



## Review

## Lack of information received by a French female cohort regarding prevention against exposure to reprotoxic agents during pregnancy



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## ARTICLE INFO

## Article history:

Received 19 April 2016

Received in revised form 11 July 2016

Accepted 26 July 2016

## Keywords:

Reprotoxic agent  
Pregnancy  
Bisphenol A  
Toluene  
Information

## ABSTRACT

**Objective:** The aim of this study was to evaluate the information pregnant women received regarding possible exposures to five recognized reprotoxic agents during their pregnancy.

**Study design:** A cohort study was conducted using two postnatal units in France. Women hospitalized in postnatal units were requested to complete a self-administered two part questionnaire. The first part gathered information about the patient's socio-professional level and the type of pregnancy follow-up. The second part examined the information the patient received regarding daily products containing the following known reprotoxic agents: bisphenol A, toluene, *n*-hexane, *cis*-chloroallyl-triaza-azonia-adamantane-chloride and *O*-phenyl-phenol. The women cited the sources of information. We combined the employment status and educational level to separate the women into two groups. The groups were then compared using the Chi Square test or Fisher's exact test.

**Result(s):** There were 390 women in this study. Our results showed the women received information regarding the following: 21.6% ( $n = 84$ ) regarding tin cans, 21.9% ( $n = 85$ ) concerning plastic meal boxes when heated in microwave ovens, 8.8% ( $n = 32$ ) about water in gas-bottles, 27.4% ( $n = 106$ ) about non-organic foods, 39.3% ( $n = 152$ ) about hair dyes, 17% ( $n = 66$ ) about nail polishes, 23.4% ( $n = 103$ ) about insect repellents, 34.4% ( $n = 133$ ) about "do-it-yourself" products, 2.1% ( $n = 8$ ) about gardening products, 26.7% ( $n = 103$ ) about electric plug-in repellents, 21.1% ( $n = 81$ ) about housekeeping products, and 6.8% ( $n = 26$ ) about register receipts. Women with a higher level of education and a qualified occupation were better informed about these daily products. These women were more likely to learn the information on their own (internet, media).

**Conclusion(s):** Our study showed French women did not receive sufficient information regarding potential exposures to reprotoxic agents during pregnancy.

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## Introduction

Inhalation, ingestion, and skin penetration of reprotoxic agents can induce non-hereditary adverse effects in offspring or interfere with reproductive functions including sexuality and fertility according to European parliament Regulation (EC) No 1272/2008. There are several reprotoxic agents that function as endocrine disruptors by interfering with the function of endocrine glands [1]. Small quantities of these substances may cause toxicity and if several substances affect the same target there may be synergistic effects from reprotoxic substances [2,3]. There is an increased sensitivity to these substances during the perinatal period. Hormone disruption during development can produce permanent effects that may not appear until adulthood [1]. It has been suggested that exposure during the organogenesis period could produce genital malformations (cryptorchidism, hypospadias, infertility) and that prenatal exposure to endocrine disruptors has contributed to the recent increases of testicular and breast cancers [4,5].

