

original article

Preliminary estimation of infantile exposure to BPA based on the standard quality of baby bottles distributed in Isfahan urban society

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ABSTRACT

Aims: This study was aimed to estimate the bisphenol A (BPA) intake from baby bottles, considering the diversity and the standard quality of the baby bottles distributed in an Isfahan urban society.

Materials and Methods: A cross-sectional study was performed in Isfahan in 2011. Baby shops ($n = 33$) and drug stores ($n = 7$) in four district areas were included in the study. The distribution of baby bottles was investigated regarding their brand, origin, and being labeled “BPA free.” Estimation of exposure to BPA from baby bottles was made based on the national and international representative data.

Results: The products marked as “BPA free” were found among the western products and limited to two of the selected areas. No “BPA free” marked baby bottle was distinguished among the Iranian made products. Of the 8% exclusively formula-fed infants, 90% may be the high consumers of BPA from polycarbonate baby bottles, with an intake of 1.5-2 $\mu\text{g}/\text{kg}$ b.w./day for the moderate and 7.5-10 $\mu\text{g}/\text{kg}$ b.w./day in case of worse condition.

Conclusion: Considering the current globally accepted threshold daily intake (TDI) for BPA, primary exposure estimation is that feeding using non-BPA-free baby bottles is not a serious health concern in Iran. Thought that threshold level of TDI is discussed to be reduced in future, improvement and revision of the national standards can be effective in reducing the exposure to BPA in Iranian infants so as to provide large margin of safety for them.

Key words: Bisphenol A, Iran, polymer baby bottle

INTRODUCTION

Bisphenol A (BPA), 2,2 bis (4-hydroxyphenyl) propane, is a chemical substance used in the production of polycarbonate plastics.^[1-7] One of the most common uses of these types of plastics is in baby feeding bottles.^[8] Owing to high transparency, light weight, high heat resistance, and shock absorbance, this type of plastic bottles have been substituted for the glass ones, which results in infantile exposure to BPA from this kind of food contact material instead.^[8-10]

Access this article online	
Quick Response Code: 	Website: www.ijehe.org
	DOI: 10.4103/2277-9183.113211

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This article may be cited as:

Moghadam ZA, Pourzamani H, Malekpour A, Mirlohi M, Amininoor Z. Preliminary estimation of infantile exposure to BPA based on the standard quality of baby bottles distributed in Isfahan urban society. *Int J Env Health Eng* 2013;2:23.

According to the previous studies, the molecules of BPA in plastic bottles can migrate into bottle content,^[11,12] while toxicological studies have indicated the important and risky aspects of BPA oral intake. Of the most cited aspects are estrogenic effects,^[13-18] increasing prostate and breast cancer risk, genital disturbance in male neonates, decreasing the quality of sperm in men, premature puberty in girls, metabolic disorders like resistance to insulin, and finally, behavioral problems like hyperactivity.^[11,12,19,20] The vast usage of BPA in polycarbonate plastic production is now one of the challenges faced by the producers of baby bottles regarding the infant's safety. According to the studies, formula-fed infants up to 6 months are the most exposed group to BPA molecules.^[21] They are also known to be highly vulnerable to BPA side effects.^[11,12,22] Today, some safety and consumer protection agencies ban any use of BPA in baby utensil production. Canada was the first to place the BPA in the list of food intoxicants for human,^[23] followed by the European Union.^[24] As a result, the "BPA free" labeled baby bottles are encouraged to be purchased by the safety authority of such countries to cut the intake of BPA. Estimation of exposure to hazardous substances such as BPA can be made based on the national administrative data in every community. But before that, evaluation of the standard quality of distributed baby bottles provides a better insight into what extent formula-fed infants are exposed to BPA through this way. No study has been conducted on this issue in Iran yet. This study firstly aimed at assessing the standard quality of the distributed baby bottles being or not being labeled "BPA free" in Isfahan city of Iran. In this regard, the factors influencing the diversity of the presented baby bottles, such as the sellers' knowledge, the customers' demands for BPA-free bottles, and the sales ratio of products were taken into consideration. Secondly, making a primary estimation of infantile exposure to BPA was aimed in the community, considering the obtained view of familiarity with BPA concept and the prevalence of BPA-free products in the investigated area.

