REPORT

SAFEGUARDING WOMEN'S HEALTH AGAINST ENDOCRINE DISRUPTING CHEMICALS

Paving the way to successful health strategies

freia PROJECT

Safeguarding women's health against endocrine disrupting chemicals

Paving the way to successful health strategies

Authors

This document was authored by Virissa Lenters, Eva Sugeng, and Majorie van Duursen.

FREIA consortium members, FREIA Scientific Advisory Board members and the Health and Environment Alliance (HEAL) provided feedback on the content.

Suggested citation: Lenters, V.C., Sugeng, E.J. and van Duursen, M.B.M. Safeguarding women's health against endocrine disrupting chemicals: Paving the way to successful health strategies. Vrije Universiteit Amsterdam. June 2024.

ISBN: 978-90-903-8747-5

Abstract

This report was written as part of the workplan of FREIA, a project funded by the Horizon 2020 Research and Innovation programme (grant agreement number 825100) of the European Commission. It describes evidence-based strategies for reducing exposure to endocrine disrupting chemicals (EDCs) and evaluates how people perceive the risk of EDCs. The report also provides guidance on how to best communicate actual risks and develop successful health promotion strategies.

Keywords: Endocrine disrupting chemicals (EDCs), environmental chemicals, prevention, female reproductive health

Acknowledgements: The authors would like to thank the people who participated in the Dutch survey.

June 2024

freia PROJECT

Table of Contents

Executive summary

Environmental pollutants and human-made chemicals, including endocrine disrupting chemicals (EDCs), pose threats to female reproductive health. This report provides recommendations using the latest scientific understandings for developing successful health promotion strategies to protect female reproductive health from hazardous chemical exposures.

This work was conducted as part of the FREIA project, a research project funded under the European Commission's Horizon 2020 Research and Innovation programme, dedicated to safeguarding female reproductive health against endocrine disrupting chemicals.

We considered the available evidence for ways to reduce chemical exposure for individuals and in clinical healthcare settings. To inform our recommendations, we evaluated public and health professionals' perceptions and attitudes on EDCs from previously conducted surveys and conducted a new in-depth survey among adults of reproductive age in the Netherlands. Additionally, we collated existing guidelines for reducing chemical exposures, focusing on those targeting adults of reproductive age.

Effective interventions, awareness and perceptions

- Interventions can **demonstrably reduce exposure to EDCs.** Successful methods include switching to low-fragrance and eco-labelled personal care products, changing diet and food handling by using fewer plastic containers to store food and beverages, avoiding re-heating food and beverages in plastic containers, and modifying habits and materials in the home, including by cleaning surfaces more regularly and purchasing non-plastic home textiles and furnishings.
- There is a moderate to high **level of awareness and concern** among women and the broader public about EDCs, although this varied across countries. 89% of the 576 people that participated in the Dutch survey expressed a **willingness to act** to reduce their exposure to EDCs, but a lack of knowledge and high costs were barriers to act. This corresponds with previously conducted surveys from other countries.
- Health professionals are generally considered as **trusted sources of reliable information**. Yet, results from the literature and the Dutch survey show that only a moderate proportion of people surveyed, including pregnant women, receives information on how reduce exposure to EDCs from this source. The internet, media and social media are common sources of information although these are generally considered less reliable by the respondents.
- **Insights into personal exposure levels** increase feelings of confidence and control and encourages people to take action to reduce exposures.

Opportunities and strategic recommendations

Enhance environmental health literacy and awareness of endocrine disrupting chemicals (EDCs)

- **Educational campaigns:** Develop and implement educational campaigns to raise awareness about the risks of chemical exposure for reproductive health and promote effective risk management strategies. These campaigns should be designed in collaboration with stakeholders, particularly women from diverse age groups and backgrounds, to address inequities and ensure relevance.
- **Curriculum integration:** Integrate education about environmental exposures, including EDCs, into secondary school curricula. This can increase awareness and reduce exposures in the years leading to potential pregnancy. Programs should leverage trusted sources, such as information from professional organisations and governmental agencies, and be adapted to local contexts.
- **Product labelling and mobile apps:** Improve product labelling and develop mobile apps that allow consumers to scan and identify product contents. This can increase consumer awareness and empower individuals to select products with fewer and lower levels of hazardous chemicals.

Increase environmental health training for health professionals

- **Professional education:** Improve education and training for health professionals in environmental health literacy and environmental history assessments. Offering continuing education credits and online education programs can be effective methods to improve knowledge and skills in this area.

Expand knowledge on the effectiveness of exposure prevention interventions and health promotion strategies

- **Human biomonitoring programs:** Establish human biomonitoring programs to monitor EDC exposure levels among (European) populations. These programs provide valuable data to inform public health strategies.
- **Intervention evaluation:** Evaluate the effectiveness of exposure-reduction interventions that address multiple chemical classes. Assess factors that facilitate the acceptability of interventions and identify effective health promotion strategies that increase self-efficacy and address concerns related to uncertainties.

Support development and implementation of EU-wide legislation to reduce the use of and exposure to EDCs

- Ensure the comprehensive and timely implementation of the **European Chemicals Strategy for Sustainability (CSS)**, in particular the commitments to protect consumers, vulnerable groups and workers from the most harmful chemicals, including EDCs.
- Update European Regulations on chemicals to ensure sufficient and appropriate data is generated to allow the identification of EDCs. Here, the outcomes of the FREIA project and other related projects can provide crucial input.

1. Introduction

Approximately one in six people have experienced infertility at some stage in their lives, globally (WHO 2023). Several factors can affect a woman's reproductive health, including obesity, smoking, and age at first childbirth. Additionally, a large body of evidence shows that exposure to some chemical substances, including endocrine disrupting chemicals (EDCs), can harm female reproductive health [1]. EDCs[i] interfere with the endocrine system and hormonal regulation (see information box), and include pesticides, phthalates, bisphenols and per- and polyfluoroalkyl substances (PFAS). Exposure to EDCs has been associated with impaired fertility, uterine fibroids, endometriosis, polycystic ovarian syndrome, pregnancy complications, breast cancer, endometrium cancer, ovarian cancer, and early onset menopause, among others [2–4].

ENDOCRINE DISRUPTING CHEMICALS (EDCs)

The World Health Organization's International Program on Chemical Safety (WHO-IPCS, 2002) defines an endocrine disruptor as "an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub)populations."

To put it simply: EDCs are chemicals or mixtures of chemicals that interfere with any aspect of hormone action at any point.

The **FREIA Factsheet** provides a clear introduction to the importance of EDCs for women's reproductive health.

EDCs are found in many daily use products, from household and personal care products to plastic food packages. Some pesticides used for agricultural purposes or at home are also EDCs. As a result, exposure to EDCs happens daily via the air, dust, food, and water or via our skin, and can occur indoors and outdoors, in the home, at work, at school, or at daycare facilities. EDCs are also used in many products and processes in clinical and health care settings, for example in tubing, catheters and in medications [5].

How EDCs are regulated in the EU

In the European Union (EU), the identification of chemicals that have endocrine disrupting properties takes place under various regulations, including the Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH, 2007), the Regulation on classification, labelling and packaging of substances and mixtures (CLP, 2008), the Plant Protection Product Regulation (PPPR, 2009), and the Biocidal Products Regulation (BPR, 2012). The EU also addresses the use of EDCs in medical devices (Medical Devices Regulation (EU) 2017/745). Here, particularly the detrimental effects of EDC exposure on the success of assisted reproduction technologies (ART) including in vitro fertilisation (IVF) is an emerging area of concern, as is also addressed in the FREIA project [6,7].

Although the EU has been proactive in regulation of EDCs, there are still limitations to existing regulations, including that they remain fragmented and not harmonized across legislations, that exceptions for known EDCs or substances of very high concern are allowed, that the burden of proof

[i] In this report, we use the term EDCs broadly, including known and suspected EDCs. Recommendations generally apply to any chemical that may harm reproductive health.

is high for identifying and restricting EDCs, and that challenges remain concerning assessment of mixtures and for consequences that appear later in life, i.e. health effects with a long latency and across generations [8].

Gaps in risk management

Today, we still have gaps in understanding how EDCs can affect women's reproductive health [9,10]. This makes it challenging to identify, regulate and take protective measures against chemicals that can disturb our hormonal system. Despite remaining uncertainties, efforts to reduce exposures to EDCs are warranted. This is in line with the EU's strategic approach to EDCs, which is based on the application of the precautionary principle [11]. As long as regulatory processes remain challenging, reducing exposure to potentially harmful substances is the most effective way to protect reproductive health against EDCs.

Various risk management approaches for EDCs are implemented in European countries and elsewhere [8]. Targeted efforts to prevent exposure to substances hazardous to female reproductive health often focus on pregnant women. However, earlier life stages, including the preconception period when couples are already trying to conceive, are also crucial periods for risk management and health promotion efforts. More broadly, reducing exposure to EDCs throughout the entire lifespan, including during childhood, puberty, and extending into menopause, is important for protecting reproductive health.

Aims of this report

The FREIA project is a research project funded under the European commission's Horizon 2020 Research and Innovation programme dedicated to safeguarding female reproductive health against EDCs [12]. One of the objectives of FREIA is to promote sustainable options for a healthy society and improve women's health. In this context, we aimed to synthesise evidence on effective exposure management and provide recommendations on how to effectively implement these and reach the intended target audiences. In this report, we:

- Summarise the evidence for effective measures to reduce EDC exposures from intervention studies (Section 2).
- Summarise studies on the knowledge, attitudes, perceptions, and practices of adults of reproductive age and health professionals concerning EDCs and reproductive health from the scientific literature and a novel in-depth assessment in the Netherlands (Section 3).
- Evaluate existing recommendations to reduce exposure to EDCs and effective health promotion strategies in the field of environmental health (Section 4).
- Provide opportunities to effectively promote actionable recommendations to reduce exposure to EDCs (Section 5).

This report aims to translate scientific evidence into actionable and effective strategies for managing exposure to EDCs. Although the primary emphasis is on reducing female exposure to EDCs and safeguarding female reproductive health, many of the findings and recommendations are relevant to anyone making household decisions and lifestyle choices that impact chemical exposures to themselves and people around them. Reducing the exposure to environmental chemicals benefits anyone's (reproductive) health.

This report is not intended to be an exhaustive or definitive guideline. Instead, it may serve to empower individuals, including health professionals and policy-makers, civil society organisations, and other stakeholders to advance their environmental health promotion activities and take exposure reducing measures using the latest scientific understandings.

2. Effective interventions to reduce EDC exposure

Intervention studies in humans have been published in the scientific literature that address possible ways to reduce exposure to environmental chemicals or EDCs in particular. By "intervention studies" we specifically refer to experimental studies where some kind of intervention is tested, and the outcomes are observed over time. Most of the intervention studies evaluated chemicals that are broken down quickly in the body (i.e. have short half-lives, including phthalates, phenols, and bisphenols). As these chemicals are more rapidly removed from the body than chemicals with a longer half-life, such as PFAS, interventions are more likely to impact a person's levels of short half-life chemicals than long-half-life chemicals. These studies, performed with participants from the general population or in a clinical setting, are a strong source of evidence to inform evidence-based recommendations to reduce exposure to chemicals.

2.1 Interventions among individuals

We conducted a scoping review of existing reviews on interventions to reduce exposure to EDCs. There have been several recent reviews that together assessed 121 studies. Martin et al. [13] and Yang et al. [14] respectively reviewed 21 and 26 studies on interventions to reduce exposures to phthalates and phenols. Martin et al. [13] focused on studies among men and women of reproductive age and Yang et al. [14] on all populations. Sieck et al. [15] reviewed 58 studies on interventions to reduce exposure to bisphenols and phthalates. Corbett et al. [16] reviewed 16 studies on dietary interventions to reduce the negative effects of EDCs on reproductive health, including studies of supplementation with micronutrients to mitigate the adverse effects of EDC exposures on development.

