 90% spożywanie alkoholu.

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Wnioski. Styl życia większości badanych studentów odbiegał od zaleceń profilaktyki zdrowotnej. Widoczna jest potrzeba edukacji młodych ludzi, która doprowadzi w przyszłości do korzystnych zmian w ich stylu życia ograniczając ryzyko chorób cywilizacyjnych.

Sowa kluczowe: styl życia, zdrowie, studenci

INTRODUCTION

The search for new solutions to improve health of communities was reflected in paying attention to the concepts of lifestyle, particularly healthy lifestyle. Very popular Lalonde Report identifies four groups of factors determining the “health field” of an individual. As a result of estimates of the share of each factor in the health field, the biggest role is assigned to lifestyle (about 53%), followed by environmental factors (21%), biological factors (16%) and health care (10%) [as cited in 4]. Lifestyle factors determine human health to a great extent in later life. They are already forming in childhood and adolescence [as cited in 8].

Economic and political system changes that took place in Poland in the recent decades had a significant impact on lifestyles of different social groups. Young people are a group undoubtedly vulnerable and open to all novelty and changes [20]. The period of studying requires a lot of both physical and mental energy as the students have to divide their time between lectures, exams and social life [8]. Aspects of health-related lifestyle behavior of students are often tested. This group is chosen due to the aforementioned openness and sensitivity to change and fashion and because of the nature of lifestyle associated with studies [4, 15].

Studying is a time when young people present a relatively high level of social activity; on the other hand they are burdened by considerable duties. The lives of students undergo numerous changes, which often aggravate stressful situations. The lack of ability to cope with stress often results in emotional disorders that manifest themselves in neurotic state, depression, eating disorders, and frequent use of stimulants. Many students after leaving their family home are not adequately educated to ensure proper eating habits in new conditions of independent existence. These deficiencies are often the result of a difficult financial situation of students [20]. Lifestyle in this period may affect health later on, also because of the consolidation of pro- and anti-healthy habits.

The aim of this study was to evaluate the healthy or non-healthy behaviors, including physical activity, diet, time devoted for sleeping, leisure, stress and the use of drugs by the students from four universities in Wrocław.

MATERIAL AND METHODS

604 students (305 women and 299 men) of four universities in Wrocław: the University of Wrocław (UWr) (n=151; 25,0%), Wrocław University of Technology (PWr) (n=148; 24,5%), the University School of Physical Education (AWF) (n=152; 25,2%) and Wrocław Medical University (UM) (n=153; 25,3%) of all years of studies took part in the voluntary and anonymous survey conducted in 2011.

In the study a diagnostic survey method was used. A questionnaire developed for this purpose consisting of 25 questions was used. Particulars of the questionnaire concerned the general characteristics of a study group; the questions were both open and closed, one or multiple answers could be matched. The questions related to: physical activity, nutrition, time devoted for sleeping, leisure, stress and stimulants.

Statistical analysis was performed using PASW Statistic 18.0 program. The significance variation of the studied groups was determined by the Chi^2 test for significance limit of $p = 0.05$.

RESULTS

The physical activities of students of all the universities were indicated by themselves as average (68.5%) and high level (25.3%). Only 6.1% evaluated the status of their activity as low. The differences in the self-assessments of their physical activity in various universities were statically significant ($Chi^2 = 63.19$ $df = 6$, $p = 0.00$). AWF students assessed their physical activity as high (47.4%) or medium (52.6%). In contrast, UWr students declared the lowest physical activity (11.3%) of the respondents. Male students were much more likely (33.4%) than female (17.4%) to rate their level of physical activity as high. They also slightly more often indicated low level of their activity (7.4%) than the females (4.9%). The differences are statistically significant ($Chi^2 = 24.2$ $df = 2$, $p = 0.00$).

In the survey on the time spent on physical activity, the respondents could indicate such answers as a) daily, b) several times a week, c) once a week, d) rarely, e) not at all. For statistical purposes, answers a and b were combined into “often”, and c and d into “rarely”. The answer e remained unchanged. The differences were statistically significant ($Chi^2 = 69.58$ $df = 6$, $p = 0.00$).

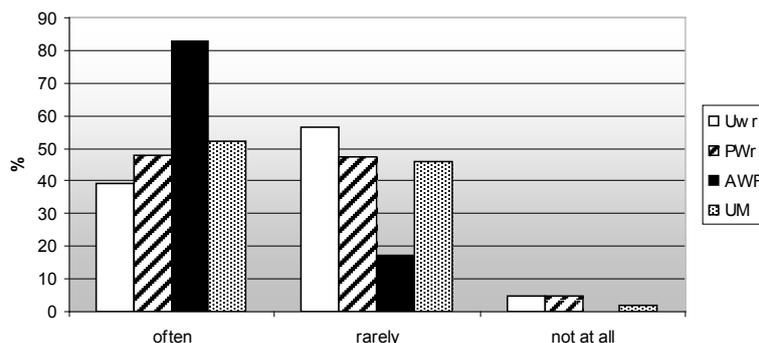


Figure 1. The frequency of physical activity did by the students of Wroclaw universities

Students of all the universities declared frequent physical activity (55.6%) (Table 1). AWF students strongly predominated in this group of respondents (82.9%). Unfortunately, almost 3% of the respondents did not take any physical activity at all. The most common in this group were students of the University of Wroclaw and Wroclaw University of Technology (4.6% and 4.7%) (Figure 1).

Table 1. The frequency of doing physical activity in relation to gender

Frequency		Gender		Total
		Women	Men	
often	number	151	185	336
	% of gender	49,5%	61,9%	55,6%
rarely	number	149	102	251
	% of gender	48,9%	34,1%	41,6%
not at all	number	5	12	17
	% of gender	1,6%	4,0%	2,8%
Total	number	305	299	604
	% of gender	100,0%	100,0%	100,0%

Over 60% of men declared frequent participation in physical activity (49.5% of women), but also 4% did not participate in it at all (female students 1.6%) (Table 1.). The differences were statistically significant ($Chi^2 = 15.06$ $df = 2$, $p = 0.001$).

The regularity of basic meals consumption was also evaluated by the respondents. Only 11.8% of students consumed meals on a regular basis - AWF students predominated in this group (21.7%). Students from

other universities ate regular meals significantly less often (PWr 10.1%, UM 7.8%, UWr 7.3%). As many as 39.4% of all the students eat irregularly, mainly students of the University of Wroclaw (48.3%) (Figure 2). The differences were statistically significant ($Chi^2 = 28,72$ $df = 6$, $p = 0.00$). Women were more likely than men to declare regular consumption of main meals (Table 2). Thus, men eat more irregularly (41.6%) than women (37.1%). The differences are not statistically significant ($Chi^2 = 2.72$ $df = 2$, $p = 0.256$).

Table 2. The regularity of meals consumed by students in relation to gender

Regularity of meals		Gender		Total
		Women	Men	
yes	number	41	30	71
	% of gender	13,7%	9,8%	11,8%
sometimes	number	147	148	295
	% of gender	49,2%	48,5%	48,8%
no	number	111	127	238
	% of gender	37,1%	41,6%	39,4%
Total	number	299	305	604
	% of gender	100,0%	100,0%	100,0%

The students slept an average of 5-7 hours (48.7%) (Table 3). Almost half of the respondents from AWF slept over 7 hours (48.3%). Every tenth student slept less than 5 hours, including every fifth student of UWr (21.7%). The differences were statistically significant ($Chi^2 = 27.89$ $df = 6$, $p = 0.00$) (Figure 3.).

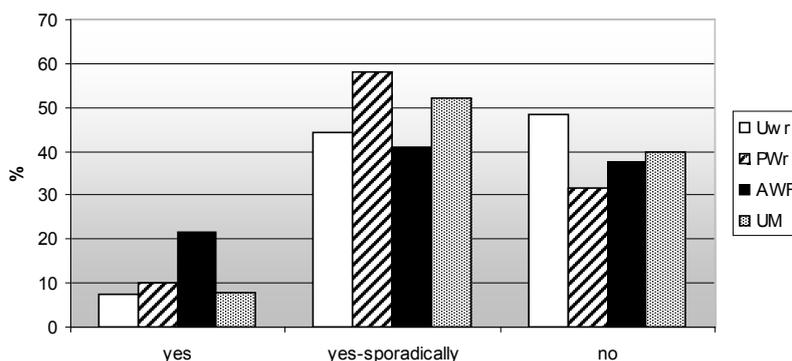


Figure 2. The regularity of meals consumed by students in relation to various universities in Wroclaw

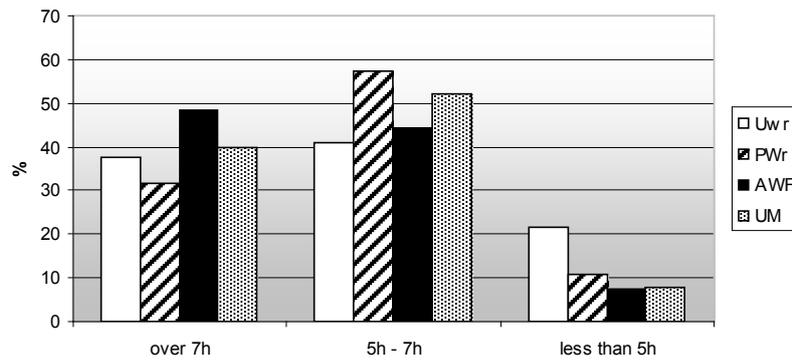


Figure 3. Time spent sleeping by the students Wroclaw universities

Women spent more time sleeping than men. Almost every other female student and every third male student slept over 7 hours. In contrast, 13.7% of men and 10.2% of women slept less than 5 hours (Table 3). These relationships are not statistically significant ($Chi^2 = 2.4$, $df = 2$, $p = 0.3$).

Table 3. Time spent sleeping in relation to gender

Time of sleep		Gender		Total
		Women	Men	
over 7 h	number	127	111	238
	% of gender	41,6%	37,1%	39,4%
5-7 h	number	147	147	294
	% of gender	48,2%	49,2%	48,7%
below 5 h	number	31	41	72
	% of gender	10,2%	13,7%	11,9%
Total	number	305	299	604
	% of gender	100,0%	100,0%	100,0%

Students of all the universities dedicated their free time mostly to meeting friends and using the computer. Much less frequently they spent their time sleeping or watching TV. AWF students often than others chose the answer associated with sporting activities (Table 4). Up to three answers could be selected in this question, therefore values do not add up to 100%.

Table 4. Leisure activities of students of particular universities

Activity	UWr	PWr	AWF	UM	Total
Reading books	44,4%	33,1%	20,4%	31,4%	32,3%
Doing sport	14,6%	24,3%	58,6%	31,4%	32,3%
Rushing the computer	60,9%	58,1%	44,7%	56,2%	55,0%
Watching TV	8,6%	13,6%	13,8%	15,7%	12,9%
Sleeping	29,8%	22,3%	29,6%	26,8%	27,2%
Going for a walk	38,4%	30,4%	27,6%	39,2%	33,9%
Meeting friends	68,2%	67,6%	62,5%	51,6%	62,4%

Women more often spent their free time with friends, while male students more often reported using computer. Out of active leisure activities men preferred sport and women going for a walk (Table 5). Up to three answers could be selected in this question, therefore values do not add up to 100%.

Table 5. Leisure activities for women and men

Activity	Women	Men	Total
Reading books	35,1%	29,4%	32,3%
Doing sport	26,2%	38,5%	32,3%
Rushing the computer	43,9%	66,2%	55,0%
Watching TV	12,8%	13,1%	12,9%
Sleeping	26,9%	27,4%	27,2%
Going for a walk	48,2%	19,4%	33,9%
Meeting friends	64,3%	60,5%	62,4%

Students of all universities tried to deal with stress by listening to music, walking or exercise. Almost half of the respondents from AWF practiced sports and only one in seven respondents from UWr did the same. Also, every seventh student of PWr and AWF drunk alcohol, students of UWr and AWF equally often smoked cigarettes (Table 6). Up to three answers could be selected in this question; therefore values do not add up to 100%.

Table 6. Ways of dealing with stress of students of particular universities

Activity	UWr	PWr	AWF	UM	Total
Eating	28,5%	26,4%	23,0%	30,7%	27,2%
Going for a walk	41,1%	43,9%	39,5%	43,1%	41,9%
Smoking cigarettes	14,6%	10,1%	12,5%	7,2%	11,1%
Taking sedatives	3,3%	2,0%	4,6%	5,2%	3,8%
Drinking alcohol	8,6%	14,2%	13,2%	3,3%	9,8%
Exercise (doing sport)	13,9%	25,0%	49,3%	36,6%	31,3%
Listening to music	66,2%	58,1%	56,6%	69,3%	62,6%

Both women and men most often listened to music in stressful situations. Female students also went for a walk or ate to relieve stress, while male students preferred doing sport or going for a walk. Every tenth respondent reached for cigarettes, regardless of gender. Every eighth student drank alcohol and every twentieth student took sedatives. Up to three answers could be selected in this question; therefore values do not add up to 100% (Table 7).

Every fourth student smoked cigarettes. Most of them were AWF students (one fifth smoked regularly), and UWr students. Frequently declaring non-smoking were UM students. The differences were statistically significant ($Chi^2 = 23.04$ $df = 6$, $p = 0.00$) (Figure 4.).

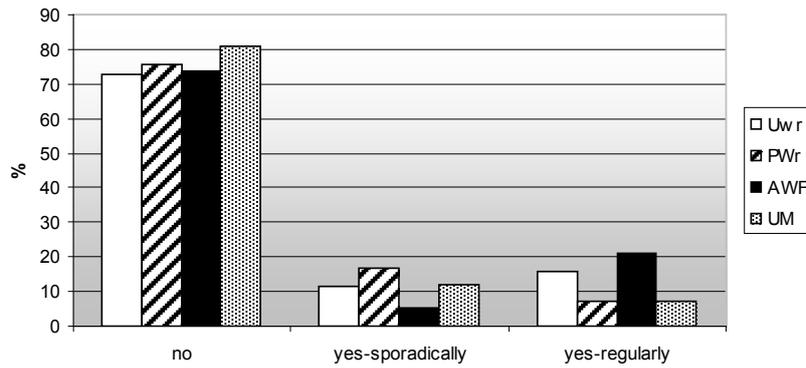


Figure 4. Frequency of smoking declared by the students of Wroclaw universities

Table 7. Ways of dealing with stress of men and women

Activity	Women	Men	Total
Eating	38,4%	15,7%	27,2%
Going for a walk	47,2%	36,5%	41,9%
Smoking cigarettes	11,8%	10,4%	11,1%
Taking sedatives	5,2%	2,3%	3,8%
Drinking alcohol	6,9%	12,7%	9,8%
Exercise (doing sport)	24,9%	37,8%	31,3%
Listening to music	60,0%	65,2%	62,6%

Almost as many women as men declared not smoking cigarettes. However, among regular smokers there are more women (Table 8). These relationships are not statistically significant ($Chi^2 = 1.29$ $df = 2$, $p = 0.52$).

Table 8. Smoking cigarettes in relation to gender

Smoking cigarettes		Gender		Total
		Women	Men	
no	number	228	230	458
	% of gender	74,8%	76,9%	75,8%
yes - sporadically	number	33	35	68
	% of gender	10,8%	11,7%	11,3%
yes - regularly	number	44	34	78
	% of gender	14,4%	11,4%	12,9%
Total	number	305	299	604
	% of gender	100,0%	100,0%	100,0%

Most of the students declared as occasional alcohol consumption. Only one in 13 of all the respondents did not drink alcohol at all. More than one-fifth of PWr students drank often, similarly to the students of UWr

and AWF (Figure 5). The differences were statistically significant ($Chi^2 = 15.79$ $df = 6$, $p = 0.015$).

By far the largest proportion of men and women drink alcohol occasionally. Among the persons who regularly consume alcohol is twice as many men than women (Table 9). The differences are statistically significant ($Chi^2 = 15.56$ $df = 2$, $p = 0.00$).

Table 9. Drinking alcohol in relation to gender

Drinking alcohol		Gender		Total
		Women	Men	
no	number	25	28	53
	% of gender	8,2%	9,4%	8,8%
yes - occasionally	number	246	203	449
	% of gender	80,7%	67,9%	74,3%
yes - regularly	number	34	68	102
	% of gender	11,1%	22,7%	16,9%
Total	number	305	299	604
	% of gender	100,0%	100,0%	100,0%

BMI in most subjects remained within standards ($n=462$; 76,5%), one in 12 persons was underweight ($n=51$; 8,4%), and every 7 person was overweight or obese ($n=91$; 15,1%).

No statistically significant correlation has been found between lifestyle and BMI of the subjects. Among parents of the students' secondary education (32.3% of fathers, 40.1% of mothers) as well as higher education prevailed (32.1% of fathers and 43% of mothers). For lower education amounted in both primary and vocatio-

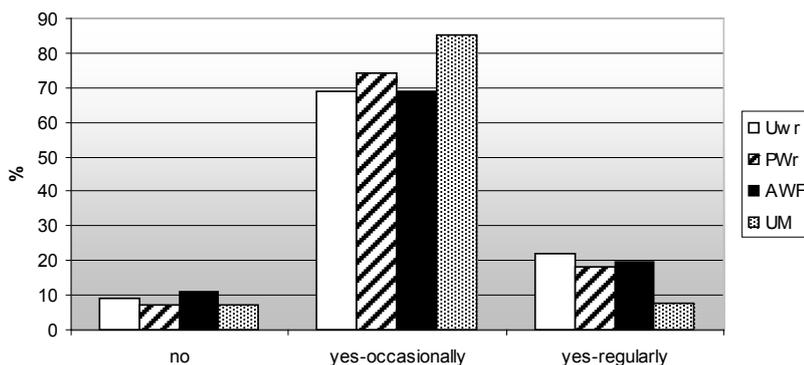


Figure 5. Frequency of alcohol consumption declared by the students of Wroclaw universities

nal education (35.6% of fathers, 16.9% of mothers). The mothers in comparison with the fathers had higher level of education. No relationship was found between the education of parents and the general lifestyle of students.

DISCUSSION

One of the most important lifestyle factors is the relation between physical activity and health. There are links between the three main components of human development, i.e. hereditary factors, physical activity and health, and it is physical activity that has direct impact on health.

The study shows that the majority of students assessed their level of activity as average (68.5%) and high (25.3%). Only 6.1% of respondents assessed the state of their activity as low. All AWF students indicated high or average state of physical activity (respectively 47.4% and 52.6%). Similar results were obtained by *Muszkiet* and *Bronikowski* [12] among students of physical education at various universities in Poland. The vast majority of respondents assessed their level of physical ability as good (women 57.8%, men 57.5%) and very good (women 28.2%, men 34.8%).

Most students of all the surveyed universities in Wroclaw often did physical activity (55.6%). Among them, 82.9% were AWF students. This data coincides with the study of *Kowalska* [7] conducted among students of the University School of Physical Education in Warsaw. 52% of the students of that university claimed to have spent a lot of time doing physical activity.

Almost 3% of the students of Wroclaw universities did not do any physical activity at all. According to a study by *Muszkiet* and *Bronikowski* [12], 9.2% of female students and 12.1% of male students of physical education did not take an active part in the development of their physical activity. It was found, however, that 80.5% female and 74.3% male students actively practiced every day, regularly every 2-3 days, or once a week.

Diet also has a major impact on lifestyle. The present study sought to quantify the regularity of eating basic meals. 39.4% of all the respondents ate irregularly, mainly students of the University of Wroclaw (48.3%). Slightly different results were obtained in a study conducted among university students in Gdansk [9]. Less than half of the respondents ate meals at stable time. Only 7% of students and 11% of students declared regular consumption of each of the basic meals. It can also be seen that male students attached a little more attention to eating regularly than female students.

Analyzing the results of *Lisicki's* study [9], it is worth paying attention to the reasons which prevent regular eating. Predominating were clearly the reasons

directly related to the studies – the amount of studying itself (55%). The vast majority of people in this group pointed to the schedule at the university as an obstacle to regular eating. University students in Lublin provided different reasons. Irregularity in eating pattern was most often associated with the need to travel between the university and the place of residence, as well as a large number of classes and financial problems [8]. Many other studies also report irregularities in basic meal consumption [5, 8, 10, 14, 18].

The present study shows that university students in Wroclaw slept an average of 5-7 hours (48.7%), which is similar to the results of *Pullman* et al. [15]. Almost half of the respondents from AWF slept more than 7 hours (48.3%). Among all the respondents 11.9% spent less than 5 hours on sleep, including every fifth student the University of Wroclaw and every tenth student of Wroclaw University of Technology. These figures are slightly different than the results from the studies of *Górska-Klęk* et al. [5]. Most students of the University of Wroclaw and the University of Economy in Wroclaw slept 6-8 hours. More than half of those surveyed also slept during the day and there was no difference in this respect between the universities. These discrepancies may be due to other hourly ranges in the questionnaire responses. A different period of the academic year and a slightly different way of life of students could also have influenced the results. According to a study by *Pawłowski* [14], female students slept regularly (7-8 hours per day) more often (24.7%) than male students (20.9%).

When analyzing the lifestyle of students it is also important to assess their anti-healthy behavior. Although the studies of *Dietz* et al. [3] and *Walther* et al. [19] found that compared to other age groups the group 18-24 has the highest percentage of smokers (25.1% in Denmark and 27% in Austria), the present study show that 75.8% did not smoke cigarettes. The study of *Górska-Klęk* [5] demonstrated that as much as 40% of AWF students and 27% of University of Economy students (Wroclaw universities) smoked habitually. Most of the students stated that they did not smoke cigarettes, which may be indicative of increasingly higher awareness of the respondents. This is also confirmed by other authors [11, 13, 14, 18, 20]. Regardless of the students' attitude towards smoking, 70% of students in each group felt that they lead a healthy lifestyle [14]. Drinking alcohol by students was studied by many authors [1, 7, 13, 16, 20]. However, data on alcohol consumption among students should be treated with caution, because even if the majority of students declared that they drink alcohol occasionally, it does not say anything about the amounts, types of alcohol drunk by the respondents, or situations in which it takes place.