MATERIALS AND METHODS

This study was a cross-sectional study carried out from 1 July 2011 to 20 September 2011. Seven drug stores and 33 baby stores in the four districts of the city were included in the study. Among the districts under investigation, three of them are the main centers of baby stores, each about 1 km² in width. The remaining district was randomly selected from the city, with a latitude double of the other three districts. Because baby shops are seldom found in this area, drug stores were selected to be checked. The distribution of the baby stores in the areas under investigation is as follows: district (1) 6 drug stores; district (2) 8 baby stores; district (3) 11 baby stores; and district (4) 15 baby stores.

A checklist including 10 questions was provided, which were completed through observation and interviews. The 10 question choices are presented in Table 1. The analysis of

the findings was done through SPSS^[16] software. Descriptive analysis was used to explain the results, and cross-tabulation analysis was used to identify the interrelation between the multivariate and the investigated districts. *P* values < 0.05 were considered significant. European Food Safety Authority (EFSA), World Health Organization (WHO), and Scientific Committee on Food (SCF) databases were searched for the representative data used in deterministic exposure to BPA for infants less than 1 year; also, the official website of Ministry of Health in Iran as well as other related Iranian databases were searched for the national administrative information.

RESULTS

All the 40 sellers of the selected stores participated in the study. The results showed that polymer baby bottles were sold in all the selected stores (100%), of which 15% offered BPA-free baby bottles. There were more than 20 brands of baby bottles on sale in the city of Isfahan, with unequal distribution of the baby bottles labeled "BPA free"; they were found only in two districts (1 and 3) among the four under investigation. The other two districts (2 and 4), which are the most crowded centers of baby stores, did not carry this type of bottles [Figure 1]. All the studied stores presented Asian products for sale; however, in the majority of them (76.9%), Iranian products were dominant [Table 2]. Neither the Iranian made products nor the Asian made ones were labeled "BPA free." Among the American and European brands of baby bottles, three brands including "Nuk, Nuby, and Novatex" carried the "BPA free" label on the baby bottles; the stores presenting these products covered 15.0% of the study area.

All of the interviewed sellers admitted that they were selling more polymer baby bottles than those of glass types; 20% was not sure about the exact quantity, but 80% of the sellers confirmed a sales ratio of 10. All of them considered the polymer bottles to be the bestsellers compared to the glass type bottles.

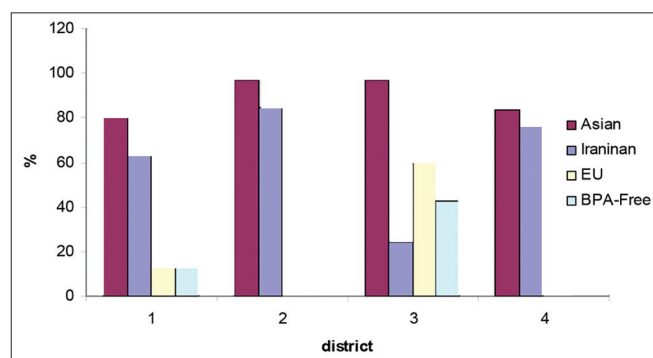


Figure 1: the percentage frequency distribution of different types of polymeric baby bottles regarding their origin and being labeled as "bpa free" in each investigated district

Table 1: The check list used in evaluating the prevalence of polymer baby bottles in baby stores and drug stores and to determine the knowledge of sellers on BPA-free polymer baby bottles in the four districts of Isfahan

A check list to become aware of the polymer baby bottles' distribution in domestic market

Store name District

The questions choice:

- Is any polymer baby bottle sold in this store?
- Is there any polymer baby bottle labeled "BPA free" among the products for sale in this store?
- What is the brand of polymer baby bottles on sale?
- Where are the offered polymer baby bottles made?
- What is the sales ratio of polymer baby bottles to those of glass in this store?
- Is the seller familiar with the BPA-free containing utensil?
- Is the seller aware of hazardous effect of BPA on human health?
- Where did the sellers get their information on BPA or BPA-free products?
- Was any action taken by the safety authority to inform the sellers on the standard quality of polymer baby bottles on sale?
- Is there any demand for BPA-free bottles from the consumers?