We present an overview of intervention studies in Corbett et al. [16], Martin et al. [13], Sieck et al. [15] and Yang et al. [14], excluding studies with fewer than 30 participants, in Supplemental Material, Annex 1. This represents 25 intervention studies that have been published between 2006 and 2022 [17–42]. The majority of the studies involved dietary or food packaging interventions. Study sample sizes ranged from 30 (our inclusion criteria) to a maximum of 268 individuals. Study populations included pregnant women, women (not pregnant), families, college students, and teenagers. Study designs included case-crossovers, randomized controlled trials (RCTs), and natural experiments (i.e. the effect of a product being phased out), and the length of the interventions varied from <1 day to 14 months. The interventions included product replacement, catered diets, and educational interventions, including accessible educational resources and support groups. Many of the dietary interventions targeted bisphenol A (BPA). Other chemical classes that were studied in the intervention studies included phenols, phthalates, parabens, persistent organic pollutants, organophosphorus pesticides, and one study evaluated changes in one chemical present in sunscreen (benzophenone-3). Most of the studies evaluated changes in chemical levels by collecting and measuring urine samples collected pre- and post-intervention. A few studies assessed blood or house dust levels.

Main findings

Dietary interventions were more frequently successful when they involved alternative food packaging rather than alternative diets. Using non-plastic beverage and food containers, including glass and stainless-steel water bottles and lunch containers, effectively reduced exposures, whereas educational programs or replacement meals yielded more mixed results [14,16]. Several studies tested and successfully demonstrated increased chemical levels, including triclosan and BPA, upon providing personal care products or canned foods with these chemicals. Interventions that were more frequently successful provided replacement diets or products [14]. For example, a study in the US among 100 Latina adolescent girls provided replacement personal care products and cosmetics and observed reductions in urinary levels of most phthalates and parabens assessed [33]. Several studies which relied on guidelines on how to reduce exposures highlighted the difficulties of identifying replacement products—for personal care products, cosmetics, food, and food packaging—that lower EDC exposures, and this was attributed to challenges in interpreting labels and inadequate labelling [14]. The importance of personal care products for EDC exposures was reinforced by a study, conducted within the FREIA project, of predictors of follicular fluid levels of PFAS, phthalates, and methylparaben [43]. Frequent use of perfume and a higher number of personal care products used on average per week were associated with increased levels of methylparaben.

Other interventions studies, not included in the aforementioned reviews, have addressed interventions that led to reductions in other chemical classes that are considered hazardous to female reproductive health. Although this is not a systematic assessment, we highlight several studies here that were deemed relevant for this report, some of which focused on longer half-life and more persistent chemicals.

Young et al. [44] observed lower levels of per- and polyfluoroalkyl substances (PFAS), polybrominated diphenyl ethers (PBDEs), and organophosphate esters (OPEs) in dust in 47 spaces at a university that had renovated spaces with 'healthier' furniture, carpets and building materials (78% lower PFAS, 65% lower OPE, and 45% lower PBDE levels in dust) compared to spaces that had conventional materials and were built prior to the phase-out of most PBDEs. Behavioural intervention studies have demonstrated that increased house cleaning and hand washing reduced exposures to flame retardants, including polybrominated diphenyl ethers (PBDEs) and organophosphate flame retardants (OPFRs) [45] and phthalates (DEHP, in this study; [46]. A study of 50 Latina women in the US found that using 'green' cleaning products reduced air concentrations of volatile and semi-volatile organic compounds (VOCs and sVOCs), including chemicals of concern such as benzene and toluene, although increased fragrance levels were observed [47].

There are limitations to the existing evidence base of intervention studies. Most studies had small to modest sample sizes, had relatively short intervention periods, and did not conduct longer-term follow-up or extensive evaluation of how well participants were amenable to follow the recommendations. Further, no intervention studies specifically focused on exposure-reducing interventions during the preconception period. Overall, relatively few intervention studies evaluated residential intervention strategies.

The weight of the evidence for the effectiveness of intervention types is summarized in Table 1. Here, we made inferences applying an informal narrative, rather than a systematic assessment.

Table 1. Summary of the weight of evidence from intervention studies on effective measures to reduce a person's chemical exposure.

Source	Interventions	Weight of evidence[a]
Personal care products	Use low/no fragrance products	+
	Use eco-labelled personal care products	++
	Frequent hand washing	+
Diet and food packaging	Consume organic food	+
	Avoid canned foods	++
	Avoid plastic food and beverage containers (including re-heating)	+++
	Avoid fast/processed foods	+
	Limit fish intake and avoid higher trophic level predatory fish	+++
Residential	Select lower-chemical materials and furnishings	+
	Avoid chemical pest management	+
	Use eco-labelled cleaning products	+/-
	Frequent vacuuming and cleaning	++
Healthcare settings	Remove EDCs from products/processes	++

[a] Based on the existing scientific literature, the weight of evidence was rated as equivocal (+/-), moderate (+), high (++) or the highest (+++) level of evidence as to whether an intervention action is effective or not. Ratings to not reflect the relative magnitude change in exposure levels expected for interventions.

Barriers and facilitators of successful interventions

Barriers to successful exposure reduction interventions included the perceived difficulty or inconvenience of the intervention and difficulties participants found in identifying 'safer' replacements [13,14]. Another barrier was financial costs; some alternatives, for example, organic and fresh food, are more expensive than non-organic, processed, or preserved foods. It is also important to note that increases in replacement chemicals after restrictions have been observed, for example, increases in BPA analogues, BPS and BPF [48].

Interventions that successfully achieved a reduction in EDC exposure levels more frequently incorporated interactive elements, reinforcements, and encouragements such as interactive websites, frequent feedback, and support via social media groups [13,15].

2.2 Interventions in clinical settings

Sieck et al. [15] identified 12 studies in 13 publications that evaluated interventions to reduce chemical exposures to bisphenols and/or phthalates in clinical settings. All studies were conducted in high-income countries, including 6 studies in the EU. Study sample sizes ranged from 4 to 216 participants, and interventions lasted <1 day to ~9 months and one natural experiment (i.e. before and after a policy change) lasted 12 years. Interventions included changes to materials (i.e. non-BPA and non-DEHP containing materials, such as tubing) or processes used for dental procedures, hemodiafiltration, peritoneal dialysis, and other medical procedures, including cardiopulmonary

bypass surgery, and blood transfusion. Nearly all studies reported a reduction in exposure, specifically lower salivary, urine, or serum/plasma levels of BPA or DEHP, following interventions using products without BPA or DEHP.

Notably, in analysis of removal of parabens in one hospital in the US, whereby preservative-free heparin lock solutions were used, an increase in catheter-related bloodstream infections was observed [49]. This underscores that benefit-risk analyses are essential in evaluating alternatives, especially in the clinical setting.

3. Perceptions about EDCs and reproductive health

Most of the studies that evaluated the risk people perceived to be associated with chemical exposure are grounded in theoretical models that are widely used to understand how perceptions and beliefs affect behaviour: the Health Belief Model and/or the Theory of Planned Behaviour. The Health Belief Model suggests that individuals are more likely to adopt health-promoting behaviours if they perceive themselves as susceptible to the health condition, believe the health risks to be severe, believe that the benefits to taking action outweigh the barriers, are exposed to cues that trigger action, and have confidence in their ability to take action or effect change (i.e. the constructs of perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy) [50]. The Theory of Planned Behaviour proposes that individuals are guided by beliefs or attitudes about the positive or negative consequences of a behaviour, the normative beliefs or perceived social pressure to perform the behaviour, and beliefs about how easy or difficult it is to perform the behaviour (i.e. the constructs of attitudes, subjective norms, and perceived behavioural control), and that these beliefs in turn influence behavioural intentions and actual behaviour [51].

In the past few years, several studies have assessed the knowledge, perceptions, and concerns of women and healthcare professionals regarding EDCs, and most focused on reproductive and developmental risks. These studies, conducted in Croatia, France, UK, USA, South Korea, Spain and Vietnam, underscore varying levels of awareness and perceptions across different countries and populations. These studies provide insight into opportunities to successfully implement strategies to reduce exposure to EDCs while emphasizing the need for country-specific strategies.

3.1 Perceptions of the public and health professionals

Perceptions of the public

A limited number of studies have been conducted to assess how the public (i.e. general population) and pregnant women perceive EDCs. A qualitative study with 34 adults (ages 19-65 years, 62% female) conducted in Northern Ireland reported that knowledge of EDCs was low [52]. Participants reported they felt limited control over exposure to EDCs and were generally more concerned about health effects on their children and future generations than the health effects of their own exposure to EDCs. However, there was large variability in the perceived severity of risks. Participants indicated wanting more knowledge through education programs, such as public awareness campaigns, and indicated confidence in self-efficacy in their ability to change their exposures to EDCs, although participants also doubted that the broader public would be interested in taking actions to reduce exposure to EDCs.

A study conducted in Vietnam was motivated by alarmingly high levels of surfactant nonylphenol (NP) and its ethoxylates (NPEOs), known EDCs, pollution in urban waters [53]. The questionnaire-based quantitative study was based on 331 adults (ages 26 to >60 years, 64% female, 36% pregnant women

or young mothers) recruited from Ho Chi Minh city, the largest city in Vietnam. Participants considered the surfactants (NP and NPEOs) to be associated with a high level of risk, although if they perceived the health risks to be uncertain, they on average reported a lower severity of the health risks. Participants favoured government-led over individual-led risk management strategies and were more likely to indicate an intention for taking non-dietary exposure prevention measures, such as considering installing a water filter or having water quality checking, rather than diet-related measures, such as reducing river fish intake. The authors recommended a government-led awareness campaign about water contamination and risks of NP and NPEOs, and highlighted the importance of communicating causal relationships between exposure to these surfactants and adverse reproductive health outcomes, as suggested by others [54].

A mixed methods study was conducted between 2014-2016 in Poitiers, France [55,56] among women and health professionals. Semi-structured interviews with 12 pregnant women, and focus groups with 8 health professionals, were used to qualitatively evaluate knowledge, attitudes and behaviours. Subsequently, determinants of risk perception were quantitatively assessed via questionnaire among 300 women in their perinatal period (i.e. during pregnancy or postpartum) [55,56]. This study reported that women had low knowledge about sources of exposure and health risks related to exposure to EDCs. Indeed, only 54% had ever heard of EDCs. The most frequently named EDCs were pesticides, bisphenol A (long banned in baby bottles in France) and parabens. Anxiety about EDC exposure was associated with greater knowledge about EDCs. Level of knowledge and older age were determinants of reporting higher perceived risks for the developing child and susceptibility to EDC exposure. Most of the participating women (92%) were willing to take various actions to reduce exposure to EDCs, with the most frequently cited action being checking labels. Higher expected costs were identified as a barrier. The main source of information was the media, although that was deemed a weak source of information. Health professionals were considered by participants as a reliable source of information, however, only 4.3% of women had been informed by a health professional about EDCs. The authors suggest that health professionals should advise pregnant women about EDC exposures and other environmental exposures and take care to avoid increasing anxiety.

Several qualitative studies in other countries reinforce these findings. In Ontario, Canada, interviews were conducted with 23 women to assess how pregnant women obtain, appraise, and act on information on chemicals, with phthalates as a case study [57]. Participants considered strong and reliable sources of information to include health professionals and governments and weaker sources to include the internet and media, although their knowledge was often first obtained via media. Women considered the financial costs, practicality of alternatives, and responsibility when deciding whether to act to avoid exposures, and several reported that the responsibility to make good choices could feel overwhelming and took an emotional toll. A qualitative study in South Korea among 12 mothers of young children on EDCs found that women perceived the health risks of EDCs to be low [58]. Nevertheless, they wished to have more information about EDCs, preferred government-led over individual-led risk mitigation and took more actions to avoid EDC exposures if their children had a health condition, such as atopic dermatitis.