Leisure activity among students is an alarming phenomenon. Surveyed students of Wroclaw universities

spent their free time primarily on meeting friends and using the computer (present study). It is difficult to compare such data to the studies of other researchers, because multiple-choice answers were not always available. However, studies of *Pullman et al.* [15] showed that nearly 80% of students spend more than 2 hours a day using computer in their free time. Physical activity during leisure time was not considered by many respondents as necessary to lead a healthy lifestyle. 77.3% of those who did not practice sport thought so [14]. Convergent results were obtained by conducting a survey among students in Olsztyn and Warsaw. Only 58.4% of those surveyed said they spend free time in an active way [18]. Passive leisure activities can be observed in the behavior of many Poles. According to a survey by CBOS from 2010 [17], leisure time is mostly spent on watching television (52%) or talking with children and family (36%). Only 24% of respondents go for a walk in their free time and every sixth actively does sports. The environment of AWF students and their parents showed much more interest in active leisure activities [6]. More than half of the parents of students from the University School of Physical Education in Gdansk spent their free time actively, whereas the percentage of parents of students of pedagogy doing so was 25%. These results indicate how significant is the impact of family home and how important are parents as a source of positive patterns of behavior.

Healthy lifestyle for the surveyed students was associated mainly with physical activity and a healthy diet, less frequently with rest or not using stimulants. Demonstrated mistakes in the behaviour of students make up an integrated group of factors that contribute to the development of lifestyle diseases. Increasingly, students were forced to work while studying or studying more than one faculty, which has a huge impact on their lifestyle and causes more non-healthy behaviour. It also seems necessary to develop at universities such organizational solutions that would allow students to begin and finish their classes at a relatively constant time and thus contribute to regular eating habits. Universities should allow students to organize their schedule so that they have a longer break in the afternoon guaranteeing peaceful consumption of a main meal. In conjunction with a thorough knowledge, it would lead to positive changes in their lifestyle and more effective prevention of lifestyle diseases.

CONCLUSIONS

1. Lifestyle of large part of the surveyed group of students did not follow the recommendations of preventive health care.
2. There is a need to focus on education that would

better inform young people on the health impact of lifestyles. It therefore seems necessary to introduce health education at universities.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. *Cybert M., Penar- Zadarko B., Binkowska-Bury M.*: Selected aspects of students' lifestyle. *Prz. Med. Uniw. Rzesz. Inst. Leków* 2008; 4:314-320 (in Polish).
2. *Czech A., Grela E.R.*: Dietary habits and frequency of consumption nutritional products among university students in lubuskie province. *Żyw. Człow. Metab.* 2003; 30 (1/2): 81-85 (in Polish).
3. *Dietz N.A., Sly D.F., Lee D.J., Arheart K.L., McClure L.A.*: Correlates of smoking among young adults: the role of lifestyle, attitudes/beliefs, demographics, and exposure to anti-tobacco media messaging. *Drug Alcohol Depend* 2013; 130 (1-3): 115-121.
4. *Gembalczyk I.*: Alkohol jako element studenckiego stylu życia. [Alcohol as an element of student's life style]. *Rocz Panstw Zakl Hig* 2006; 57, Supplement: 101- 105 (in Polish).
5. *Górska-Klęk L., Meleszko K., Boerner E.*: Health-promoting lifestyle factors of students of the University School of Physical Education and the University of Economics. *Acta Bio-Opt. Inf. Med. Biomed. Eng.* 2011; 17 (4): 268-270 (in Polish).
6. *Kosińska E.*: The place of sport and physical recreation among leisure activities for students and their parents. *Zdrowie. Kultura Zdrowotna. Edukacja* 2008; 2: 93-102 (in Polish).
7. *Kowalska J.E.*: Lifestyle and physical activity in physical education university students in Poland in terms of health education. *Kultura fizyczna* 2005; 7-8: 10-17 (in Polish).
8. *Kowalska A.*: Zwyczaje żywieniowe studentów Uniwersytetu Ekonomicznego we Wrocławiu. [Nutritional habits of students at the University of Economics in Wrocław]. *Rocz Panstw Zakl Hig* 2010; 61(3): 277-282 (in Polish).
9. *Lisicki T.*: Nutrition as a sign of lifestyle of students entering university. *Wych Fiz Zdr* 2004; 10: 10-14 (in Polish).
10. *Lisicki T.*: Nutrition as a sign of lifestyle of students entering university. *Rocz Panstw Zakl Hig* 2010; 61(3): 283-287 (in Polish).
11. *Mędreła-Kuder E.*: Selected elements of lifestyle of young people actively doing sport. *Kultura fizyczna* 2004; 1-2: 23-26 (in Polish).
12. *Muszkiet R., Bronikowski M.*: Selected components of a healthy lifestyle of physical education students. *SRPC* 2003; 1-2: 24-34 (in Polish).
13. *Patok J.*: Antyzdrowotne zachowania studentów Uniwersytetu Gdańskiego. *Zdrowie- Kultura Zdrowotna- Edukacja* 2008; 2: 111-115 (in Polish).

14. *Pawłowski R.*: Health behaviors of first year students and self-evaluation of their lifestyle. *Zdrowie- Kultura Zdrowotna- Edukacja* 2008; 2: 117-123 (in Polish).
15. *Pullman A.W., Masters R.C., Zalot L.C., Carde L.E., Saraiva M.M., Dam Y-Y, Simpson J.A., Duncan A.M.*: Effect of the transition from high school to university on anthropometric and lifestyle variables in males. *Appl Physiol Nutr Metab* 2009; 34: 162–171
16. *Rybowska A., Nazarewicz R., Babicz-Zielińska E.*: Model of alcohol consumption among students. *Żyw Człow Metab* 2003; 30 (1/2): 423-427. (in Polish).
17. *Stasik A.*: Leisure time of Polish people. CBOS 2010. 1-12 (in Polish).
18. *Uramowska-Żyto B., Kozłowska-Wojciechowska M., Jarosz A., Makarewicz-Wujec M.*: Wybrane element stylu życia studentów wyższych uczelni w świetle badań empirycznych. [Selected lifestyle elements of university students in the light of empirical research]. *Rocz Panstw Zakł Hig* 2004; 55(2): 171-179 (in Polish).
19. *Walther J., Aldrian U., Stüger H.P., Kiefer I., Ekmekcioglu C.*: Nutrition, lifestyle factors, and mental health in adolescents and young adults living in Austria. *Int J Adolesc Med Health* 2014; 26 (3): 377-386.
20. *Wyka J., Żechałko-Czajkowska A.*: Wiedza żywieniowa, styl życia i spożycie grup produktów w grupie studentów I roku Akademii Rolniczej we Wrocławiu. [Nutrition knowledge, lifestyle and consumption of product groups in the group of first year students of the Agricultural University in Wrocław]. *Rocz Panstw Zakł Hig* 2006; 57(4): 381-388 (in Polish).

Received: 31.03.2015

Accepted: 10.09.2015

ANALYSIS OF THE DECLARED NUTRITIONAL BEHAVIORS IN A GROUP OF DIABETOLOGY NURSES EDUCATING PATIENTS ABOUT DIABETES DIET THERAPY

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ABSTRACT

Background. The proper nutrition in diabetes is one of the crucial elements of therapy, but in practice, diet of diabetic individuals is commonly improperly balanced, that is associated with lack of nutritional knowledge. The nurses are also often characterized by insufficient knowledge about diabetes diet therapy and poor nutritional behaviors.

Objective. The aim of the study was to analyze of the declared nutritional behaviors in a group of diabetology nurses and to compare it with declared nutritional behaviors of the control group.

Material and Methods. The group of 52 nurses recruited from all the regions of Poland working with diabetic patients was analysed and compared with control group of 63 individuals – random non-diabetic patients from all the regions of Poland. They were asked about accomplishing practical recommended nutritional goals for adults in Poland and were able to indicate if they follow detailed recommended nutritional goals “always” (3 points), “sometimes” (1 point) or “never” (0 points).

Results. The diabetology nurses rarely declared fish and legumes intake (never or sometimes accomplishing goal: 87%), milk and dairy products intake (75%), as well as moderate sugar and sweets intake (69%). Nurses significantly rarer than control group declared regularity of meals ($p=0.0000$) and diversion of meals ($p=0.0000$). The lack of correlation between number of years of working with diabetic individuals and number of obtained points during assessment of nutritional behaviors was observed.

Conclusions. The nutritional behaviors of diabetology nurses are not good, even if they educate diabetic patients on daily basis. Nutritional education should be conducted not only in groups of diabetic patients, but also, in groups of diabetology nurses.

Key words: *nutritional behaviors, diabetology nurses, diabetes, nutritional education*

STRESZCZENIE

Wprowadzenie. Prawidłowe żywienie jest w cukrzycy jednym z kluczowych elementów terapii, ale w praktyce, dieta osób z cukrzycą często jest nieprawidłowo zbilansowana, co wiąże się z brakiem wiedzy żywieniowej. Badania wskazują, że pielęgniarki również często mają niedostateczną wiedzę na temat zaleceń żywieniowych w cukrzycy i nieprawidłowe nawyki żywieniowe.

Cel. Celem badań była analiza deklarowanych zachowań żywieniowych w grupie pielęgniarek diabetologicznych i porównanie ich z deklarowanymi zachowaniami grupy kontrolnej.

Material i Metody. Grupa 52 pielęgniarek diabetologicznych, rekrutująca się ze wszystkich regionów Polski została poddana analizie i porównaniu z grupą kontrolną 63 osób (losowo dobranych osób nieleczonych z powodu cukrzycy, rekrutowanych ze wszystkich regionów Polski). Uczestnicy byli pytani o realizację praktycznych zaleceń żywieniowych kierowanych do osób dorosłych w Polsce i mogli wskazać częstość realizacji poszczególnych zaleceń jako „zawsze” (3 punkty), „czasami” (1 punkt) lub „nigdy” (0 punktów).

Wyniki. Pielęgniarki diabetologiczne rzadko deklarowały spożywanie ryb i roślin strączkowych (odpowiedzi „nigdy” lub „czasami” na pytanie o realizację zalecenia: 87%), mleka i produktów mlecznych (75%) oraz umiarkowane spożywanie cukru i słodczy (69%). Pielęgniarki istotnie rzadziej niż grupa kontrolna deklarowały regularne spożywanie posiłków ($p=0,0000$) i ich urozmaicenie ($p=0,0000$). Nie obserwowano zależności między liczbą lat pracy z pacjentami diabetologicznymi i liczbą uzyskanych punktów przy ocenie zachowań żywieniowych.

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Wnioski. Zachowania żywieniowe pielęgniarek diabetologicznych nie są poprawne, nawet jeśli na co dzień zajmują się one edukacją pacjentów. Edukacja żywieniowa powinna być prowadzona nie tylko wśród pacjentów diabetologicznych, ale również wśród pracujących z nimi pielęgniarek.

Słowa kluczowe: zachowania żywieniowe, pielęgniarki diabetologiczne, cukrzyca, edukacja żywieniowa

INTRODUCTION

The proper nutrition in diabetes, as well as regular physical activity, is one of the crucial elements of therapy [7]. According to the Polish clinical recommendations of diabetes care [6], the proper nutrition is essential to prevent and cure chronic complications of diabetes, as well as to improve general well-being. However, the problem arises, as the diet in a groups of Polish diabetic individuals is observed to be not properly balanced, both in own research [30], and research of other authors [16, 27]. As a consequence, the body mass index commonly indicates the overweight and obesity in Polish diabetic individuals, even if they declare reducing sugar intake [12].

The described situation is observed not only in Poland, as generally in diabetic individuals, in research conducted worldwide, despite lower carbohydrate and sugar intake, than in control ones [3], poor glycemic control is noted [31]. Moreover, even if the diet of diabetic individuals may be assessed to be better, than in case of healthy individuals, it is not associated with higher level of compliance with recommendation and such diet is still not properly balanced [5]. Simultaneously, it is stated, that diabetic individuals are following diet being not only not properly adjusted to their diabetes, but also being highly atherogenic [25].

Such not properly balanced diet is associated with lack of knowledge of diabetic individuals – 30% of Polish diabetic individuals have no knowledge about the symptoms of diabetes and when asked about the purpose of a diabetic diet, only 52% indicates preventing early and late diabetes complications [10]. However, it is observed, that properly conducted education may be an effective way to increase knowledge of diabetic individuals [2].

Taking into account the need of properly conducted education of diabetic individuals, the high level of knowledge of educators seems to be essential. However, the research of *Ahmed et al.* [1] about diabetes knowledge (including dietetic issues), revealed the considerable gaps in the knowledge of health care professionals and the fact, that from all the analyzed groups, nurses had the lowest level of knowledge about the basic diabetes issues.

In general, low level of knowledge is associated with unfavorable nutritional behaviors [21]. Also in case of nurses, very often unfavorable nutritional behaviors are observed [4; 15; 34].

The aim of the study was to analyze of the declared nutritional behaviors in a group of diabetology nurses and to compare it with declared nutritional behaviors of the control group.

MATERIALS AND METHODS

The group of 52 nurses working with diabetic patients on daily basis, was analysed. The group of nurses was recruited from all the regions of Poland and represented both large clinical hospitals and smaller ones. They were characterized by diverse age and status. The nurses were asked if they educate patients and how long they work with diabetic individuals.

The control group were 63 individuals – random non-diabetic patients from all the regions of Poland, who were not previously educated due to research participation and wanted to verify their nutritional behaviors.

Both diabetic nurses group and control group were recruited during nutrition workshops conducted for participants from all the regions of Poland. The diabetic nurses group was recruited during nutrition workshops for diabetic nurses and the exclusion criterion was not working currently with diabetic individuals. The control group was recruited during nutrition workshops conducted for patients with various diseases and the exclusion criterion was diagnosed diabetes.

Individuals from both nurses group and control group were asked about accomplishing practical recommended nutritional goals for adults in Poland according to Committee of Human Nutrition Science of Polish Academy of Sciences, National Food And Nutrition Institute and Polish Society of Nutritional Sciences. The practical recommended nutritional goals for adults in Poland are presented in Table 1. Participants were able to indicate if they follow detailed recommended nutritional goal “always”, “sometimes” or “never”.

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Ethic Committee of the Regional Medical Chamber in Warsaw, Poland (No 4/08; 7.02.2008).

During further analysis, of accomplishing recommended nutritional goals each answer was quantify by calculating points. For declared following nutritional recommendation “always”, the number of 3 points was attributed, for declared following nutritional recom-

Table 1. Practical recommended nutritional goals for adults in Poland according to the Committee of Human Nutrition Science of Polish Academy of Sciences, National Food and Nutrition Institute and Polish Society of Nutritional Sciences

1	Eat regularly at least 3 meals a day with breakfast as the first meal everyday
2	Consume diversified animal and plant products
3	Consume everyday cereal products as well as fruits and vegetables, while vegetables are eaten raw or cooked for a short period of time
4	Consume milk, cottage cheese or low-fat yoghurt/ kefir two or better three times a day
5	Consume meat and meat products in moderation two or three times a week, while lean meat is preferred and the other days fish and legumes are chosen
6	Limit the fat intake and during meals preparation replace animal fat with oils
7	Limit the salt intake, while one teaspoon of salt in meals with more other condiments is enough
8	Have moderate sugar and sweets intake with more fruits and vegetables instead of them
9	Be physically active

mendation “sometimes”, the number of 1 point was attributed, while for declared following nutritional recommendation “never”, no points were attributed, so the potential maximum number of points to obtain was 27.

The statistical analysis involved comparison of declared accomplishing recommended nutritional goals between group of nurses and control group, that was conducted using χ^2 test. The comparison of total number of obtained points was conducted for mentioned groups, using *U Mann-Whitney* test, as well as for subgroups of educating nurses working with diabetic individuals ≤ 5 years; (5-15 years) and (15-30 years), using *Kruskal-Wallis* ANOVA. Also the analysis of correlation between number of years of working with diabetic individuals and total number of obtained points, was conducted using Spearman rank correlation coefficient. The analysis of distribution was verified using *Shapiro-Wilk* test. The level of significance $p \leq 0.05$ was accepted. The statistical analysis was carried out, using

the Statistica software version 8.0 (StatSoft Inc) and Statgraphics software version 5.1 (Statistical Graphics Inc).

RESULTS

Table 2 presents the comparison of frequency of accomplishing the recommended goals in groups of nurses (n=52) and control group (n=63). It was observed, that the differences between groups were observed in case of regularity of meals, diversion of meals and physical activity. The control group was characterized by higher declared regularity of meals and higher diversion of meals and at the same time by lower declared physical activity level.

The comparison of total number of obtained points conducted for groups revealed similar results. The median of number of obtained points for nurses (15.0, differing from 7.0 to 27.0) was significantly lower than for control group (19.0, differing from 8.0 to 25.0) ($p=0,0187$, *U Mann-Whitney* test).

The analysis of correlation of number of years of working with diabetic individuals with number of obtained points conducted for nurses revealed no significant correlation between number of years and obtained points ($p=0,6142$, *Spearman's* rank correlation).

Table 3 presents the comparison of number of obtained points in groups of nurses declaring educating patients about diet (n=45) characterized by various number of years of working with diabetic individuals – ≤ 5 years (n=17), (5-15 years) and (15-30 years) (n=14). The lack of difference in the number of obtained points in groups of educating nurses was also observed ($p=0,9205$, *Kruskal-Wallis* ANOVA).

DISCUSSION

The diabetology nurses are the specific type of health care professionals, as they have all the time the

Table 2. Comparison of frequency of accomplishing the recommended goals in groups of nurses and control group

	Nurses [%] n= 52			Control group [%] n= 63			p-value*
	always	sometimes	never	always	sometimes	never	
Regularity of meals	50.0	42.3	7.7	88.9	9.5	1.6	0.0000
Diversion of meals	44.2	53.8	1.9	96.8	3.2	0	0.0000
Vegetables and fruits intake	40.4	57.7	1.9	58.7	39.7	1.6	0.1458
Milk and dairy products intake	25.0	65.4	9.6	28.6	54.0	17.4	0.3637
Fish and legumes intake	13.5	75.0	11.5	11.1	79.4	9.5	0.8563
Limitation of fat intake	71.2	26.9	1.9	50.8	46.0	3.2	0.0854
Limitation of salt intake	44.2	34.6	21.2	60.3	23.8	15.9	0.2249
Moderate sugar and sweets intake	30.8	61.5	7.7	30.2	52.4	17.4	0.2851
Physical activity	46.2	53.8	0.0	42.9	42.9	14.2	0.0164

* the comparison of frequency was conducted using *Chi²* test

Table 3. Comparison of number of obtained points in groups characterized by various number of years of working with diabetic individuals ($p=0.9205$ for *Kruskal-Wallis* ANOVA)

Number of years of working with diabetic individuals	Mean \pm SD	Median	Min – max
≤ 5 years	15.82 \pm 5.28	15.00	8.00 – 25.00
(5-15 years>	15.79 \pm 4.82	15.50	9.00 – 27.00
(15-30 years>	16.07 \pm 4.89	17.5*	7.00 – 21.00

* nonparametric distribution

direct contact with patients and have a significant role, as the consultants and educators for patients and their families, having necessary knowledge and skills. As it was previously mentioned, in the research of *Ahmed* et al. [1], the nurses from all the analysed groups of health care professionals, were characterized by the lowest level of diabetes knowledge. However, the knowledge analysed was diverse in case of various issues [1]. The insufficient and diverse level of nutritional knowledge was observed by *Findlow & McDowell* [11] – the lowest level of knowledge was noted in case of meal plan (51%), as well as diet and nutrients (68%), while higher it was in case of food requirements (83%) and food exchange (89%). However, it must be stated, that nutritional knowledge in the mentioned analysis was quite high in comparison with other issues, as the majority of participating nurses were not able to indicate properly the symptoms of hypoglycemia or association between blood glucose level and glycosuria [11]. In the research of *Trepp* et al. [28], not only knowledge, but also comfort level in dealing with diabetes was analysed and compared in case of various types of health care professionals – it was concluded, that nurses have a high comfort level, which, however, did not correlate with their knowledge, that was lower than in case of other health care professionals. On the other hand, in the research of *van Zyl & Rheeder* [29], the knowledge associated with diet in diabetes, was higher in nurses (67% of points scored), than in other health care professionals (50%), however the general poor knowledge of both nurses and physicians was concluded.

The problem of knowledge of diabetic nurses is recognized for years, as in the 1983, the research of *Scheiderich* et al. [23] was published and the observation, that each third nurse scored below 70% correct was made, while nurses who scored below 60% consistently missed items requiring use of exchange lists of food products. The education of nurses and other health care professionals is constantly indicated as a top priority [11], as the role of continuing education is essential to support nurses' knowledge of complex clinical conditions, such as diabetes [32].

Not only nutritional knowledge, but also nutritional behaviors of nurses are poor. In the research of *Zapka*

et al. [34], it was observed, that the majority of nurses were overweight and obese and some of them were not actively involved in weight management behaviors, while their self-reported diet and physical activity behaviors were poor. The similar observations were made by *Malinauskiene* et al. [15], as majority of nurses in their research were overweight and obese, while about 47% declared their leisure physical activity less than weekly. Moreover, in the research of *Blake* et al. [4], not only majority of analysed nurses reported not following physical activity recommendations for general population, but also physically inactive ones were more likely to report poor general health, poor dietary practices and less sleep, accompanied by higher cigarette smoking and alcohol consumption than their active counterparts.

The similar observations of not following recommended nutritional goals in groups of nurses were made in the presented research. Moreover, the fact, that nurses are less often following the recommendations than random non-diabetic patients from adequate regions of Poland, indicates, that their compliance with recommendations is very poor. Especially in case of regularity of meals and diversion of meals, the recommendations following in a group of nurses was worse, than in control group. Simultaneously, the lowest frequency of accomplishing always the recommended nutritional goals was observed for nurses in case of fish and legumes intake, milk and dairy products intake, as well as moderate sugar and sweets intake.

The research of *Sahu & Day* [22] indicate, that problem with regularity of meals in case of nurses may be associated not only with lack of their will to follow recommendations, but also, in case of rotating shift nurses, with the type of their work, as it was noted that night-shift nurses are characterized by lower number of meals daily and higher number of snacks daily, that was accompanied by lower eating habit satisfaction, than in case of morning-shift nurses, afternoon-shift nurses and general duty nurses. The similar observations were made by *Zverev* [35], as in his research all irregular rotating-shift nurses were characterized by irregular eating pattern, while in case of nurses who did not perform night duties, it was observed for 41% of group. However, it must be stated, that in the same research, author indicate, that rotating shifts are not only reason of irregular meals consumption observed in case of nurses [35].

