Incremental lifetime cancer risk associated with airborne arsenic, nickel and lead exposure in the megacity of Sao Paulo

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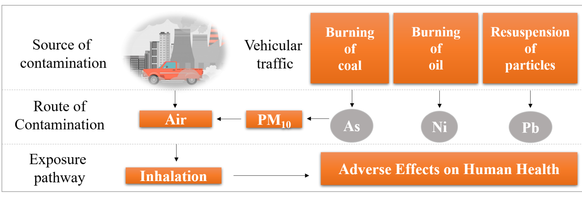
Key findings: The risk of carcinogenic effects due to chronic inhalation of PTEs analyzed in this study was considered not tolerable to the health of the exposed population, being higher during the winter.

Background

The particulate matter (PM) from **vehicular emissions can lead to environmental exposure to several Potentially Toxic Elements (PTEs)** *(1)*



The ambient air pollution is a critical problem of public health *(1)*

with cardiovascular, cerebrovascular, and respiratory complications *(1)*

Therefore, this study aimed to assess the incremental lifetime cancer risk (ILCR) associated with airborne As, Ni, and Pb exposure in PM_{10} from vehicular source, collected at one of the air quality monitoring stations in the megacity of Sao Paulo, in all seasons, over the years 2002, 2006, 2009 and 2012.

Materials and Methods

Concentrations of PTEs (As, Ni and Pb), in PM_{10} used in this study were provided by the São Paulo State Environmental Protection Agency (CETESB), sampled at Cerqueira César Monitoring Station, near an avenue with a high vehicle traffic density. ProUCL software was used to estimate UCL95% values.

The risk assessment methods recommended by the US Environmental Protection Agency (USEPA)*(2)* were used to evaluate the ILCR associated with airborne As, Ni, and Pb exposure, by age group (<1-70 years), according to variables of interest (seasons).

- The inhalation potential dose (*Dpot j*) was estimated according to Equation (a);
- The risk of carcinogenic effect was estimated according to Equation (b);
- The Incremental Lifetime Cancer Risk (ILCR) was estimated according to Equation (c).

$$Dpot\ j = [CA \,.\, IRj \,.\, EDj \,.\, EFj] \,/\, [BWj \,.\, AT] \quad (a)$$

$$Risk = Dpot\ j \,.\, SF \quad (b)$$

$$IRLC = \Sigma_{j=1}^{n} [Dpot\ j \,.\, SF]. \,[\, EDj \,.\, LT] \quad (c)$$

*The label of the Equations is in additional methods.

The cancer risk 1E-06 is used as a tolerability criterion adopted by many countries.

Results

Airborne As and Pb concentrations showed higher means during the winter than in other seasons ($p<0.05$). However, the PTE annual concentrations means remained below the recommended limits for air quality**.

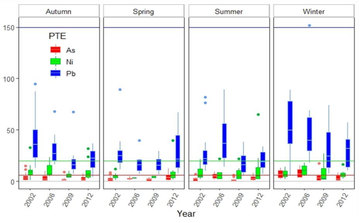


Fig. 1. PTE concentration (ng/m^3), by seasons, in all years.

The **ILCR** for the exposed population to As and Ni were found to be higher than the value considered tolerable, as well as the sum of ILCR of the PTEs. Chronic inhalation exposure to PTEs (As, Ni and Pb) is associated with risk of cancer, mainly for the respiratory system *(3)* .

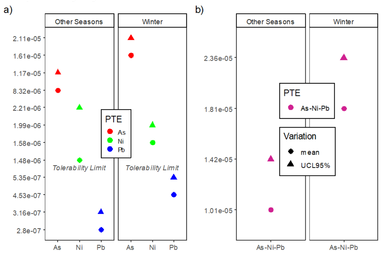


Fig. 2. a) ILCR for PTEs and **b)** sum of ILCR.

Additional Methods and/or Results

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Lebal		
Dpot j	µg kg $^{-1}$ day $^{-1}$	*potential dose for the age group j*
CA	µg kg $^{-1}$	*concentration of As, Ni, and Pb in PM_{10}*
IR j (4)	m^3 day $^{-1}$	*inhalation rate for the age group j*
EDj	years	*exposure duration for the age group j*
EFj	day year $^{-1}$	*exposure frequency for the age group j (in this study, EF = 365 days year $^{-1}$)*
BWj (5)	kg	*bodyweight for the age group j*
AT	days	*average time, which is ED j x 365 days*
Risk j	---	*risk of carcinogenic effect for the age group j*
SF (6)	mg kg $^{-1}$ day $^{-1}$	*slope factor, for As, Ni and Pb was 1.2E+1; 9.1E-1 e 4.2E-2, respectively.*
ILCR	---	*Incremental Lifetime Cancer Risk*
LT		*lifetime, which is 70 years*

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Limits for Air Quality (ng/m^3)
As: 6 *(7)*
Ni: 20 *(7)*
Pb: 150 *(8)*

Conclusions

- Although the PTE average annual concentration (As, Ni and Pb) in PM_{10} remained below the recommended limits for air quality, the cancer risk found was significant, mainly considering cancer of the respiratory system.

- These findings highlight the importance of air pollution as a risk factor for population health, especially in urban centers with high vehicular traffic.
- Actions to reduce air pollution exposure should be prioritized in environmental and health policies agendas.

Fig.: WHO, 2020.

References:
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