Determination of Human Exposure Sources for BPA by Using Questionnaire Survey

Jiyeon Yang[1], Bora Wi[1], Yongjin Lee[1], Geonwoo Lee[1], Sunha Jee[2], Yunseok Kang[3], Youngwook Lim[1,*]

[1] The Institute for Environmental Research, Yonsei University College of Medicine, Seodaemun-gu, Seoul, Korea
[2] Department of Epidemiology and Health Promotion, Yonsei University College of Medicine, Seodaemun-gu, Seoul, Korea
[3] Department of test and evaluation, Lab Frontier Co., Ltd, Anyang-si, Gyeonggi-do, Korea

Introduction

BPA (Bisphenol A) is a widely used chemical in many types of products that affect body conditions such as weight gain, insulin resistance, thyroid dysfunction and endocrine disorders. In fact, it was found that more than 93% of BPA was detected from adult urine in USA.

According to EFSA(2006), the main source of BPA was from canned beverage and wine in adults. Moreover, Brede etc (2003) found food migration of bisphenol A from polycarbonate containers. The study showed that the mean bisphenol A level ranged from 0.23 to 6.7㎍/ℓ and increased migration levels of bisphenol A from polycarbonate bottles after dishwashing, boiling and brushing.

According to various studies regarding the possibility of BAP elution from Food contact containers, European Union (EU) strengthened the migration limit of BPA from 0.6 mg/kg to 0.05 mg/kg in food contact materials and articles under Draft Regulation to amend Regulation (EC) 10/2011.

Thus, in this study, we analyzed how BPA is exposed to people through using questionnaire responses and urinary samples. Through the result of BPA exposure scenario, we also assessed its influence factors in health.

Materials and methods

1) Study subjects and analysis of BPA

This study is based on the data obtained from "Integrated Risk Assessment Study Endocrine Disruptors (2015-2016)" on Ministry of Food and Drug Safety in Korea to analyze detailed BPA exposure through urinary BPA. The study participants were 250 adults (140 adults in 2015 and 110 adults in 2016) ranging from the ages of 23 to 65, who had a check-up in Korea Medical Institute (KMI). All participants also completed the questionnaire related BPA exposure factors in life. (Table 1)

Urinary BPA was analyzed by GC/MS in 2015 and LC/MS-MS in 2016 from Lab Frontier Co., Ltd. The analysis methods of 2015's and 2016's were different because LC/MS-MS in 2016 could detect lower concentration than GC/MS in 2015; the detection range were improved 10-fold from 0.5 ug/L to 0.05 ug/L. Also, the level of BPA in urinary was examined along with Creatinine correction.

2) Collection of dietary and living behavior data

The questionnaire survey tool was developed in order to evaluate BPA exposure and to investigate the exposure environment and factors of the subjects. The questionnaire was grouped by the pollution sources due to the diverstity of BPA usage which caused extreme air pollution.

Questionnaire items were consisted of subject's general information such as residence form and period, ventilation in the house, remodeling, use of household(fragrances, water purifiers, plastic container), smoking and drinking alcohol, etc. In addition, it was also studied that the effects of eating patterns such as frequency of intake, purchasing containers, storage containers and the way of cooking for specific foods. (Figure 1)

3) Statistical analysis

Statistical analysis was performed using IBM SPSS(version 20) and SAS(version 9.4). IBM SPSS(version 20) was used to investigate the correlation between urinary BPA and its influencing factors. Questions Related to the frequency of questionnaire items were analyzed by correlation analysis with Scatter plot. Also, Multiple regression analysis were performed to determine the influencing factors for urinary BPA by SAS(version 9.4).

Results and discussion

1) Correlation analysis

Questions Corresponding to strong positive correlation were consisted of product's use and intake frequency such as frying pan, air freshener and food (Tea, Honey or Syrup, soymilk, milk, raw vegetables, canned vegetables, beverages, alcoholic beverages, meat (pig, chicken), fish, peeled fruit, coffee, instant rice, instant food (disposable packaging or plastic bags)).

In addition, Questions Corresponding to weak positive correlation were consisted of Second-hand smoke frequency (outdoor space), working hours, frequency of eating out, use frequency of makeup products and manicure, number of processed food purchases and intake frequency (Tea, Honey or Syrup, soymilk, milk, raw vegetables, canned vegetables, beverages, alcoholic beverages, meat (pig, chicken), fish, peeled fruit, coffee, instant rice, instant food (disposable packaging or plastic bags)).

2) Multiple regression analysis

As the result of Multiple regression analysis, The variables of the model are shown in Table 2. The significance of the regression model as a whole is 0.0194, which is statistically significant because Pr> F is smaller than 0.05. Also, The adjusted R-squared for this model is 22.28%. (Table. 2)

Based on the correlation analysis and multiple regression analysis, this study indicated that Bisphenol A exposure may be contributed to lifestyle and dietary behavior. In the future research, we can determine the more definite variables associated BPA exposure through urinary BPA and blood BPA comparison.

