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Self-rated health and chronic conditions are associated with blood concentrations of persistent organic pollutants in the general population of Catalonia, Spain

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ABSTRACT

Background: Self-rated health (SRH) is a powerful predictor of mortality, morbidity, and need for health services. SRH generally increases with educational level, and decreases with age, number of chronic conditions, and body mass index (BMI). Because human concentrations of most persistent organic pollutants (POPs) also vary by age, education, and BMI, and because of the physiological and clinical effects of POPs, we hypothesized that body concentrations of POPs are inversely associated with SRH.

Objectives: To analyze the relation between serum concentrations of POPs and SRH in the general population of Catalonia, Spain, taking into account sociodemographic factors and BMI, as well as chronic health conditions and mental disorders, measured by the General Health Questionnaire-12 (GHQ-12).

Methods: POP serum concentrations were measured by gas chromatography with electron-capture detection in 919 participants of the Catalan Health Interview Survey.

Results: Individuals with higher concentrations of POPs had significantly poorer SRH; e.g., the median concentration of HCB in subjects with poor SRH was twice as high as in subjects with excellent SRH (366 ng/g vs. 169 ng/g, respectively; p -value < 0.001). In crude models and in models adjusted for sex and BMI, the POPs-SRH association was often dose-dependent, and the likelihood of poor or regular SRH was 2 to 4-times higher in subjects with POP concentrations in the top quartile. In models adjusted for age or for chronic conditions virtually all ORs were near unity. No associations were found between POP levels and GHQ-12.

Conclusions: Individuals with higher concentrations of POPs had significantly poorer SRH, an association likely due to age and chronic conditions, but not to sex, education, social class, BMI, or mental disorders.

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1. Introduction

Most persistent organic pollutants (POPs) are known or reasonably suspected to harm relevant aspects of human health, and some probably even do so at low doses (Department of Health and Human Services, 2009; Faroon and Ruiz, 2015; Lee et al., 2014; Litwack, 2014; National Research Council, 2006; Patterson et al., 2009; Porta et al., 2008, 2012; Prüss-Ustün et al., 2011; Vandenberg et al., 2012; World Health Organization, 2013). Even though they have not been manufactured in developed countries for several decades, in the global and highly intertwined economies of today many POPs remain detectable in animal and human food webs, and in virtually all human beings, commonly at low and high concentrations (Aylward et al., 2014; Den Hond et al., 2015; Department of Health and Human Services, 2009; Litwack, 2014;

Abbreviations: ANOVA, analysis of variance; β , regression coefficient; BMI, body mass index; CC, chronic conditions; CHIS, Catalan Health Interview Survey; CI, confidence interval; DDD, dichlorodiphenyldichloroethane; DDE, dichlorodiphenyldichloroethane; DDT, dichlorodiphenyltrichloroethane; GHQ-12, Goldberg's General Health Questionnaire-12; HCB, hexachlorobenzene; HCH, hexachlorocyclohexane; OR, odds ratio; \geq P75, equal or above the 75th percentile (top quartile); PCBs, polychlorinated biphenyls; PeCB, pentachlorobenzene; POPs, persistent organic pollutants; SD, standard deviation; SRH, self-rated health; TL, total lipids

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Porta et al., 2010, 2012; Prüss-Ustün et al., 2011; World Health Organization, 2013).

Self-rated health (SRH) does not just capture the individual's subjective well-being: decades of research have shown that it is also a simple and powerful predictor of morbidity and mortality (Baron-Epel, 2004; Bjorner et al., 2005; Brunström and Fredlund, 2001; DeSalvo et al., 2006; Diehr et al., 2001, 2002; Eriksson et al., 2001; Idler and Benyamini, 1997; Idler et al., 2000). SRH is most commonly rated using a five-point scale ranging from excellent health to poor health. Its validity, ease of collection and assessment, and all-inclusive nature, make it a useful tool for measuring the health impact of various chronic conditions (Alonso, 2000; Baron-Epel, 2004; Tarlov et al., 1989). Women tend to have worse perceived health than men, although in studies that corrected for medical indicators gender differences disappeared, and women tended to assess their health more favorably than men (Crimmins et al., 2010; Malmusi et al., 2012; Undén and Elofsson, 2006). SRH generally increases with educational level, decreases with age, and is lower in individuals underweight and obese (Dowd and Zajacova, 2010; Imai et al., 2008; Jiménez-García et al., 2008; Molarius et al., 2006).

In principle, SRH could be influenced by some environmental pollutants, and could thus be helpful to assess the health impacts of environmental exposures (Carrasco et al., 2007; Nakata et al., 2009; Sala et al., 1999; Ushijima et al., 2004; Van Larebeke et al., 2015). Human concentrations of most POPs generally increase with age and body mass index (BMI), though some compounds (as PCBs) may be inversely associated with BMI; birth cohort effects also exist (Gasull et al., 2013; Porta et al., 2008). POP levels often increase with decreasing social class and educational level, particularly when age and birth cohort effects are not accounted for (Gasull et al., 2013). Because of these associations, and because of the physiological and clinical effects of POPs, it is reasonable to hypothesize that POP concentrations are associated with SRH. An ensuing question is whether any putative associations between POPs and SRH will hold once the effects of sex, age, occupational social class, educational level, and BMI are taken into account. Furthermore, a POPs–SRH association might partly be due to chronic health conditions or to mental disorders (Fig. 1). Surprisingly, virtually no studies have analyzed the relationships between body concentrations of POPs or other environmental chemicals, and SRH.