The diversion of meals, that in the presented research was also stated to differ significantly between nurses and control group, may be defined as choosing products from all groups of food products, so choosing *inter alia* fish and legumes, or milk and dairy products, with moderate sugar and sweets intake is necessary, that was concluded to be rarely followed. Also in other Polish studies, conducted in groups of nurses, the im-

properly balanced food rations were observed, that was accompanied by low intake of fish and dairy products, as well as high intake of sugar and sweets [19].

In the other studies, the higher fish intake was observed, as in the Nurses' Health Study (the United States of America cohort study) the median of fish intake was 1,5 serving per week [26] and mean daily intake of milk was one glass, while total calcium intake from milk and other products (without supplementation) was 730 mg [8]. However, for sucrose and other simple carbohydrates energy intake in case of the results of Nurses' Health Study, no such positive observations were made – the share of energy in diet from sucrose varied from 10 to 13%, while additionally assessed fructose energy intake varied from 4 to 9% in subgroups, so simple carbohydrates energy intake was often higher than 20% [24].

Mentioned nutritional problems are not only diagnosed in groups of nurses. In the research of *Blake et al.* [4] it was observed, that over three-quarters did not consume five servings of fruit and vegetables per day, while two-thirds reported exceeding the recommended maximum daily alcohol intake. However, it was also not confirmed by results of Nurses' Health Study and Health Professionals' Follow-up Study combined, as the median intake of total fruits and vegetables was 5.3 servings per day in mentioned studies [13].

In the analysed group of nurses declared physical activity was more regular, than in case of control group, so the observations are more positive, than in previously mentioned research of *Blake et al.* [4], *Malinauskiene et al.* [15] and *Zapka et al.* [34]. However, even more important are the conclusions from the systematic review about physicians' and nurses' personal physical activity habits, as it was stated, that the majority of studies found that a higher personal physical activity level was associated with higher physical activity-promoting practices, and that health professionals with positive attitudes towards physical activity were more likely to promote physical activity to their patients [9].

The problem arises, as educating nurses are presenting recommendations, that they are not following themselves. If following recommendations in case of patients is more frequent, than in case of nurses, it may negatively affect patients' perception of nurses credibility, as it was observed in case of overweight or obese physicians [20]. In the Polish clinical recommendations of diabetes care, it is stated that all diabetic patients should be educated about recommended nutrition, by the entitled individuals (physician, dietician, diabetology nurse, diabetology educator) [6]. Taking it into account, it is essential not only to educate patients, but also to educate them in the way reliable for them, so good nutritional behaviors of nurses observed by patients may be not only beneficial for nurses, but also for their patients.

The lack of association between number of years of working with diabetic individuals and obtained points was in agreement with results of other studies, as *Findlow & McDowell* [11] concluded, that neither grade nor perceived professional experience was associated with results of diabetes basic knowledge test. On the other hand, the different observations are made in case of practical skills, that are learnt during professional work, as the results of *Yamauchi* [33] indicate, that the group of nurses with more clinical practice experience had more knowledge of physical assessment skills. Also the results of the research of *Ndosi & Newell* [17] indicate a significant correlation between experience and pharmacology knowledge, however, authors stated, that this should be interpreted with caution, as nurses with less experience were underrepresented and also significant correlation with qualifications of nurses may had interfered.

The research conducted in Polish population indicate, that individuals with diabetes, in comparison with patients with other diseases, have lower tendency to make early changes in diet and are the least convinced to early weight reduction [18]. However, the results of the studies carried out proved the efficiency and profitable influence of dietary education on changes of the nutritional habits of respondents [27]. As a consequence, it may be stated, that each intervention, conducted in groups of diabetic individuals is needed, not only if education is addressed to patients, but also, if it addressed to nurses, as their better knowledge as well as understanding of the role of proper nutritional behaviors is needed. Even if educational program do not cause the direct changes of glycemic parameters, it may significantly improve wellbeing of patients [14], that is also important.

CONCLUSIONS

1. The nutritional behaviors of diabetology nurses are not good, even if they educate diabetic patients on daily basis, as they rarely declare fish and legumes intake, milk and dairy products intake, as well as moderate sugar and sweets intake.
2. The nutritional behaviors of diabetology nurses are worse than behaviors of non-diabetic individuals, as they significantly rarer declare regularity of meals and diversion of meals.
3. The professional experience of nurses is not associated with their declared nutritional behaviors.
4. Nutritional educations should be conducted not only in groups of diabetic patients, but also, in groups of diabetology nurses.

Conflict of interest

The authors declare non conflict of interest.

REFERENCES

- Ahmed A., Jabbar A., Zuberi L., Islam M., Shamim K.: Diabetes related knowledge among residents and nurses: a multicenter study in Karachi, Pakistan. *BMC Endocr Disord* 2012;12:18, DOI: 10.1186/1472-6823-12-18.
- Alves Pereira D., da Silva Campos Costa N.M., Lima Sousa A.L., Veiga Jardim P.C.B., de Oliveira Zanini C.R.: The effect of educational intervention on the disease knowledge of diabetes mellitus patients. *Rev Lat Am Enfermagem* 2012;20(3):478-485.
- Bardenheier B.H., Cogswell M.E., Gregg E.W., Williams D.E., Zhang Z., Geiss L.S.: Does knowing one's elevated glycemic status make a difference in macronutrient intake? *Diabetes Care* 2014;37(12):3143-3149.
- Blake H., Malik S., Mo P.K., Pisano C.: 'Do as say, but not as I do': are next generation nurses role models for health? *Perspect Public Health* 2011;131(5):231-239.
- Castetbon K., Bonaldi C., Deschamps V., Vernay M., Malon A., Salanave B., Druet C.: Diet in 45- to 74-year-old individuals with diagnosed diabetes: comparison to counterparts without diabetes in a nationally representative survey (Etude Nationale Nutrition Santé 2006-2007). *J Acad Nutr Diet* 2014;114(6):918-925.
- Czech A., Cypryk K., Czupryniak L., Gajewska D., Grzeszczak W., Gumprecht J., Idzior-Waluś B., Jarosz-Chobot P., Kalarus Z., Karnafel W., Kokoszka A., Koblik T., Korzon-Burakowska A., Kowalska I., Loba J., Majkowska L., Malecki M., Mamcarz A., Mirkiewicz-Sieradzka B., Młynarski W., Noczyńska A., Raczyńska K., Sieradzki J., Słowik A., Solnica B., Stankiewicz A., Strojek K., Szadkowska A., Szlachowska M., Wender-Ożegowska E., Wierusz-Wysocka B., Zozulińska-Ziółkiewicz D.: Zalecenie kliniczne dotyczące postępowania u chorych na cukrzycę 2015. [Clinical recommendations for diabetic individuals 2015]. *Diab Klin* 2015;4(suppl A):1-73 (in Polish).
- Evert A.B., Boucher J.L., Cypress M., Dunbar S.A., Franz M.J., Mayer-Davis E.J., Neumiller J.J., Nwankwo R., Verdi C.L., Urbanski P., Yancy W.S. Jr.: Nutrition therapy recommendations for the management of adults with diabetes. *Diabetes Care* 2014;37(suppl 1):120-143.
- Feskanich D., Willett W.C., Colditz G.A.: Calcium, vitamin D, milk consumption, and hip fractures: a prospective study among postmenopausal women. *Am J Clin Nutr* 2003;77(2):504-511.
- Fie S., Norman I.J., While A.E.: The relationship between physicians' and nurses' personal physical activity habits and their health-promotion practice: A systematic review. *Health Edu J* 2013;72(1):102-119.
- Filip R., Lewandowska A., Szczepankiewicz M., Majda B.: State of patients' knowledge about treatment and proceedings in type 2 diabetes. *Ann Agric Environ Med* 2014;21(2):359-363.
- Findlow L.A., McDowell J.R.S.: Determining registered nurses' knowledge of diabetes mellitus. *J Diabetes Nurs* 2002;6(6):170-175.
- Gajda K., Sulich A., Hamulka J., Bialkowska A.: Comparing diabetic with non-diabetic overweight subjects through assessing dietary intakes and key parameters of blood biochemistry and haematology. *Rocz Panstw Zakl Hig* 2014;65(2):133-138.
- Hung H.C., Joshipura K.J., Jiang R., Hu F.B., Hunter D., Smith-Warner S.A., Colditz G.A., Rosner B., Spiegelman D., Willett W.C.: Fruit and vegetable intake and risk of major chronic disease. *J Natl Cancer Inst* 2004;96(21):1577-1584.
- Krok-Schoen J.L., Shim R., Nagel R., Lehman J., Myers M., Lucey C., Post D.M.: Outcomes of a Health Coaching Intervention for Older Adults With Uncontrolled Type 2 Diabetes. *Gerontol Geriatr Educ* 2015; DOI: 10.1080/02701960.2015.1018514
- Malinauskiene V., Leisyte P., Romualdas M., Kirtikyte K.: Associations between self-rated health and psychosocial conditions, lifestyle factors and health resources among hospital nurses in Lithuania. *J Adv Nurs* 2011;67(11):2383-2393.
- Medrela-Kuder E.: Prawidłowa dieta w cukrzycy typu II jako forma rehabilitacji chorych. [Proper diet in type 2 diabetes as a means of patients' rehabilitation]. *Rocz Panstw Zakl Hig* 2011;62(2):219-223 (in Polish).
- Ndosi M.E., Newell R.: Nurses' knowledge of pharmacology behind drugs they commonly administer. *J Clin Nurs* 2009;18(4):570-580.
- Olszanecka-Glinianowicz M., Chudek J.: The level of health education in the Polish population. *Ann Agric Environ Med* 2013;20(3):559-565.
- Przeor M., Goluch-Koniuszy Z.: Ocena stanu odżywienia oraz sposobu żywienia pielęgniarek będących w okresie około menopauzalnym pracujących w systemie zmianowym. *Probl Hig Epidemiol* 2013;94(4):797-801.
- Puhl R.M., Gold J.A., Luedicke J., DePierre J.A.: The effect of physicians' body weight on patient attitudes: implications for physician selection, trust and adherence to medical advice. *Int J Obes (Lond)* 2013;37(11):1415-1421.
- Rustad C., Smith C.: Nutrition knowledge and associated behavior changes in a holistic, short-term nutrition education intervention with low-income women. *J Nutr Educ Behav* 2013;45(6):490-498
- Sahu S., Dey M.: Changes in food intake pattern of nurses working in rapidly rotating shift. *AJMS* 2011;4(1):14-22.
- Scheiderich S.D., FreiBaum C.N., Peterson L.M.: Registered Nurses' Knowledge About Diabetes Mellitus. *Diabetes Care* 1983;6(1):157-161.
- Schulze M.B., Manson J.E., Ludwig D.S., Colditz G.A., Stampfer M.J., Willett W.C., Hu F.B.: Sugar-sweetened beverages, weight gain, and incidence of type 2 diabetes in young and middle-aged women. *JAMA* 2004;292(8):927-934.
- Soedamah-Muthu S.S., Chaturvedi N., Fuller J.H., Toeller M.: Do European people with type 1 diabetes consume a high atherogenic diet? 7-year follow-up of

- the EURODIAB Prospective Complications Study. *Eur J Nutr* 2013;52(7):1701-1710.
26. Sun Q., Ma J., Campos H., Rexrode K.M., Albert C.M., Mozaffarian D., Hu F.B.: Blood concentrations of individual long-chain n-3 fatty acids and risk of nonfatal myocardial infarction. *Am J Clin Nutr* 2008;88(1):216-223.
27. Szczepańska E., Klocek M., Kardas M., Dul L.: Change of the nutritional habits and anthropometric measurements of type 2 diabetic patients – advantages of the nutritional education carried out. *Adv Clin Exp Med* 2014; 23(4):589-598.
28. Trepp R., Wille T., Wieland T., Reinhart W.H.: Diabetes-related knowledge among medical and nursing house staff. *Swiss Med Wkly* 2010;140(25-26):370-375.
29. Van Zyl D.G., Rheeder P.: Survey on knowledge and attitudes regarding diabetic inpatient management by medical and nursing staff at Kalafong Hospital. *JEMDSA* 2008;13(3):90-97.
30. Włodarek D., Głąbska D.: Zwyczaje żywieniowe osób chorych na cukrzycę typu 2. [The dietary habits of people with type 2 diabetes]. *Diabetol Prakt* 2010;11(1):17-23 (in Polish).
31. Xu J., Eilat-Adar S., Loria C.M., Howard B.V., Fabsitz R.R., Begum M., Zephier E.M., Lee E.T.: Macronutrient intake and glycemic control in a population-based sample of American Indians with diabetes: the Strong Heart Study. *Am J Clin Nutr* 2007;86(2):480-487.
32. Yacoub M.I., Demeh W.M., Darawad M.W., Barr J.L., Saleh A.M., Saleh M.Y.: An assessment of diabetes-related knowledge among registered nurses working in hospitals in Jordan. *Int Nurs Rev* 2014;61(2):255-262.
33. Yamauchi T.: Correlation between work experiences and physical assessment in Japan. *Nurs Health Sci* 2001;3(4):213-224.
34. Zapka J.M., Lemon S.C., Magner R.P., Hale J.: Lifestyle behaviours and weight among hospital-based nurses. *J Nurs Manag* 2009;17(7):853-860.
35. Zverev Y.P.: The impact of rotating shift work on eating patterns and self-reported health of nurses in Malawi. *Malawi Med J* 2005;16(2):37-39.

Received: 30.04.2015

Accepted: 21.08.2015

DIETARY INTAKE OF VITAMIN D IN CHILDREN AGED 1-3 YEARS WITH SIMPLE OBESITY

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ABSTRACT

Background. Obese children are predisposed to vitamin D deficiency. Most of the findings suggest that requirement for vitamin D is increased in obese children due to this vitamin sequestration in adipose tissue.

Objective. The aim of the study was to evaluate dietary intake of vitamin D in children with simple obesity in relation to nutritional standards.

Materials and Methods. The study included 73 children aged 1-3 years: 38 with simple obesity (group I) and 35 non-obese ones (group II - control). The inclusion criterion for the obese group was BMI z-score > +2.0, for the control group BMI z-score between -1.0 and +1.0. The intake of vitamin D was estimated using the Dieta 5.0 software on the basis of 3-days dietary record. Outcomes were related to nutritional standards. Differences in intake of energy and nutrients between both groups were assessed using the *Mann-Whitney* test (statistical significance was set at $p = 0.05$).

Results. Vitamin D intake in both groups was below the nutritional standards (10 $\mu\text{g}/400$ IU). Median values / interquartile ranges of results were 2.0 / 1.3-5.9 μg and 4.0 / 1.1-7.6 μg daily, for obese and non-obese children, respectively. The risk of deficient vitamin D intake was observed in 94.7% of obese children and in 82.4% of control group. The main dietary source of vitamin D in both groups was growing-up milk/Junior formula. The median intake of energy, protein, fat and carbohydrates in the obese children were significantly higher than in the control group ($p < 0.05$).

Conclusions. In obese children aged 1-3 years adequate dietary intake of vitamin D was not achieved. Similarly, the intake of vitamin D by normal weight children was lower than recommended. Consequently, it is necessary to provide products rich in vitamin D in the diet of toddlers, particularly obese.

Key words: dietary intake of vitamin D, diet, children, obesity

STRESZCZENIE

Wstęp. Dzieci z otyłością są szczególnie narażone na niedobór witaminy D. Wiele badań wskazuje, że jednym z czynników mogących niekorzystnie wpływać na biodostępność witaminy D jest jej sekwestracja w tkance tłuszczowej.

Cel badań. Celem badania była ocena podaży witaminy D w dietach dzieci z otyłością prostą w odniesieniu do norm żywienia.

Material i metody. Badaniem objęto 73 dzieci w wieku 1-3 lat, w tym 38 dzieci z otyłością prostą (grupa I) i 35 dzieci z prawidłową masą ciała (grupa II/ grupa kontrolna). Kryterium włączenia dzieci do grupy I było BMI z-score > +2,0, do grupy II BMI z-score od -1,0 do +1,0. Spożycie witaminy D oceniono na podstawie 3-dniowego zapisu jadłospisu wykorzystując program żywieniowy Dieta 5.0. Uzyskane wyniki odniesiono do norm żywienia. Do oceny różnic w wartości energetycznej diet i spożyciu składników pokarmowych pomiędzy grupami posłużono się testem *Manna-Whitneya* (za poziomu istotności statystycznej przyjęto $p = 0,05$).

Wyniki. Zawartość witaminy D w dietach dzieci z obu grup była zbyt mała w odniesieniu do norm spożycia (10 $\mu\text{g}/400$ j.m.). Wartości mediany i zakresu 1.-3. kwartyła wynosiły w dietach dzieci otyłych i z prawidłową masą ciała, odpowiednio: 2,0 μg (1,3-5,9 μg) i 4,0 μg (1,1-7,6 μg). Ryzyko niewystarczającego spożycia witaminy D obserwowano u 94,7% dzieci otyłych i u 82,4% dzieci z prawidłową masą ciała. Głównym źródłem witaminy D w dietach z obu grup było mleko modyfikowane typu Junior. Mediany wartości energetycznej diet oraz zawartości białek, tłuszczów i węglowodanów w dietach dzieci otyłych były istotnie większe w porównaniu z grupą dzieci z prawidłową masą ciała ($p < 0,05$).

Wnioski. U dzieci otyłych jak i z prawidłową masą ciała w wieku 1-3 lat spożycie witaminy D z całodzienną dietą było mniejsze od zalecanego. Dzieci w wieku 1-3 lat, w tym dzieci otyłe, wymagają modyfikacji diety pod względem doboru produktów bogatych w witaminę D.

Słowa kluczowe: spożycie witaminy D, dieta, dzieci, otyłość

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INTRODUCTION

Obesity is a growing health problem, also in the children population. According to the 2007–2008 National Health and Nutrition Examination Survey (NHANES), from 1980 to 2008 the percentage of obese children doubled (5.0% to 10.4%) among children aged 2-5 years, tripled (6.5% to 19.6%) in group aged 6-11 years, and almost quadrupled (5.0% to 18.1%) in adolescents aged 12-19 years [29]. Polish epidemiological data indicate that 20% of toddlers and 9-18% of preschool children are overweight or obese [20]. One of the basic causes obesity is a long-term imbalance between the amount of energy supplied with food and those expended.

This leads to abnormal or excessive fat accumulation exceeding its physiological needs and possibilities of adaptation, that may impair health [41]. Despite of the energy oversupply, diets of obese children may be deficient in various components including minerals, eg. calcium and iron [13,14] and vitamins (eg. vitamin D) [9]. Children are especially vulnerable for vitamin deficiencies. Insufficient vitamins supply affects them more seriously than adults [38].

Vitamin D plays a pivotal role in the organism, affecting the calcium and phosphorus homeostasis, thus providing a proper bone development and mineralization. Besides these well-known effects, vitamin D has much border range of actions (pleiotropic effects) in the human body. It is essential for the proper functioning of the immune, endocrine, neurological, muscular and cardiovascular systems [19, 26, 28, 45].

Vitamin D refers to the group of fat-soluble vitamins. Vitamin D is a steroid hormone with a broken B – ring known as secosteroid, involved in enhancement of calcium, iron, magnesium, phosphorus and zinc absorption [24]. The term “vitamin D” refers to several different forms of this vitamin. Two forms are essential in humans: vitamin D₂ (ergocalciferol) derived from products of plant origin including fungi, and vitamin D₃ (cholecalciferol) occurring in products of animal origin, especially fatty marine fish species, eggs and liver [19, 22, 46]. For infants and toddlers the food sources of vitamin D₃ are also milk formulas and cereals fortified with this vitamin [28].

It must be stressed, that the most important source of vitamin D₃ is skin exposure to solar UV irradiation with wavelengths of 290-315 nm. The effectiveness of this process is affected by numerous factors, such as the amount of sunlight (depending on latitude, season and time of day), the surface of the exposed parts of the body, skin pigmentation, age and body weight [27].

Vitamin D deficiencies are found in populations worldwide and due to pandemic nature, they are a serious public health problem [17, 21]. Among the factors

responsible for the increased incidence of deficiency of this vitamin in children there are: limited time spent outdoors, the use of sunscreens and inadequate intake of food that are sources of vitamin D, fortified foods and especially marine fish [28]. It has been documented in numerous studies that overweight/obesity is an important risk factor for vitamin D deficiency in children [2, 34, 36]. Moreover, it has been observed that the increased amount of subcutaneous adipose tissue in overweight children sequesters vitamin D, thus preventing its transport to the blood stream. It results in the reduction of vitamin D concentrations in serum [2, 34, 39, 44]. Recent research has shown that 25 (OH)D blood concentration are lower among obese children. The prevalence of the vitamin D hypovitaminosis increased with degree of adiposity: in healthy weight at 21%, in overweight at 29%, in obese at 34%, and in severely obese at 49% [25].

The aim of the study was to evaluate dietary intake of vitamin D in obese children with reference to nutritional standards.

MATERIAL AND METHODS

The examined group consisted of 38 children (Group I), aged 1-3 years diagnosed simple obesity, recruited from the Gastroenterology Outpatient Clinic at the Warsaw Institute of Mother and Child. The inclusion criterion for the group I was BMI z-score > +2.0. The reference group (Group II) were 35 age-matched healthy subjects with normal body mass (BMI z-score between -1.0 and +1.0). Nutritional status was assessed using Body Mass Index (BMI) which was standardised according to the WHO growth charts for children [42, 43] to obtain BMI z-scores independent of gender and age.

Vitamin D intake and daily food rations (DFR) of children were estimated on the basis of 3 days record, randomly chosen from the dietary records, using the “Album of Photographs of Food Products and Dishes” [5, 15, 32]. The average energy value and nutrients intake from DFR was calculated using Dieta 5.0 nutritional software [37].