A study in Bordeaux, France, evaluated the perception of environmental risks and behaviour changes during pregnancy using a questionnaire [59]. Participants were 121 women staying in the hospital after delivering a healthy child. Most reported modifying some of their behaviours and practices during pregnancy. The majority (81%) made changes to reduce exposure to chemicals, such as reducing their use of hair dyes, nail polishes, insecticide sprays, and home renovation products. However,

most women reported a lack of knowledge about environmental risks. The internet and media were their main sources of information.

A study in Germany evaluated perceptions of environmental chemicals in a survey among 289 women aged 18-45 years [60]. Nearly all participants (95%) agreed that environmental chemicals can pose a hazard, yet only 17% felt sufficiently informed about the risks and potential health effects of environmental chemicals. Nearly all (94%) wanted more information about environmental chemicals. The majority (69%) believed that they could protect themselves from environmental chemicals and believed (75%) that they, and not only politicians, have responsibility to protect themselves from hazardous environmental chemicals. Most (75%) preferred to receive information from a health professional. Notably, 60% reported difficulty in assessment the trustworthiness of available information from other sources and 67% reported feeling overwhelmed by too much information. The authors recommend that targeting education to pregnant women, specifically during the initial consultation during pregnancy by a health professional, is a good opportunity to address environmental chemicals [60] (see Annex 3 for the authors' guidelines for counselling pregnant women regarding environmental chemicals).

Perceptions of health professionals

A handful of qualitative and quantitative studies have been conducted among health professionals to assess their knowledge and perceptions of EDCs.

A questionnaire-based study conducted in France in 2015 assessed knowledge of phthalates among 189 perinatal health professionals (57% midwives, 27% general practitioners, and 17% obstetricians) and their habits for providing exposure preventive advice [61]. Of the 189 respondents (11% response rate), exposure to phthalates was perceived as high risk by most (66%), however, only 17% felt sufficiently knowledgeable to provide advice to pregnant women about reducing exposure to phthalates. Only 5.8% had received training in environmental health. Health professionals more frequently addressed dietary-related advice than other important recommendations regarding personal care products, cosmetics, and consumer products.

Another study assessed perceptions among health professionals of one chemical class, brominated flame retardants, among 400 professionals in Croatia [62] and similarly showed a lack of knowledge.

A questionnaire-based study conducted across France in 2018 assessed the knowledge, attitudes and practices of perinatal health professionals about EDCs and pregnancy [63]. Among the 1640 participants (41% response rate; 74% midwives, 14% obstetrician- gynaecologists, including residents, and 12% general medicine or general practitioners), the majority (83%) did not feel sufficiently knowledgeable about the health risks of EDCs in pregnancy and over half (57%) did not routinely provide information about EDCs to their patients.

A smaller qualitative study conducted in France found that health professionals (11 participated in focus groups) are moderately knowledgeable about environmental health issues, but less so about health risks associated with EDCs [64].

A quantitative study of knowledge of environmental exposures among 446 primary care health professionals and students (nurses, family doctors, paediatricians, gynaecologists, and medical and nursing students) in Basque Country, Spain, found moderate levels of environmental health knowledge [65]. However, only 6.5% had received training on how to conduct an environmental clinical history and only 6.3% routinely did so.

This is in line with a mixed methods study of 2,514 obstetricians in the US (members of the American Congress of Obstetricians and Gynaecologists, 14% response rate) where only 7% reported training

on environmental exposures and only 20% routinely conducted environmental clinical history in practice, to ask about exposures common in pregnancy women [66]. Barriers to counselling included a lack of training, time, and relevant risk communication tools. Furthermore, participating obstetricians were concerned about increasing anxiety among patients and uncertainty about the magnitude or severity of health risks associated with exposures. The authors note that in contrast to pharmaceuticals, the evidence of safety is inadequate for most environmental chemicals and that a precautionary approach and counselling patients to avoid exposures is appropriate.

A scoping review of 43 studies (published 2000-2014) of beliefs, training, and perceived competence among maternal and child health professionals found that environmental health training is limited in many countries and that environmental health history assessment is infrequently part of routine clinical practice [67].

General conclusions

Themes that emerge from these studies are:

- Perceptions among the public and health professionals has been studied most comprehensively in France. Most countries lack data on perceptions and knowledge.
- Surveys of pregnant women and general populations usually show that a moderate proportion are concerned about environmental exposures and EDCs, however, most feel insufficiently informed and obtain their information from the internet and media rather than more reliable sources.
- Most (perinatal) health professionals report limited training in environmental health and inadequate training in assessing the history of environmental exposures in patients.
- Barriers to advising patients include a lack of knowledge, uncertainties about evidence, doubt about the agency or self-efficacy of individuals to be able to change their exposures, and concerns about increasing anxiety among patients.

3.2 Perceptions in the Netherlands

We conducted an in-depth survey to gain more insight into the knowledge, perceptions and concerns of adults regarding EDCs and health, including reproductive health. We also assessed how peoples wish to gain knowledge and addressed barriers that people experience to implement changes in their lives. For practical purposes, this survey was focused on one country—the Netherlands—for which this has not been evaluated systematically. We aimed to synthesize results from this in-depth survey with the broader literature, to address country-specific factors for a successful health strategy.

3.2.1. Study design

Questionnaire

We developed a questionnaire to study the perceptions of adults of reproductive age in the Netherlands. The questionnaire included questions about participants' knowledge and risk perception of environmental chemicals, attitudes towards environmental chemicals, perceptions towards actions to reduce exposure to environmental chemicals, and from which stakeholders they would like to receive information on reducing their exposure to environmental chemicals. Demographic characteristics of the participants were also collected. The questionnaire was based on the Health Belief Model (HBM) [50]and the Theory of Planned Behaviour (TBP) [51] as described above (in Section 3.1). Questions were designed to assess each construct of both theories (i.e. HBM: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy; and TPB: attitudes, subjective norms, perceived behavioural control, intention, and behaviour). Most questions were modelled after similar questionnaire-based studies which assessed behaviours in relation to environmental hazards and chemical exposure reduction behaviours [19,55,56,63,68,69]. To take data quality into account, two attention check questions, unrelated to the content of the questionnaire, were embedded to verify whether respondents read questions sufficiently by selecting the correct answer provided in the text of the question [70]. Only participants with at least one correct attention check were included in the data analysis.

Recruitment and subpopulations

For this study, ethical approval was obtained from the research Ethics review committee Faculty of Science (BETCHIE) of the Vrije Universiteit Amsterdam, the Netherlands. Adults of reproductive age (18-49 years) from all regions in the Netherlands were recruited. Adults over 50 years of age may have perceptions that are not representative of adults of reproductive age. Younger participants (<18 years) were not included due to ethical constraints. Participants were considered eligible when able to read and fill out the Dutch questionnaire. All participants had to sign informed consent.

Two strategies were used to recruit participants. First, Freya, a Dutch organisation for people with fertility issues, shared the questionnaire with its members via newsletters and social media (approximately 4,500 social media followers). Second, PanelInzicht B.V., a research panel company with approximately 110,000 Dutch members aged ≥18 years encompassing geographic and socioeconomic variability, was used. Here, we used stratified sampling, where we aimed for a representative sample of the Dutch population based on distributions by age, gender, highest-attained education-level and region in the Netherlands based on numbers of Statistics Netherlands (Centraal Bureau voor de Statistiek, CBS).

A total of 846 people responded to the questionnaire of which 745 via PanelInzicht and 101 via Freya in the period January–April 2024. Of all respondents, 32% failed both attention checks and were excluded from data analysis, including 55% of the FREYA subpopulation and 29% of the PanelInzicht

subpopulation. This proportion of respondents failing to correctly answer attention checks is in line with similar surveys [71,72]. The final, total study population consisted of 576 respondents: 64% female, 64% had no children, 50% indicated a wish to have children at some point, and 48% were 18-30 years old. In the Freya subpopulation, 91% were female and 80% had a wish to have children. Participants were asked to rate their societal position, reflecting subjective socioeconomic position, using a 10-rung ladder [73], and most people regarded themselves as above the middle but before the top (average rung 6 for the PanelInzicht respondents and rung 7 for the Freya respondents).

3.2.2. Results of the survey

Perceptions of adults of reproductive age

The 576 participants were recruited via two strategies, leading to two subpopulations: 531 via PanelInzicht, a representative sample of adults of reproductive age from the Netherlands, and 45 via Freya, representing adults associated with a support organisation for persons with fertility issues in the Netherlands. There were a few striking differences between the subpopulations. Firstly, 96% of the Freya and 53% of the PanelInzicht respondents replied to have heard of EDCs.

In the PanelInzicht subpopulation, 11% often worried about chemical exposure and 45% sometimes worried about chemical exposure. However, almost half of the Freya subpopulation (47%) often worried about chemical exposure and 44% sometimes (Figure 1).

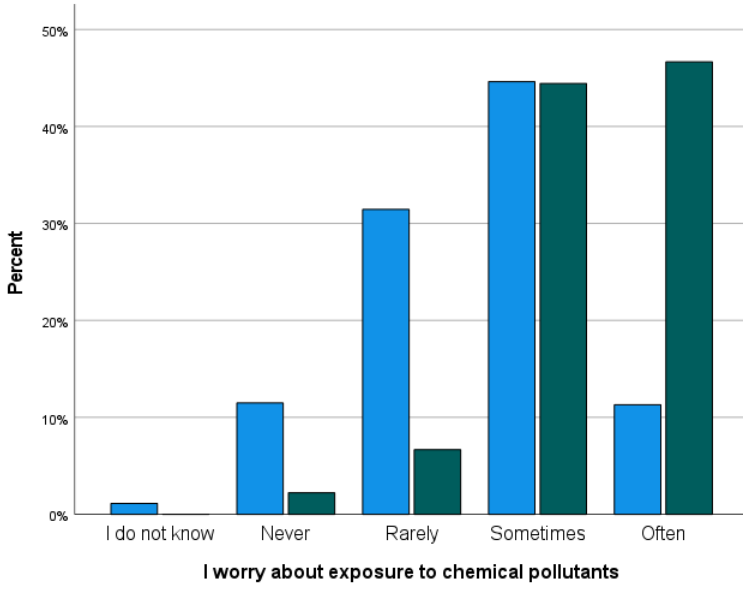


Figure 1. The extent to which adults in the Netherlands worry about chemical pollutants in the two subpopulations: persons associated with an organization for people with fertility issues (Freya, green) and representative of the general population of adults of reproductive age (18-50 years), (PanelInzicht, blue).

We asked participants to indicate how frequently they engaged in certain behaviours that are associated with chemical pollutant exposure (i.e. actual behaviour). More Freya respondents engage in exposure reducing behaviours than PanelInzicht respondents. Specifically, 67% of the Freya subpopulation often or frequently buys personal care products without harmful chemicals and 70% often or frequently heats food in a glass or ceramic container instead of a plastic container. In contrast, only 39% and 41% of the PanelInzicht subpopulation, respectively, engage in these behaviours (Annex 2, Figure S1; values for all respondents shown in Figure S2).

Finally, the perceived risk differed between the subpopulations. To estimate the perceived risk, people were first asked to estimate the health risk for an adult, child or unborn child (perceived severity, Annex 2, Figure S3). Then, they were asked how they estimate the health risk for themselves and their child (in case they have a child/children) or unborn child (in case of a wish to have children). Overall, the Freya subpopulation perceives a higher risk than the PanelInzicht subpopulation (Annex 2, Figure S4).

