

# Health Risk Assessment Associated With Bisphenol A (A Case Study of Qatar)

## Abstract

This study aimed to evaluate exposure to bisphenol A in drinkable water. Much study has not been conducted on Bisphenol A in the drinkable water globally, Arabia gulf particularly in Qatar. This assessment studies the probable risks associated with exposure of children as well as adults to bisphenol A in drinkable water around Doha. The risk assessment was conducted based on the water analyses collected over the two seasons (winter and summer) as well as most recent bisphenol A toxicity data published (US EPA) Environmental Protection Agency, USA. It was found that the concentration levels of bisphenol A (0.0002205mg/kg b.w./day, 0.0001515mg/kg b.w./day) in both seasons fell below acceptable levels (0.05mg/kg b.w./day). Statistical analysis established that there is no variation in the concentration levels during summer and winter. The calculated health risk assessment which were hazard quotient or hazard ratio and hazard index were less than one (summer  $6.18E-02 < 1$ , winter  $4.24E-02 < 1$ ). Hence, non-carcinogenic health risk were found to be within the safety limit for bisphenol. **Keywords:** Bisphenol, risk, dose, hazard.

## Introduction

More than 800,000 substances precisely chemicals with various properties are in use all across the globe and nearly 1000 - 2000 newly produced chemicals enter the market annually, but unfortunately Environmental Protection or Management Agencies(EPA) fail to take regular routine check to assess the associated risks and safety common with the existing or newly introduced chemicals. Bisphenol A (BPA) has been categorized among the large group of organic contaminant that are just emerging lately. It is partially hydroxylated hydrophobic ring carbon attached with methyl functional groups as well as one or more functional groups with hydrophilic properties which enhances its solubility when in contact with water. BPA consider to be of great threat to the environment recently established from numerous studies. BPA leaches often from the baby bottles made from polycarbonate (Vandenberg et al. 2007a) as well as reusable bottles used in water bottling factories as well as reusable bottles used in water bottling factories (Le et al. 2008). BPA was suspected to be hazardous to human, worries concerning the utilization of BPA in most consumable products and goods. BPA exposure has been linked to cancer, liver disease, oncological diseases, diabetes, obesity, dermatitis, irritation of mucous membranes of the eyes.

## Objectives

1. To identify possible source of BPA in drinkable water.
2. To conduct health risk assessment of BPA in drinkable water through ingestion route

## Methodology-

### Methods 1 - Does – Response

#### Animals

Male and female DBA/1J mice, 8 – 9 weeks of age, were used in the experiments.

#### Administration of BPA

Varying doses (3, 30, 300, and 3000  $\mu\text{g kg}^{-1}$ ) of BPA (Sigma) were given orally for 20 days.

### Method 2 - Sampling and sample preparation

Samples of drinkable water were collected around Doha , and out of the total samples collected, only nine samples with their replicates were used for this study. Adequate chemical analyzed was assumed to have been carried out to determine their respective concentrations as shown in the table (supplementary)

### Method 3 - Potential health risk assessment model

$$\text{ADD} = \left( C \text{ (mg/mL)} * \text{IR} \text{ (mL/kg-day)} * \text{EF} \text{ (days/year)} * \text{ED} \text{ (years)} \right) / \text{AT} \text{ (days)}$$

### Risk characterization

The non-carcinogenic health risk whenever applicable to any human being exposure is a way of expressing the toxicity level of a pollutant bisphenol A in water, is a dimensionless quantity known as hazard quotient (HQ). The risk of exposure to BPA is determined from the equation:

$$\text{HQ} = \frac{\text{ADD}}{\text{RfD}} \quad \text{HI} = \sum_{i=1}^n \text{HI} = \sum_{i=1}^n \frac{\text{ADD}_i}{\text{RfD}_i}$$