The medians and interquartile ranges of dietary intake of vitamin D, energy, macronutrients, other vitamins and minerals in obese and non-obese children were related to the current nutritional standards [19] and the model food ration for children aged 13-36 months [40]. Odds of children with dietary intake below the Estimated Average Requirement (EAR) and Adequate Intake (AI) were evaluated in both groups using Dieta 5.0 software.

The differences in energy and nutritional value of an average daily food ration between studied groups of children as well as in amounts of food from each of 6

groups of products consumed by children were evaluated by *Mann-Whitney* test.

The variables measuring the nutritional status of children and their diets were not normally distributed and statistical analyses were performed with non-parametric methods with *p* value below 0.05 adopted as being significant. The testing was conducted with the Statistica 10 PL package.

RESULTS

The characteristics of the studied groups are presented in Table 1.

Table 1. Characteristics of studied children

Parameter	Obese children (n=38)		Control group (n=35)		<i>Mann-Whitney</i> test p value
	Median	Interquartile range	Median	Interquartile range	
Age (years)	2.5	2.2-3.1	2.5	1.9-3.1	0.5
Body weight (kg)	20.0	16.6-24.8	12.9	11.6-14.4	<0.001*
Height (cm)	97.0	91.0-105.0	92.0	86.5-95.5	0.005*
BMI (kg/m ²)	20.9	19.6-23.1	15.5	14.8-16.1	<0.001*
BMI z-score	3.2	2.5-4.6	-0.1	-0.8-0.4	<0.001*

* – statistically significant differences

BMI – Body Mass Index

The median age for children of the both group were 2.5 years, the difference in age was not statistically significant (*p*>0.05). There were significant differences between children from Group I and II with regard to anthropometric parameters and indices (*p*<0.05).

Table 2 provides results of dietary intake of energy and nutrients in children's diet.

The median and interquartile ranges of vitamin D daily intake were as follows: in the obese children 2.0 µg (1.3-5.9 µg), in the control group 4.0 µg (1.1-7.6 µg). No statistically significant difference was found (*p*>0.05). The risk of deficient vitamin D intake was observed in 94.7% of obese children and in 82.4% of control group.

The median intake of energy, protein, fat and carbohydrates in the obese children were significantly higher than in control group (*p*<0.05).

Table 3 provides comparison of medians of daily food consumption in two groups of studied children in relation to the model food ration for children aged 1-3 years.

The main dietary source of vitamin D in both groups was junior formula. The percentage of children consuming growing-up milk was 42.1% of obese (n=16/38) vs 55.9% of non-obese ones (n=19/35). The interquartile range of junior formulas daily intake in obese children was 0-238 ml (median 0.0), while in non-obese group 0-317 ml (median 96.5). This milk provided respectively

49.8% and 66.7% of vitamin D supplied with food in the obese and healthy weight children.

Cow's milk was consumed by 92% of children from Group I (n=35/38) and 94% from Group II (n=33/35). The median values and interquartile ranges of amounts of cow's milk consumed daily were respectively: 101.9 ml (43.7-210), and 54.5 ml (11.6-113.6). These amounts of milk provided 0.02 µg (0.8 IU) vitamin D for children from Group I and 0.01 µg (0.4 IU) of this vitamin for children from Group II.

The percentage of obese and non-obese children eating fish was 34% (n=13/38) of obese and 28% (n=10/35) non-obese ones. The medians and the interquartile ranges of the portion of fish daily consumption by children

from Group I and II were respectively: 19.1 g (8.0-29.1) vs 29.6 g (19.1-46.7).

DISCUSSION

Given that the problem of obesity in Poland affects about 20% of children aged 1-3 [20, 23], and that Polish geographic location impedes the effective process of photosynthesis of vitamin D [26], exogenous supplies of this vitamin such as diet sources and supplementation seem to be important to ensure its adequate provision. Insufficient dietary intake of vitamin D in children was confirmed by various studies [4, 9, 11, 12, 28-31, 33].

In the present study, the average content of vitamin D in the diets of obese and healthy weight children was lower, as compared to the Polish nutritional standards [19] as well as to Polish Expert Group statement [7].

In our study, most of the children did not reach EAR standard (94.7% in Group I vs 82.4% in Group II) [19]. Also the results of the National Health and Nutrition Examination Survey showed that over 75% of older children (9-13 years of age) did not achieve the EAR for vitamin D through dietary intake [11]. Similarly, 85% of boys and 93% of girls (aged 9-13 years of age) from a nationally representative sample of Canadian children did not achieve the EAR from food sources alone [16].

Table 2. The energy and nutrients intake in relation to Polish nutritional standards 2012 [19] in obese and non-obese children

Energy value Nutrients	Units	Obese children (n=38)		Control group (n=35)		Mann-Whitney test p value	Nutritional standards EAR/AI ⁺
		Median	Interquartile range	Median	Interquartile range		
Energy	Kcal	1497.1	944.0-1686.5	1113.2	993.7-1361.6	0.011*	1000 (EER)
Total protein	g	50.4	34.2-59.9	41.4	32.0-48.9	0.049*	12
Total fat	g	51.3	32.4-64.3	35.7	28.7-45.8	0.01*	33-44
· saturated fatty acids	g	19.5	11.9-24.7	14.2	10.9-19.2	0.044*	-
· monounsaturated fatty acids	g	19.5	13.4-27.6	13.4	11.0-17.5	0.006*	-
· total polyunsaturated fatty acids	g	6.7	4.4-8.2	4.5	3.1-5.7	0.001*	-
- LC-PUFA	g	0.0	0.0-0.1	0.0	0.0-0.1	0.9	0.25 ⁺
Cholesterol	mg	147.5	108.5-231.4	123.8	96.1-233.6	0.5	-
Total carbohydrates	g	199.1	139.5-242.1	159.7	125.9-202.7	0.046*	-
Digestive carbohydrates	g	186.2	129.7-225.9	150.8	121.9-196.2	0.06	100
Starch	g	65.4	46.0-103.1	58.7	29.4-74.5	0.036*	-
Sucrose	g	55.6	32.0-79.7	34.0	25.5-50.8	0.006*	-
Lactose	g	13.5	9.0-24.0	12.0	4.8-24.1	0.8	-
Fibre	g	11.7	8.2-15.2	7.8	5.5-12.0	0.01*	10 ⁺
Percent of energy							
· from protein	%	14.1	12.2-15.5	14.5	12.9-16.6	0.2	5-20
· from fat	%	30.9	27.3-35.6	30.5	24.8-35.2	0.4	20-35
· from carbohydrates	%	54.0	49.2-58.7	53.4	50.8-60.0	0.9	50-70
Vitamin A	µg	799.4	576.8-1038.6	767.8	557.5-944.1	0.4	280
Vitamin E	mg	7.0	5.2-9.1	5.2	3.6-7.5	0.042*	6 ⁺
Vitamin D	µg/IU	2.0/80	1.3-5.9/52-236	4.0/160	1.1-7.6/44-304	0.3/12	10/400
Vitamin B ₁	mg	0.8	0.6-1.0	0.8	0.5-1.0	0.7	0.4
Vitamin B ₂	mg	1.3	1.0-1.7	1.3	0.8-1.4	0.1	0.4
Folate	µg	166.8	123.4-208.1	174.8	122.8-200.1	0.9	120
Vitamin B ₁₂	µg	2.2	1.7-2.9	1.9	1.5-2.4	0.08	0.7
Vitamin C	mg	66.8	38.7-88.2	72.6	44.3-98.5	0.6	30
Vitamin PP	mg	10.9	7.5-13.3	9.1	6.5-11.6	0.02*	5
Vitamin B ₆	mg	1.3	1.1-1.6	1.2	0.8-1.4	0.053	0.4
Calcium	mg	480.5	413.4-675.4	540.6	329.6-637.3	0.9	500
Phosphorus	mg	831.7	558.4-1019.4	700.7	564.6-804.1	0.053	380
Magnesium	mg	185.9	125.9-215.2	127.5	108.7-179.7	0.005*	65
Iron	mg	7.4	6.1-10.0	7.2	5.2-9.7	0.5	3
Zinc	mg	5.9	4.6-8.4	6.1	4.4-7.4	0.5	2.5
Copper	mg	0.8	0.5-0.9	0.5	0.4-0.8	0.004*	0.25
Iodine	µg	95.8	59.1-123.2	87.1	55.8-124.8	0.9	65
Potassium	mg	2159.7	1492.1- 2532.5	1580.6	1277.0-1878.6	0.003*	2400 ⁺
Sodium	mg	1913.2	1392.1- 2614.4	1399.7	1243.2-1794.1	0.002*	750 ⁺

LC-PUFA – long-chain polyunsaturated fatty acids

EAR – Estimated Average Requirement

EAR intake of vitamin D for children aged 1-3 years was adopted in accordance with the statement of Polish Expert Group (2012) [7].

EER – Estimated Energy Requirement

AI⁺ – Adequate Intake

* – statistically significant differences

We found a twofold lower intake of vitamin D in diets of obese children (2.0 µg/80 IU vs 4.0 µg/160 IU), however this difference was not statistically significant. Similarly, Dyląg et al. [9] reported lower vitamin D intake among obese children aged 1-5 years compared to healthy weight children (3.2 µg/128 IU vs 4.7 µg/188 IU). The same tendency was observed by

Barry [1] in a cohort of older children aged 6 – 14.9 years. The vitamin D intake was significantly lower in obese children compared to the normal weight children (4.5 µg/181.9 IU vs 6.6 µg/259.5 IU). In addition to the insufficient vitamin D intake by obese children found in our study, it is worth noting that calcium intake, which was adequate according to current Polish nutri-

Table 3. Comparison of medians of daily foods consumption in two groups of studied children with reference to model food ration for children aged 1-3 years [40]

Groups of food products	Obese children (n=38)		Control group (n=35)		Mann-Whitney test p value	Model food ration	Percentage of vitamin D from food products	
	Median	Interquartile range	Median	Interquartile range			Obese children	Control group
Cereal products (based on flour)	92.6	68.6-121.8	88.0	68.8-118.8	0.6	-	-	-
Flour, pasta	24.4	14.6-38.4	24.9	14.8-42.7	0.7	25	0.5	0.3
Groats, rice	7.7	0.0-30.0	15.9	1.3-37.0	0.1	30	1.6	0.3
Breakfast cereals	5.2	0.0-9.1	1.3	0.0-7.0	0.2		0.0	0.0
Bread	47.5	24.0-86.0	36.3	19.0-54.9	0.1	20	0.6	0.5
Potatoes	95.2	28.9-160.3	45.0	27.8-103.8	0.03*	80-100	0.0	0.0
Vegetables and fruits	311.7	218.2-365.5	237.7	113.1-403.0	0.2	450	0.0	0.0
Vegetables	142.9	68.9-177.0	92.0	62.6-138.5	0.1	200	2.3	0.1
Fruits	156.8	123.3-212.5	106.1	45.0-260.4	0.4	250	0.0	0.0
Juices, beverages	83.3	0.0-200.0	15.9	0.0-110.0	0.1	-	0.0	0.0
Nuts, seeds	0.0	0.0-1.3	0.0	0.0-0.0	0.2	-	0.0	0.0
Milk and dairy products (based on milk)	502.5	318.3-706.0	435.5	261.1-627.6	0.5	-	-	-
Milk and junior formula	203.4	92.9-404.6	210.3	91.3-440.0	0.96	450	-	-
Milk	91.7	33.0-195.1	49.3	8.3-113.6	0.06	450	0.9	0.5
Junior formula	0.0	0.0-238.0	96.5	0.0-317.0	0.2		49.8	66.7
Fermented milk beverages	16.5	0.0-50.0	23.5	0.0-60.8	0.96	100	0.2	0.2
Rennet cheese	0.0	0.0-0.0	0.0	0.0-5.0	0.6	2	0.2	0.2
Cottage cheese	24.3	6.7-67.0	8.0	0.0-33.3	0.07	10-15	1.1	0.9
Meat and poultry, cold meats, fish, eggs	98.9	74.5-155.7	88.5	57.3-147.6	0.3	-	-	-
Meat and poultry	48.4	30.7-65.8	38.2	18.9-53.2	0.1	20	9.2	7.0
Cold meats	32.7	13.8-50.4	20.0	6.7-30.0	0.04*		5.3	3.1
Fish	0.0	0.0-8.0	0.0	0.0-17.0	0.95	10	8.0	4.3
Eggs	10.4	3.6-24.7	19.0	4.5-47.9	0.2	25	7.3	10.7
Fats	22.9	13.2-41.0	12.2	6.0-22.6	0.002*	16	-	-
Oils	5.0	2.0-9.0	1.5	0.0-6.0	0.04*	10	0.0	0.0
Margarines	3.3	0.0-9.2	1.7	0.0-4.8	0.2	6	10.3	3.8
Butter	6.3	1.0-14.0	5.0	2.0-10.0	0.6		2.1	1.3
Cream	2.1	0.4-5.0	0.0	0.0-1.0	0.0009*		0.5	0.2
Sugar and sweets	28.7	18.0-56.3	24.5	12.7-37.7	0.09	20	0.0	0.0

* – statistically significant differences

tional standards [19] could be regarded as insufficient taking into the account previous recommendations [8]. Simultaneous deficiency of these nutrients in toddlers may have an adverse effect on the rapidly growing bone mineralization.

Adequate supply of vitamin D from food products is generally not achievable. Important food sources of vitamin D in the diets of young children include: milk formulas and baby cereals fortified with this vitamin, and oily marine fish. The other relevant vitamin D sources are eggs, meat and full-fat dairy products [19]. The main food source of vitamin D in this study for both groups of children was growing-up milk fortified with this vitamin. Its level in milk formulas intended for children aged 12 months and older available in Poland is about 1.75-2.0 µg (70-80 IU) per 100 mL [26]. According to nutritional recommendations, children aged 1-3 years should consume 450 ml of milk every day (the model food ration) [40]. Such amount of junior formula provides 7.9-9.0 µg (315-360 IU) of vitamin

D, while cow's milk (2.0-3.2% of fat) provides 0.09-0.14 µg (3.6-5.6 IU) of the vitamin.

In this study, the daily amount of milk (cow's/modified) consumed in both groups of children was roughly the same and was about half of the recommended in the model food ration (median and interquartile ranges for obese and normal weight children: 203.4 ml and 92.9-404.6; 210.3 ml and 91.3 – 440.0, respectively). Less than recommended milk consumption among children aged 13-36 months (average 310 ml per day) was shown also in another recent Polish study [12]. In our study 42.1% children from Group I and 55.9% children from Group II consumed junior formulas. Cow's milk was consumed by the most of children from both groups (Group I – 92.0%, Group II – 94%), however due to the low content of vitamin D it was not a significant source of this vitamin in children's diets.

The other dietary sources of vitamin D were meat and meat products, fats, especially margarines fortified with this vitamin, and fish. According to the nutritional

requirements toddlers should eat fish 1-2 times per week [8]. Model food ration includes an average fish consumption of 10 g per day (ie. 70 g weekly) [40].

In the United States FDA [35] suggests an amount of 3-5 ounces (85-142 g) of fish per week for children under the age of six. According to EFSA scientific opinion weekly consumption of oily fish in the general population should amount to 1-2 portions (130 g) [10].

Although fish are an important natural source of vitamin D, their consumption in both observed groups of children were relatively small, that was confirmed by the interquartile ranges of fish intake (0.0-8.0 g in obese children vs 0.0-17.0 g in healthy group). Fish was consumed only by 34.2% of obese and 28.6% of healthy weight children. Opposite to the recommendations children consumed primarily lean fish species, not oily marine ones which are better source of vitamin D and valuable fatty acids of n-3 family [6, 7, 18, 19]. It should also be noted that obese children consumed significantly smaller quantities of fish as compared to healthy weight children (19.1 vs 29.6 g per day). The results of a nationwide survey [12] confirmed low fish intake by children aged 1-3 years (obese children 19.6 ± 9.4 g, non-obese children 16.9 ± 8.3 g). Fish consumption rates among children aged 2 and 3 years found in the above cited study was 58% and 41% respectively. Inadequate consumption of fish by toddlers was shown in results of other authors [6, 31].

Considering the phenomenon of vitamin D sequestration by adipose tissue, which reduces its bioavailability, Polish Expert Group issued recommendations for prevention of vitamin D deficiency among obese children. They urge to consider supplementation with twofold higher dose of vitamin D in a group of obese children (20-25 $\mu\text{g}/800\text{-}1000$ IU daily) as compared to children with normal weight (10 $\mu\text{g}/400$ IU daily) [3]. According to the Practical Guidelines for the supplementation of vitamin D [26] an intake of vitamin D 15-25 $\mu\text{g}/600\text{-}1000$ IU/day (depending on the body weight) for children aged 1-18 is recommended and for obese ones an intake of 30-50 $\mu\text{g}/1200\text{-}2000$ IU/day (depending of severity of obesity). The supplementation is recommended from September to April or throughout the whole year if sufficient skin synthesis of vitamin D is not ensured in summer.

Adequate supply of children with vitamin D is particularly important not only because of the effects of vitamin D on bone mineralization, but also due to its beneficial pleiotropic action. Results of many studies suggest that proper supply of this vitamin may play a role in prevention of certain chronic diseases [26].

CONCLUSIONS

In obese children aged 1-3 years adequate dietary intake of vitamin D was not achieved. Similarly, the intake of vitamin D by normal weight children was lower than recommended. Consequently, it is necessary to provide products rich in vitamin D in the diet of toddlers, particularly obese.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. Barry J.: The relationship between Vitamin D and calcium/dairy intake and obesity in children. Thesis, Georgia State University, 2011. Available from: http://scholarworks.gsu.edu/nutrition_theses/14 (Accessed on 2015.05.04)
2. Bellone S., Esposito S., Giglione E., Genoni G., Fiorito C., Petri A., Bona G., Prodam F.: Vitamin D levels in a paediatric population of normal weight and obese subjects. *J Endocrinol Invest* 2014;37:805-809.
3. Charzewska J., Chlebna-Sokół D., Chybicka A., Czech-Kowalska J., Dobrzańska A., Helwich E., Imiela J.R., Karczmarewicz E., Książyk J.B., Lewiński A., Lorenc R.S., Lukas W., Łukaszkiwicz J., Marcinowska-Suchowierska E., Milanowski A., Milewicz A., Pludowski P., Pronicka E., Radowicki S., Ryżko J., Socha J., Szczapa J., Weker H.: Prophylaxis of vitamin D deficiency – Polish Recommendations 2009. *Pol J Endocrinol* 2010;61: 228-232.
4. Charzewska J., Weker H.: Ogólnopolskie badanie nad zawartością wapnia i witaminy D w dietach dzieci w wieku 4 lat. *Pediatr Współcz Gastroenterol Hepatol Żywnienie Dziecka* 2006;8:107-109.
5. Coulston A.M., Boushey C.J., Ferruzzi M.G. (eds.): Nutrition in the prevention and treatment of disease (3rd edition). Elsevier, 2013.
6. Czajkowski K., Czerwionka-Szaflarska M., Charzewska J., Chybicka A., Dobrzańska A., Gruszfeld D., Imiela J.R., Jackowska T., Helwich., Kaczmarek M., Poręba R., Książyk J.B., Lauterbach R., Lukas W., Mojska H., Milanowski A., Radowicki S., Ryżko J., Socha P., Szajewska H., Szczapa J., Walkowiak J., Weker H.: Stanowisko Grupy Ekspertów w sprawie suplementacji kwasu dokozaheksaenowego i innych kwasów tłuszczowych omega-3 w populacji kobiet ciężarnych, karmiących piersią oraz niemowląt i dzieci do lat 3. [Position paper of the expert group on DHA and other omega-3 fatty acid supplementation in pregnant and lactating women, infants and children up to 3 years of age]. *Standarty Medyczne/ Pediatria* 2010;7:729-736 (in Polish).
7. Dobrzańska A., Charzewska J., Weker H., Socha P., Mojska H., Książyk J., Gajewska D., Szajewska H., Stolarczyk A., Marć M., Czerwionka-Szaflarska M., Ryżko J., Wąsowska-Królikowska K., Chwojnowska Z., Chybicka A.,