Despite the differences in awareness and risk perception between the subpopulations, the answers to questions about attitudes towards environmental chemicals, perceptions towards actions to reduce exposure to environmental chemicals, and from which stakeholders they would like to receive information on reducing their exposure to environmental chemicals, were similar. Therefore, these will be described from here on for all respondents as one group.

Knowledge of EDCs among Dutch adults

Of the 576 participants surveyed in the Netherlands, 56% had ever heard about EDCs. Seventy percent wanted to have additional information about chemical pollutants, for example about health risks and exposure reduction. This increased to 80% among people with a desire to have children. Most people (76%) indicated they wanted to receive information about chemical pollutants in the period around pregnancy; and preferably before (52%) or while trying (27%) to get pregnant. The minority indicated during pregnancy (9%), after birth (3%), it does not matter (8%), or does not know (1%).

Sources of information

Sources of information were predominantly the internet (39%), television (25%), and social media (23%). A majority (61%) felt insufficiently informed about chemical pollutants, while 25% indicated to be sufficiently informed and 14% did not know. When asked how people would like to be informed about EDCs (multiple options were possible), most indicated through governmental public health organizations (66%) followed by their general practitioner (42%), the midwife (36%), a non-governmental organization (35%), and the gynaecologist (30%). Social media channels were less preferred (Facebook 5%, Instagram 8%, TikTok 5%, X/Twitter 2%). Some people indicated that school would be a preferred source of information (secondary school 18%, vocational education and higher education 17%).

Perceived benefits, control, intention, and barriers to change behaviour

The vast majority of participants (95%) agreed to some extent that it is important to reduce exposure to chemical pollutants and 89% were willing to change their habits to lower exposure. More than 90% of the respondents believed that reducing exposure would benefit their health or their child's or future child's health (i.e. perceived benefits).

About 49% felt they had control to some or great extent over their exposure. Notably, 49% agreed to some or great extent that it is not solely their responsibility to manage this, and 92% agreed that the government is responsible for protecting people from exposure. However, 55% disagreed to some or great extent that the government protects them well from exposure to chemical pollutants.

When asked if they would intend to adopt certain behaviours (i.e. intention) that have been shown to reduce chemical exposures (see Section 2), overall, a high proportion of participations reported the intention to perform exposure reducing behaviours (Figure 2). For example, 84% expressed the intention ('maybe' or 'yes') to increase cleaning (mopping and vacuuming) and ventilation. There was more reluctance for engaging in other behaviours, for example, for limiting fatty fish consumption and limiting the use of personal care products and make-up.

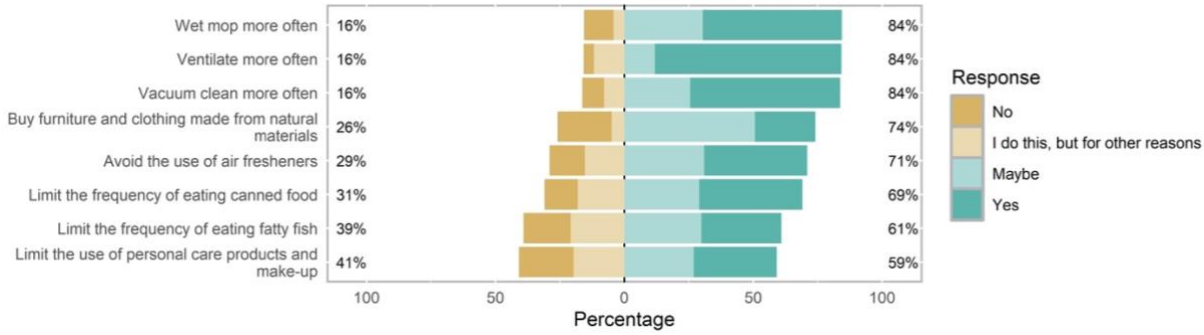


Figure 2. Intention to perform exposure-reducing behaviours in a Dutch survey with 576 respondents. Percentages indicate people who responded 'maybe' and 'yes' (green bar) and 'no' and 'I do this for other reasons' (gold bar).

We evaluated if people were already carrying out exposure reducing behaviours. For example, 66% sometimes, often or frequently heated food in a glass/ceramic container instead of a plastic container, and 67% sometimes, often or frequently bought personal care products without harmful chemicals (e.g. 'paraben-free'). Of these people, 66-82% indicated that they take these actions to limit exposure to chemicals and also for other reasons, and 18-34% that they did not do this to limit their exposure to chemicals. Of the people who did not regularly carry out exposure reducing behaviours, 21–51% responded '*yes'* they intended and 27-52% responded they '*maybe'* intended to adopt certain behaviours, depending on the behaviour (Annex 2, values reported for Freya and PanelInzicht separately in Figure S1, and for all respondents in Figure S2). For example, a greater proportion indicated an intention to heat food in glass or ceramic instead of plastic (49% responded '*yes'*) compared to buying different cleaning products (37% responded '*yes'*) or buying organic fruits and vegetables (21% responded '*yes'*).

When asked about barriers people perceived for exposure reducing behaviours in terms of costs, skills, time, and living a comfortable life, participants indicated most often that reducing exposure to chemical pollutants is regarded as expensive (Figure 3). Furthermore, skills were an important barrier: 60% agreed to find it hard to reduce exposure and 59% said not know how to reduce exposure. Investment of time or living a comfortable life were considered less important barriers.

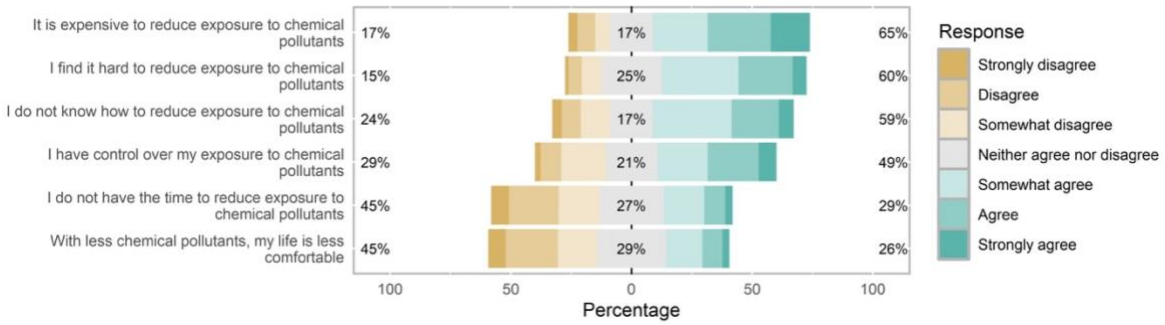


Figure 3. The extent to which people experience barriers and control over exposure reducing behaviours. Percentages indicate people who responded 'maybe' and 'yes' (green bar) and 'no' and 'I do this for other reasons' (gold bar) in a Dutch survey with 576 respondents.

Based on the Theory of Planned Behaviour and the Health Belief Model we expected that certain constructs we studied in the questionnaire predict intention and/or behaviour. Analyses of the survey results showed that when people find it important to be less exposed to chemical pollutants, they were more likely to perform exposure reducing behaviours. Also, when people were aware of higher risks and perceived more benefits of reduced exposure, they were more likely to exert behaviour to reduce their exposure. When barriers were considered high, people were less likely to change their behaviour to reduce exposure.

3.2.3. Conclusions

Overall, we can conclude from the survey among 576 Dutch participants:

- Information regarding health hazards of chemical exposure reaches half of the population aged 18-49 years.
- People are willing to change their behaviour, but financial costs and lack of adequate information are considered barriers.
- People prefer to receive information via governmental public health organisations and especially people who desire to have children would prefer to receive more information about chemical exposure and associated health risks, notably prior to pregnancy (i.e. preconception and earlier).

These findings from the survey in the Netherlands broadly align with findings reported in other studies, notably in the studies on perceptions from France [55,56,59].

4. Existing prevention and health promotion strategies

4.1 Existing health promotion strategies to reduce exposure to EDCs

Various national, European, and international recommendations to reduce the detrimental impact of exposure to EDCs on reproductive health and child development have been published that are targeted at individuals and healthcare providers. There is not a systematic overview of guidelines that are offered to women during pregnancy, to persons interested in becoming parents, or to the general public regarding protecting reproductive health.

The International Federation of Gynaecology and Obstetrics (FIGO) emphasizes that the preconception period is a critical window to improve maternal and child health and that preconception care should be provided to all women of childbearing age during routine visits to health professionals [74]. The WHO consensus on preconception care also emphasizes environmental factors: "*It aims to improve their health status and reduce behaviours and individual and environmental factors that contribute to poor maternal and child health outcomes.*" [75]. In the FIGO Preconception Checklist, created to promote adequate preconception care, one question specifically addresses EDCs: "Do you think you are exposed to any toxic environmental chemicals? If you have replied YES, you should be given specific advice on how to avoid/reduce exposure" (see also Annex 3). However, FIGO does not have a comprehensive guide on counselling that should be offered regarding environmental chemicals. The Endocrine Society, an international professional organisation of endocrine scientists and clinical practitioners, provides background information on EDCs targeted at healthcare professionals and the public [76,77]; see also Annex 3). The World Health Organisation antenatal care guidelines [78] do not specifically address chemical exposures, EDCs, or toxic substances beyond tobacco smoke.

Several professional, medical organisations have guidelines related to EDCs. The European Society of Endocrinology [79], for example, published 10 recommendations for good hormone health (see Annex 3).

Most countries have educational materials (e.g. a pamphlet or website) provided to women and their partners during pregnancy informing them of ways to reduce exposure to risk factors. Some countries have apps that individuals can use to guide their purchasing options or to contact the manufacturer directly. According to the REACH regulation in the EU (Article 33), manufacturers and suppliers of products are legally obligated to respond within 45 days if a consumer requests information about Substances of Very High Concern (SVHCs) above 0.1% weight in their products.

Selected recommendations targeted at reducing chemical exposures during or prior to pregnancy are included in Annex 3. A few examples of country-specific governmental actions, recommendations and public health guidelines targeted to reduce exposure to EDCs in some EU countries are given below:

Belgium. Belgium has a national action plan on EDCs, provides information on EDCs and launched a campaign, including recommendations to reduce exposure. There is also a mobile app available since 2023, Scan4Chem, which is a tool individuals can use for identifying substances of very high concern, including EDCs, in consumer products by scanning their barcodes.

Denmark. The Danish government established a national centre for endocrine disruptors. An online information page, backed by the Danish consumer council, provides 10 tips on reducing exposure to unwanted chemicals during pregnancy (see Annex 3) and the consumer app Kemiluppen allows to check if personal care products and cleaning products contain unwanted chemicals, including EDCs. An information leaflet from the Danish Environmental Protection Agency (EPA) providing advice on healthy pregnancies, including advice on avoiding products with harmful chemicals. The Danish EPA has also initiated a project Survey of chemical substances in consumer products; a report where FREIA partners were involved in the hazard and risk assessment.

France. As part of their national action plan on endocrine disruptors, France published a decree that manufacturers have to provide information on known, suspected or alleged EDCs in products. The French National College of Midwives set up a multidisciplinary working group to create clinical practice guidelines for preventive interventions during the perinatal period which include sections addressing exposure to hazardous chemicals [80]. We highlight this as a systematic, expert and evidence-based, and well-documented approach. There are specific guidelines for reducing EDC exposures focusing on cosmetics [81] and household products, building materials, decorations, and pesticides [82] (refer to Annex 3 for the suggested interventions including the level-of-evidence grade).

Germany. The German government launched a five-point plan on EDCs for federal government actions. There is a mobile app (ToxFox, BUND-produktcheck) that allows consumers to check the contents and contact the manufacturer directly regarding the contents of a product. This tool is also available without mobile phone via BUND's website.