## Dose – Response Models Proast Software

### Exponential and Hill Models

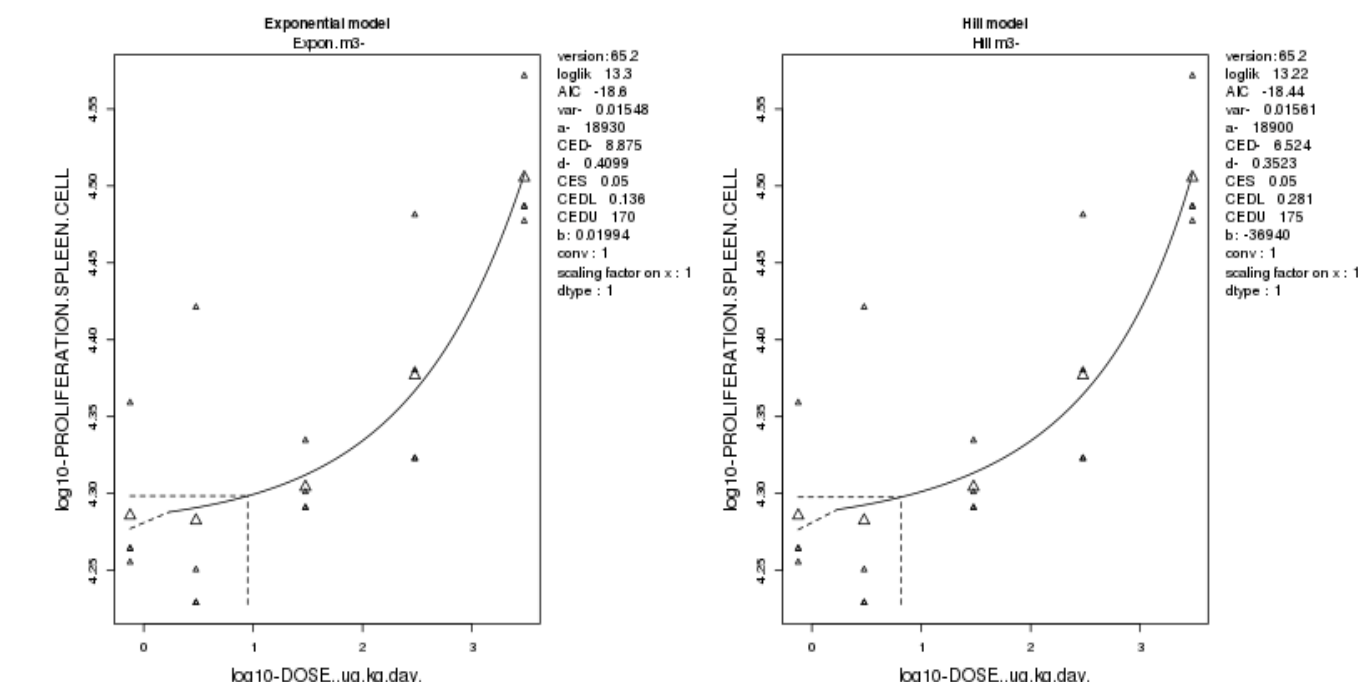
model	converged	loglik	npar	AIC
full	1	13.52	6	-15.04
null-	1	0.99	2	2.02
Expon. m3-	1	13.30	4	-18.60
Expon. m5-	1	13.50	5	-17.00
Hill m3-	1	13.22	4	-18.44
Hill m5-	1	13.50	5	-17.00