- Horvath A., Socha J.: Normy żywienia zdrowych dzieci w 1-3. roku życia – stanowisko Polskiej Grupy Ekspertów. Część II – Omówienie poszczególnych składników odżywczych. [Nutritional guidelines for health children aged 1-3 years – Polish Expert Group statement Part II – Individual nutritional components review]. *Standardy Medyczne/Pediatrics* 2012;9:200-205 (in Polish).
8. Dobrzańska A., Czerwionka-Szaflarska M., Kunachowicz H., Książek J., Łukas W., Ryżko J., Socha J., Stolarczyk A., Szajewska H., Wąsowska-Królikowska K., Weker H.: Zalecenia dotyczące żywienia dzieci zdrowych w wieku 1-3 lata (13-36 miesięcy) opracowane przez zespół ekspertów powołany przez konsultanta krajowego ds. pediatrii. *Pediatr. Pol.* 2008, 82(1):93-95.
 9. Dyląg H., Rowicka G., Strucińska M., Riahi A.: Assessment of vitamin D status in children aged 1-5 with simple obesity. *Rocz Panstw Zakł Hig* 2014;65:325-330.
 10. EFSA (European Food Safety Authority): Opinion of the scientific panel on contaminants in the food chain on a request from the European parliament related to the safety assessment of wild and farmed fish. *EFSA J* 2005;236:1-118.
 11. Fulgoni VL III., Keast D.R., Bailey R.L., Dwyer J.: Foods, fortificants and dietary supplements: Where do Americans get their nutrients? *J Nutr* 2011;141:1847-54.
 12. Fundacja Nutricia. Żywnienie Dzieci w wieku 13-36 miesięcy. Warszawa, 2011. Available from: <http://fundacjanutricia.pl/archiwum/badania-naukowe/zywnienie-dzieci-w-wieku-13-36-miesiecy/> (Accessed on 2015.05.17)
 13. Garcia O.P., Long K.Z., Rosado J.Z.: Impact of micronutrient deficiencies on obesity. *Nutr Rev* 2009;67(10):559-572.
 14. Gillisi L., Gillisi A.: Nutrient inadequacy in obese and non-obese youth. *Can J Diet Pract Res* 2005 Winter;66(4):237-242.
 15. Gronowska-Senger A. (red.): Przewodnik metodyczny badań sposobu żywienia. Komitet Nauki o Żywieniu Człowieka, Polska Akademia Nauk, Warszawa 2013.
 16. Health Canada: Do Canadian adolescents meet their nutrient requirements through food intake alone? Ottawa, ON, 2012. Available from: http://www.hc-sc.gc.ca/fn-an/alt_formats/pdf/surveill/nutrition/commun/art-nutr-adol-eng.pdf (Accessed on 2015.05.17)
 17. Huh S.Y., Gordon C.M.: Vitamin D deficiency in children and adolescents: Epidemiology, impact and treatment. *Rev Endocr Metab* 2008;9:161-170.
 18. Jańczyk W., Socha P.: Respiratory health in DHA-supplemented toddlers. DHA requirements in children. *Standardy Medyczne/Pediatrics* 2010;7:555-557 (in Polish).
 19. Jarosz M. (red.): Normy żywienia dla populacji polskiej – nowelizacja. Instytut Żywności i Żywienia Warszawa, 2012.
 20. Kulaga Z.: Epidemiologia nadwagi i otyłości wśród dzieci i młodzieży w Polsce. Available from: <http://forumfarmaceutyczne.pl> (Accessed on 2015.05.22)
 21. Lappe J.M.: The role of vitamin D in Human Health: A paradigm shift. *Complementary Health Practice Review* 2011;16:58-72.
 22. Molgaard C., Michaelsen K.F.: Vitamin D and bone health in early life. *Proc Nutr Soc* 2003;62:823-828.
 23. Oblacińska A., Weker H. (red.): Profilaktyka otyłości dzieci i młodzieży. Wydawnictwo Help Med, Kraków 2008.
 24. Perez-Lopez F.R.: Vitamin D: the secosteroid hormone and human reproduction. *Gynecol Endocrinol* 2007;23:13-24.
 25. Peterson C.A.: Vitamin D deficiency and childhood obesity: interactions, implications, and recommendations. *Nutrition and Dietary Supplements* 2015;7:29-39.
 26. Płudowski P., Karczmarewicz E., Bayer M., Carter G., Chlebna-Sokół D., Czech-Kowalska J., Dębski R., Decsi T., Dobrzańska A., Franek E., Glusko P., Grant W.B., Holick M.F., Yankovskaya L., Konstantynowicz J., Książek J.B., Książkowska-Orłowska K., Lewiński A., Litwin M., Lohner S., Lorenc R.S., Łukaszewicz J., Marcinowska-Suchowierska E., Milewicz A., Misiorowski W., Nowicki M., Povoroznyuk V., Rozentryt P., Rudenka E., Shoenfeld Y., Socha P., Solnica B., Szalecki M., Talałaj M., Varbiro S., Żmijewski M.A.: Practical guidelines for the supplementation of vitamin D and the treatment of deficits in Central Europe - recommended vitamin D intakes in the general population and groups at risk of vitamin D deficiency. *Endokrynol Pol* 2013;64(4):319-327.
 27. Płudowski P., Kryśkiewicz E., Karczmarewicz E.: Zasady suplementacji i standardy oceny zaopatrzenia organizmu w witaminę D w świetle jej działania plejotropowego. *Post Nauk Med* 2012;3:265-272.
 28. Rowicka G., Strucińska M., Ambroszkiewicz J.: Vitamin D status in children with cow's milk allergy. *Dev Period Med* 2012;16:307-312.
 29. Sharma S., Kolahdooz F., Butler L., Budd N., Rushovich B., Mukhina G.L., Gittelsohn J., Caballero B.: Assessing dietary intake among infants and toddlers 0-24 months of age in Baltimore, Maryland, USA. *Nutr J* 2013;12:52. doi:10.1186/1475-2891-12-52.
 30. Stoian C.A., Lyon M., Cox R.G., Stephure M.D., Mah J.K.: Vitamin D concentration among healthy children in Calgary, Alberta. *Paediatr Child Health* 2011;16(2):82-86.
 31. Strucińska M., Rowicka G., Riahi A.: Profiles of selected nutrients affecting skin condition in children with atopic dermatitis. *Rocz Panstw Zakł Hig* 2015;66(1):45-53.
 32. Szponar L., Wolnicka K., Rychlik E.: Album of Photographs of Food Products and Dishes. National Food and Nutrition Institute, Warsaw 2011 (in Polish).
 33. Trafalska E.: Assessing diets for energy and nutrients content in nursery school children from Lodz, Poland. *Rocz Panstw Zakł Hig* 2014;65(1):27-33.
 34. Turer C.B., Lin H., Flores G.: Prevalence of vitamin D deficiency among overweight and obese US children. *Paediatrics* 2013;131:152-161.
 35. US FDA (US Food and Drug Administration): Fish: what pregnant women and parents should know. June 2014 Available from: <http://www.fda.gov/Food/Foodborne-IllnessContaminants/Metals/ucm393070.htm> (Accessed on 2015.05.03)
 36. Wahl D.A., Cooper C., Ebeling P.R., Eggersdorfer M., Hilger J., Hoffmann K., Josse R., Kanis J.A., Mithal A., Pierroz D.D., Stenmark J., Stöcklin E., Dawson-Hughes

- B.: A global representation of vitamin D status in healthy populations. *Arch Osteoporos* 2012;7:155-172.
37. *Wajszczyk B., Chwojnowska Z., Chabros E., Nasiadko D., Rybaczuk M.*: Manual of Dieta 5.0 Program for planning and current assessment of individual diet. National Food and Nutrition Institute, Warsaw 2011.
38. *Wartanowicz M., Gronowska-Senger A.*: Witaminy, W: Gawęcki J. (red.) *Żywnienie człowieka t. 1*, Wydawnictwo PWN, Warszawa 2012, 268-338.
39. *Wąsowski M., Czerwińska E., Marcinkowska-Suchowierska E.*: Otyłość – stan predysponujący do niedoborów witaminy D. [Obesity – the condition predisposing to vitamin D deficiency]. *Post Nauk Med* 2013;258-264 (in Polish).
40. *Weker H., Strucińska M., Barańska M., Więch M., Riahi A.*: Modelowa racja pokarmowa dziecka w wieku poniemowlęcym - uzasadnienie wdrożenia. [Model food ration of children aged 13-36 months – scientific background and practical implementation]. *Standardy Medyczne/Pediatrics* 2013;10:815-830 (in Polish).
41. WHO (World Health Organization). Obesity and overweight. Fact sheet N°311, updated January 2015. Available from: <http://www.who.int/mediacentre/factsheets/fs311/en/> (Accessed on 2015.05.01)
42. WHO Anthro for personal computers, version 3.1, 2010: Software for assessing growth and development of the world's children. Geneva, WHO, 2010.
43. WHO child growth standards: length/height-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. WHO 2006. Available from: <http://www.who.int/childgrowth/standards/en/index.html> (Accessed on 2015.05.03)
44. *Wortsman J., Matsuoka L.Y., Chen T.C., Lu Z., Holick M.F.*: Decreased bioavailability of vitamin D in obesity. *Am J Clin Nutr* 2000;72:690-693.
45. *Wrancisz J., Szostak-Węgierek D.*: Health outcomes of vitamin D. Part I. Characteristics and classic role. *Rocz Panstw Zakl Hig* 2014;65:179-184.
46. *Wrancisz J., Szostak-Węgierek D.*: Health outcomes of vitamin D. Part II. Role in prevention of diseases. *Rocz Panstw Zakl Hig* 2014;65:273-279.

Received: 25.05.2015

Accepted: 15.09.2015

ASSOCIATION BETWEEN SELF-EFFICACY AND DIETARY BEHAVIOURS OF AMERICAN FOOTBALL PLAYERS IN THE POLISH CLUBS IN THE LIGHT OF DIETARY RECOMMENDATIONS FOR ATHLETES

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ABSTRACT

Background. Personality traits associated with one's health beliefs and expectations constitute a determinant of dietary behaviours.

Objective. The aim of the study was to analyse the dietary behaviours of young American football players in the Polish clubs and association thereof with their general self-efficacy level.

Materials and Methods. The study included the group of 100 young men (20-30 years of age) who practiced American football on a professional basis in three Polish clubs. The study was based on an original dietary behaviour questionnaire derived from the Swiss Food Pyramid for Athletes and General Self-Efficacy Scale (GSES). Statistical analysis, conducted with Statistica 10.0 PL software, included intergroup comparisons with the *Chi*-square test.

Results. Having at least three meals per day (82%), consumption of such protein products as eggs and/or meat several times per week (68%) and including cereal products in every main meal (67%) turned out to be the most often followed qualitative recommendations of the Swiss Food Pyramid for Athletes in the group of American football players. Other, frequently followed dietary recommendations included remaining on a variable diet (75%), preference to mineral water and other non-sweetened beverages (69%), reduced intake of sweets and salted snacks (65%), energy drinks (64%) and fast food products (60%). The least frequently declared dietary behaviours included consuming recommended amounts of vegetables/fruits (48%) and wholegrain cereal products (45%), and reduced intake of animal fats (42%). Analysis of a relationship between specific dietary behaviours and general self-efficacy level showed that the athletes with higher levels of this trait consumed recommended daily amounts of vegetables (54% vs. 26%, $p < 0.01$) and cereal products (87% vs. 50%, $p < 0.001$), had recommended number of meals per day (96% vs. 70%, $p < 0.001$) and ate regularly (76% vs. 24%, $p < 0.001$) significantly more often than the persons characterized by lower self-efficacy levels.

Conclusions. Players with higher general self-efficacy levels adhere to the recommendations of the Swiss Food Pyramid for Athletes to a larger extent than the sportsmen with lower levels of this trait.

Key words: *athletes, American football, dietary behaviours, personality traits, general self-efficacy*

STRESZCZENIE

Wprowadzenie. Jednym z czynników warunkujących zachowania żywieniowe są cechy osobowości związane z przekonaniami i oczekiwaniami zdrowotnymi.

Cel. Celem badań była ocena zachowań żywieniowych grupy polskich zawodników trenujących futbol amerykański w zależności od poczucia własnej uogólnionej skuteczności sportowców, jako jednej z cech osobowości.

Material i metody. Badaniem objęto grupę 100 młodych mężczyzn w wieku 20-30 lat, wyczynowo trenujących futbol amerykański w trzech polskich klubach. Badania przeprowadzono z zastosowaniem autorskiego kwestionariusza zachowań żywieniowych, uwzględniającego jakościowe zalecenia szwajcarskiej piramidy żywienia dla sportowców oraz Skali Uogólnionej Własnej Skuteczności (GSES). Analizy statystyczne wykonano za pomocą testu Chi^2 w programie Statistica 10.0 PL.

Wyniki. Spośród jakościowych założeń szwajcarskiej piramidy żywienia dla sportowców, zawodnicy wyczynowo trenujący futbol amerykański w najwyższym stopniu realizowali zalecenia dotyczące spożywania przynajmniej 3 posiłków dziennie (82%) oraz produktów białkowych (jaj i/lub mięsa) kilka razy w tygodniu (68%) i produktów zbożowych w każdym posiłku głównym (67%). Często także stosowali urozmaiconą dietę (75%), preferowali wodę mineralną i inne niesłodzone napoje

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(69%), a także ograniczali spożycie słodczy i słonych przekąsek (65%), napojów energetyzujących (64%) i produktów Fast food (60%). Rzadziej spożywali zalecaną liczbę porcji warzyw i owoców (48%) i pełnoziarnistych produktów zbożowych (45%) oraz unikali tłuszczów zwierzęcych (42%). Analiza zachowań żywieniowych w zależności od poziomu własnej uogólnionej skuteczności wykazała, że zawodnicy o wysokiej samoskuteczności istotnie częściej niż o niskiej skuteczności spożywali codziennie zalecaną liczbę porcji warzyw (54% vs. 26%; $p < 0,01$) i produktów zbożowych (87% vs. 50%; $p < 0,001$) oraz zalecaną liczbę posiłków w ciągu dnia (96% vs. 70%; $p < 0,001$), w regularnych odstępach czasu (76% vs. 24%; $p < 0,001$).

Wnioski. Jakościowe zalecenia szwajcarskiej piramidy żywienia dla sportowców w wyższym stopniu realizowali zawodnicy o wysokim nasileniu poczucia własnej uogólnionej skuteczności.

Słowa kluczowe: sportowcy, futbol amerykański, zachowania żywieniowe, cechy osobowości, poczucie własnej uogólnionej skuteczności

INTRODUCTION

Well-balanced diet, covering increased demand of athletes for energy, protein, vitamin B complex, antioxidants and some minerals, promotes improvement in their health potential and exercise capacity [12].

Satisfying physiological demand for nutrients requires planning variable food rations, including various products, in line with the recommendations for individuals characterized by high levels of physical activity. Diet of sportspersons can be rationalized with an aid of dedicated food pyramids [12], such as the Swiss Food Pyramid for Athletes, a new dietary model for individuals characterized by higher levels of physical activity [2, 17, 25]. The basis of the Swiss Pyramid is formed by non-sweetened beverages, whereas the top includes sweets, salted snacks and sweetened drinks; other, variably interspaced groups include vegetables, fruits, wholegrain cereals, legume seeds, protein products, oils, fats and nuts, with various amounts and frequency of consumption recommended for these foods [2, 17]. The pyramid represents a novel instrument supporting nutritional education; furthermore, it helps the athletes to make more rational dietary choices being adequate to their training loads, specifying the recommended amounts and frequency of consumption for products from various groups [2, 17].

Health-seeking behaviours of various population groups are determined by a wide spectrum of socioeconomic, cultural and personality-based factors. General self-efficacy plays an important role among personality traits determining health culture of an individual [4, 27]. Self-efficacy, defined as an optimistic belief in one's ability to reach goals, can be used to predict one's intentions and activities in various areas, including health-seeking behaviours. In this context, self-efficacy should be considered a key component of a modern, procession model of change in one's health-seeking behaviours, among them dietary habits [16].

Consequently, this study was undertaken to determine the role of self-efficacy as a predictor of dietary

behaviours in athletes. Specifically, the aim of the study was to analyse the dietary behaviours of young American football players in Polish clubs and association thereof with their general self-efficacy level.

MATERIAL AND METHODS

The study included the group of 100 young men (20-30 years of age, mean 24.27 years) who practiced American football on a professional basis in three Polish clubs: 'Warsaw Eagles', 'Krakow King' and 'Wilki Łódzkie'. The participants were either students (45%) or professionally active employees with higher (23%), secondary (28%) or vocational education (4%). They have been practicing American football for three years on average and declared being in very good (70%) or good health (30%). The athletes participated in 1-2 training sessions per day, five times per week on average; mean duration of a single training session was two hours.

The participants were asked to complete an original dietary behaviour questionnaire including 18 diagnostic statements derived from the qualitative assumptions of the Swiss Food Pyramid for Athletes. The statements referred to the frequency and regularity of meals, consumption of recommended food products, avoidance of foods that are non-recommended in rational diet, and obeying the principles of fluid repletion for sportspersons. The respondents could answer 'yes' or 'no' to each statement. Prior to the proper study, the questionnaire was validated in a group of 23 individuals, with a retest after 6 weeks. Psychometric assessment revealed high reproducibility of results obtained with the dietary behaviour questionnaire. McNemar's *Chi-square* test did not show significant differences between the test and retest results for any of the statements ($p > 0.05$). The level of general self-efficacy was determined with General Self-Efficacy Scale (GSES) by Schwarzer, Jerusalem and Juczyński [14]. The scale includes 10 statements that are scored in such way that the higher the global GSES score (ranging from 10 to 40 points), the stronger the sense

of self-efficacy. Based on the median of the raw GSES score for our sample, we classified the participants as presenting with lower and higher levels of self-efficacy. Statistical analysis was conducted with STATISTICA 10.0 PL software. The distributions of health-seeking behaviour types in the individuals with higher and lower self-efficacy levels were compared with the *Chi-square* test. The results were considered significant at $p < 0.05$ and highly significant at $p < 0.01$.

RESULTS

Having at least three meals per day (82%), consumption of protein from such sources as eggs and/or meat several times per week (68%) and including cereal products in every main meal (67%) turned out to be the most often followed qualitative principles of rational nutrition in our group of athletes. Other, frequently followed dietary recommendations included remaining on a variable diet (75%), preference to mineral water and other non-sweetened beverages (69%), reduced intake of sweets and salted snacks (65%), energy drinks (64%) and fast food products (60%). In turn, the least frequently declared dietary behaviours included consuming vegetables and fruits with the recommended frequency of 3-5 servings per day (48%), including raw vegetables and whole grain cereal products in at least two servings per day (39% and 45%, respectively). Reduced intake of animal fats was declared by 42% of the respondents, and eating regularly, with 3- to 5-hour intervals between meals, by 48% (Table 1).

Analysis of a relationship between specific dietary behaviours and general self-efficacy level showed that the athletes with higher levels of this trait consumed two servings of vegetables per day (54% vs. 26%, $p < 0.01$), included cereal products in every meal (87% vs. 50%, $p < 0.001$), had at least 3 meals per day (96% vs. 70%, $p < 0.001$) and ate regularly (76% vs. 24%, $p < 0.001$) significantly more often than the persons characterized by lower self-efficacy levels (Table 1).

DISCUSSION

We showed that American football players followed the qualitative recommendations of the Swiss Food Pyramid for Athletes only to a limited extent. Furthermore, we revealed that some dietary behaviours of the American football players differed depending on their general self-efficacy level.

Assuming that efficient fluid repletion of athletes who remain on an appropriate diet can be achieved with mineral water, diluted fruit, fruit-vegetable and vegetable juices and/or isotonic drinks [2], the fact that as many as 69% of our respondents declared their preference to mineral water and other non-sweetened beverages should be considered a positive finding. Vegetables and fruits (as well as fruit and vegetable juices), constituting moderately- and low-glycemic sources of bioavailable carbohydrates, fiber, minerals and vitamins (also antioxidants), were included in everyday diet of only a half of our athletes. Noticeably, the sportsmen who presented with higher self-efficacy

Table 1. Adherence of American football players in Polish clubs to the recommendations of the Swiss Food Pyramid for Athletes

Recommendation	Overall (%)	General self-efficacy (GSES) (%)		p
		High	Low	
Hydration with mineral water and other non-sweetened beverages	69.0	70.0	69.0	0.7083
3-5 servings of fruits and vegetables per day	48.0	54.0	43.0	0.2405
Vegetables included in at least two daily meals	39.0	54.0	26.0	0.0035
Raw vegetables at least once a day	54.0	63.0	46.0	0.0929
Cereal products in every main meal	67.0	87.0	50.0	0.0000
Wholegrain cereals at least twice a day	45.0	41.0	48.0	0.4926
Dairy products at least twice a day	47.0	50.0	46.0	0.2520
High-quality protein (eggs/meat) 2-3 times per week	68.0	74.0	63.0	0.2400
Fish 1-2 times per week	51.0	61.0	43.0	0.0676
Reduced intake of animal fats	42.0	52.0	33.0	0.0567
Plant oils daily or nearly every day	54.0	50.0	57.0	0.4588
Reduced intake of carbonated beverages	57.0	67.0	48.0	0.0515
Reduced intake of energy drinks	64.0	67.0	61.0	0.5137
Reduced intake of fast-food products	60.0	63.0	57.0	0.5660
Reduced intake of sweets and salted snacks	65.0	72.0	59.0	0.1903
At least three meals per day	82.0	96.0	70.0	0.0004
Eating regularly (every 3-5 hours)	48.0	76.0	24.0	0.0000
Variable diet	75.0	80.0	70.0	0.2437

p – significance of differences found on the chi-square test (comparison between athletes presenting with higher vs. lower self-efficacy levels)

levels declared consuming vegetables at least twice a day significantly more often than did the persons with lower levels of this trait ($p < 0.01$). Comparison between our findings and the recommended frequencies of vegetable and fruit consumption (3 and 2 servings per day, respectively) [2, 17] pointed to an insufficient intake of these products in our group of American football players. Complex carbohydrates, present in large amounts in potatoes, cereal products and legume seeds, should constitute the principal source of energy in a rational diet [2, 17]. Wholegrain cereals and legumes are particularly valuable due to their high contents of various fractions of dietary fiber and low glycemic index, an important parameter considered in planning a diet for athletes during an intensive exercise period [17]. However, only 45% of our respondents declared consumption of cereal products with the recommended frequency. Physical exercise is generally associated with increased demand for protein [17], and therefore according to the Swiss Pyramid, athletes should choose between one serving of meat, fish, eggs, cheese or protein from other sources (e.g. tofu) daily, and enrich their diets with 2-3 servings of low-fat dairy products [2, 17]. Analyzing the frequencies of consuming these products by our athletes we showed that their diets included insufficient amounts of dairy (only 47% of the respondents declared consuming at least two servings of these products per day) and fish (consumed with the recommended frequency of 1-2 times per week by only 51% of the participants). These inconsistencies might lead to deficiency of calcium and polyunsaturated omega-3 fatty acids. Lipid profile of the blood can be also optimized with a plant oil- and nut-rich diet. Although, according to the Swiss Pyramid, athletes should include moderate amounts of these products in their everyday diet [25], we documented their reduced intake among our participants. The recommended reduced intake of atherogenic fats of animal origin was declared by only a half of our respondents (42%), and only a slightly higher fraction (54%) declared consuming plant oils on a daily basis or at least nearly every day. Concerning the products forming the top of the Swiss Food Pyramid, the intake of which should be controlled, our participants most often declared limited consumption of sweets and salted snacks (65%), energy drinks (64%) and fast food products (60%). They less often refrained from drinking sweetened carbonated beverages (57%), which as hypertonic are not suitable for an efficient repletion of fluids during intensive physical exercise [12]. A study of young Belgian sprinters showed that sweetened non-alcoholic beverages have contributed significantly to the energy value of their dietary intake [1]. Regarding other qualitative principles of rational diet, we observed a low, corresponding to no more than a half of our sample, prevalence of regular eating with 3- to 5-hour intervals

between the meals. In turn, eating regularly constitutes an important measure of rational diet and prerequisite of normal metabolism. A meal with high energy value, rich in carbohydrates, protein, vitamins and minerals, is vital for appropriate post-exercise regeneration [12]. In our study, the athletes characterized by higher self-efficacy levels showed more favorable attitude in this matter than did those presenting with low levels of this trait ($p < 0.001$). The distribution of dietary behaviours presented by our athletes might be associated with their daily training schedules.

