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Methods to assess cadmium intake in biomonitoring surveys

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Background and aim

Cadmium (Cd) is a human carcinogen, and represents one of the prioritized substances included in the current European Human Biomonitoring Initiative. A Tolerable Weekly Intake (TWI) for this heavy metal of 2.5 µg/kg body weight (bw) was recently set by the European Food and Safety Authority (EFSA). In order to estimate the weekly intake of cadmium, commonly implemented methods include the dietary assessment and use of biomarkers such as urine and blood/serum Cd levels. We assessed dietary Cd intake within a biomonitoring survey using these alternative methods in order to estimate the weekly intake of an Italian population.

Methods

In a random sample of the adult general population of Modena municipality we assessed Cd intake using the EPIC semi-quantitative self-administered food frequency questionnaire. Then we also estimated Cd intake with an alternative method based on serum Cd levels measured through ICP-MS. To do that, we considered that 10% of circulating Cd is found in plasma/serum and that 5% of Cd ingested with foods is generally absorbed. We also took into account the contribution to Cd exposure by tobacco smoking, i.e. around 50% in current smokers. The weekly intake of Cd was estimated using equations implemented for each method in Box 1.

Results

In the 51 subjects investigated (men/women: 26/25; mean age 50 years, range: 35-71) the median dietary Cd intake estimated with the questionnaire was 13.4 µg/day (interquartile range (IQR) 10.4-16.8), yielding a weekly intake (WI) of 1.34 µg/kg body weight (IQR: 0.85-1.70, range: 0.26-3.18). On the contrary, based on measured serum Cd levels (median of 0.041 µg/L, IQR: 0.030-0.054) in this population and taking into account tobacco smoking habits, we estimated instead a WI of 0.80 µg/kg body weight (IQR: 0.62-1.09, range: 0.27-2.47).

Box 1. Equations implemented for the esstimation of Cd weekly intake from serum levels in non-smokers (1) and current smokers (2) and from dietary intake estimated with the FFQ (3).

(1) $$\frac{\mathrm{sCd}\ (\mu g/L) * 100}{10} * \frac{100}{5} * \frac{7}{body\ weight\ (Kg)}$$

(2) $$\frac{[\mathrm{sCd}\ (\mu g/L) - \mathrm{sCd}/2] * 100}{10} * \frac{100}{5} * \frac{7}{body\ weight\ (Kg)}$$

(3) $$\mathrm{dCd\ (da\ FFQ)} * \frac{7}{body\ weight\ (Kg)}$$

Table 1. Estimation of weekly intake using two different methods, serum Cd (sCd) and dietary Cd from FFQ (dCd).

	N	WI from blood			WI from diet		
		Mean	SD	*P*[a]	Mean	SD	*P*[a]
Total	51	0.90	0.48		1.38	0.68	
Sex							
Men	26	0.88	0.57	*0.738*	1.37	0.68	*0.927*
Women	25	0.92	0.37		1.39	0.70	
Age							
<50 years	23	1.02	0.59	*0.087*	1.40	0.76	*0.881*
≥50 years	28	0.79	0.34		1.37	0.62	
BMI							
<25	23	0.87	0.30	*0.671*	1.47	0.64	*0.385*
≥25	28	0.92	0.59		1.31	0.71	
Smoking habits							
Non-smokers	42	0.97	0.49	*0.021*	1.43	0.73	*0.270*
Current-smokers	9	0.57	0.21		1.15	0.29	
Se-supplement use							
No	33	0.87	0.51	*0.537*	1.30	0.63	*0.221*
Yes	18	0.95	0.42		1.54	0.76	

[a]*P value* of two-sample *t*-test. FFQ: food frequency questionnaire; SD: standard deviation; WI: weekly intake.