The aim of the present study was to analyze the relation between serum concentrations of POPs and SRH, taking into account sociodemographic factors and BMI, as well as chronic health conditions and mental disorders, in the non-institutionalized, adult, general population of Catalonia, Spain.

2. Materials and methods

2.1. Study population

The study population has been described in detail elsewhere (Porta et al., 2010). Briefly, in 2002, the Department of Health of the regional Government of Catalonia conducted a new health interview survey (CHIS) to obtain information on perceived health, health-related behaviors, and use of health services (Departament de Salut, 2002; Porta et al., 2010, 2012). The interviews were conducted face to face by trained staff at the home of the interviewee. To achieve a representative sample of the non-institutionalized population of residents in Catalonia a multi-stage random sampling strategy was applied (Departament de Salut, 2002; Juncà et al., 2003).

Once the CHIS interview was finalized, participants 18–74 years old were asked if they wanted to take part in a health examination, which included a supplementary interview, physical examination, and blood and urine samples. Participation was voluntary and had no economic compensation. A random sample was selected amongst those who consented to participate and, of these, 1374 individuals participated during 2002 in the health examination; in such examination, trained nurses measured weight and height, and blood samples were drawn after twelve hours of fasting (Porta et al., 2010, 2012). Information on blood concentrations of lipids and at least 1 mL of serum were available from 919 participants. There were no significant differences between the 919 participants and the remaining participants in the health examination with respect to age, sex, BMI, social class, and educational level (Porta et al., 2010, 2012).

2.2. Health outcomes and socioeconomic variables

As in other similar surveys (Dowd and Zajacova, 2010; Ho et al., 2007; Jiménez-García et al., 2008; Molarius et al., 2006), in the CHIS self-rated health (SRH) status was measured by the question 'How would you rate your overall health?'. The question had five possible answers: 'excellent', 'very good', 'good', 'regular', and 'poor' (Brugulat et al., 2003). For part of the analyses we grouped SRH into two categories, with 'regular' and 'poor' in one group ('poor'), and the remainder in the other ('good'). In other parts of the analyses the variable was analyzed using all five categories.

CHIS interviewers gathered information about 26 chronic conditions (CC). We categorized the number of CC per person in quartiles (Table 1). We also selected two different subgroups of CC based on their possible relationships with POP concentrations (Department of Health and Human Services, 2009; Lee et al., 2014; World Health Organization, 2013). A third subgroup was created including the ten CC that were found to be most correlated with POP concentrations in the study participants.

The lower educational category of subjects without formal studies included the illiterate. To assign the occupational social class we used the Spanish classification, based on Goldthorpe's scheme; the current or last occupation of the head of the household was thus used (Porta et al., 2010). The presence of mental disorders was assessed with Goldberg's General Health Questionnaire (GHQ-12): individuals with a score ≥ 4 were considered likely to have a mental disorder (Sabes-Figuera et al., 2012).

Over 56% of the participants were women, and the average age

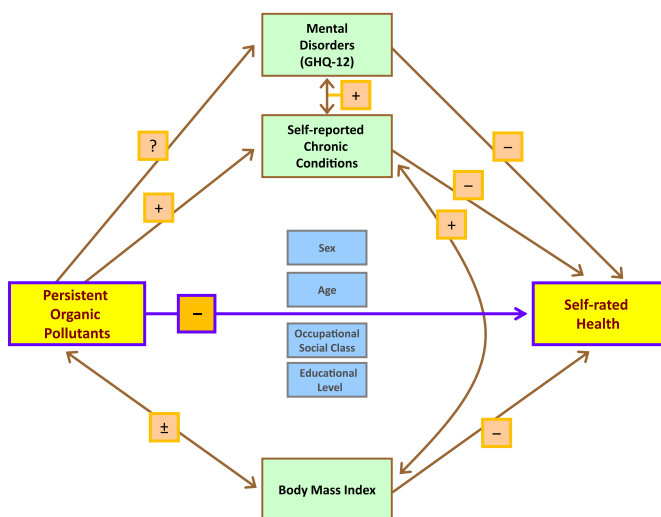


Fig. 1. Diagram summarizing the main study hypotheses. Footnote: Plus signs (+) indicate a positive association (e.g., higher concentrations of persistent organic pollutants are associated to a higher number of self-reported chronic conditions), whereas negative signs (–) indicate an inverse association (e.g., a higher body mass index is associated with a poorer self-rated health, higher concentrations of persistent organic pollutants are associated to a poorer self-rated health).

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