Finnish Institute of Occupational Health

Occupational Exposure to Bisphenols in the Construction Sector

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(1) Background: Bisphenol based epoxy coatings are commonly used in the construction sector. Skin allergies caused by epoxy chemicals are widely studied but little is known about a systemic exposure to bisphenol compounds used as building blocks of epoxy coatings.

(2) Aim was to study floor covering workers and cured-in-place-pipe (CIPP) workers exposure to bisphenols. All workers used epoxy resins which are based on BADGE and BFDGE in varying proportions.

(3) Methods: Bisphenol A (BPA), bisphenol A diglycidyl ether (BADGE), bisphenol F (BPF), bisphenol F diglycidyl ether (BFDGE) and their metabolites were analysed in urine samples of both workers and occupationally non-exposed control group by LC-MS/MS. All urinary results are normalized to a specific gravity of 1,021.

(4) Results: Workers urinary concentrations of some BADGE and BFDGE metabolites (Tables 1 and 2) are clearly elevated when compared to the respective urinary levels of the control group (Table 3). The results indicate occupational exposure to these chemicals. Urinary BPA and BPF concentrations, on the other hand, remain at the level of the occupationally non-exposed population.

(5) Conclusions: The biomonitoring results of some construction workers indicate occupational exposure to BADGE and BFDGE. When considering the available information on the systemic toxicity of these substances, the level of exposure is, however, low. This does not exclude the potential for dermal sensitization and therefore more emphasis to the prevention of exposure is needed.

Occupational exposure:

Table 1. Cured-in-place-pipe (CIPP) workers (n=10) urinary bisphenol medians by sampling time. Control group's (n=151) median and P95 are given for comparison. Unit: µg/l.

	CIPP workers' medians (µg/l)					Controls	
Chemical	After two days off	Pre-shift	Post-shift	Post-shift evening	Pre-shift next morning	Median	P95
BPA	1.05	0.79	1.04	1.60	1.03	0.71	2.39
BPF	2.27	2.02	2.51	2.73	1.93	2.54	12.27
BADGE	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.53
BADGE·H_2O	0.41	0.39	0.59	0.36	0.40	0.17	1.09
BADGE·$2H_2O$	0.11	0.64	0.60	0.78	0.62	<LOQ	0.14
BADGE·HCl·H_2O	0.12	0.37	0.43	0.37	0.28	<LOQ	<LOQ
BADGE·HCl	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BADGE·2HCl	0.12	0.26	0.18	0.14	<LOQ	<LOQ	0.75
BFDGE	2.20	4.87	4.33	5.79	4.21	2.43	12.56
BFDGE·$2H_2O$	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BFDGE·2HCl	0.11	0.13	0.15	0.17	0.16	<LOQ	<LOQ

Table 2. Floor covering workers (n=5) urinary bisphenol medians by sampling time. Control group's (n=151) median and P95 are given for comparison. Unit: µg/l.

	Floor covering workers' median (µg/l)					Controls	
Chemical	After two days off	Pre-shift	Post-shift	Post-shift evening	Pre-shift next morning	Median	P95
BPA	0.78	1.74	1.77	2.75	1.87	0.71	2.39
BPF	1.34	3.83	2.76	3.72	3.16	2.54	12.27
BADGE	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	0.53
BADGE·H_2O	0.20	0.32	0.29	0.28	0.28	0.17	1.09
BADGE·$2H_2O$	0.09	0.66	1.44	3.00	1.53	<LOQ	0.14
BADGE·HCl·H_2O	0.15	0.42	0.70	0.93	1.06	<LOQ	<LOQ
BADGE·HCl	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BADGE·2HCl	0.18	0.22	0.29	0.25	0.35	<LOQ	0.75
BFDGE	2.17	2.77	0.83	2.90	2.18	2.43	12.56
BFDGE·$2H_2O$	<LOQ	<LOQ	1.93	1.68	0.57	<LOQ	<LOQ
BFDGE·2HCl	0.36	1.42	0.94	0.96	1.00	<LOQ	<LOQ

Non-occupational exposure:

Table 3. Urinary bisphenol results of non-occupationally exposed Finnish population (n=151). Unit: µg/l.

Chemical	LOQ	≥LOQ	GM	Median	P75	P90	P95
BPA	0.37	75 %	0.70	0.71	1.08	1.75	2.39
BPF	0.9	85 %	2.59	2.54	4.14	7.27	12.27
BADGE	0.2	20 %	<LOQ	<LOQ	<LOQ	0.38	0.53
BADGE·H_2O	0.15	54 %	0.23	0.17	0.52	0.85	1.09
BADGE·$2H_2O$	0.05	23 %	<LOQ	<LOQ	<LOQ	0.09	0.14
BADGE·HCl·H_2O	0.08	4 %	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BADGE·HCl	0.08	1 %	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BADGE·2HCl	0.08	30 %	<LOQ	<LOQ	0.10	0.25	0.75
BFDGE	0.93	66 %	2.12	2.43	4.49	10.73	12.56
BFDGE·$2H_2O$	0.65	0 %	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ
BFDGE·2HCl	0.08	0 %	<LOQ	<LOQ	<LOQ	<LOQ	<LOQ

LOQ, limit of quantification; GM, geometric mean); P75, P90 and P95 are 75th, 90th, and 95th percentiles, respectively.

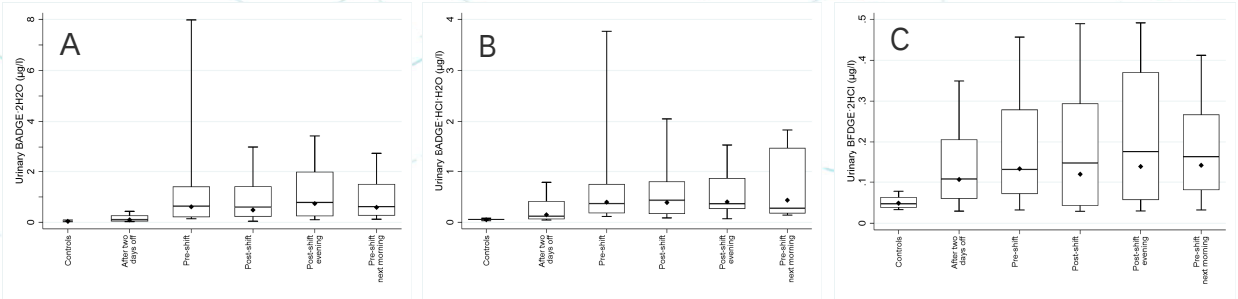

Figure 1. Urinary (A) BADGE·$2H_2O$, (B) BADGE·HCl·H_2O, and (C) BFDGE·2HCl results of CIPP workers (n=10) by sampling time. Box plots: The bottom and top of the box are, respectively, P25 and P75, and the horizontal line inside the box is the median (P50). The lower and upper ends of the whiskers are P10 and P90, respectively. The solid diamond is GM. Note that most of the control data are below the LOQ.

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