The Netherlands. Government-backed website with information on chemicals, including EDCs, and measures to reduce exposure targeted at specific populations, including for pregnant women.

Sweden. Information on chemicals, including EDCs, is provided by the government along with an app (Kemikalieappen) which allows consumers to scan a product barcode and receive information or easily ask the company for information on chemicals and EDCs in the product.

Commonly addressed aspects in guidelines include:

- Dietary: prefer organic and fresh foods; avoid plastic in food packaging, containers, and during food preparation.
- Personal care products and cosmetics: avoiding fragrances, phthalates, parabens.
- Residential: avoid chemicals during renovations, pest control, increase cleaning.

Overall, there is limited knowledge on the effectiveness of existing guidelines with respect to acceptability, access rates, compliance, and effectiveness with respect to reducing exposures to EDCs and more broadly environmental risk factors. For example, numerous guidelines suggest using 'fragrance free' labelled personal care products during pregnancy, yet reductions in phthalates and replacements were modest to null for numerous compounds in a longitudinal study of 303 pregnant women in the US [83]. This label is poorly regulated in many countries, although recently amended EU regulation on cosmetics and fragrance allergens and labelling (Commission Regulation (EU) 2023/1545) is expected to improve the efficacy of this type of label. We address other opportunities and recommendations for health promotion below (Section 4.2).

For some recommendations, assessment is required regarding benefits versus costs. For example, many countries have advice on the quantity and/or types of fish consumption to reduce exposure to heavy metals and POPs and address cost-benefit considerations [84,85].

Finally, we note that the use of analgesic pain medication during pregnancy, specifically paracetamol (also known as acetaminophen), has received attention as warranting further research and action with respect to guideline development due to its endocrine-disrupting effects [86,87]. Although paracetamol is a pharmaceutical agent and not an environmental chemical, the broader issue of the safe use of pharmaceuticals during pregnancy remains critical. This issue should be addressed in health promotion strategies, thereby complementing the discussion of reducing environmental EDCs exposures covered in this report.

4.2 Effective health promotion strategies

We summarise recommendations for strategies for reducing exposure to EDCs, focusing on safeguarding female reproductive health in Section 5. In this paragraph, we describe the evidence and considerations underlying these recommendations.

4.2.1 Enhance environmental health literacy and awareness of EDCs

Increasing an individual's self-efficacy—the belief in abilities and competencies to influence or make changes in something—is at the core of health promotion [88]. Yet, a large part of the population is not aware of the health risks of EDCs. People who are aware of these risks are more willing to adjust their behaviour and reduce their exposure to EDCs.

Labelling consumer products with information about chemical contents can increase risk perception and motivate behaviour changes [89]. Eco-labels aid consumers in avoiding EDCs in personal care products and consumer products. A study of Nordic consumers found that awareness of EDCs is positively linked with label performance, including willingness-to-buy and willingness-to-pay [72]. Label performance is linked to informational value and trust in the label, and how much the label aligns with consumers' values [90].

We highlight the mobile apps in several countries (see Section 4.1) which can be used by individuals to check the chemical and EDC content of products. However, to our knowledge, their efficacy has not been comprehensively evaluated.

Stakeholders

Generally, strategies should be created in collaboration with stakeholders. We conducted a preliminary stakeholder analysis (Table 2) to describe our assumptions about the interest and influence of stakeholders with respect to health promotion for reducing EDCs exposures and suggest the role stakeholders could play in future co-creation processes. Given the high-level of trust generally reported in government-backed public health guidelines and in information from health professionals (Section 3), they should take leading roles in providing information to the public. There are good examples of well-described approaches that can serve as an example for others. NGOs may play a role in amplifying awareness of public health guidelines.

We highlight the clinical practice guidelines for preventive interventions during the perinatal period commissioned by the French National College of Midwives as exemplary [80–82] (see Section 4.1 and Annex 3). This addresses straightforward measures perinatal health professionals can use in counselling individuals on how to reduce their exposure to reprotoxic chemical and EDCs. This could provide the basis for development of similar guidelines in other countries, considering also country-

specific context and needs. We propose that FIGO could play a role in developing accessible and expert consensus-based exposure prevention guidelines relevant for the periods prior to pregnancy (preconception) and during pregnancy. However, it is anticipated that prior to pregnancy, contact and opportunities for counselling by health professionals on environmental health and EDCs will be limited in some countries.

Table 2. Categories of stakeholders and proposed roles in co-creation of health promotion strategies for reducing exposures to EDCs and protecting female reproductive health.

Stakeholder	Selected stakeholders	Stakeholder analysis	Proposed role
Government bodies	• Ministry of Health • Ministry of Education • National Health Council	Low/moderate interest and moderate/high influence	Inform, collaborate
Professional organisations, health professionals	• International Federation of Gynecology and Obstetrics (FIGO) • European Society of Human Reproduction and Embryology (ESHRE) • National Professional Organisations for Midwives; for Obstetrics and Gynaecology • Endocrine Societies	Moderate interest and high influence	Collaborate: actively co-create
Advocacy organisations, NGOs	• EDC-Free Europe (coalition of public interest groups) • International Pollutants Elimination Network (IPEN) network • Health and Environment Alliance (HEAL)	High interest and low/moderate influence	Consult
Educators	• Higher education educators (medical, public health) • Highschool teachers	Unknown interest and moderate influence	Consult
Young women and prospective parents	• Adolescents, young and middle-aged adults	Moderate interest and high influence	Collaborate: Co-create

Communication channels

Social media is an effective way to reach a broad audience, although evaluating the performance of social media to promote health promotion behaviours is complex and limited [91,92]. Consideration should be given to the perception studies indicating that trust in social media is lower than for other sources, and promotion may need to be clearly linked to authoritative and trusted information sources.

A growing number of countries are including environmental health literacy as part of the core curriculum for secondary school students [93,94]. Education targeted at adolescents in schools would have broad reach and prevent exposures over a longer period than programs initiated during pregnancy, thereby reducing the duration and cumulative exposure burdens.

Personalized profiling can increase self-efficacy. A recent epidemiological cohort study found that providing individual-level feedback on level of multiple chemicals increased knowledge, risk perception, and changes in behaviour [95]. As future technological advances lower the cost of chemical

exposomics screening, this may prove to be an avenue for increasing self-efficacy and empowering individuals to make changes to lower their exposures.

Maximise impact

Important barriers to action were reported to be financial costs and uncertainties about effective ways to reduce exposures and health risks (Section 3). There is robust evidence for multiple interventions that decrease EDC exposures (Section 1). Regarding the costs of avoiding EDCs, there is scarce data on this. It is anticipated that some options, such as purchasing organic food, installing air or water filters, and purchasing selected eco-labelled products may be more expensive than standard alternatives. A series of surveys conducted in 22 countries by the OECD evaluated willingness-to-pay to avoid negative chemicals-related health effects [96]. Preliminary results showed that respondents were willing to pay the most to avoid a very low birth weight outcome (USD 1 194 000 value per statistical case), and substantial amounts for other outcomes, including to avoid infertility (USD 91 000). Forthcoming results of additional surveys will inform cost-benefit analyses of chemicals management policies. Here, the cost of inaction should also be considered; several studies have calculated that the socio-economic cost of diseases in the EU related to EDC exposure can amount up to billions of Euros per year, of which a substantial part is attributed to female reproductive disorders [97–100].

4.2.2 Increase environmental health training for health professionals

As described in previous sections, healthcare providers are viewed as reliable sources of information, but many lack sufficient knowledge and training in environmental health [67,101]. Training health professionals in environmental health literacy and how to conduct environmental history assessments is crucial.

An effective way to integrate environmental health training into health professionals' education, including continuing education, may be web-based modules (e-learning). This approach was demonstrated to be successful in a study of professionals whereby e-learning modules paediatric environmental health promoted by the US Centers for Disease Control and Prevention (CDC) showed improved knowledge test scores at re-assessment 6 months afterwards [102]. However, a review of 16 studies (randomised control trials) on the effectives of e-learning compared to traditional learning for health professionals indicated inconclusive findings [103]. Therefore, integrated environmental health education into core training programs remains important. A one-hour lecture was shown to be insufficient to acquire environmental health history taking skills [104]. Problem-based learning may be an effective approach for integrating environmental health into curricula [105].

4.2.3 Expand knowledge on effectiveness of interventions and health promotion strategies

There remain knowledge gaps that hamper the development of robust health promotion strategies. We emphasize the need for:

- National human biomonitoring programs to provide insight into country-specific exposure distributions to a wide range of chemicals of concern, including EDCs, across a variety of age groups.
- Additional research into the effectiveness of exposure-reduction interventions, notably focusing on more than one chemical class, and concerning acceptability, compliance, and long-term effectiveness.
- Research into how health promotion strategies regarding EDCs should effectively deal with uncertainties in risks; communicating benefit-cost considerations; a growing lack of trust in

experts and government-backed guidelines; and approaches that minimize rather than increase exposure and health disparities.

- Research and guidelines on medical devices and processes using formulations without known EDCs should be carried out.

These knowledge gaps do not preclude the need for implementing health promotion strategies.

4.3 Strong policies are essential to prevent adverse health effects caused by EDCs

Avoiding exposure to EDCs and other hazardous chemicals is important to prevent adverse health effects. It is crucial to emphasise that although individual behaviour changes can significantly reduce exposure to EDCs, comprehensive public policies at the population level are essential to fully address the health concerns associated with EDCs. The Chemicals Strategy for Sustainability (CSS, 2020) published by the European Commission committed to address some of the gaps in regulating and managing the health risks of exposure to EDCs, but to date its implementation remains incomplete to fully address the concerns of EDCs [106]. Therefore, strong political support is crucial to develop and implement EU-wide legislation to reduce the use of and exposure to EDCs. This may include:

- Ensure the comprehensive and timely implementation of the European Chemicals Strategy for Sustainability (CSS), in particular the commitments to protect consumers, vulnerable groups and workers from the most harmful chemicals, including EDCs.
- Phase out chemicals that affect the endocrine system from consumer products as committed in the CSS.
- Strengthen the implementation of the EU legal frameworks to reduce the use of and exposure to pesticides and biocides classified as or containing EDCs.
- Provide adequate resources and support for the identification and classification of EDCs under the EU regulation on classification, labelling and packaging of substances and mixtures (CLP).
- Revise and strengthen the REACH information requirements to ensure that sufficient and appropriate data is made available to allow the identification of EDCs. Here, the outcomes of the FREIA project, as well as from 7 other related projects with the aim to improve test methods for EDC identification, can provide significant input (see also EURION Policy Brief).

5. Recommendations

Based on the literature on the evidence for the efficacy of exposure reduction approaches (Section 2); the knowledge and perceptions of EDCs of the public and health professionals (Section 3); and existing public health guidelines and evidence-based health promotion approaches (Section 4), we derived recommendations that may support a successful strategy to reduce the exposure of individuals to EDCs and as a result prevent EDC-related harmful health effects (Table 3). The key considerations for these recommendations are described above (Section 4.2).

Table 3. Recommendations for strategies to reduce exposure to EDCs and protect reproductive health.