Acknowledgements

This research was supported by a grant 15162MFDS631 from Ministry of Food and Drug Safety in 2016.

References

Shankar A, Teppala S. Urinary bisphenol A and hypertension in a multiethnic sample of US adults. J Environ Public Health. 2012;2012:481641. Epub 2012 Jan 27.

Brede C. Increased migration levels of bisphenol A from polycarbonate baby bottles after dishwashing, boiling and brushing. Food Addit Contam. 2003 Jul;20(7):684-9.

Wolfgang Dekant a, Wolfgang Völkel. Human exposure to bisphenol A by biomonitoring: Methods, results and assessment of environmental exposures, Toxicology and Applied Pharmacology 228 (2008) 114–134.

Chunyang Liao. Determination of Free and Conjugated Forms of Bisphenol A in Human Urine and Serum by Liquid Chromatography-Tandem Mass Spectrometry. American Chemical Society, April 10 2012. 5003-5009.

Table 1. Characteristics of "Integrated Risk Assessment Study Endocrine Disruptors (2015-2016)"

Classification	Target item
Study period	In 2015 and 2016
Study population	250 adults (140 adults in 2015 and 110 adults in 2016)
Participant age	Range from the ages of 23 to 65
Measurement of bisphenol A	Biomarker(urine), Questionnaire

Table 2. Multiple regression analysis between questionnaire responses and urinary BPA by SAS(version 9.4)

Parameter Estimates					
Variable	**DF**	**Parameter Estimate**	**Standard Error**	**t Value**	**Pr > |t|**
Intercept	1	-14.70	6.34	-2.32	0.02
Use frequency of insecticide	1	0.003	0.04	0.09	0.93
Regular exercise	1	-2.04	1.43	-1.43	0.16
Drinking alcohol	1	0.89	1.34	0.66	0.51
Use frequency of frying pan	1	0.15	0.07	2.06	0.04
Purchasing containers of fruit juice	1	0.45	0.46	0.97	0.34
Purchasing containers of coffee	1	0.19	0.38	0.5	0.62
Storage containers of coffee	1	0.51	0.40	1.28	0.21
Intake frequency of instant rice	1	0.15	0.10	1.56	0.13
Purchasing containers of instant rice	1	0.59	0.55	1.08	0.28
Intake frequency of cup noodles	1	0.26	0.15	1.74	0.09
The way of cooking instant food (pizza, hamburger)	1	0.94	0.69	1.35	0.18
Intake frequency of instant food (disposable packaging or plastic bags)	1	0.13	0.25	0.54	0.59
The way of cooking instant food (disposable packaging or plastic bags)	1	1.43	0.83	1.71	0.09
Use frequency of makeup products	1	0.06	0.035	1.33	0.19

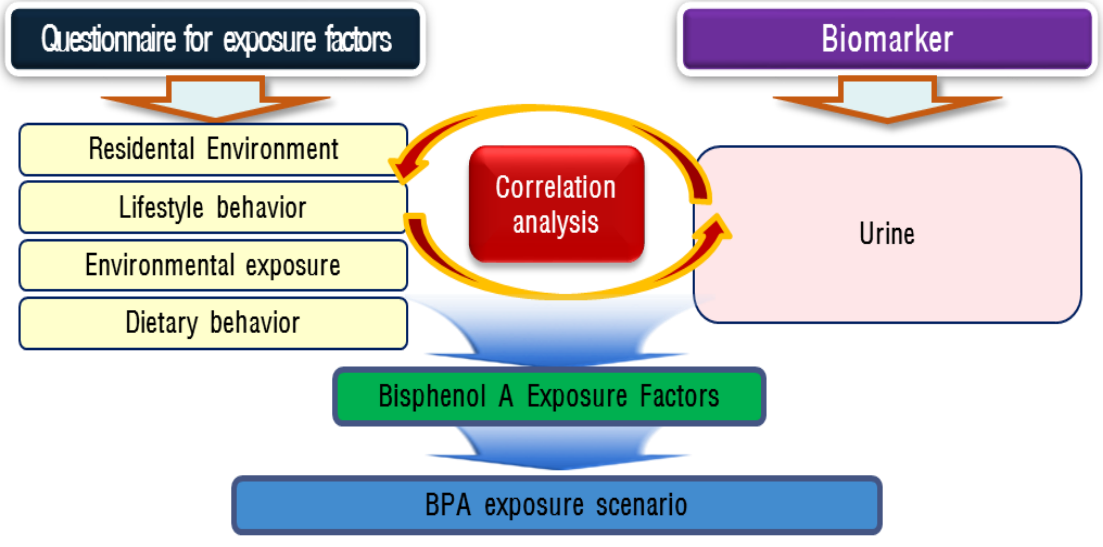

Figure 1. "The Study of Bisphenol A Exposure Factors by Using Questionnaire Responses" framework