In 2014, the French National Agency on Sanitary, Food, Environmental, and Workplace Safety (Agence Nationale de l'Environnement, de l'Alimentation et du Travail—ANSES) published opinions and recommendations concerning the following five reprotoxic agents: bisphenol A, toluene, *n*-hexane, *cis*-chloroallyl-triaza-azonia-adamantane-chloride (*cis*-CTAC), and *O*-phenyl-phenol (OPP). Bisphenol A (BPA) is a monomer used in the manufacture of polycarbonate plastics and epoxy resins and is found in food containers and polycarbonate utensils, such as tin cans, airtight microwavable containers, water containers, and thermal paper receipts. BPA is an oestrogen mimetic endocrine disruptor that binds the  $\alpha$  oestrogen receptors. BPA is toxic to the female reproductive system because it disrupts the ovarian cycle [6], affects the central nervous system [7], and alters the mammary glands [8,9]. Toluene is a volatile aromatic hydrocarbon used in the production of industrial chemicals as a solvent carrier in paints, lacquers, adhesives, inks, and fabric dyes. It is also used as an extraction solvent in pharmaceuticals and cosmetics. The exposure to toluene was suggested to be a risk factor for spontaneous miscarriage in a group of women working in an audio speaker factory [10]. The chemical has also been shown to cause weight loss in rat offspring [11,12]. *n*-Hexane is a solvent used in housekeeping products and ambient air deodorants. *n*-Hexane decreased the testicle weight of rats by causing atrophy of seminiferous tubules [13] and may have adverse effects on oocyte maturation [14]. Exposure to solvents during pregnancy was demonstrated to increase the risk of congenital malformations in humans [15]. Garlandezec et al. observed a significant correlation between major congenital malformations (oral clefts, urinary malformations and male genital malformations) and maternal occupational exposure to solvents. Occupations mainly classified as exposed were hairdressers, nurses' aides, nurses and chemists/biologists. *cis*-CTAC is used for its biocide properties as a preservative and is known to induce congenital malformations in rats including ocular, facial, and skeletal anomalies. *cis*-CTAC is present in insect repellents, paints, lacquers and adhesives. *ortho*-

Phenylphenol (OPP) is used for its biocide properties as a disinfectant, preservative, fungicide, and fireproofing agent. OPP impacts fetal development of rats and rabbits (weight loss of offspring, increased spontaneous miscarriage). OPP was detected in air samples collected from the homes of pregnant women using insect repellents [16]. There were summaries of toxicology data for *cis*-CTAC and OPP produced by the California department of pesticide regulation and environmental protection.

Although scientists can track these substances it is more complicated for the general public. There are several household products that contain these five reprotoxic substances and they are widely used by the general public. In France, the ANSES recommends informing the general public, worker populations, and pregnant women of the potential risks associated with the use of products containing these reprotoxic substances because they represent a hazard for the fetus. The ANSES also recommends describing prevention methods to reduce exposure. The objective of our study was to evaluate the information received by pregnant women regarding exposures to these five recognized reprotoxic agents.

## Materials and methods

A cohort study was conducted between November 2014 and August 2015 with women from the post-natal services of two French maternities in the Marseille area (University Teaching Hospital La Conception, Aix-Marseille Université and Maternity of Pertuis, Centre Hospitalier du Pays d'Aix). A self-administered questionnaire was developed using the data published by the ANSES (questionnaire available upon request to authors). The inclusion criteria were women hospitalized in the postnatal unit who had a normal pregnancy with a term delivery of a healthy child. The exclusion criteria were the following: an early delivery before 37 weeks of amenorrhea (GA), a child born with a health problem, and a lack of pregnancy follow-up. The women were first informed by the study investigator and provided their written consent to participate in the study. Women who were not able to read French writing and anyone refusing to participate were excluded. The questionnaire was given to each patient directly by the investigator. The patients were instructed to complete the questionnaire on their own and returned it to the investigator or to the healthcare professionals before the end of their hospitalization.

The questionnaire included 28 items (available upon request to authors). The aim of the first part of the questionnaire (questions 1–13) was to gather information regarding the patient's characteristics, socio-economic level, and the type of pregnancy follow-up. Each patient's occupation was listed by The International Standard Classification of Occupations (ISCO). We also included the following three categories: "student", "housewife", and "non-employed". The second part of the questionnaire (questions 14–28) described the information about avoiding daily products containing reprotoxic agents. There were three questions focused on tobacco, alcohol, and cannabis consumption. The remaining questions focused on preventing exposure to the five reprotoxic agents (bisphenol A, toluene, *n*-hexane, *cis*-chloroallyl-triaza-azonia-adamantane-chloride (*cis*-CTAC) and *O*-phenyl-phenol).

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