What	Why	Who	How	How to maximise impact
Enhance environmental health literacy and awareness of EDCs	A large part of the population is not aware of the health risks of EDCs. People who are aware of these risks are more willing to adjust their behaviour and reduce their exposure to EDCs.	Governmental environment and public health organisations should take a leading role in providing information. Also, consumer councils should play a role in information campaigns.	• Place easily accessible, understandable information on governmental websites. • Provide evidence-based recommendations to increase credibility, without being overly conservative. • Improve labelling of consumer products. • There are good examples of well-described governmental approaches, information campaigns and useful apps that can serve as an example for others.	Identify barriers and turn these into opportunities. Make information on how to reduce exposure to EDCs easily accessible and show people that reducing exposure to EDCs does not have to be expensive.
	Ensure broad outreach and effective dissemination.	NGOs	• Campaigns (social media), infographics	Refer to governmental information.
	People may seek medical advice about the health risks of EDCs, e.g. when trying to conceive; and should be routinely counselled.	Health professionals	• Refer to existing pamphlets and infographics from reliable sources.	Be open to the dialogue when patients come with questions. Refer to governmental information.
	School programs are considered a reliable source of information on the health risks of chemicals.	Educators, curricula developers, governmental health care organisations, perinatal professional organisations, Ministry of Education	• Thematic (online) modules are easy to develop and implement when made freely available.	Creating awareness from a young age onwards will generate the most health impact as exposure will likely be reduced throughout a person's life and behaviour passed on to future generations.

Increase environmental health training for health professionals	Healthcare providers feel not sufficiently informed to provide advice to patients. Surveys of the public and women who are pregnant or seeking to become pregnant indicate that health professionals are a trusted and desired source of information.	National professional organisations settings standards for (continuing) education and international professional societies creating training resources and statements (including FIGO).	• Education through core curriculum and continuing education credits.	Including environmental health in advanced educational programs, including medical schools, will empower health professionals to address this issue among patients.
Expand knowledge on the effectiveness of exposure prevention interventions and promotion strategies	There is limited knowledge regarding the effectiveness of existing guidelines concerning acceptability, access rates, compliance, and effectiveness with reducing exposures to EDCs and more broadly environmental risk factors. Biomonitoring of population exposure levels is relevant to create country-specific insights in mitigation priorities.	Researchers, government knowledge institutes.	• Biomonitoring and intervention studies generate important knowledge on effective exposure-reduction measures and account for country-specific contexts. • Mixed method studies (quantitative surveys and qualitative focus groups) are a good approach to identifying country-specific factors for successful interventions.	Share knowledge on effective exposure-reduction health promotion strategies during various life stages (adolescence, preconception, pregnancy, etc.).
Support development and implementation of EU-wide legislation to reduce the use of and exposure to EDCs	Individual behaviour changes can reduce exposure to EDCs, but comprehensive public policies at the population level are essential to fully address the health hazards associated with EDCs.	European Parliament, member state representatives	• Ensure the comprehensive and timely implementation of the European Chemicals Strategy for Sustainability. • Update chemical Regulations to ensure sufficient and appropriate data is generated to allow the identification of EDCs.	Preventing exposure to EDCs helps to prevent diseases.

References

1. Teysseire R, Brochard P, Sentilhes L, Delva F. Identification and Prioritization of Environmental Reproductive Hazards: A First Step in Establishing Environmental Perinatal Care. *International Journal of Environmental Research and Public Health 2019, Vol 16, Page 366*. 2019;16(3):366. doi:10.3390/IJERPH16030366
2. Karwacka A, Zamkowska D, Radwan M, Jurewicz J. Exposure to modern, widespread environmental endocrine disrupting chemicals and their effect on the reproductive potential of women: an overview of current epidemiological evidence. *Hum Fertil*. 2019;22(1):2-25. doi:10.1080/14647273.2017.1358828
3. Green MP, Harvey AJ, Finger BJ, Tarulli GA. Endocrine disrupting chemicals: Impacts on human fertility and fecundity during the peri-conception period. *Environ Res*. 2021;194:110694. doi:10.1016/J.ENVRES.2020.110694
4. Kim YR, Pacella RE, Harden FA, White N, Toms LML. A systematic review: Impact of endocrine disrupting chemicals exposure on fecundity as measured by time to pregnancy. *Environ Res*. 2019;171:119-133. doi:10.1016/J.ENVRES.2018.12.065
5. Genco M, Anderson-Shaw L, Sargis RM. Unwitting Accomplices: Endocrine Disruptors Confounding Clinical Care. *J Clin Endocrinol Metab*. 2020;105(10):1-6. doi:10.1210/CLINEM/DGAA358
6. Bellavia A, Zou R, Björvang RD, et al. Association between chemical mixtures and female fertility in women undergoing assisted reproduction in Sweden and Estonia. *Environ Res*. 2023;216(Pt 1). doi:10.1016/J.ENVRES.2022.114447
7. Björvang RD, Damdimopoulou P. Persistent environmental endocrine-disrupting chemicals in ovarian follicular fluid and in vitro fertilization treatment outcome in women. *Ups J Med Sci*. 2020;125(2):85-94. doi:10.1080/03009734.2020.1727073
8. Duh-Leong C, Maffini M V., Kassotis CD, Vandenberg LN, Trasande L. The regulation of endocrine-disrupting chemicals to minimize their impact on health. *Nature Reviews Endocrinology 2023 19:10*. 2023;19(10):600-614. doi:10.1038/S41574-023-00872-X
9. Fowler PA, Bellingham M, Sinclair KD, et al. Impact of endocrine-disrupting compounds (EDCs) on female reproductive health. *Mol Cell Endocrinol*. 2012;355(2):231-239. doi:10.1016/J.MCE.2011.10.021
10. Hassan S, Thacharodi A, Priya A, et al. Endocrine disruptors: Unravelling the link between chemical exposure and Women's reproductive health. *Environ Res*. 2024;241:117385. doi:10.1016/J.ENVRES.2023.117385
11. European Union. Press release: 'Endocrine disruptors: A strategy for the future that protects EU citizens and the environment.' https://ec.europa.eu/commission/presscorner/detail/en/IP_18_6287.
12. van Duursen MBM, Boberg J, Christiansen S, et al. Safeguarding Female Reproductive Health Against Endocrine Disrupting Chemicals—The FREIA Project. *International Journal of Molecular Sciences 2020, Vol 21, Page 3215*. 2020;21(9):3215. doi:10.3390/IJMS21093215
13. Martin L, Zhang Y, First O, et al. Lifestyle interventions to reduce endocrine-disrupting phthalate and phenol exposures among reproductive age men and women: A review and future steps. *Environ Int*. 2022;170:107576. doi:10.1016/J.ENVINT.2022.107576
14. Yang TC, Jovanovic N, Chong F, et al. Interventions to Reduce Exposure to Synthetic Phenols and Phthalates from Dietary Intake and Personal Care Products: a Scoping Review. *Curr Environ Health Rep*. 2023;10(2):184-214. doi:10.1007/S40572-023-00394-8/TABLES/3
15. Sieck NE, Bruening M, van Woerden I, Whisner C, Payne-Sturges DC. Effects of Behavioral, Clinical, and Policy Interventions in Reducing Human Exposure to Bisphenols and Phthalates: A Scoping Review. *Environ Health Perspect*. 2024;132(3). doi:10.1289/EHP11760/SUPPL_FILE/EHP11760.S001.ACCO.PDF
16. Corbett GA, Lee S, Woodruff TJ, et al. Nutritional interventions to ameliorate the effect of endocrine disruptors on human reproductive health: A semi-structured review from FIGO. *International Journal of Gynecology & Obstetrics*. 2022;157(3):489-501. doi:10.1002/IJGO.14126

17. Pirard C, Charlier C. Urinary levels of parabens, phthalate metabolites, bisphenol A and plasticizer alternatives in a Belgian population: Time trend or impact of an awareness campaign? *Environ Res*. 2022;214:113852. doi:10.1016/J.ENVRES.2022.113852

18. Sakaki JR, Provatas AA, Perkins C, Chun OK. Urinary excretion of estrogenic chemicals following consumption of capsule coffee and French press coffee: A crossover study. *Toxicol Rep*. 2022;9:728-734. doi:10.1016/J.TOXREP.2022.03.024

19. El Ouazzani H, Fortin S, Venisse N, et al. Perinatal environmental health education intervention to reduce exposure to endocrine disruptors: The preved project. *Int J Environ Res Public Health*. 2022;19(1). doi:10.3390/IJERPH19010070/S1

20. Hagobian T, Delli-Bovi Z, Mercado A, Bird A, Guy M, Phelan S. Development and feasibility of randomized trial to reduce urinary bisphenols in women with obesity. *Pilot Feasibility Stud*. 2021;7(1):1-8. doi:10.1186/S40814-020-00744-5/TABLES/2

21. Kim JH, Kwak JM, Kang H. Web-based behavioral intervention to reduce exposure to phthalate metabolites, bisphenol A, triclosan, and parabens in mothers with young children: A randomized controlled trial. *Int J Hyg Environ Health*. 2021;236:113798. doi:10.1016/J.IJHEH.2021.113798

22. Park SM, Chung CW. Effects of a dietary modification intervention on menstrual pain and urinary BPA levels: a single group clinical trial. *BMC Womens Health*. 2021;21(1):1-9. doi:10.1186/S12905-021-01199-3/FIGURES/2

23. Sessa F, Polito R, Monda V, et al. Effects of a Plastic-Free Lifestyle on Urinary Bisphenol A Levels in School-Aged Children of Southern Italy: A Pilot Study. *Front Public Health*. 2021;9:626070. doi:10.3389/FPUBH.2021.626070/BIBTEX

24. van der Meer TP, Thio CHL, van Faassen M, et al. Endocrine disrupting chemicals during diet-induced weight loss – A post-hoc analysis of the LOWER study. *Environ Res*. 2021;192:110262. doi:10.1016/J.ENVRES.2020.110262

25. Wu W, Cao L, Zheng TT, et al. Prenatal phthalate exposure reduction through an integrated intervention strategy. *Environmental Science and Pollution Research*. 2021;28(40):57183-57191. doi:10.1007/S11356-021-14613-Y/FIGURES/3

26. Kim S, Lee I, Lim JE, et al. Dietary contribution to body burden of bisphenol A and bisphenol S among mother-children pairs. *Science of The Total Environment*. 2020;744:140856. doi:10.1016/J.SCITOTENV.2020.140856

27. Sears CG, Lanphear BP, Calafat AM, et al. Lowering urinary phthalate metabolite concentrations among children by reducing contaminated dust in housing units: A randomized controlled trial and observational study. *Environ Sci Technol*. 2020;54(7):4327. doi:10.1021/ACS.EST.9B04898

28. Dusanov S, Svendsen M, Ruzzin J, et al. Effect of fatty fish or nut consumption on concentrations of persistent organic pollutants in overweight or obese men and women: A randomized controlled clinical trial. *Nutrition, Metabolism and Cardiovascular Diseases*. 2020;30(3):448-458. doi:10.1016/J.NUMECD.2019.11.006

29. Dallio M, Masarone M, Errico S, et al. Role of bisphenol A as environmental factor in the promotion of non-alcoholic fatty liver disease: in vitro and clinical study. *Aliment Pharmacol Ther*. 2018;47(6):826-837. doi:10.1111/APT.14499

30. Galloway TS, Baglin N, Lee BP, et al. An engaged research study to assess the effect of a 'real-world' dietary intervention on urinary bisphenol A (BPA) levels in teenagers. *BMJ Open*. 2018;8(2):e018742. doi:10.1136/BMJOPEN-2017-018742

31. Correia-Sá L, Kasper-Sonnenberg M, Pälmke C, et al. Obesity or diet? Levels and determinants of phthalate body burden – A case study on Portuguese children. *Int J Hyg Environ Health*. 2018;221(3):519-530. doi:10.1016/J.IJHEH.2018.02.001

32. Correia-Sá L, Kasper-Sonnenberg M, Schütze A, et al. Exposure assessment to bisphenol A (BPA) in Portuguese children by human biomonitoring. *Environmental Science and Pollution Research*. 2017;24(35):27502-27514. doi:10.1007/S11356-017-0358-7/TABLES/1