Dietary inconsistencies and qualitative mistakes documented in our group of American football players correspond to the tendencies reported by the authors of other Polish and international studies of athletes practicing various sports on a competitive basis. These studies confirmed that the intakes of some food products, namely wholegrain cereals, vegetables, fruits, dairy products and fish, in various groups of athletes are often insufficient [1, 5, 6, 7, 9, 13, 18, 23, 24]. Also the hereby documented dietary inconsistencies, such as the limited control of the dietary intake of sweetened carbonated beverages, were previously observed among elite athletes [1]. Too low intakes of vegetables and fruits, frequently observed among athletes, may potentially lead to unbalanced supply of some antioxidative vitamins [26]. This is unfavorable in the case of intensive physical exercise, as the latter is associated with enhanced oxidative stress. Furthermore, insufficient intake of wholegrain cereal products, vegetables and fruits promotes deficiency of vitamin B complex, which is reflected by limited exercise capacity, documented previously in various groups of athletes [26]. Finally, it may lead to dietary fiber deficiency in physically active individuals [1, 11, 22, 26]. Previous studies conducted among the representatives of various sports disciplines confirmed that too low intake of dairy is associated with the risk of calcium deficiency [8, 11, 22, 26].

The relationship between specific dietary behaviours of our American football players and their general self-efficacy level, namely the fact that the sportsmen presenting with higher levels of this trait usually undertook more rational dietary choices, can be explained by the characteristics of this personality dimension [4, 27] and corresponds to the associations observed previously in other groups of athletes [3, 10, 15, 16, 19, 20, 21]. More rational dietary choices undertaken by our American football players characterized by higher self-efficacy levels, namely more frequent consumption of vegetables and cereal products, and eating regularly, can be interpreted as a method for improving their health potential and training effect optimization, both requiring variable and well-balanced diet.

Incomplete adherence of our athletes to the qualitative dietary recommendations justifies monitoring and

rationalization of their diet, with emphasis on specific nutritional problems which can be modulated by individual traits, such as the level of general self-efficacy.

CONCLUSIONS

1. This study documented incomplete adherence of American football players to the qualitative recommendations of the Swiss Food Pyramid for Athletes, especially with regards to the recommended frequency of vegetable, wholegrain cereal product, dairy, fish and plant oil consumption, reduced intake of animal fats and eating regularly.
2. The most prevalent rational dietary behaviours included having at least three meals per day, remaining on a variable diet, consuming high-quality protein, reduced intake of sweets, salted snacks, energy drinks and fast food products.
3. Dietary behaviours of the athletes were modulated by their general self-efficacy level; namely, the players with higher levels of this trait were shown to adhere to the recommendations of the Swiss Pyramid to a larger extent.

Conflict of interest

The author declares no conflict of interest.

REFERENCES

1. Aerenhouts D., Hebbelinck M., Poortmans J.R., Clarys P.: Nutritional habits of Flemish adolescent sprint athletes. *Int J Sport Nutr Exerc Metab* 2008; 18 (5): 509-523.
2. Burke L.M.: A food pyramid for Swiss athletes. *Int J Sport Nutr Exerc Metab* 2008; 18 (4): 430-437.
3. Cain A., Bardone-Cone A., Abramson L., Vohs K., Joiner T.: Prospectively predicting dietary restraint: the role of interpersonal self-efficacy, weight/shape self-efficacy, and interpersonal stress. *Int J Eat Disord* 2010; 43 (6): 505-512.
4. Chiang L., Kuo Y., Lin C.: A concept analysis of self-efficacy. *Hu Li Za Zhi* 2004; 51 (2): 67-72.
5. Czaja J., Lebidzińska A., Szefer P.: Eating habits and diet supplementation of Polish middle- and long-distance representative runners in years 2004-2005. *Rocz Panstw Zakl Hig* 2008; 59 (1): 67-74. (in Polish)
6. Frączek B., Gacek M.: Frequency of consumption of food products by a group of Polish athletes in relationship to the qualitative recommendations included in the Swiss food pyramid. *Med Sportiva* 2013; 17 (1): 13-17.
7. Gacek M.: Wiedza i zachowania żywieniowe młodzieży uprawiającej sport w Szkole Mistrzostwa Sportowego w Krakowie. [Knowledge and nutritional behaviours among the youth practising sports at School of Sports Championship in Cracov]. *Rocz Panstw Zakl Hig* 2007; 58 (4): 641-648. (in Polish)
8. Gacek M.: Ocena poziomu spożycia wybranych składników odżywczych w grupie hokeistów w okresie przygotowawczym. [Evaluation of consumption of selected nutrients in a group of hockey players during the preparation period.] *Rocz Panstw Zakl Hig* 2010; 61 (3): 259-264. (in Polish)
9. Gacek M.: Zwyczaje żywieniowe grupy osób wyczynowo uprawiających siatkówkę. [Eating habits of a group of professional volleyball players]. *Rocz Panstw Zakl Hig* 2011; 62 (1): 77-82. (in Polish)
10. Gacek M., Frączek B.: Nutritional evaluation of junior football players depending on the global level of self-efficacy of the athletes. *Med Sportiva* 2013; 17 (2): 72-75.
11. Garrido G., Webster A.L., Chamorro M.: Nutritional adequacy of different menu settings in elite Spanish adolescent soccer players. *Int J Sport Nutr Exerc Metab* 2007; 17 (5): 421-432.
12. González-Gross M., Gutiérrez A., Mesa J.L., Ruiz-Ruiz J., Castillo M.J.: Nutrition in the sport practice: adaptation of the food guide pyramid to the characteristics of athletes diet. *Arch Latinoam Nutr* 2001; 51 (4): 321-331.
13. Jessri M., Jessri M., Rashid-Khani B., Zinn C.: Evaluation of Iranian college athletes' sport nutrition knowledge. *Int J Sport Nutr Exerc Metab* 2010; 20 (3): 257-263.
14. Juczyński Z.: Measurement tools in health promotion and health psychology. Warszawa, Wyd. PTP, 2009. (in Polish)
15. Larson N., Neumark-Sztainer D., Story M., Burgess-Champoux T.: Whole-grain intake correlates among adolescents and young adults: findings from Project EAT. *J Am Diet Assoc* 2010; 110 (2): 230-237.
16. Luszczynska A., Tryburcy M., Schwarzer R.: Improving fruit and vegetable consumption: a self-efficacy intervention compared with a combined self-efficacy and planning intervention. *Health Educ Res* 2007; 22 (5): 630-638.
17. Mettler S., Mannhart C., Colombani P.C.: Development and validation of a food pyramid for Swiss athletes. *Int J Sport Nutr Exerc Metab* 2009; 19 (5): 504-518.
18. Ono M., Kennedy E., Reeves S., Cronin L.: Nutrition and culture in professional football. A mixed method approach. *Appetite* 2012; 58 (1): 98-104.
19. Pearson N., Ball K., Crawford D.: Predictors of changes in adolescents' consumption of fruits, vegetables and energy-dense snacks. *Br J Nutr* 2011; 105 (5): 795-803.
20. Posadzki P., Stockl A., Musonda P., Tsouroufli M.: A mixed-method approach to sense of coherence, health behaviors, self-efficacy and optimism: towards the operationalization of positive health attitudes. *Scand J Psychol* 2010; 51 (3): 246-252.
21. Schwarzer R., Richert J., Kreausukon P., Remme L., Wiedemann A., Reuter T.: Translating intentions into nutrition behaviors via planning requires self-efficacy: evidence from Thailand and Germany. *Int J Psychol* 2010; 45 (4): 260-268.
22. Soric M., Misigoj-Durakovic M., Pedisic Z.: Dietary intake and body composition of prepubescent female aesthetic athletes. *Int J Sport Nutr Exerc Metab* 2008; 18 (3): 343-354.

23. *Szczepańska E., Spalkowska A.*: Wybrane zachowania żywieniowe sportowców wyczynowo uprawiających siatkówkę i koszykówkę. [Dietary behaviours of volleyball and basketball players]. *Rocz Panstw Zakł Hig* 2012; 63 (4): 483-489.
24. *Ubeda N., Palacios Gil-Antuñano N., Montalvo-Zenarruzabeitia Z., García J.B., García A., Iglesias-Gutiérrez E.*: Food habits and body composition of Spanish elite athletes in combat sports. *Nutr Hosp* 2010; 25 (3): 414-421.
25. *Walter P., Infanger E., Muhlemann P.*: Food Pyramid of the Swiss Society for Nutrition. *Ann Nutr Metab* 2007; 51 (Suppl. 2): 15-20.
26. *Wierniuk A., Włodarek D.*: Estimation of energy and nutritional intake of young men practicing aerobic sports. *Rocz Panstw Zakł Hig* 2013; 64 (2): 143-148. (in Polish)
27. *Zalewska-Puchala J., Majda A., Galuszka A., Kolonko J.*: Health behaviour of students versus a sense of self-efficacy. *Adv Med Sci* 2007; 52 (Suppl 1): 73-77.

Received: 25.05.2015

Accepted: 14.09.2015

COMPLIANCE OF MENUS WITH NUTRITIONAL STANDARDS IN PUBLIC AND PRIVATE KINDERGARTENS IN CROATIA

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ABSTRACT

Background. It is necessary to ensure a variety of nutrients in weekly menus in kindergartens according to the recommendations and standards currently in effect. It is also important to follow the energy value of macronutrients, which is usually carried out by the relevant institutions quarterly in every kindergarten. However, the quality of menus in relation to the representation of different types of food is not monitored.

Objective. The aim of this study was to estimate the quality of meals in relation to the representation of different types of food in state and privately owned kindergartens in one of Zagreb district in Croatia.

Material and Methods. Weekly menu's daily meals served in kindergarten groups for children (4 - 6 years old) were analysed and compared with the Croatian Health Care, Hygiene and Balanced Diet Programme for Children in Kindergartens and with Food Plan Standards for Children in Kindergartens - Menus and Standards. The studies were performed in state and privately owned kindergartens in Zagreb, district Maksimir.

Results. Except in the serving of dairy products, which were in comparison to the proscribed standard overrepresented, other foods such as grains, fruits, vegetables, meat, eggs, pulse were underrepresented. Grains, except in a smaller number of servings, were statistically underrepresented in state owned kindergartens in comparison to the privately owned ones. The largest discrepancy was shown in the low number of fish servings, equally so in the state and privately owned kindergartens.

Conclusions. In recent years strides have been made to harmonise menus provided by kindergartens with standards based on scientific research on the prevention of obesity. However, further harmonisation of "old" and "new" foods intended to achieve a more substantial balance of the consumption of certain foods and the adequate amounts of their nutritional values is necessary.

Key words: *child, preschool, food, kindergarten*

INTRODUCTION

A balanced diet is of utmost importance through all stages of human life cycle. Numerous studies prove the relationship between obesity and various physical diseases [1] and mental diseases [19]. It is therefore important to establish appropriate dietary habits and attitudes from an early age [4, 20, 21]. In view of this fact, increasingly more effort is dedicated to the implementation of nutritional standards when planning meals in kindergartens. The Republic of Croatia adopted amendments to the Health Care, Hygiene and Balanced Diet Programme for Children in Kindergartens [9], (referred later as Health Kindergarten Programme), and issued guidelines Food Plan Standards for Children in Kindergartens - Menus and Standards [23]. Food pro-

ducts, based on new studies concerning the prevention of health risks and obesity related to unhealthy diet, were consequently added to kindergarten menus. In regard to previous guidelines, which were developed over two decades ago, this indicated progress [18, 19].

However, in the time of fast foods, general lack of time and shortage of trained specialists, who would provide education on proper nutrition and ensure its adoption from an early age, we can surmise the presence of oversights in the implementation of health standards. In the comparison of required standards before and after the introduction of "new menus" in 2008 [5], numerous studies conducted in Croatia revealed significant deviations in a number of factors associated with daily meals. These studies mostly focused on the energy value of meals in relation to the amount of carbohydrates, proteins

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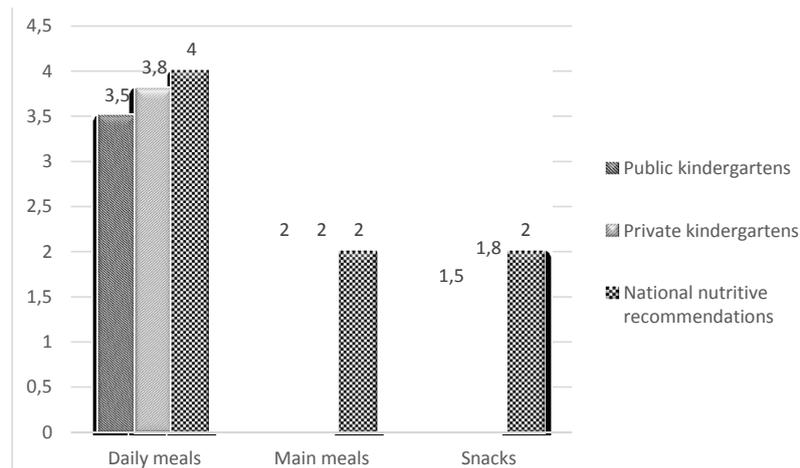


Figure 1. Average number of daily meals served in public and private kindergartens

and fats. Some of them also examined the differences between state-owned (public) and privately owned kindergartens. These studies paid little attention to the composition of menu items and food variety [3, 12].

The aim of this study was to determine the compliance of specific menus with nutritional standards in state-owned and privately owned kindergartens in one district of Zagreb. It was specially aimed to assess: (1) the number of servings in the “Morning Program 4” which is required to meet 80% of the recommended daily intake; (2) the amount of food items per serving - type and quantity, with special attention focused on the fish.

MATERIALS AND METHODS

In Croatia the city of Zagreb is divided into 17 city districts. Using a random number generating software, the Maksimir district was selected. The sample included all kindergartens in the district, namely four state-owned and four privately owned kindergartens. Weekly menu's daily meals were analysed using a check-list comprising the basic items on the menu in line with Health Kindergarten Programme [9] and Food Plan Standards for Children in Kindergartens - Menus and Standards [23]. In addition, authorised kindergarten employees

were interviewed. The weekly menu “Morning Program 4” daily meals were analysed in kindergarten groups for children between 4 and 6 years of age. The results were processed by conventional methods of descriptive statistics and presented as measures of location, dispersions, percentages and absolute numbers in tables and graphs. The differences between state-owned and privately owned kindergartens were examined using the *Student's t-test*.

RESULTS

The results of the analysed number of daily meals on the weekly menu demonstrate that the number of meals was in compliance with the Health Kindergarten Programme [9] in both state-owned and privately owned kindergartens (Figure 1). The number of snacks was lower and ranged from 1-2 snacks per day with an average value of 1.5 in state-owned and 1.8 in privately owned kindergartens. According to Health Kindergarten Programme [9] the total number of daily meals was, therefore, less than 4.

The results of analysed menus, in view of the daily serving of certain food types presented in Table 1 and Figure 2 indicate that, on average, grains were present in 3.2 servings per day in state-owned and in 3.8 se-

Table 1. Representation of foods and their relation to the nutritional recommendations [9] and nutritional standards [23] in public and private kindergartens

Daily serving of foods	Public kindergartens				Private kindergartens				p
	Mean value	Range	Relation to nutritional recommendations	Percentage in comparison to nutritional standards	Mean value	Range	Relation to nutritional recommendations	Percentage in comparison to nutritional standards	
Grains	3.2	2 - 5	100%	-27	3.8	3 - 5	100%	-17	0.01
Fruits	1.1	1 - 2	100%	-25	1.1	1 - 2	100%	-25	0.52
Vegetables	1.3	1 - 3	100%	-37	1.4	1 - 2	100%	-34	0.71
Meat, fish, eggs, pulses	1.2	1 - 2	100%	-40	1.3	1 - 2	100%	-37	0.49
Milk	2.1	1 - 4	100%	+20	1.9	1 - 3	100%	+15	0.56

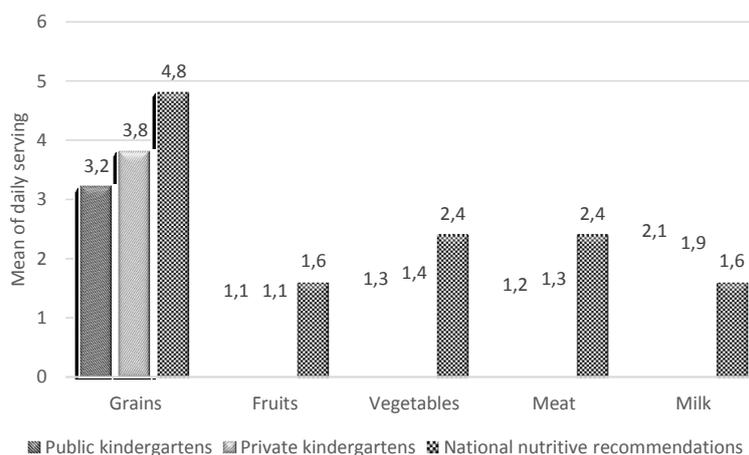


Figure 2. Representation of foods in public and private kindergartens

rvings per day in privately owned kindergartens. Thus although in compliance with the Health Kindergarten Programme [9], which prescribes the number of meals for each day, and in relation to the Food Plan Standards for Children in Kindergartens - Menus and Standards [23], which recommends that 80% of 6 daily meals be served during a 9-10 hour stay, the results revealed a deficiency of 27%.

On average, fruit was served 1.1 times a day in both state-owned and privately owned kindergartens, which, although in compliance with the Health Care, Hygiene and Balanced Diet Programme for Children in Kindergartens [9], demonstrated 25% less servings when compared to the Food Plan Standards for Children in Kindergartens - Menus and Standards [23], which recommends that fruit makes 80% of 2 daily meals served. Vegetables were, on average, served 1.3 times a day in state-owned and 1.4 times a day in privately owned kindergartens. Although the results were in compliance with the Health Care, Hygiene and Balanced Diet Programme for Children in Kindergartens [9], in relation to the Food Plan Standards for Children in Kindergartens - Menus and Standards [23] they showed a deficiency of 37% in state-owned and 34% in state-owned kindergartens. According to the Health Kindergarten Programme [9], meat, fish, eggs and pulses should be present in children's daily diet and can be interchangeably combined on the weekly menu and constitute three servings per day. However, only 1.2 servings a day were recorded in state-owned and 1.3 servings a day in privately owned kindergartens, which in relation to the Food Plan Standards for Children in Kindergartens - Menus and Standards [23] revealed a deficiency of 40% in state-owned and 37% in privately owned kindergartens.

Milk was served in 2.1 serving units in state-owned and 1.9 serving units in privately owned kindergartens, thus exceeding the Food Plan Standards for Children in Kindergartens - Menus and Standards [23] recommendations of 80%, namely 2 serving units.

The weekly menus analysed in view of the recommended servings of fish, whose results are demonstrated in Table 2, indicated that only one kindergarten within the privately owned group served fish on a weekly basis, while all other kindergartens, from both groups, did not serve fish at all. Seafood, specifically squid, was included in the weekly menu in one kindergarten within the state-owned group and in 2 kindergartens within the privately owned group.

Table 2. Weekly frequency of serving fish and squids in kindergartens

Kindergarten	Fish	Squids
Public 1	0	1
Public 2	0	0
Public 3	0	0
Public 4	0	0
Private 1	1	0
Private 2	0	1
Private 3	0	1
Private 4	0	0

No weekly menus of kindergartens from examined groups included foods high in fat, with added sugar or salt. Water was readily available for drinking at all times.

DISCUSSION

The modern society we live in imposes new lifestyles under whose conditions it is necessary to provide adequate measures of health care and nutrition for children, in accordance with the Health Kindergarten Programme [9]. A balanced diet in kindergartens is of utmost importance because it improves children's health, growth and development, as well as prevents disease and promotes the adoption of healthy habits at an early age, which in turn have an impact on reducing the incidence of obesity and other chronic non-communicable diseases in later stages of life [10, 11, 13].

Numerous research studies investigated the nutritive value of kindergarten meals through the years and their compliance with the recommended standards. The issue was particularly salient after the introduction of “healthy menus” in all kindergartens in 2008, which aimed to update and augment such menus in order to prevent the development of diet-related diseases. Such researches were only concerned with determining the energy value and macronutrient content (carbohydrates, proteins and fats) of meals, as well as the deviation of macronutrient content from the recommended values and prescribed standards [6, 12]. This study demonstrated the prevalence of major food groups on kindergarten menus which could explain certain phenomena observed in the aforementioned research dealing with the energy value of macronutrients.

Analysis of the results pertaining to the number of servings showed that the number of snacks was not in accordance with the Health Kindergarten Programme [9], which prescribes two snacks a day, neither in state-owned nor in privately owned kindergartens. Although there was no statistically significant difference in average number of snacks between state-owned and privately owned kindergartens, a slightly better conditions were noted in privately owned kindergartens where the average number of snacks served per day amounted to 1.8, compared to 1.5 snacks served per day in state-owned kindergartens.

The analysis of the results of daily servings of grains showed a statistically significant difference between the state-owned kindergartens, where grains were served 3.2 times on average and privately owned kindergartens, where they were served 3.8 times on average. Furthermore, a difference of 27% from the Food Plan Standards for Children in Kindergartens - Menus and Standards [23], which recommends 6 servings of grains on a daily menu, was recorded in both groups. Grains are primarily a source of carbohydrates, mostly complex carbohydrates. They are located at the base of the healthy diet pyramid and should be the most prevalent group of foods consumed [16]. Reducing the frequency of serving foods pertaining to this group can result in reduced energy and the loss of the nutritional value of the menu. Other Croatian research conducted in Zagreb kindergartens, as well as kindergartens in other parts of Croatia, yielded similar results [3, 22].

