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Canned food as a source of bisphenol a (BPA) exposure – estimation of consumption among young women from Gdańsk, Poland

Żywność puszkowana jako źródło ekspozycji na bisfenol A (BPA) – oszacowanie spożycia wśród młodych mieszkanek Gdańska

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ABSTRACT

Introduction: Bisphenol A (BPA) is an organic endocrine disrupting chemical (EDC) that modifies the activity of hormones, leading to adverse health effects. BPA is a stabilizer of polyvinyl chloride – one of the most common synthetic plastic polymers, used in the production of common products, including packaging materials, plastic bottles, toys, and thermal paper; it is also used to synthetize the epoxy resins, a component of food cans. Hence, consumption of canned products – the source of BPA exposure – increases BPA concentration in human body and may increase the risk of several lifestyle diseases and hormonal, metabolic, and fertility disorders.

Objectives: To evaluate the regularity of consumption of canned products among young women living in the city of Gdansk (Poland).

Patients and methods: 277 women filled a food frequency questionnaire to determine consumption of alimentary products which, according to published research, may be contaminated with BPA

Results: Products with high BPA content (>100 ng/g) were consumed at least once a week by 7% of respondents, while these with moderate (10-100 ng/g) and low (<10 ng/g) content of BPA by 33% and 60%, respectively.

Conclusions: Young women regularly consume canned products, mostly with low or moderate BPA content. However, persistent exposure, even at low doses, may trigger adverse health effects. Thus, it is crucial to conduct further research on the effects of this EDC on human health and reconsider tolerable daily intake, if such a safe dose of BPA exposure exists. Simultaneously, it would be advisable to find safer materials for food packaging, free from EDC.

Key words: endocrine disrupting chemicals; food, canned; packaging, food; epidemiological monitoring; women's health

STRESZCZENIE

Wstęp: Bisfenol A (BPA) jest organicznym związkiem endokrynnie czynnym (ang. endocrine disrupting chemical, EDC), który modyfikuje pracę hormonów powadząc do niekorzystnych dla zdrowia skutków. BPA jest substancją stabilizującą chlorek poliwinylu – jednego z najczęściej stosowanych polimerów plastiku, wykorzystywanego w produkcji powszechnie używanych produktów, w tym: opakowań, plastikowych butelek, zabawek, papieru paragonowego; używany jest także w produkcji żywic epoksydowych umieszczanych w puszkach do żywności. Zatem spożywanie produktów puszkowanych, będące źródłem ekspozycji na BPA, zwiększa jego stężenie BPA w organizmie człowieka i może zwiększać ryzyko chorób cywilizacyjnych, a także zaburzeń hormonalnych, metabolicznych oraz płodności.

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Celem pracy było oszacowanie częstości spożycia produktów puszkowanych wśród młodych mieszkanek Gdańska.

Pacjenci i metody: 277 kobiet wypełniło kwestionariusz żywieniowy mający na celu określenie spożycia produktów puszkowanych, które według danych literaturowych mogą być zanieczyszczone BPA.

Wyniki: Produkty o wysokim stężeniu BPA (>100 ng/g) były konsumowane co najmniej raz w tygodniu przez 7% respodentów, podczas gdy te o umiarkowanym (10–100 ng/g) oraz niskim stężeniu (<10 ng/g), były spożywane z tą samą częstością przez odpowiednio 33% oraz 60%.

Wnioski: Młode kobiety regularnie spożywają produkty puszkowane, głównie o niskim oraz umiarkowanym stężeniu BPA. Jednakże, długotrwała ekspozycja, nawet na niewielkie dawki, może wywoływać niekorzystne dla zdrowia skutki. Kluczowym jest przeprowadzenie dalszych badań celem określenia efektów ekspozycji człowieka na ten związek oraz ponowne rozważenie tolerowanego dziennego spożycia oraz tego czy istnieje bezpieczna dawka narażenia na BPA. Jednocześnie wskazane jest znalezienie materiałów do opakowań produktów spożywczych, które będą pozbawione EDC.

Słowa kluczowe: związki endokrynnie czynne; żywność puszkowana; opakowania żywności; monitoring epidemiologiczny; zdrowie kobiet

INTRODUCTION

Bisphenol A (BPA) is an organic compound that belongs to endocrine disrupting chemicals (EDCs), substances altering functions of the endocrine system, leading to adverse health effects, both in the organism and its progeny [1]. Phenolic structure of BPA allows interaction with hormone receptors; despite the fact that it is primarily estrogenic, BPA may interact not only with estrogen receptors (ER) but also androgen, thyroid hormone, and glucocorticoid receptors [2]. As a consequence, BPA exposure may contribute to the onset of cancer, obesity, insulin resistance and type 2 diabetes (T2DM), cardiovascular disease (CVD), and other metabolic as well as fertility disorders [3–6].

Human exposure to BPA occurs through a variety of routes. BPA is added to polyvinyl chloride (PVC), one of the most common synthetic plastic polymers, in order to create softer, flexible plastics used worldwide for water pipes, vinyl flooring, wrapping film, packaging materials, plastic bottles, toys, dental materials, thermal paper, and electronic or medical devices [7, 8]. BPA exposure also occurs through diet, as it is present not only in plastic food packaging but also in a variety of canned products where, as a component of PVC and epoxy resins, it is used as the inner layer of food cans [9-11]. And though both the migration of BPA and its concentration in food depend on a number of factors, such as the acidity of each product, fat/oil content, the duration of storage, and the treatment at higher temperature or pressure, resulting in reshaping of cans, human exposure to BPA is inevitable [12, 13].