33. Harley KG, Kogut K, Madrigal DS, et al. Reducing phthalate, paraben, and phenol exposure from personal care products in adolescent girls: Findings from the hermosa intervention study. *Environ Health Perspect*. 2016;124(10):1600-1607. doi:10.1289/EHP.1510514/SUPPL_FILE/EHP.1510514.S001.ACCO.PDF

34. Chen CY, Chou YY, Lin SJ, Lee CC. Developing an intervention strategy to reduce phthalate exposure in Taiwanese girls. *Science of The Total Environment*. 2015;517:125-131. doi:10.1016/J.SCITOTENV.2015.02.021

35. Bae S, Hong YC. Exposure to bisphenol a from drinking canned beverages increases blood pressure: Randomized crossover trial. *Hypertension*. 2015;65(2):313-319. doi:10.1161/HYPERTENSIONAHA.114.04261/-/DC1

36. Sathyanarayana S, Alcedo G, Saelens BE, et al. Unexpected results in a randomized dietary trial to reduce phthalate and bisphenol A exposures. *Journal of Exposure Science & Environmental Epidemiology 2013 23:4*. 2013;23(4):378-384. doi:10.1038/jes.2013.9

37. Carwile JL, Ye X, Zhou X, Calafat AM, Michels KB. Canned Soup Consumption and Urinary Bisphenol A: A Randomized Crossover Trial. *JAMA*. 2011;306(20):2218-2220. doi:10.1001/JAMA.2011.1721

38. Carwile JL, Luu HT, Bassett LS, et al. Polycarbonate Bottle Use and Urinary Bisphenol A Concentrations. *Environ Health Perspect*. 2009;117(9):1368-1372. doi:10.1289/EHP.0900604

39. Janjua NR, Kongshoj B, Andersson AM, Wulf HC. Sunscreens in human plasma and urine after repeated whole-body topical application. *Journal of the European Academy of Dermatology and Venereology*. 2008;22(4):456-461. doi:10.1111/J.1468-3083.2007.02492.X

40. Lu C, Toepel K, Irish R, Fenske RA, Barr DB, Bravo R. Organic Diets Significantly Lower Children's Dietary Exposure to Organophosphorus Pesticides. *Environ Health Perspect*. 2006;114(2):260. doi:10.1289/EHP.8418

41. Ley C, Pischel L, Parsonnet J. Triclosan and triclocarban exposure and thyroid function during pregnancy—A randomized intervention. *Reproductive Toxicology*. 2017;74:143-149. doi:10.1016/J.REPROTOX.2017.09.005

42. Kahleova H, Tonstad S, Rosmus J, et al. The effect of a vegetarian versus conventional hypocaloric diet on serum concentrations of persistent organic pollutants in patients with type 2 diabetes. *Nutr Metab Cardiovasc Dis*. 2016;26(5):430-438. doi:10.1016/J.NUMECD.2016.01.008

43. Hallberg I, Björvang RD, Hadziosmanovic N, et al. Associations between lifestyle factors and levels of per- and polyfluoroalkyl substances (PFASs), phthalates and parabens in follicular fluid in women undergoing fertility treatment. *Journal of Exposure Science & Environmental Epidemiology 2023 33:5*. 2023;33(5):699-709. doi:10.1038/S41370-023-00579-1

44. Young AS, Hauser R, James-Todd TM, et al. Impact of "healthier" materials interventions on dust concentrations of per- and polyfluoroalkyl substances, polybrominated diphenyl ethers, and organophosphate esters. *Environ Int*. 2021;150:106151. doi:10.1016/J.ENVINT.2020.106151

45. Gibson EA, Stapleton HM, Calero L, et al. Flame retardant exposure assessment: findings from a behavioral intervention study. *Journal of Exposure Science & Environmental Epidemiology 2018 29:1*. 2018;29(1):33-48. doi:10.1038/S41370-018-0049-6

46. Lin PID, Wu CF, Kou HS, Huang TY, Shiea J, Wu MT. Removal of Diethylhexyl Phthalate from Hands by Handwashing: Evidence from Experimental N-of-1 and Crossover Designs. *Scientific Reports 2017 7:1*. 2017;7(1):1-7. doi:10.1038/S41598-017-00581-2

47. Harley KG, Calderon L, Nolan JES, et al. Changes in latina women's exposure to cleaning chemicals associated with switching from conventional to "green" household cleaning products: The lucir intervention study. *Environ Health Perspect*. 2021;129(9). doi:10.1289/EHP8831/SUPPL_FILE/EHP8831.S001.ACCO.PDF

48. Frederiksen H, Nielsen O, Koch HM, et al. Changes in urinary excretion of phthalates, phthalate substitutes, bisphenols and other polychlorinated and phenolic substances in young Danish men; 2009–2017. *Int J Hyg Environ Health*. 2020;223(1):93-105. doi:10.1016/J.IJHEH.2019.10.002

49. Shenep LE, Shenep MA, Cheatham W, et al. Efficacy of intravascular catheter lock solutions containing preservatives in the prevention of microbial colonization. *Journal of Hospital Infection*. 2011;79(4):317-322. doi:10.1016/j.jhin.2011.07.010
50. Champion VL, Skinner CS. The health belief model. In: Glanz K, Rimer BK, Viswanath K, eds. *Health Behavior and Health Education: Theory, Research, and Practice*. Jossey-Bass; 2011:45-65.
51. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process*. 1991;50(2):179-211. doi:10.1016/0749-5978(91)90020-T
52. Kelly M, Connolly L, Dean M. Public Awareness and Risk Perceptions of Endocrine Disrupting Chemicals: A Qualitative Study. *Int J Environ Res Public Health*. 2020;17(21):1-16. doi:10.3390/IJERPH17217778
53. Ho H, Watanabe T. The Roles of Three Types of Knowledge and Perceived Uncertainty in Explaining Risk Perception, Acceptability, and Self-Protective Response—A Case Study on Endocrine Disrupting Surfactants. *Int J Environ Res Public Health*. 2018;15(2). doi:10.3390/IJERPH15020296
54. Maxim L, Mansier P, Grabar N. Public reception of scientific uncertainty in the endocrine disrupter controversy: the case of male fertility. *J Risk Res*. 2013;16(6):677-695. doi:10.1080/13669877.2012.726245
55. Rouillon S, Deshayes-Morgand C, Enjalbert L, et al. Endocrine Disruptors and Pregnancy: Knowledge, Attitudes and Prevention Behaviors of French Women. *International Journal of Environmental Research and Public Health 2017, Vol 14, Page 1021*. 2017;14(9):1021. doi:10.3390/IJERPH14091021
56. Rouillon S, El Ouazzani H, Rabouan S, Migeot V, Albouy-Llaty M. Determinants of Risk Perception Related to Exposure to Endocrine Disruptors during Pregnancy: A Qualitative and Quantitative Study on French Women. *Int J Environ Res Public Health*. 2018;15(10). doi:10.3390/IJERPH15102231
57. Ashley JM, Hodgson A, Sharma S, Nisker J. Pregnant women's navigation of information on everyday household chemicals: Phthalates as a case study. *BMC Pregnancy Childbirth*. 2015;15(1):1-11. doi:10.1186/S12884-015-0748-0/FIGURES/2
58. Park SM, Chung CW. How do mothers with young children perceive endocrine-disrupting chemicals?: an exploratory qualitative study. *Korean Journal of Women Health Nursing*. 2023;29(4):337. doi:10.4069/KJWHN.2023.11.28
59. Teysseire R, Lecourt M, Canet J, Manangama G, Sentilhes L, Delva F. Perception of Environmental Risks and Behavioral Changes during Pregnancy: A Cross-Sectional Study of French Postpartum Women. *International Journal of Environmental Research and Public Health 2019, Vol 16, Page 565*. 2019;16(4):565. doi:10.3390/IJERPH16040565
60. Fischer F, Zenclussen AC, Meyer N. Hazards due to everyday chemicals: An impulse for prenatal care. *Gynakologie*. 2023;56(9):633-640. doi:10.1007/S00129-023-05125-6/TABLES/2
61. Marie C, Lémery D, Vendittelli F, Sauvant-Rochat MP. Phthalate Exposure in Pregnant Women: Risk Perception and Preventive Advice of Perinatal Health Professionals. *Matern Child Health J*. 2019;23(3):335-345. doi:10.1007/S10995-018-2668-X/TABLES/5
62. Jakšić K, Matek Sarić M, Čulin J. Knowledge and attitudes regarding exposure to brominated flame retardants: a survey of Croatian health care providers. *Environmental Science and Pollution Research*. 2020;27(7):7683-7692. doi:10.1007/S11356-019-07496-7/TABLES/6
63. Marguillier E, Beranger R, Garlantezec R, et al. Endocrine disruptors and pregnancy: Knowledge, attitudes and practice of perinatal health professionals. A French multicentre survey. *European Journal of Obstetrics and Gynecology and Reproductive Biology*. 2020;252:233-238. doi:10.1016/j.ejogrb.2020.06.032
64. Albouy-Llaty M, Rouillon S, Ouazzani H El, Disprose G, Rabouan S, Migeot V. Environmental Health Knowledge, Attitudes, and Practices of French Prenatal Professionals Working with a Socially Underprivileged Population: A Qualitative Study. *Int J Environ Res Public Health*. 2019;16(14). doi:10.3390/IJERPH16142544
65. Subiza-Pérez M, Vrotsou K, Esnal H, et al. Environmental health knowledge and competences in Basque health workers. A comparison of different professional profiles. *Environ Res*. 2024;243. doi:10.1016/J.ENVRES.2023.117789

66. Stotland NE, Sutton P, Trowbridge J, et al. Counseling Patients on Preventing Prenatal Environmental Exposures - A Mixed-Methods Study of Obstetricians. *PLoS One*. 2014;9(6):e98771. doi:10.1371/JOURNAL.PONE.0098771

67. Massaquoi LD, Edwards NC. A Scoping Review of Maternal and Child Health Clinicians Attitudes, Beliefs, Practice, Training and Perceived Self-Competence in Environmental Health. *International Journal of Environmental Research and Public Health 2015, Vol 12, Pages 15769-15781*. 2015;12(12):15769-15781. doi:10.3390/IJERPH121215018

68. Orru H, Olstrup H, Hagenbjörk A, Nordin S, Orru K. Exposures, Symptoms and Risk Perception among Office Workers in Relation to Nanoparticles in the Work Environment. *International Journal of Environmental Research and Public Health 2022, Vol 19, Page 5789*. 2022;19(10):5789. doi:10.3390/IJERPH19105789

69. Conradie P, Van Hove S, Pelka S, et al. Why do people turn down the heat? Applying behavioural theories to assess reductions in space heating and energy consumption in Europe. *Energy Res Soc Sci*. 2023;100:103059. doi:10.1016/J.ERSS.2023.103059

70. Berinsky AJ, Margolis MF, Sances MW, Warshaw C. Using screeners to measure respondent attention on self-administered surveys: Which items and how many? *Political Sci Res Methods*. 2021;9(2):430-437. doi:10.1017/PSRM.2019.53

71. Paas LJ, Morren M. PLease do not answer if you are reading this: respondent attention in online panels. *Mark Lett*. 2018;29(1):13-21. doi:10.1007/S11002-018-9448-7/TABLES/3

72. Sigurdsson V, Folwarczny M, Larsen NM, Menon RGV, Sigurdardottir FT, Perkovic S. Utilizing consumer-based label equity to signal consumer products free from endocrine-disrupting chemicals. *Journal of Retailing and Consumer Services*. 2024;76:103611. doi:10.1016/J.JRETCONSER.2023.103611

73. Adler NE, Epel ES, Castellazzo G, Ickovics JR. Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy white women. *Health Psychology*. 2000;19(6):586-592. doi:10.1037/0278-6133.19.6.586

