

Human exposure to heavy metals in the vicinity of Portuguese solid waste incinerators—Part 2: Biomonitoring of lead in maternal and umbilical cord blood

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Abstract

As part of environmental health surveillance programs related to solid waste incinerators located near Lisbon and on Madeira Island, human biomonitoring projects have been implemented in Portugal, some of them focused on cross-sectional surveys of heavy metals in blood. One of the general aims of these programs is to provide Portuguese data on the extent and pattern of human exposure to the pollutants potentially released in the stack gases from the incinerators, namely heavy metals. The present investigation reports information specifically on blood lead levels of newborn–mother pairs living in the vicinity of the incinerators under study, as well as of statistically similar participants living outside the exposed area. For Lisbon, lead levels determined at the baseline period (T0), as well as three subsequent evaluations of potential specific impacts of the incinerator (T1, T2 and T3) are described in order to investigate spatial and temporal trends of human exposure to lead. Available data for Madeira, namely lead levels in blood from the study population before the incinerator started operation, is also described. For Lisbon, analyses showed a statistically significant decrease of lead concentrations in maternal ($p < 0.001$) and umbilical cord blood ($p < 0.001$) during the whole monitoring period. Practically “overt” transplacental exposure to lead was observed only in the Lisbon biomonitoring project and for some cross-sectional surveys. Baseline levels for Madeira were the lowest found in all observations already performed in both programs (maternal and umbilical cord mean lead levels of 0.4 µg/dl and 0.3 µg/dl, respectively). No statistical associations have been found between lead levels in blood and age neither for global populations from Lisbon and Madeira nor for specific groups included in the different observational periods. © 2007 Elsevier GmbH. All rights reserved.

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Introduction

Lead is the most abundant of the heavy metals on earth (Tong and McMichael, 1999). Its toxicity can exert a wide range of biological effects on various organ systems depending on the level and duration of exposure. Lead exposure is a more profound problem

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for an infant or young child than for an adult (Tang et al., 1999). Results of many studies on lead poisoning in children have demonstrated alterations of neurobehavioural performance and psychological development (Papanikolaou et al., 2005; Tang et al., 1999). While some aspects of lead poisoning are reversible in adults, in children it can interfere with normal development (Lisa et al., 2005). In addition, evidence that in utero exposure to low levels of lead may harm the developing nervous system of children has mounted over the past decade (Tang et al., 1999). Despite lead's toxicity, its physical and chemical characteristics have prompted its use throughout history for a wide variety of purposes resulting in increased exposure to this heavy metal by humans, through a myriad of pathways, including air, food, soil, dust, and water. Lead, as well as mercury and cadmium, are included in the multitudinous array of chemicals emitted in stack gases from waste incineration. Studies of human exposure to this kind of compounds have shown that lead levels in blood are significant biomarkers of exposure (Barbosa et al., 2005; Reis et al., 2003, 2004; Skerfving et al., 1998). Since 1999 a modern municipal solid waste (MSW) incinerator is operating in the metropolitan area of north Lisbon. On Madeira Island, an old incinerator at Meia Serra has been renovated and, through modern technology, recommenced operations (June, 2002) to incinerate either municipal, hospital or slaughter house solid waste. An environmental health surveillance program, relative to each facility, is being developed with the main objective of monitoring magnitude as well as spatial and temporal trends of specific indicators of both exposure to the environmental agents of concern and potential adverse health effects in subjects living in the area under influence of the facilities. These programs include biomonitoring projects focused on heavy metal determination, with the global objective of the dissemination of their results being that of providing indicative data from Portuguese regions, on human exposure to these pollutants. The present paper is the second in a series of three that has been prepared to accomplish that aim. The still-in-progress investigation is addressed to lead exposure as measured by lead levels in the blood of newborn—mother pairs, with the ultimate objective of determining whether living in the vicinity of the incinerators increases the lead body burden as determined by blood lead levels. Data will also be collected longitudinally in order to provide information on temporal trends in blood lead levels, which will indicate whether controls on sources of this pollutant are effective. From Lisbon, baseline levels of lead (before the incinerator started operations) as well as concentrations of this heavy metal determined in blood during the three subsequent observational periods are discussed, while for Madeira only the reference or baseline period is characterized relative to lead exposure of the

population under study. Conclusions are drawn in relation to health hazards for the residents in the vicinity of the incinerator when compared to those living outside the potentially exposed area.

Material and methods

Study group

Apparently healthy women, non-occupationally exposed to heavy metals, primiparous and/or breast-feeding their first child or at least 3 years after breast-feeding their last child living at current residence for over 1 year, volunteered to participate in the biomonitoring study in Lisbon and Madeira Island after written informed consent. Participants were classified as exposed or controls, depending on their respective living area. In Lisbon the study group included exposed women living at a distance under 5 km from the incineration facility and, as controls, women living over 5 km from the plant, but as similar as possible to those from the exposed area. For Madeira Island the study group included individuals living in the small town of Camacha or its surroundings, at a distance under 3 km from the incineration facility. As controls, another group of volunteers has been recruited among the residents at Estreito-Jardim da Serra, living over 20 km from the plant. Similar relevant socio-demographic characteristics were ensured in both cases, in order to avoid between-group bias.

Sample and data collection

To date, only 79 pregnant women were recruited for the reference or baseline period (T0) in Madeira whereas in the Lisbon biomonitoring project 400 participants have already been included for the four observational periods (T0 to T3, T_i being the i th observation for assessment of potential specific impacts of the solid waste incinerator). A venous blood sample of about 7.5 ml has been collected by health professionals from all parturients and from their newborns' umbilical cords before labor and after delivery, respectively, to evaluate transplacental exposure to heavy metals, namely lead. For gathering relevant information on study participants, age, residence, parity, smoking habits, use of medicines, dietary information on recent fat intake, occupational exposure, and on their newborns, a self-administered questionnaire was applied. Complementary information on the newborns was obtained from the mothers and from records at the Maternidade Dr. Alfredo da Costa in Lisbon and at both local health centers (Camacha and Estreito-Jardim da Serra) in Madeira Island. Pubic hair samples for heavy metal determinations have also been collected before labor but results are not presented in this study.

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