Table 2: The percentage frequency distribution of baby bottles with respect to their brand, country of origin, and "BPA free" marking in total investigated zone, city of Isfahan

Marked as BPA free	Frequency (%)	Distributed brand	Origin
-	48.7	Camero	Iranian
-	23.1	Panberes	
-	17.9	My baby	
-	35.1	Camera	Asian
-	25.6	Wee	
-	15.4	Chicco	
-	10.3	Potato	
-	10.3	Disney	
+ / -		Nuk	European-American
+	Total 15.4	Nuby	
+		Novatex	

The symbol of (-) shows that among the products of the given brand, there was no bottle marked BPA free; (+) shows that all the distributed polymer bottles of the given brand were marked BPA free and (+/-) shows that BPA free marked samples could be found among the products of the given brand

In addition, the inquiries indicated that only the sellers and employees who are dealing with BPA-free bottles in their trade were familiar with this type of product (15.0%) and there was no external official source of information in this regard. Interestingly, even those who sold BPA-free bottles were not aware of BPA human health concern. As BPA is a very common additive in polycarbonate made baby bottles, the results obtained in this study could have been an index of high exposure to BPA. For the estimation of exposure to chemical substances like BPA, it is possible to consider a worst case scenario. There is a vast variation among the results of BPA migration studies; migration levels of less than 1–25 µg/kg were reported in different studies. Thus, the safety organizations usually consider two concentrations of 10 and 50 µg/kg as the typical and the conservative value for deterministic exposure estimation, respectively.^[8,25] We found

just one study in the literature that reported on the mean weight of exclusively formula-fed Iranian infants, in which 3.95 kg and 7.06 kg were reported as the mean weights of infants having 1 month and 6 months of age respectively.^[26] Considering a daily consumption of 790–1400 ml milk for the given infant age groups, our estimation of exposure to BPA would be 1.5–2 µg/kg b.w./day for the typical baby bottles and 7.5–10 µg/kg b.w./day in the case of worse condition; both are well below the currently accepted threshold daily intake (TDI) (50 µg/kg b.w./day) for BPA. Two independent studies reported on the exclusive formula-fed rate of 8–8.5% in Iran,^[26,27] according to the results of the present study at least 9 out of 10 babies from the mentioned population (about 8% of the total population of infants) may be exposed to the estimated level of BPA through baby bottles.

DISCUSSION

Based on the national program of toxicology in the US, formula-fed infants and babies, feeding through baby bottles, are the most exposed age group to BPA. The concern is more about the delay in growth and other health problems related to their future life.^[28] In the US, the exposure to BPA in infants less than 6 months and in babies from 6 months to 1 year of age is estimated to be 1–24 and 1.65–13 µg/kg/day, respectively. According to the SCF, formula-fed infants less than 4 months of age are receiving 1.6 µg/kg/day BPA through baby bottles.^[25] Considering a migrated level of 11 µg/kg BPA concentration as the typical value, WHO has stated that girls are exposed to 1.2–2.7 µg/kg b.w./day and boys are exposed to 1.1–2.6 µg/kg b.w./day. Also, EFSA proposed a conservative estimate of total intake of 11 µg/kg b.w./day based on the upper value of 50 µg/l migrated level of BPA in infant formula. As it was found in the present study, all the representative estimated data are less than the indicated TDI for BPA.^[29,30] Note that recently, a new, reduced level of TDI of about 0.01 µg/kg/day for BPA has been proposed by some safety agencies.^[8,31] Although there is not global agreement on this new threshold limit, regulations to cut the infants' exposure have been sped up in recent years in many countries. Studies showed that the rapid increase in the demand of BPA-free products in the public has played a particular role in the expansion of this market, rather than the regulations. Such demand was shown to be the consequence of increase in public knowledge about polycarbonate baby bottles. On the other hand, fears from BPA have encouraged mothers to sustain on breast feeding. In Iran, the rate of breast feeding up to 4 and 6 months was 56.8% and 27.9%, respectively, in 2005. Unfortunately, the rate decreased from 47 to 23% from 1993 to 2005, according to the Ministry of Health report.^[32,33] We focused on the exclusively formula-fed infants in our estimation (8%) because they are the high consumers of BPA from baby bottles; also, the sales ratio of 10/1 for polymer/glass type baby bottles, which was obtained in the primary evaluation, was considered. However, distribution of BPA-free bottles was not included in our estimation