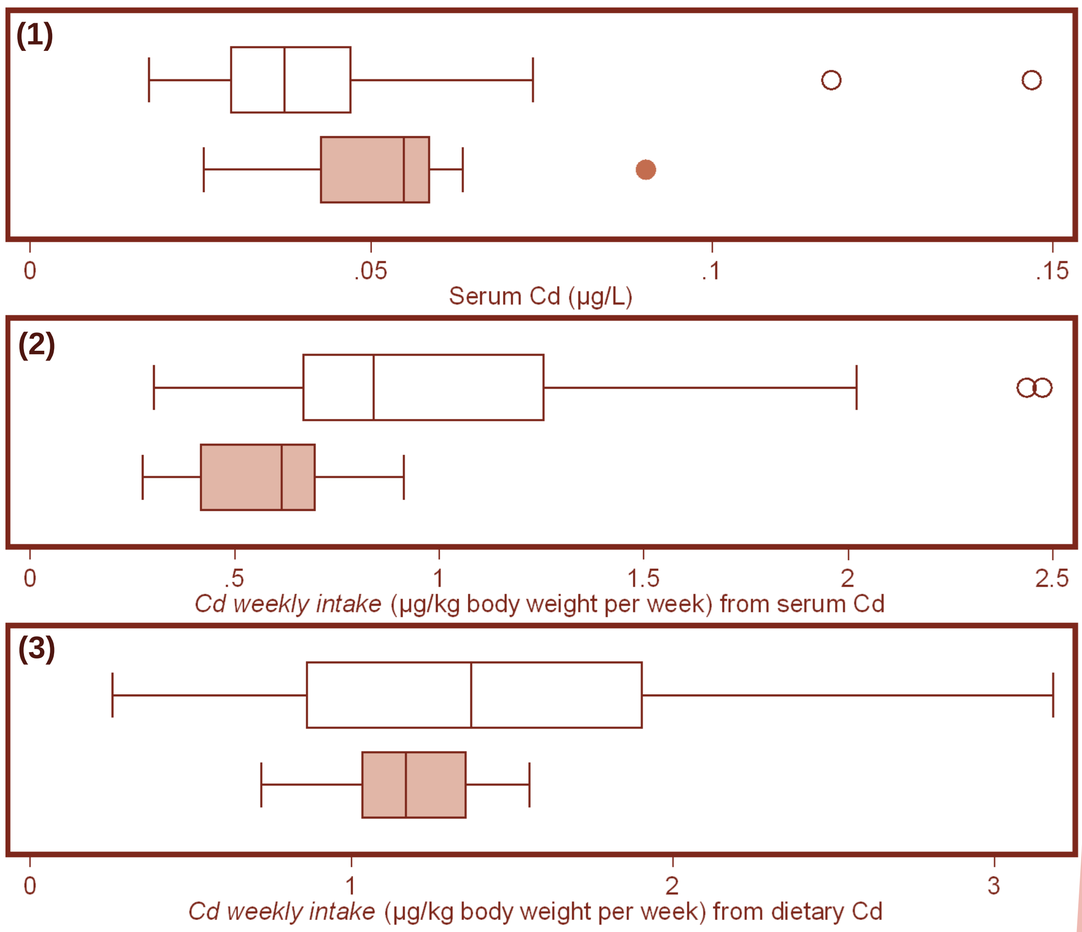
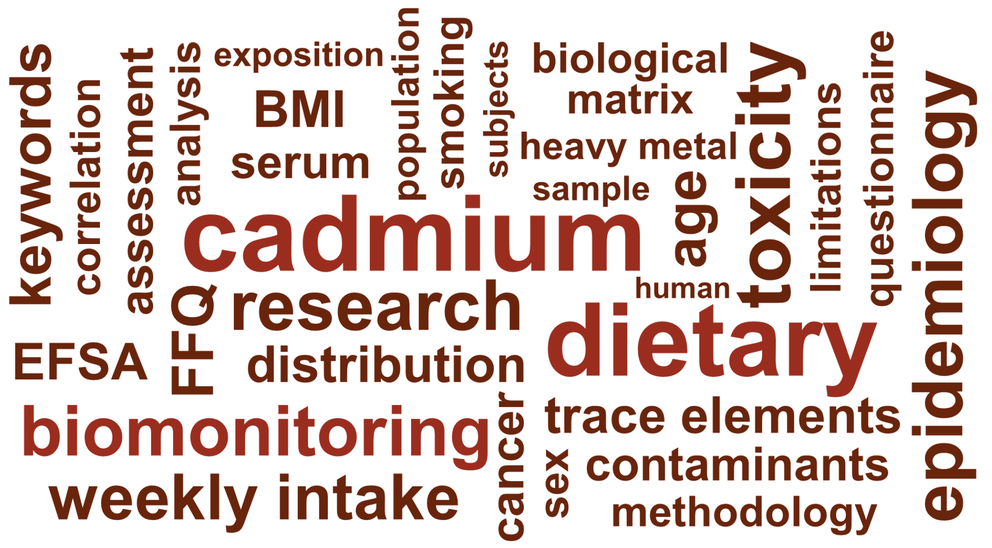


Figure 1. Levels of serum cadmium (1), estimation of weekly cadmium intake from serum (2) and dietary (3) cadmium, splitted in non-smokers (white box) and current-smokers (rouge box).

Conclusions

In this Italian population, we found higher estimates of Cd intake using a dietary questionnaire than when we estimated it through its serum levels. Dietary assessment methods based on food frequency questionnaires might therefore overestimate Cd intake, or alternatively a higher ratio between dietary and serum Cd has to be considered compared to what predicted by literature data. Finally, possible health concern arose when, based on dietary assessment method, some subjects of the study population may exceed the Cd TWI set by EFSA.



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