Fruit and vegetables are also rich in carbohydrates but poor in fats and complete proteins. However, according to the Food Plan Standards for Children in Kindergartens - Menus and Standards [23], the number of servings of fruit and vegetables was not sufficient neither in state-owned nor in privately owned kindergartens. It is similar to results of other studies which reported shortage of fruits and vitamins in meals served in kindergartens [8, 15]. It should nonetheless be noted

that the number of servings of fruit and vegetables was in compliance with the Health Care, Hygiene and Balanced Diet Programme for Children in Kindergartens [9], which prescribes a daily intake of foods pertaining to these groups. All kindergartens served at least one serving of fruit and vegetables per day, ranging from 1 to 3 servings.

According to the Food Plan Standards for Children in Kindergartens - Menus and Standards, meat, fish, eggs and pulses should make 2-3 serving units a day, and can be interchangeably combined on the weekly menu. It is recommended to serve fish 1-2 and egg up to 3 times a week on average whereas meat should be served every day [23]. The analysis results indicated that meats and pulses were the most prevalent foods with 1.2 servings, on average, in state-owned and 1.3 servings, on average, in privately owned kindergartens. Egg, as a main dish, was not served in any kindergarten. Fish was served in only one kindergarten, once a week. Therefore, in terms of fish consumption, in seven of the eight investigated kindergartens neither Health Kindergarten Programme nor Food Plan Standards for Children in Kindergartens - Menus and Standards requirements were met [9, 23].

The results of these studies demonstrated that milk and dairy products were often served in both state-owned and privately owned kindergartens and that the Food Plan Standards for Children in Kindergartens - Menus and Standards [23] recommendations were exceeded by 15-20%. Milk and dairy products are an important source of biologically valuable proteins, so if such foods make up a significant part of the meal on the menu, along with the latest trend to supplement “new menus” with various pulses, the amounts of protein in daily meals could be exceeded by up to 30%, as referenced in national research [12]. Such prevalence of proteins directly burdens the liver and kidneys, and disrupts metabolic functions. The studies dealing with the analysis of energy value of macronutrients, including meals provided in kindergartens and at home, also reported an increased presence of proteins in the diet of children eating outside the kindergarten [2, 7].

CONCLUSIONS

In recent years efforts have been made in Croatia to harmonise menus in kindergartens with nutritional standards based on scientific research on the obesity prevention. Many foods high in fat, as well as foods with added sugar or salt were therefore replaced in the menus by new pulses, whole grains and fresh fruits. However, further harmonisation of “old” and “new” foods intended to achieve a more substantial balance of the consumption of certain foods with adequate nutritional values is necessary.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. *Aballay L.R., Navarro A., Munoz AR., Eynard AR.*: Overweight and obesity: a review of their relationship to metabolic syndrome, cardiovascular disease, and cancer in South America. *Nutr Rev* 2013; 71(3):168-179.
2. *Bernardi JR., Cezaro C.D., Fisberg R.M., Fisberg M., Vitolto M.R.*: Estimation of energy and macronutrient intake at home and in the kindergarten programs in preschool children. *J Pediatr* 2010; 86:59-64.
3. *Bošnjir J., Puntarić D., Tomašić A., Capuder L.*: Caloric and Nutritive Value of Kindergarten Meals in Zagreb from 1988 to 1993. *Lijec Vjesn* 1996; 118: 229-34.
4. *Chiras D. D.*: Human biology. Gerald, Jones & Bartlett Publishers, 2013.
5. Convention on the Rights of the Child. Available from: <http://www.ohchr.org/EN/ProfessionalInterest/Pages/CRC.aspx> (09.09.2015.)
6. *Ćurin K., Mrša R.*: Assessment of the quality of meals in Šibenik preschools. *Med Jad* 2012;42(1-2):33-42 (in Croatian).
7. *Frackiewicz J., Ring-Andrzejczuk K., Gronowska-Senger A.*: Energy and selected nutrients content in pre-school children diet of Warsaw district. *Rocz Panstw Zakl Hig* 2011; 62(2):181-5.
8. *Górnicka M., Frąckiewicz J., Trela I.*: Selected vitamins content in pre-school children diet in Warsaw and regions. *Rocz Panstw Zakl Hig* 2011; 62(2):205-208.
9. Health Care, Hygiene and Balanced Diet Programme for Children in Kindergartens. No.121/2007. *Narod ne novine*, 26.11.2007 (in Croatian).
10. *Ho M., Garnet SP., Baur LA, Burrows T, Stewart L., Neve M., Collins C.*: Impact of dietary and exercise interventions on weight change and metabolic outcomes in obese children and adolescents: a systematic review and meta-analysis of randomized trials. *JAMA Pediatr*. 2013;167(8):759-68, doi: 10.1001/jamapediatrics.2013.1453.
11. *Hu F.B.*: Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. *Obesity Reviews* 2013;14(8):606-19.
12. *Jagic V., Bosnir J., Racz A., Jelusic S.*: Caloric and nutritive value of kindergarten meals in Zagreb after implementation of the new national nutritive recommendation and standards 2007. *Paediatr Croat*. 2011;55:11-16 (in Croatian).
13. *Kuhl E.S., Clifford L.M., Stark L.J.*: Obesity in preschoolers: behavioural correlates and directions for treatment. *Obesity* 2012;20(1):23-29.
14. *Larson N., Ward D.S., Neelon S.B., Story M.*: What role can child-care settings play in obesity prevention? A review of the evidence and call for research efforts. *J Am Diet Assoc* 2011;111(9):1343-62.
15. *Lazarevic K., Stojanovic D., Bogdanovic D.*: Energy and nutritional value of the meals in kindergartens in NIS. *Rocz Panstw Zakl Hig* 2014; 65(2):127-131
16. *Matić I.*: 5 meals a day – perfect health. Available from: <http://bib.irb.hr/prikazi-rad?&rad=424341> (05.08.2015.) (in Croatian).
17. *Novaković R., Cavelaars A., Geelen A., Nikolic M., Altaba H., Vinas BR., Ngo J., Golsorkki M., Medina MW., Brzozowska A., Szczecinska A., de Cock D., Vansant G., Renkema M., Majem LS, Moreno LA, Gibetic M., Gurinovic M., van't Veer P., de Groot LC.*: Socio-economic determinants of micronutrient intake and status in Europe: a systematic review. *Public Health Nutr* 2014;17(5): 1031-1045.
18. *Pavlovic M., Prentice A., Thorsdottir I., Wolfram G., Branca F.*: Challenges in harmonizing energy and nutrient recommendations in Europe. *Ann Nutr Metab* 2007; 51(2):108-14.
19. *Sanhueza C., Ryan L., Foxcroft D.R.*: Diet and the risk of unipolar depression in adults: systematic review of cohort studies. *J Hum Nutr Diet* 2013;26(1):56-70.
20. *Sankeshwari R. M., et al.*: Association of socio-economic status and dietary habits with early childhood caries among 3-to 5-year-old children of Belgium city. *Eur Arch Paediatr Dent* 2013;14(3):147-153.
21. *Te Morenga L.A., Howatson A.J., Jones R.M., Mann J.*: Dietary sugars and body weight: systematic review and meta-analyses of randomised controlled trials of the effects on blood pressure and lipids. *Am J Clin Nutr* 2014;100(1):65-79.
22. *Valek M., Ebling Z., Laslavić B., Pitlik N.*: Carbohydrates in the main meal of Osijek kindergartens. Available from: <http://www.izlog.info/tmp/hejz/clanak.php?id=13153>
23. *Vučemilović Lj., Vujić Šisler Lj.*: Food Plan Standards for Children in Kindergartens - Menus and Standards. Zagreb, Croatian Nurses Association, 2007.

Received: 25.05.2015

Accepted: 16.09.2015

EFFECT OF PREBIOTIC AND STORAGE TIME ON THIAMINE AND RIBOFLAVIN CONTENT IN THE MILK DRINKS FERMENTED BY *LACTOBACILLUS CASEI* KNE-1

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ABSTRACT

Background. Fermented milk drinks are unique products due to content of *Lactobacillus* and *Bifidobacterium* that are recognized as probiotics. They are a natural component of the colon microbiota as well as commonly used probiotics in functional food.

Objectives. The effects of the storage time and prebiotic type (inuline or oligofructose) were studied in banana-milk drink after fermentation by *Lactobacillus casei* KNE-1 on the thiamine and riboflavin concentrations.

Material and methods. The material for the study was fermented fruit milk drinks: banana-milk prepared in laboratory conditions and fruit milk drinks purchased in a local shop, as a comparative material. The thiamine was determined by thiochrome method and the riboflavin was determined by fluorometric method.

Results. The storage time after the end of the fermentation process did not increase the content of thiamine and riboflavin in fermented banana-milk drink more than the output level. The addition of oligofructose significantly affected the synthesis of thiamine by *Lactobacillus casei* KNE-1 irrespectively of the storage time. The storage time but not the type of prebiotic affected the riboflavin concentration. Taking into account the highest content of both vitamins, the banana-milk drink fermented by *Lactobacillus casei* KNE-1 should be consumed immediately or 24 days after fermentation.

Conclusions. This information could be used by manufacturers for the planning of technological process. The content of thiamine and riboflavin in the fermented milk drinks is the result of the type of prebiotic, the individual bacterial strain properties as well as the storage time. These factors should be investigated to optimize the content of B vitamins in fermented milk drinks in the future.

Key words: fermented drinks, *Lactobacillus casei* KNE-1, riboflavin, thiamine

STRESZCZENIE

Wprowadzenie. Mleczne napoje fermentowane są produktami unikalnymi ze względu na zawartość bakterii probiotycznych rodzaju *Lactobacillus* i *Bifidobacterium*. Są one naturalnym składnikiem mikroflory okrężnicy, jak również powszechnie stosowane w żywności funkcjonalnej.

Cel badań. Celem badania była analiza wpływu czasu przechowywania i rodzaju dodanego prebiotyku (inuliny i oligofruktozy) na zawartość tiaminy i ryboflawiny w mlecznym napoju o smaku bananowym fermentowanym *Lactobacillus casei* KNE-1.

Materiał i metoda. Materiałem do badań były mleczne napoje fermentowane o smaku bananowym wytworzone w warunkach laboratoryjnych oraz fermentowane napoje mleczno-owocowe zakupione w handlu detalicznym, jako materiał porównawczy. Tiamina została oznaczona metodą tiochromową, a ryboflawina metodą fluorometryczną.

Wyniki. Czas przechowywania po zakończeniu procesu fermentacji nie wpłynął na zwiększenie zawartość tiaminy i ryboflawiny w fermentowanych napojach o smaku bananowym w stosunku do poziomu wyjściowego. Dodanie oligofruktozy miało istotny wpływ na syntezę tiaminy przez *Lactobacillus casei* KNE-1, bez względu na czas przechowywania. Czas przechowywania, ale nie typ dodanego prebiotyku wpływał na koncentrację ryboflawiny. Biorąc pod uwagę najwyższą zawartość obu witamin w mlecznym napoju fermentowanym przez *Lactobacillus casei* KNE-1, produkt ten powinien być spożywany natychmiast lub po 24 dniach fermentacji.

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Wnioski. Wyniki naszych badań mogą być wykorzystywane przez producentów do planowania procesu technologicznego. Zawartość tiaminy i ryboflawiny w mlecznych napojach fermentowanych jest skutkiem właściwości poszczególnych szczepów bakteryjnych, jak i przechowywania. Czynniki te powinny być poddane dalszym badaniom w celu ich optymalizacji na zawartość witamin z grupy B w mlecznych napojach fermentowanych.

Słowa kluczowe: napoje fermentowane, *Lactobacillus casei* KNE-1, ryboflawina, tiamina

INTRODUCTION

In a typical human diet milk and milk products are one of the major sources of protein, calcium, B vitamins, vitamin A and D. Fermented milk drinks are unique products due to content of *Lactobacillus* and *Bifidobacterium* that are recognized as probiotics. They are a natural component of the colon microbiota as well as commonly used probiotics in functional food [11]. The most important benefits of *Bifidobacterium* and *Lactobacillus* are the inhibition of pathogenic microorganisms, reduction of serum cholesterol level, prevention of cancer, enhancement of the immune system, improvement of lactose digestion as well as the synthesis of B vitamins (thiamine, riboflavin, niacin and folate) [7, 13, 16]. Food-grade bacteria make it possible to fortify some raw food products with B vitamins by natural process. On the other hand the levels of some vitamins can be reduced during fermentation as they are absorbed by lactic acid bacteria. This process concerns thiamine, riboflavin, pyridoxine, pantothenic acid and cobalamin, and its rate is dependent on the type of bacterial strain and the conditions of fermentation [15]. It has been shown that the simultaneous application of pre- and probiotics can efficiently enhance these effects [3]. Additionally prebiotics as dietary supplements increase the content and proportion of bifidobacteria and improve an absorption of nutrients, synthesis of vitamins, prevent constipation, colon cancer and exert positive effect on blood sugar and lipid profile [8, 10]. Combination of pre- and probiotic as a synbiotic can improve the survival of the probiotic strains and prolong their beneficial effect in human gut [4]. The probiotic bacteria (*Lactobacillus* and *Bifidobacterium*) are the producers of B vitamins so that food fermented by them can be the additional source of these vitamins. Moreover, prebiotic supplements intensify bacterial growth and thus vitamin synthesis in the gut as well as in foods. The species of *L. casei* has a good stability in the conditions of the human gastrointestinal tract and its probiotic properties may be intensively used in the dairy industry [12]. To meet the expectations of consumers, manufacturers offer dairy products of different flavours as well as functional additives, including pro- and prebiotics, whose primary role is beneficial effect on human health [5]. Prebiotics are the selectively fermented ingredients that allow specific changes, both in the composition and/or activity of the microflora of

the gastrointestinal tract, thereby improving the health and well-being of the organism [9]. The best documented prebiotic properties have inulin and oligofructose, what was shown in human and animal studies [6, 17]. These compounds are used as functional additives, stimulate the growth of probiotics and may contribute to increase of the content of B vitamins in fermented milk drinks. Therefore the aim of this study was to investigate the effect of various types of prebiotics on the contents of thiamine and riboflavin during storage of the banana-milk drink fermented by *Lactobacillus casei* KNE-1 strain.

MATERIAL AND METHODS

The material for the study was fermented fruit milk drinks: banana-milk prepared in laboratory conditions and fruit milk drinks purchased in a local shop, as a comparative material.

Experiment 1 – Fermented banana-milk drink was prepared in Department of Food Gastronomy and Food Hygiene, WULS, Poland [14]. The following materials were used in the process: banana nectar (pasteurized, prepared on the basis of the concentrate, sweetened); 0.5% fat UHT milk, the probiotic strain *Lactobacillus casei* KNE-1 (Institute of Fermentation Technology and Microbiology, Lodz University of Technology, Poland). Oligofructose and inulin with sucrose added were used as prebiotics. Oligofructose (5% added) RAFTILOSE P95 (ORAFTI, Belgium) and inulin with sucrose (5% added) FRUTOFIT (Sensus, the Netherlands). Sucrose was added for taste enhancement [14]. After the fermentation process (12 hours, 37°C) products were stored for 32 days in 10°C. The samples were collected immediately after fermentation (day 0) and then after 1, 8, 16, 24 and 32 days of storing to determine the content of thiamine and riboflavin.

Experiment 2 – Commercially available fruit milk drinks fermented by *L. casei* and “yoghurt bacteria” (as named by manufacturer) were used to compare contents of thiamine and riboflavin. These were drinks produced by one company in five different flavours: natural, strawberry, raspberry and cranberry, multi fruit, peach and honey.

The thiamine was determined by thiochrome method with the modification of Soliman [19]. The procedure involved release of thiamine from phosphate

binding protein by the enzymatic hydrolysis using Taka-Diastase (Sigma 86247). Next step was thiochrome formation in the reaction with potassium hexacyanoferrate (II) (Chempur, Poland) under alkaline conditions. The procedure was carried out in two parallel samples, in one of which thiochrome formation was inhibited by the addition of benzenesulfonyl chloride (Aldrich 108138) to eliminate column purification [1]. The intensity of the fluorescence of isobutyl alcohol solutions was measured at the maximum excitation and emission wavelengths of 365 nm and 435 nm, respectively. The riboflavin was determined by fluorometric method [2]. After the extraction of vitamin and the oxidation of the interfering substances the fluorescence of riboflavin was measured at the maximum excitation and emission wavelengths of 365 nm and 435 nm, respectively. The fluorescence measurements were carried out using photofluorometer (KONTRON INSTRUMENTS) connected to computer with SFM 25 software. Analysis of the vitamins was repeated 3 times: in experiment 1 – every day of the fermentation; in experiment 2 – for every flavour of the commercial drink.

Data was analyzed using Statistica software version 10 (StatSoft, Poland). The results were presented as the mean \pm standard deviation (SD). Data with a normal distribution were subjected to one-way analysis of variance (ANOVA) to assess the potential statistical significance. In addition, two-way ANOVA analysis was done in which the classification factors included time of storage and prebiotic. The Fishers LSD test was used to compare the means between groups. The results with p -values ≤ 0.05 were considered as statistically significant.

RESULTS

The thiamine and riboflavin contents in the banana-milk drink have changed significantly during the

storage (Table 1). The length of the storage time significantly influenced the content of vitamins in drink with inulin added as well as with oligofructose added ($p < 0.001$). The type of prebiotic affected only the content of thiamine ($p < 0.05$), which was higher in the drink with oligofructose added. The growth of lactic acid bacteria should result in an increase vitamin production during fermentation. However, the nutrients present in the environment are used by bacteria for growth, therefore nutrient content may vary.

Based on the results of the study of fruit milk drinks available on the Polish market, obtained in the second experiment, there was the highest amount of (17.4 \pm 0.98 $\mu\text{g}/100\text{ g}$) and riboflavin (306 \pm 6.34 $\mu\text{g}/100\text{ g}$) in a fermented beverage of natural flavour (Table 2). In contrast, the least amount of thiamine and riboflavin were found in fermented multi fruit milk drink (13.3 \pm 1.02 $\mu\text{g}/100\text{ g}$; 262 \pm 2.99 $\mu\text{g}/100\text{ g}$, respectively). Commercial drinks contained similar amounts of riboflavin, but much more thiamine than tested banana-milk drink.

Table 2. The content of thiamine and riboflavin in the commercial fermented fruit milk drinks

Flavour	Thiamine ($\mu\text{g}/100\text{ g}$)	Riboflavin ($\mu\text{g}/100\text{ g}$)
Natural (n=6)	17.4 \pm 0.98	306 \pm 6.34
Strawberry (n=6)	17.3 \pm 1.10	290 \pm 2.97
Raspberry and cranberry (n=6)	14.4 \pm 0.81	286 \pm 3.05
Peach and honey (n=6)	13.9 \pm 0.78	276 \pm 4.04
Multi fruit (n=6)	13.3 \pm 1.02	262 \pm 2.99

DISCUSSION

The length of the storage time significantly influenced the content of vitamins in drink with inulin added as well as with oligofructose added. The type of prebiotic affected only the content of thiamine, which was higher in the drink with oligofructose. Previous results showed

Table 1. The content of thiamine and riboflavin in a banana-milk fermented drink depending on the type of prebiotic and storage time

Storage time (days)	Thiamine ($\mu\text{g}/100\text{ g}$)		Riboflavin ($\mu\text{g}/100\text{ g}$)	
	Inulin	Oligofructose	Inulin	Oligofructose
0	10.9 \pm 0.03 ^{a*(a)**}	9.82 \pm 0.05 ^{a(b)}	321 \pm 1.80 ^{A*}	303 \pm 0.63 ^E
1	8.61 \pm 0.02 ^{a(a)}	12.8 \pm 0.01 ^{a(b)}	279 \pm 4.71 ^B	308 \pm 0.75 ^B
8	6.53 \pm 0.02 ^{c(a)}	6.43 \pm 0.02 ^{c(b)}	233 \pm 0.59 ^C	231 \pm 1.20 ^C
16	4.62 \pm 0.04 ^{c(a)}	6.81 \pm 0.03 ^{c(b)}	305 \pm 3.10 ^D	248 \pm 0.80 ^D
24	9.71 \pm 0.07 ^{a(a)}	10.5 \pm 0.02 ^{a(b)}	272 \pm 6.1 ^E	311 \pm 0.73 ^E
32	7.23 \pm 0.08 ^{b(a)}	9.51 \pm 0.04 ^{b(b)}	263 \pm 0.68 ^F	229 \pm 3.72 ^F
Two-way ANOVA				
Storage time	$p < 0.001$		$p < 0.001$	
Prebiotic	$p < 0.05$		NS	

Thiamine: ^{a-c} - statistically significant differences between means marked with different letters in the columns ($p \geq 0.05$); ^{**a-b} - statistically significant differences between means marked with different letters in rows ($p \leq 0.05$).

Riboflavin: ^{A-F*} - statistically significant differences between means marked with different letters in the columns and rows ($p \leq 0.05$); NS – no statistical differences ($p > 0.05$).

that some starter cultures that are able to produce B vitamin, most probiotic strains of lactobacilli, consume these vitamins and thus decrease their contents [15].

Studies of the same banana-milk drink with oligofructose, *Jalosińska* have shown that the number of bacteria kept increasing until day 16 of storage (after fermentation) and stay stable on the similar level until day 24 [14]. In the presence of inulin, such differences were not observed. However, there was a similar number of *Lactobacillus casei* KNE-1 in the drinks between day 16 and 24 of storage regardless of the type of prebiotic. There was an increase of thiamine in the beverages with inulin or oligofructose at that time, but the riboflavin - only in product with oligofructose. On day 24 of storage at 10°C synthesis of both vitamins reached optimum level. On that day a high content of thiamine and riboflavin was observed for both prebiotics, which even exceeded the output level in beverage with oligofructose. This proves that fermented banana-milk drink was the best source of thiamine and riboflavin after about 3 weeks of storage. In similar studies *Beitane* and *Ciprovisa* [3], using a *Bifidobacterium lactis* (Bb-12) and inulin, have shown a greater amount of thiamine and smaller amount of riboflavin than shown in this study in the same day (day 0), immediately after 16 hours of fermentation. This may suggest better efficiency of the *Bifidobacterium* strain than *Lactobacillus* in the production of thiamine, and the inverse relationship for the riboflavin. Although *Bifidobacterium* and *Lactobacillus* genera are both considered to be efficient producers of B vitamins, it is specific characteristics of individual strains that have recently become a subject of interest [20]. What is more the complete pathway for thiamine production has been predicted only in *L. reuteri* ATCC 55730 and ATCC PTA 6475 [18]. Depending on the type of prebiotic, fermentation time and storage time the amount of thiamine and riboflavin in fermented milk beverages can vary significantly.