The chosen Exponential model was Expon. m3-  
The chosen Hill model was Hill m3-

### BMD confidence interval

Lowest BMDL	Highest BMDU
0.136	175

### Fitted Models

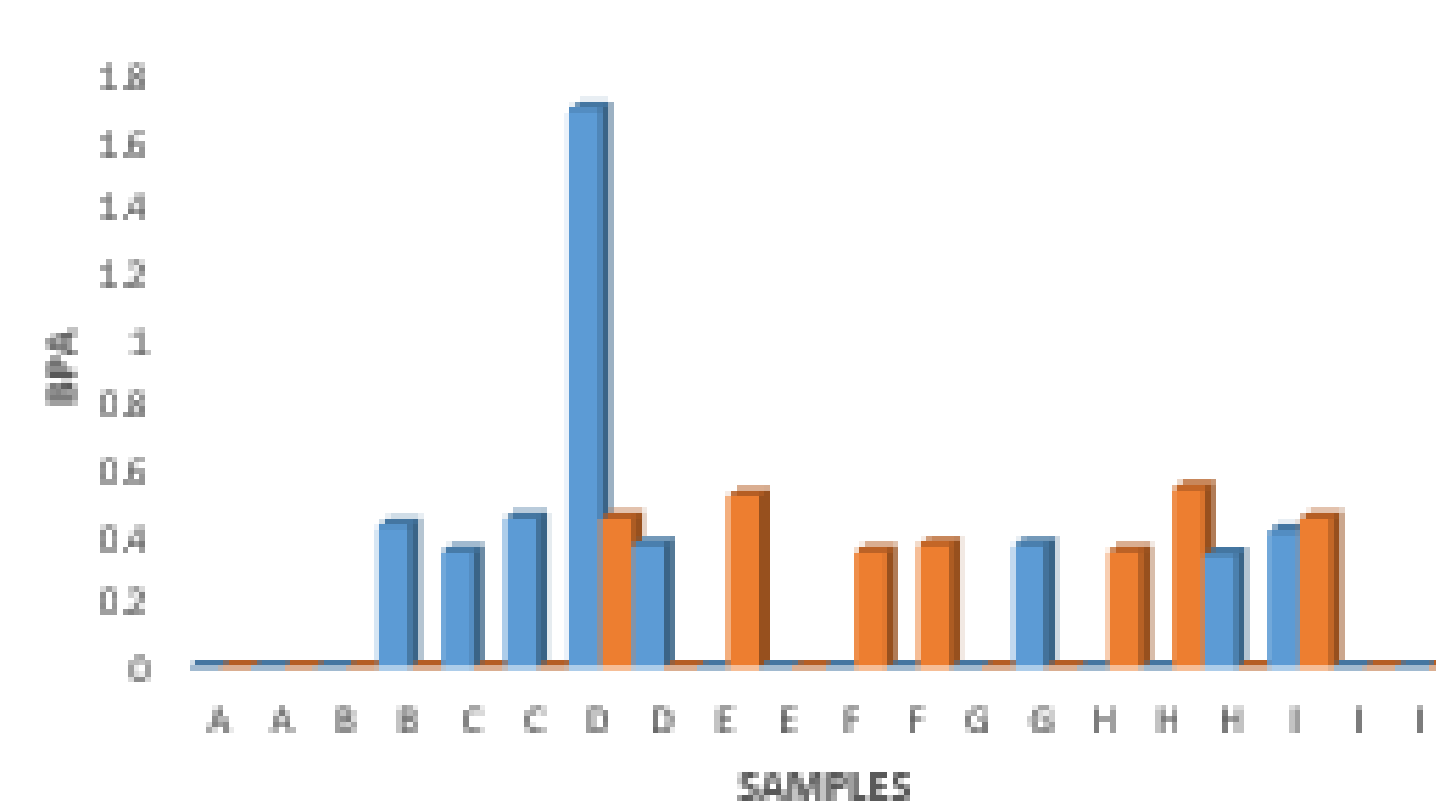


Male and female mice were given the required given doses of BPA dissolved in 0.5 ml of corn oil immediately after i.p. injection of HEL. Both sexes exposed to BPA showed increased in all the responses examined. The increases in rates of proliferation spleen cell increases as the dose increases. From the graph it clearly shown that as dose increases, proliferation of spleen ceil increases, a positive dose response to BPA. It was considered that there were no differences in this responses between males and females as they exhibited 73% and 56% response rate. Summarily, there is positive relationship between the dose(s) of BPA and corresponding response proliferation of spleen cell