because we found that the general public does not have access to them. Unequivocal distribution and their higher price make it difficult for people to buy even they are aware of their higher standards. Therefore, the current state of their presentation is more likely to be intended as the brand new, luxury commodity than the safe and healthier products.

Although it was not included in the question choices, some distributors explained the reason for higher market demands of polycarbonate bottles than those of glass type. They believed that its low price, light weight, and shock absorbance are the main reasons for high sales of the polymer baby bottles. Normally, all baby bottles made from polycarbonate have BPA as one the constructed monomers or as an additive. In the present study, the products with “BPA free” label on them were considered as being BPA free. It was due to the fact that there is sufficient evidence that “BPA free” marked baby bottles have been made of polysulfane, polystyrene, or polypropylene, and do not have BPA in their structure.^[9] The other type of BPA-free baby bottles are the polycarbonate made bottles which have tritan instead of BPA as an additive. Tritan was shown to be much safer than BPA.^[34] Producers of BPA-free containers are widely inspected by the safety authorities; however, in a recent study carried out by Health Canada, very low levels of BPA were detected from two brands. Such presence was believed to pose no health concern and could be due to cross contamination during the process.^[35] In another study, different kinds of polymeric baby bottles were tested for migration of the chemical substance with estrogen disruption characteristics. All the tested bottles including BPA-free products were positive in the test.^[36] Despite such doubt raising information, most of the world’s safety organizations ensure that non-polycarbonate bottles and “BPA free” labeled bottles reasonably provide larger margin of safety and are better to use for infants.^[35]

Iran national standard for baby bottles registered with No. 2469 is titled as “the features and the methods of testing polycarbonate baby bottles.” It was published in 1997, and up to this time has gone under review only once. At the moment, in the national standards for baby bottles, BPA-free products are not defined. Also, BPA detection regulation and its measuring method are not considered based on the findings of this research. It sounds important to consider the educational programs on this issue for public and the involved parties in particular.

Regarding the published data on the exclusively formula-fed Iranian infants and the current TDI for BPA, primary exposure estimation is that feeding through baby bottles dose not imply serious health concern in Iran even in the worst condition. However, more detailed exposure assessment in future can provide a better view of the relevant risk. The wide distribution of the Iranian baby bottles in comparison with that of the European–American made in the market was revealed in the present study. Substitution of nationally produced BPA-free products for the traditional ones can

protect Iranian infants from facing extra BPA. So, it is necessary to update the Iranian national standards regarding the production of BPA-free baby bottles. In addition, the publicity of the BPA issue must be considered in the society by conducting educational and informative programs.

ACKNOWLEDGMENTS

This research was conducted as a part of Ms. Zohreh Abdi Moghadam Ms dissertation on the risk assessment of BPA intake through baby bottles in Iran, which was approved by food security research center in Isfahan University of Medical Science.

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Source of Support: Isfahan University of Medical Sciences, **Conflict of Interest:** None declared.