Commercial drinks contained similar amounts of riboflavin, but much more thiamine than tested banana-milk drink. Differences could arise primarily from the presence of other bacterial species than *L. casei*, time since the end of fermentation and storage conditions that were not precisely known here. Based on the survey, it was found that the fermented beverage with natural flavor can be the best source of thiamine and riboflavin, among the analyzed commercial beverages.

CONCLUSIONS

Storage time after the end of the fermentation process had no effect on increasing the final amount of thiamine and riboflavin in fermented fruit milk drinks over the output level.

Oligofructose, more than inulin, stimulated the synthesis of thiamine by *Lactobacillus casei* KNE-1, in most days of storage. The type of prebiotic was not significant for the synthesis of riboflavin. The banana-milk drink fermented by *Lactobacillus casei* KNE-1 should be consumed right after fermentation process has been completed, or about 24 days later due to the highest content of thiamine and riboflavin at this time. This seems to be important information for manufacturers and can be used in food labeling. The content of thiamine and riboflavin in milk fermented beverages is the result of the type of prebiotic, the individual characteristics of the bacterial strain and the storage time. These factors should be tested in the future to optimize B vitamin content in this type of drinks.

Conflict of interest

The authors declare no conflict of interest.

REFERENCES

1. AOAC International Method 942.23. Thiamine (Vitamin B1) in Foods. In Official Methods of Analysis of AOAC International, 18th Ed, AOAC Intl: Gaithersburg, Maryland, 2005.
2. AOAC International Method 970.65. Riboflavin (Vitamin B2) in Foods and Vitamin Preparations. In Official Methods of Analysis of AOAC International, 18th Ed., AOAC Intl: Gaithersburg, Maryland, 2005.
3. *Beitane I., Ciprovisa I.*: The study of added prebiotics on B group vitamins concentration during milk fermentation. *ACRomanian Biotechnological Letters* 2011; 16:92-96.
4. *Collins M.D., Gibson G.R.*: Probiotics, prebiotics, and synbiotics: approaches for modulating the microbial ecology of the gut. *The American Journal of Clinical Nutrition* 1999;69(Suppl):1052-1057.
5. *Corbo M.R., Bevilacqua A., Petrucci L., Casanova F.P., Sinigaglia N.*: Functional Beverages: The Emerging Side of Functional Foods. *Commercial Trends, Research, and Health Implications. Comprehensive Reviews in Food Science and Food Safety* 2014; 13:1192-1206. doi: 10.1111/1541-4337.12109
6. *Drywień M.*: Studia nad wpływem inuliny i oligofruktozy na gospodarkę tiaminą u szczurów w warunkach jej niedoboru. [Study on inulin and oligofructose influence on thiamine utilization in thiamine-deficient rats]. *Wydawnictwo SGGW, Warszawa, 2009* [in Polish].
7. *Farnworth E.R.*: The evidence to support health claims for probiotics. *Journal of Nutrition* 2008;138(Suppl):1250-1254.
8. *Gibson G.R.*: Dietary modulation of the human gut microflora using prebiotics. *British Journal of Nutrition* 1998;80 (Suppl), 209-212.
9. *Gibson G.R., Probert H.M., Van Loo J.A.E., Roberfroid H.B.*: Dietary modulation of the human colonic microbio-

- ta: updating the concept of prebiotics. Nutrition Research Review 2004;17:259-275.
10. Goetze O., Fruehauf H., Pohl D., Giarrè M., Rochat F., Ornstein K., Menne D., Fried M., Thumshirn M.: Effect of a prebiotic mixture on intestinal comfort and general wellbeing in health. British Journal of Nutrition 2008;100:1077-1085.
 11. Guarner F., Malagelada J.R.: Gut flora in health and disease. Lancet 2003;361:512-519.
 12. Horáčková Š., Žaludová K., Plocková M.: Stability of selected Lactobacilli in the conditions simulating those in the Gastrointestinal tract. Czech Journal of Food Sciences 2011;29:30-35.
 13. Hugenholtz J., Smid E.J.: Nutraceutical production with food-grade microorganisms. Current Opinion in Biotechnology 2002;13:497-507.
 14. Jalošinska M.: The survivability of probiotic strain in a banana-milk drink depending on the various prebiotic added. Żywn Nauka Technol Jakość 2007;6(55):127-137 [in Polish]
 15. LeBlanc J.G., Laiño J.E., Juarez del Valle M., Vannini V., van Sinderen D., Taranto M.P., Font de Valdez D., Savoy de Giori G., Sesma F.: B-Group vitamin production by lactic acid bacteria – current knowledge and potential applications. J. Appl. Microbiol. 2011;111:1297-1309, doi:10.1111/j.1365-2672.2011.05157.x
 16. Parvez S., Malik K.A., Ah Kang S., Kim H.Y.: Probiotics and their fermented food products are beneficial for health. Journal of Applied Microbiology 2006;100:1171-1185.
 17. Roberfroid M.: Prebiotics: The concept revisited. Journal of Nutrition 2007;137:830-837.
 18. Saulnier D.M., Santos F., Roos S., Mistretta T-A., Spinler J.K., Molenaar D., Teusink B., Versalovic J.: Exploring metabolic pathway reconstruction and genome-wide expression profiling in *Lactobacillus reuteri* to define functional probiotic features. doi: 10.1371/journal.pone.0018783 (2011).
 19. Soliman A.G.: Comparison of manual and benzenesulfonyl chloride-semiautomated thiochrome methods for determination of thiamine in foods. Journal of the Association of Official Analytical Chemists 1981; 64:616-622.
 20. Tetsuo Y.: Thiamine synthesis by bacterial cells(II) synthesis of thiamine by Enterobacteriaceae. Vitamins 1960;20:151-155.

Received: 11.05.2015

Accepted: 08.09.2015

ORIGINAL ARTICLE

PREVALENCE OF SKELETAL FLUOROSIS IN FISHERMEN FROM THE KUTCH COAST, GUJARAT, INDIA

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ABSTRACT

Background. In health terms, consuming fluoride is well recognised to be a double-edged sword. Consumption of optimal amounts is beneficial to health, however an excess constitutes a health hazard.

Objectives. To assess the prevalence of skeletal fluorosis in fishermen from the Kutch coast, Gujarat, India.

Materials and method. A descriptive cross-sectional survey was conducted on 653 fishermen from the Kutch District, Gujarat, India, from October 2014 to December 2014. Clinical skeletal fluorosis was assessed using three diagnostic tests. Drinking water fluoride concentrations in different regions of the study area were determined. General information regarding age, gender and adverse habits were also collected. The *Chi square* test was used for comparisons and the confidence level and critical p-value were set at 95% and 5% respectively.

Results. Fluoride concentrations in water from the study area ranged between 3.4- 6.9 ppm. The prevalence of skeletal fluorosis was 30.3%, out of which, the majority of the subjects had mild skeletal fluorosis (18.4%). This condition was found to be significantly associated with age and gender along with tobacco and alcohol consumption; depending on the habit's duration.

Conclusion. Being a public health problem in the fishermen community, skeletal fluorosis requires *a-priori* attention. Measures for preventing this disease should be undertaken on a communitywide basis.

Key words: *fishing industry, prevalence, fluoride poisoning*

INTRODUCTION

Fluorosis is an important public health problem in 24 countries, including India, which lies in the geographical fluoride belt that extends from Turkey to China and Japan through Iraq, Iran and Afghanistan. Endemic fluorosis is prevalent in India since 1937 [1]. The available data suggest that 15 States in India are endemic for fluorosis (fluoride level in drinking water >1.5 mg/l), five of these have category III (>50% of the districts affected) which includes Gujarat [15]. In Gujarat, 18 districts have high water fluoride content. Kutch coast is one of the affected district of Gujarat [8].

Acute to chronic skeletal fluorosis is a result of exposure to very high fluoride over a prolonged period. Early stages of skeletal fluorosis start with pain in bones and joints, muscle weakness, sporadic pain stiffness of joints and chronic fatigue. During later stages, calcification of the bones takes place, osteoporosis in long bones, and symptoms of osteosclerosis where the bones become denser and develop abnormal crystalline structure. In the advanced stage the bones and joints become completely weak and moving them is difficult. The vertebrae in the spine fuse together and the patient is left crippled which is the final stage. Skeletal fluorosis is usually not recognized until the disease reaches an

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advanced stage [4]. General skeletal fluorosis directly affects the economy of villagers (mostly tribal population) as it causes illness and debilitation not only in humans but, also in their domestic animals, on which they depend for their basic income. Skeletal fluorosis leads to impairment, disability and subsequently makes the affected subject handicap. Therefore, they are unable to get employment or labour for their daily livelihood, lead their life as dependents on others [5].

Kutch is the largest district in India with a total area of 45652 km². Kutch has 400 km coastline that constitutes 1/4 of Gujarat's coastline and 1/20 of India's coastline. The Kutch coast and fishing community are well known in India. Owing to high water fluoride content at Kutch district [8] and high prevalence of dental fluorosis reported among fishermen of Kutch coast [2], the present study was undertaken to assess the prevalence of skeletal fluorosis in fishermen from the Kutch coast, Gujarat, India.

MATERIALS AND METHODS

Study design, population and duration

A descriptive cross-sectional survey was conducted to assess the prevalence of the skeletal fluorosis among fishermen community of Kutch District, Gujarat, India, from October to December 2014.

Informed consent

After explaining the purpose and details of the study, a written informed consent was obtained from all the subjects who were willing to participate.

Inclusion criteria

1. Subjects who were born and brought up at the study area.
2. Subjects more than 15 years of age.
3. Subjects who were willing to participate.

Exclusion criteria

1. Subjects on medications that may influence bone metabolism, any metabolic and inflammatory bone disease.
2. Subjects with any systemic diseases.
3. Sick individuals and individuals with debilitating diseases.

Survey proforma

Survey proforma designed in English was consisting of:

- a. General information: demographic data, tobacco use and alcohol use.
- b. The three diagnostic tests to assess the clinical features of skeletal fluorosis:

- i. Touching the toes without bending the knees;
- ii. Touching the chest with the chin;
- iii. Stretching the arms sideways & folding the arms to touch the back of the head.

Subjects who could perform any of the three tests were taken under "mild" category, those who could perform two tests and the ones who were not able to perform any of the three tests were included in "moderate" or "severe" category of skeletal fluorosis respectively [13,14].

Training and calibration

All the examinations were carried out by a single qualified examiner. Training sessions and calibration of examiner were conducted by the two consultants until an acceptable level of consistency in diagnosis was reached. The intra-examiner reliability were assessed using Kappa statistics, which was found to be 97.7%.

Pilot survey

A pilot study was carried out among 50 fishermen subjects to determine the feasibility and practicability of the study and the time required for examination of each subject. It helped to know the practical difficulties while conducting the survey. It took around 2-3 min to assess each subject. The prevalence of skeletal fluorosis was found to be 38%.

Sample size calculation

Depending on the prevalence of skeletal fluorosis obtained (38%), 95% confidence level and 10% allowable error, the minimum sample size was determined to be 653.

Sampling design

Multistage random sampling was employed to select the study population. Kutch coast is divided into four zones from which one zone (Anjar, Mundra) was randomly selected. From the selected zone, a taluka (Mundra) was randomly selected. From the selected taluka, 2 villages (Bhadreshwar and Luni) were randomly selected. Subjects were randomly selected starting from the reference point.

Determination of water fluoride concentration

Drinking water fluoride concentration in different regions of study area was determined [11].

Clinical examination

The examiner visited the villages on the predetermined dates according to the schedule. The participants were asked to sign a written informed consent form and were asked to perform the three diagnostic tests for skeletal fluorosis.

Table 1. Distribution of study subjects by age and gender

Variables	Number (n)	Percent (%)
Age (Years)		
15-24	19	2.9
25-34	121	18.5
35-44	242	37.1
45-54	245	37.5
55-64	26	3.9
Gender		
Male	382	58.5
Female	271	41.5
Total	653	100

Table 2. Prevalence of skeletal fluorosis by age and gender

Variables	Skeletal fluorosis n (%)				p- value
	None	Mild	Moderate	Severe	
Age (Years)					
15-24 (n=19)	10 (52.6)	6 (31.6)	3 (15.8)	0	0,023*
25-34 (n=121)	95 (78.5)	21 (17.4)	4 (3.3)	1 (0.8)	
35-44 (n=242)	183 (75.6)	38 (15.7)	17 (7)	4 (1.7)	
45-54 (n=245)	156 (63.7)	51 (20.8)	27 (11)	11 (4.5)	
55-64 (n=26)	11 (42.3)	4 (15.4)	8 (30.8)	3 (11.5)	
Gender					
Male (n=382)	252 (65.9)	77 (20.2)	38 (9.9)	15 (3.9)	0.044*
Female (n=271)	203 (74.9)	43 (15.8)	21 (7.7)	4 (1.5)	
Total (n=653)	455 (69.7)	120 (18.4)	59 (9)	19 (2.9)	

Test applied: *Chi* square test, *statistically significant difference at p<0.05.

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2007) and then exported to data editor page of SPSS version 11.5 (SPSS Inc., Chicago, Illinois, USA). *Chi* square test was used for comparisons. Confidence level and p-value were set at 95% and 5% respectively.

RESULTS

The water fluoride concentration in the study area was assessed to be in the range of 3.4- 6.9ppm. Among all, majority of the study participants were in the age range of 35-54 years and were males (58.5%) (Table 1). Prevalence of skeletal fluorosis was observed as 30.3%, out of which, majority of the participants had mild skeletal fluorosis (18.4%). Severe skeletal fluorosis affected very small proportion (2.9%) of participants. Statistically significant (p=0.023) increase in the prevalence of skeletal fluorosis was observed with increase in age.

Table 3. Prevalence of skeletal fluorosis by adverse habits

Variables	Skeletal fluorosis n (%)				Total n (%)	p-value
	None	Mild	Moderate	Severe		
Adverse habits						
None	113 (91.9)	4 (3.3)	4 (3.3)	2 (1.6)	123 (18.8)	0.015*
Tobacco	237 (69.5)	67 (19.6)	30 (8.8)	7 (2.1)	341 (52.2)	
Alcohol	45 (67.2)	10 (14.9)	9 (13.4)	3 (4.5)	67 (10.3)	
Both tobacco and alcohol	60 (49.2)	39 (31.9)	16 (13.1)	7 (5.7)	122 (18.7)	
Duration of adverse habits						
<5 years	196 (88.7)	15 (6.8)	9 (4.1)	1 (0.5)	221 (33.8)	0.03*
5-10 years	174 (75.3)	31 (13.4)	17 (7.4)	9 (3.9)	231 (35.4)	
>10 years	85 (42.3)	74 (36.8)	33 (16.4)	9 (4.5)	201 (30.8)	
Total	455 (69.7)	120 (18.4)	59 (9)	19 (2.9)	653 (100)	

Test applied: *Chi* square test, *statistically significant difference at p<0.05.

More than half of the subjects (57.7%) in the age group of 55-64 years were affected with skeletal fluorosis, out of which majority (30.8%) had moderate skeletal fluorosis. Males exhibited significantly (p=0.044) greater prevalence of mild (20.2%), moderate (9.9%) and severe (3.9%) skeletal fluorosis than females (Mild: 15.8%, Moderate: 7.7%, Severe: 1.5%) (Table 2). When skeletal fluorosis was assessed according to adverse habits and duration of habits, significant associations were observed. Maximum prevalence of skeletal fluorosis was observed among those who had both tobacco and alcohol habits (50.8%). Proportion of subjects with skeletal fluorosis also augmented significantly (p=0.03) with increase in duration of adverse habits (Table 3).

DISCUSSION

The present study aimed to assess the prevalence of skeletal fluorosis among fishermen population in the coastal region of Kutch, Gujarat, India. A total of 653 fishermen participated in the study.

Thorough literature search did not divulge any evidence of skeletal fluorosis among fishermen population. Hence the findings of present study are compared with results of general populations.

Around 30% of present study population suffered from skeletal fluorosis which corresponds to the high water fluoride content of the study area. The prevalence found in the present study was higher than that reported at Southern Rajasthan (22%) [6]. The difference may be attributed to difference in concentration of water fluoride

and difference in eligibility criteria of the subject selected. A study conducted at Wonji Shoa sugar factory in Ethiopia showed the clinical prevalence of skeletal fluorosis in the range of 20.6% to 40.2%. The radiological prevalence in the same population was noted as 70.3% [3].

Significant escalation of skeletal fluorosis with increasing age in the present study corroborates with the previous studies [6, 10, 12]. The significant age difference might be due to the increase in duration of exposure to fluoride with increasing age. Genderwise comparisons of skeletal fluorosis in the present study elicited male preponderance which is in agreement with previous studies [6, 7, 10, 12]. One possible explanation might be that men drink more water than women to compensate for fluid loss during field work. They also drink more wine and tea, both of which can increase fluoride intake.

Association of skeletal fluorosis and adverse habits observed in fishermen in this study confirm the findings of Hussain et al. (2010) [9] among the residents of central Rajasthan. Also significant association was observed with the duration of exposure to tobacco and alcohol. This shows that fluoride sources other than water also contribute to the occurrence of fluorosis.

For the reason that fishermen are exposed to sun over a long period of time and owing to their strenuous nature of work, water consumption tends to be more. Hence, provision of defluoridated drinking water and health education aimed at abating fluorosis are highly desirable among the fishermen community. The present study also significantly expands our knowledge of fluorosis.

CONCLUSIONS

Prevalence of skeletal fluorosis in the fisherman community of Kutch Coast, Gujarat, India was found to be 30.3%. Significant augmentation in the prevalence of skeletal fluorosis was observed with increasing age and presence of adverse habits. Need of the hour is the development of an innovative approach for fluorosis mitigation in this high risk studied group. Promotion of consumption of fluoride water, either defluoridated water or water from alternative low fluoride sources should be emphasized. Significant association of skeletal fluorosis with adverse habits also demands conception of awareness about the fact among the general public. More detailed multicentric studies are warranted in fishermen groups of endemic fluoride areas.

Acknowledgement

The author would like to express his appreciation to King Saud University, Vice Deanship of Research Chairs, Kingdom of Saudi Arabia, Riyadh for funding this research.

Conflict of interest

The author declare no conflict of interest.

REFERENCES

1. *Arlappa N., Qureshi A., Srinivas R.*: Fluorosis in India: an overview. *Int J Res Dev Health* 2013; 1 (2): 97-102.
2. *Asawa K., Pujara P., Tak M., Nagarajappa R., Aapaliya P., Bhanushali N., Mishra P., Sharma A.*: Oral health status of fishermen and non-fishermen community of Kutch district, Gujarat, India: a comparative study. *Int Marit Health* 2014; 65 (1): 1-6.
3. *Assefa G., Shifera G., Melaku Z., Haimanot R.T.*: Clinical and radiological prevalence of skeletal fluorosis among retired employees of Wonji-Shoa sugar estate in Ethiopia. *East Afr Med J* 2004; 81(12): 638-40.
4. *Brindha K., Elango L.*: Fluoride in Groundwater: Causes, Implications and Mitigation Measures. In: Monroy, S.D. (Ed.), *Fluoride Properties, Applications and Environmental Management*, 2011. p. 111-136.
5. *Chauhan D., Chauhan T., Sachdev V., Kirtaniya B.C.*: Prevalence and severity of dental fluorosis among school children in a Northern hilly state of India. *SRM J Res Dent Sci* [serial online] 2012; 3: 170-174.
6. *Choubisa S.L.*: Endemic Fluorosis in Southern Rajasthan, India. *Fluoride* 2001; 34: 61-70.
7. *Dhurvey V., Dhawas S.*: Skeletal Fluorosis In Relation To Drinking Water, Nutritional Status And Living Habits In Rural Areas Of Maharashtra, India. *IOSR Journal of Environmental Science, Toxicology And Food Technology* 2014; 8 (1): 63-7.
8. Ground water scenario of Gujarat. Central Ground Water Board, Ministry of Water Resources, Government of India. Available at: http://cgwb.gov.in/gw_profiles/st_Gujarat.htm
9. *Hussain J., Hussain I., Sharma K.C.*: Fluoride and health hazards: community perception in a fluorotic area of central Rajasthan (India): an arid environment. *Environ Monit Assess* 2010; 162 (1-4): 1-14.
10. *Jolly S.S., Singh B.M., Mathur O.C., Malhotra K.C.*: Epidemiological, clinical, and biochemical study of endemic dental and skeletal fluorosis in Punjab. *Br Med J* 1968; 4: 427-9.
11. *Giljanović J., Prkić A., Bralić M., Brkljača M.*: Determination of fluoride content in drinking water and tea infusions using fluoride ion selective electrode. *Int J Electrochem Sci* 2012; 7: 2918-2927.
12. *Nirgude A.S., Saiprasad G.S., Naik P.R., Mohanty S.*: An Epidemiological Study on Fluorosis in an Urban Slum Area of Nalgonda, Andhra Pradesh, India. *Indian J Public Health* 2010; 54 (4): 194-6.
13. *Susheela A.K.*: Prevention and control of Fluorosis: Skeletal fluorosis- symptoms. 1st ed. New Delhi. National Technology Mission on Drinking Water. 1991, p. 4-6.
14. *Susheela A.K.*: Prevention and control of fluorosis- health aspects, volume – I. Rajiv Gandhi National Drinking Water Mission, New Delhi: Ministry of Rural development, 1994.
15. *Susheela A.K.*: Fluorosis: Indian scienario: A treatise on fluorosis. New Delhi: Fluorosis Research and Rural Development Foundation, 2001.

Received: 20.05.2015

Accepted: 21.09.2015

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ROCZ PANSTW ZAKL HIG VOLUME 66, 2015

Editor-in-Chief wishes to thank all the Reviewers listed below for their invaluable contribution in reviewing the manuscripts submitted for publication in our journal *Roczniki Państwowego Zakładu Higieny* [Annals of the National Institute of Hygiene].

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