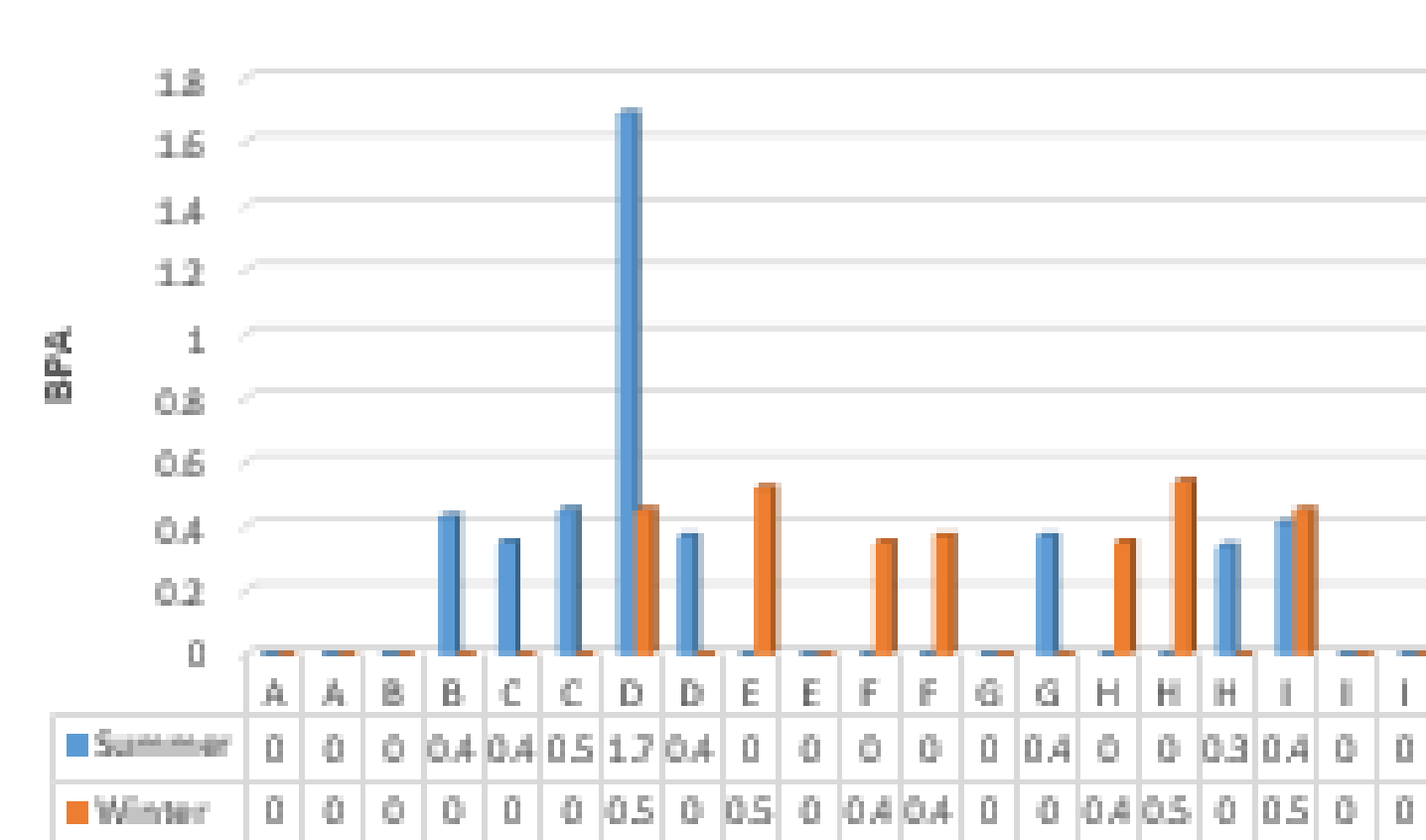
## Results

### BPA concentrations

A). Comparing BPA Conc. in Summer & Winter



B). Comparing BPA Conc. in Summer & Winter



from the same fig. a and b indicated that in the both seasons, the concentration of BPA in samples A (1) are negligible while in the sample B (2) it was recorded as 0.00043 mg/L during summer and zero in summer. The values were obtained for sample C (3) during summer but nothing was found during summer. The highest concentration was recorded in sample D (4) during winter far more than the value during winter. Contrarily the highest concentration in sample H (8) was recorded during winter while nothing was found during summer. The variation is not much but it establishes that concentration tends to increase during summer compared with winter

### Statistical analysis

Table 6- Mixed Model Statistical Analysis Summary

Fixed Effect				
Type III Tests of Fixed Effects				
Source	Numerator df	Denominator df	F	Sig
Intercept	1	17.697	12.076	.003
Season	1	17.697	0.077	0.785

#### Dependent Variable: BPA

Mixed Model statistical analysis that involved the type III Tests of Fixed Effects was performed on the BPA to find out if the is variation in the concentration levels of BPA is enhanced by the two seasons; winter and summer.

We actually hypothesized that “seasonal variation will have effect on the concentration levels of BPA”. However it was found not to be significant at 0.05 (significant level) because the calculated P – value is 0.785 (Table 6) which is greater than 0.05. So, the season have no control on the quantity of BPA that can be release into water at any particular time all thing being equal

## Health Risk Assessment

	Summer	Winter
$\text{HQ} = \frac{\text{ADD}}{\text{RfD}}$	0.0618 = 6.18E-02	0.0424 = 4.24E-02
	< 1	< 1
$\text{HI} = \sum_{i=1}^n \text{HI} = \sum_{i=1}^n \frac{\text{ADD}_i}{\text{RfD}_i}$	0.01042 < 1	

The average daily dose (ADD) of BPA from water samples around Doha for people of all age based on our assumption through the majorly known

exposure pathway (route) ingestion was calculated using equation (1) or (2) but as shown in the table 3a and b it was generated from the Expo FIRST software for the both seasons; summer and winter. The maximum ADD was recorded for the population investigated with the 3.09E-03 during the summer season and 2.21E-03 during the winter season.

Also, the health risk levels were estimated from the HQ for exposure route (ingestion) with non-carcinogenic health risk index (HI) for all age group calculated by using the equations (3) and (5). From HQ obtained for both seasons, they were less than 1; for summer  $0.0618 = 6.18E-02 < 1$  and winter  $0.0424 < 1 = 4.24E-02$  (Table 5) and cumulatively,  $\text{HI} = 0.01042 < 1$  (Eqn. 6). Hence there is probability of non-carcinogenetic effect through the exposure route investigated. In a plain language, the drinkable water around Doha is safe of consumption as the level of BPA cannot possibly cause any carcinogenic threat in the all age habiting or living around the city of Doha.

## Conclusions

Nine samples of drinkable water with replicates were randomly collected in the city of Doha, Qatar were carefully investigated for their BPA concentrations.

Concentration levels of BPA based on the seasonal variation, varies with concentration levels during summer season greater than that of winter but statistically insignificant.

Non-carcinogenic risk estimated for all age group through exposure route for both seasons were found to lie within acceptable safety levels.

There is no any potential risk that can cause cancer through drinking water.

From the study, the estimated health risks were far below the level that might cause concern.

## References

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