Exposure to canned products significantly increases serum and urine BPA concentrations [14, 15], and its levels correlate with several lifestyle diseases, cancer, and metabolic or hormonal disturbances [16–19]. Therefore, the aim of the present study was to assess the exposure to BPA from canned products among young women in Gdańsk.

PATIENTS AND METHODS

We conducted a survey to estimate BPA exposure in 277 young women aged 19–25 years, using a food frequency questionnaire to determine consumption of alimentary products which, according to published research, may be contaminated with BPA. Participants completed the questionnaires in the presence of the researcher, choosing one of the following responses: never or less than once a month, 2–3 times a month, once a week, 2–4 times a week, 5–6 times a week, once a day, and more than once a day; with food products (Table I) further divided into three groups according to the estimated BPA content: low (<10 ng/g), moderate (10–100 ng/g), and high (>100 ng/g)

RESULTS

Products containing high BPA concentrations (e.g. beans, canned tuna, and herring), were consumed once a week or more by 7% of the respondents, several times a month by 13% of those questioned, and once a month or less by 32% of the participants. Among the products containing moderate BPA concentrations, corn and canned meat products were the most frequent and consumed at least once a week by 33% of the respondents. Forty six percent of the respondents consumed these products 2–3 times a month, while 27% once a month or less. Products with low BPA content were consumed several times a week by 60% of the respondents.

Table I. Estimated BPA content in food products according to the literature [20, 21]
Tabela I. Szacunkowa zawartość BPA w produktach żywnościowych na podstawie danych literaturowych [20, 21]

	Canned food product	BPA concentration (ng/g)
Low BPA content (<10 ng/g)	Non-alcoholic beverages	0.57
	Carton juices	0.7
	Non-canned fish	7.4
	Non-canned meat/meat products	9.4
Moderate BPA content (10-100 ng/g)	Fruits (i.e. peach, pineapple)	13.4
	Pâté	14.7
	Condensed milk	15.2
	Coconut milk	21.7
	Tomato and tomato sauces	23.5
	Composite food (soups, dishes)	25.9
	Tuna in oil	32.8
	Seafood	37
	Corn	50.9-145.4
	Luncheon meat	51.1
	Peas	69-145.4
High BPA content (>100 ng/g)	Natural tuna	102.2-550.5
	Beans	103
	Fish (i.e. herrings, sprats)	125.3

DISCUSSION

EDCs are believed to play a role in the pathogenesis of obesity and its complications, such as T2DM and CVD. Due to its ability to interact with the ER, BPA, one of the most common EDCs, is considered to be a weak environmental estrogen, and as such, it may also play a role in the pathogenesis of infertility and hormone-dependent cancer [22].

In our study, products with high BPA content were consumed rarely, with only 7% of the respondents consuming these products more than once a week. However, products with moderate and low BPA content were consumed several times a week by 33% and 60% of the respondents, respectively. To our knowledge, no similar studies have yet been conducted in Poland. The Can Manufacturers Institute (CMI) has reported that canned fruits are consumed by 25% while canned vegetables by 31% of United States citizens at least once a week. Additionally, data from the CMI show that individuals who received food assistance in the Supplemental Nutrition Assistance and in the Women, Infant and Children Programs consume an even higher amount of canned products than those who did not participate in the assistance programs [23]. Bemrah et al. have demonstrated that in France canned foods consumption contributes to 50% of dietary BPA exposure, along with products of animal origin, possibly contaminated by this EDC, i.e. from food packaging [24]. National Health and Nutrition Examination Survey (NHANES) researchers used a 24-hour dietary record, in which 9% of the 7669 participants reported the consumption of one canned food and 2% of two or more canned foods in 24 hours prior to the study. Additionally, they have proved that consumption of canned foods is associated with higher levels of urinary BPA concentrations when compared to consumption of other types of products (uncanned) [15].

Numerous studies have confirmed detectable levels of BPA both in food contact materials (FCMs) and food products [25–27], and Sungur et al. have demonstrated that BPA concentration in food depends on the type of packaging; in canned products, it ranged from 21.9 ng/g to 1858.7 ng/g; for foodstuffs stored in glass, from undetectable up to 399.2 ng/g; and for foods stored in cartons, it varied from 36.5 ng/g to 554.7 ng/g of BPA [21].

The French Agency for Food, Environmental and Occupational Health Safety set a dose of 0.08 µg/kg bw/d of BPA as the toxic maternal exposure value associated with a change in the structure of the mammary gland in progeny [24]. It is far lower than the recently reduced value of tolerable daily intake that European Food Safety Authority set temporarily at 4 µg/kg bw/d. According to the recent statement of the World Health Organization (WHO) as well as global medical and scientific societies, reducing the exposure to EDCs, including BPA, is crucial for human health [28–30].

CONCLUSIONS

Young women regularly consume canned products containing low to moderate concentrations of BPA. In view of the recent reports on the negative impact of low doses of BPA on human body and its synergistic action with other EDCs, it is crucial to conduct further research on the effects of BPA on human health and to find other, safer and more economical forms of food storage.

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