74. Benedetto C, Borella F, Divakar H, et al. FIGO Preconception Checklist: Preconception care for mother and baby. *International Journal of Gynecology & Obstetrics*. 2024;165(1):1-8. doi:10.1002/IJGO.15446

75. WHO (World Health Organization). Meeting to develop a global consensus on preconception care to reduce maternal and childhood mortality and morbidity. *WHO Headquarters, Geneva Meeting report Geneva: …*. Published online 2013:78. Accessed June 27, 2024. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Meeting+to+Develop+a+Global+Consensus+on+Preconception+Care+to+Reduce+Maternal+and+Childhood+Mortality+and+Morbidity#0%5Cnhttp://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Meeting+t

76. Endocrine Society. What You Can Do About EDCs. Published 2024. Accessed June 27, 2024. https://www.endocrine.org/topics/edc/what-you-can-do

77. Endocrine Society. Let's Talk EDCs. Published 2024. Accessed June 27, 2024. https://www.endocrine.org/topics/edc/talking-edcs

78. WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience - PubMed. Accessed June 28, 2024. https://pubmed.ncbi.nlm.nih.gov/28079998/

79. European Society of Endocrinology. Recognising the Key Role of Hormones in European Health: "The Milano Declaration" – Annex I: 10 recommendations for good hormone health. Published online 2023. Accessed June 27, 2024. https://www.ese-hormones.org/media/cncbp0wn/milano-declaration-2022-annex-i-web-final.pdf

80. Barasinski C, Zaros C, Bercherie J, et al. Intervention during the Perinatal Period: Synthesis of the Clinical Practice Guidelines from the French National College of Midwives. *J Midwifery Womens Health*. 2022;67(S1):S2-S16. doi:10.1111/JMWH.13421

81. Marie C, Garlantézec R, Béranger R, Ficheux AS. Use of Cosmetic Products in Pregnant and Breastfeeding Women and Young Children: Guidelines for Interventions during the Perinatal Period from the French National College of Midwives. *J Midwifery Womens Health*. 2022;67(S1):S99-S112. doi:10.1111/JMWH.13428

82. Rousseau M, Rouzeau C, Bainvel J, Pelé F. Domestic Exposure to Chemicals in Household Products, Building Materials, Decoration, and Pesticides: Guidelines for Interventions During the Perinatal Period from the French National College of Midwives. *J Midwifery Womens Health*. 2022;67(S1):S113-S134. doi:10.1111/JMWH.13426

83. Rosen EM, Stevens DR, Ramos AM, et al. Personal care product use patterns in association with phthalate and replacement biomarkers across pregnancy. *Journal of Exposure Science & Environmental Epidemiology 2024*. Published online January 4, 2024:1-10. doi:10.1038/s41370-023-00627-w

84. Taylor CM, Emmett PM, Emond AM, Golding J. A review of guidance on fish consumption in pregnancy: is it fit for purpose? *Public Health Nutr*. 2018;21(11):2149-2159. doi:10.1017/S1368980018000599

85. Health Council of the Netherlands. *Assessment of Fish Species and Dosage of Fish-Fatty-Acid Supplements for Pregnant Women; and Health Effects of Food Consumption and Dietary Patterns during Pregnancy. Background Documents to: Dietary Recommendations for Pregnant Women No. 2021/26*.; 2021.

86. Bauer AZ, Swan SH, Kriebel D, et al. Reply to 'Paracetamol use in pregnancy — caution over causal inference from available data'; 'Handle with care — interpretation, synthesis and dissemination of data on paracetamol in pregnancy.' *Nature Reviews Endocrinology 2021 18:3*. 2021;18(3):192-192. doi:10.1038/S41574-021-00610-1

87. Bauer AZ, Swan SH, Kriebel D, et al. Paracetamol use during pregnancy — a call for precautionary action. *Nature Reviews Endocrinology 2021 17:12*. 2021;17(12):757-766. doi:10.1038/S41574-021-00553-7

88. Bandura A, Walters R. *Social Learning Theory*. Vol 1. Prentice Hall: Englewood cliffs.; 1977.

89. Grason HA, Misra DP. Reducing Exposure to Environmental Toxicants Before Birth: Moving from Risk Perception to Risk Reduction. *Public Health Reports*. 2009;124(5):629. doi:10.1177/003335490912400505

90. Coderre F, Sirieix L, Valette-Florence P. The facets of consumer-based food label equity: Measurement, structure and managerial relevance. *Journal of Retailing and Consumer Services*. 2022;65:102838. doi:10.1016/J.JRETCONSER.2021.102838

91. Ghahramani A, de Courten M, Prokofieva M. "The potential of social media in health promotion beyond creating awareness: an integrative review." *BMC Public Health*. 2022;22(1):1-13. doi:10.1186/S12889-022-14885-0/FIGURES/5

92. Kite J, Chan L, MacKay K, et al. A Model of Social Media Effects in Public Health Communication Campaigns: Systematic Review. *J Med Internet Res 2023;25:e46345 https://www.jmir.org/2023/1/e46345*. 2023;25(1):e46345. doi:10.2196/46345

93. Vamos S, Okan O, Sentell T, Rootman I. Making a Case for "Education for Health Literacy": An International Perspective. *International Journal of Environmental Research and Public Health 2020, Vol 17, Page 1436*. 2020;17(4):1436. doi:10.3390/IJERPH17041436

94. Finn S, O'Fallon L. The Emergence of Environmental Health Literacy—From Its Roots to Its Future Potential. *Environ Health Perspect*. 2017;125(4):495. doi:10.1289/EHP.1409337

95. Boronow KE, Cohn B, Havas L, Plumb M, Brody JG. The Effect of Individual or Study-Wide Report-Back on Knowledge, Concern, and Exposure-Reducing Behaviors Related to Endocrine-Disrupting Chemicals. *Environ Health Perspect*. 2023;131(9). doi:10.1289/EHP12565/SUPPL_FILE/EHP12565.S001.ACCO.PDF

96. The costs and benefits of regulating chemicals - OECD. Accessed June 28, 2024. https://www.oecd.org/environment/tools-evaluation/costs-benefits-chemicals-regulation.htm#Results

97. Kassotis CD, Vandenberg LN, Demeneix BA, Porta M, Slama R, Trasande L. Endocrine-disrupting chemicals: economic, regulatory, and policy implications. *Lancet Diabetes Endocrinol*. 2020;8(8):719. doi:10.1016/S2213-8587(20)30128-5

98. Hunt PA, Sathyanarayana S, Fowler PA, Trasande L. Female reproductive disorders, diseases, and costs of exposure to endocrine disrupting chemicals in the European Union. *Journal of Clinical Endocrinology and Metabolism*. 2016;101(4):1562-1570. doi:10.1210/JC.2015-2873/SUPPL_FILE/JC-15-2873.PDF

99. Trasande L, Zoeller RT, Hass U, et al. Estimating Burden and Disease Costs of Exposure to Endocrine-Disrupting Chemicals in the European Union. *J Clin Endocrinol Metab*. 2015;100(4):1245-1255. doi:10.1210/JC.2014-4324

100. Rijk I, van Duursen M, van den Berg M. *Health Costs That May Be Associated with Endocrine Disrupting Chemicals. An Inventory, Evaluation and Way Forward to Assess the Potential Socio-Economic Impact of EDC-Associated Health Effects in the EU.*; 2016. doi:10.13140/RG.2.2.21380.81283

101. Goldman RH, Zajac L, Geller RJ, Miller MD. Developing and implementing core competencies in children's environmental health for students, trainees and healthcare providers: a narrative review. *BMC Med Educ*. 2021;21(1). doi:10.1186/S12909-021-02921-3

102. Wong KH, Allen A, Durrani TS. Evaluating Effectiveness of Online Learning Modules in Pediatric Environmental Health Education. *Journal of Medical Toxicology*. 2020;16(3):269. doi:10.1007/S13181-019-00746-7

103. Vaona A, Banzi R, Kwag KH, et al. E-learning for health professionals. *Cochrane Database Syst Rev*. 2018;25(2):49. doi:10.1002/14651858.CD011736.PUB2/MEDIA/CDSR/CD011736/IMAGE_N/NCD011736-CMP-003-04.PNG

104. Roberts JR, Reigart JR. Environmental Health Education in the Medical School Curriculum. *Ambulatory Pediatrics*. 2001;1(2):108-111. doi:10.1367/1539-4409(2001)001<0108:eheitm>2.0.co;2

105. Garg A, Mulloy KB. Developing a problem-based learning approach to the integration of environmental and occupational health topics into medical school curriculum. *J Occup Environ Med*. 2018;60(8):754-759. doi:10.1097/JOM.0000000000001325

106. Duh-Leong C, Maffini M V., Kassotis CD, Vandenberg LN, Trasande L. The regulation of endocrine-disrupting chemicals to minimize their impact on health. *Nat Rev Endocrinol*. 2023;19(10):600-614. doi:10.1038/S41574-023-00872-X

107. Brody JG, Cirillo PM, Boronow KE, et al. Outcomes from returning individual versus only study-wide biomonitoring results in an environmental exposure study using the digital exposure reportback interface (DERBI). *Environ Health Perspect*. 2021;129(11). doi:10.1289/EHP9072/SUPPL_FILE/EHP9072.S001.ACCO.PDF

108. Bellingham M, Sharpe RM. Chemical exposures during pregnancy: Dealing with potential, but unproven, risks to child health. *Scientific Impact Paper 37*. Published online 2013.

Supplemental Material

Annex 1 Characteristics and overview of findings from intervention studies

Supplemental Table S1. Characteristics and overview of findings from intervention studies evaluating changes in exposures to EDCs (including phthalates, phenols, parabens, PFAS, PBDEs, and other POPs) following an intervention (dietary, behavioural, or residential).

Author (year)	Participants	Intervention	Exposures	Intervention findings	Percent change
Pirard and Charlier (2022)[17]	n=92 (49 females); mean age (SD): 49.0 (10.2) years	Education campaign: public conferences on EDCs and how to reduce exposures, combined with individual reports of biomonitoring results	Urinary BPA, BPS, BPF, and phthalate metabolites for DEHP, DEP, and BBzP	BPS & BPF concentrations increased over time; phthalate metabolites for DnBP, BBzP and select DEHP metabolites decreased over time.	↓ 37% DEHP metabolites; ↓ 42% BBzP metabolites
Sakaki et al. (2022)[18]	n=30 (22 females); mean age (SD): 24.8 (5.5) years	Randomized crossover: Comparison of exposure biomarkers after consuming capsule coffee compared to French press coffee from ceramic mug; participants instructed to avoid all other coffee	Urinary BPA, BPS, BPF, DBP, and DEHP metabolites	No association between the type of coffee consumed and biomarker levels; BPS, BPF, and DBP low/no detection after consuming French press; BPA and DEHP metabolites detected in multiple samples but no clear patterns	Ø
El Ouazzani et al. (2022)[19]	n=230 (n=152 intervention; n=78 control) pregnant women, France; Age (mean): 33 years	RCT: Environmental health education during pregnancy on nutrition (canned foods), personal care product use, and indoor air quality. Control group received information leaflets only and intervention arms followed workshops on EDCs. Duration: 14 months	Urinary parabens and BPA	There were no significant differences in BPA concentrations or canned food consumption. Difference in butylparaben (BuPB) in colostrum: higher detection rate in intervention compared to control group.	Ø BPA ↑ BuPB
Hagobian et al. (2021)[20]	n=30 premenopausal females with obesity	RCT: Behavioural intervention that encouraged organic food consumption, avoidance of foods	Urinary BPA, BPS, and BPF	BPS concentrations decreased in the intervention group compared to the control group over the intervention	↓ 55% BPS in intervention group; Ø BPA & BPF

Author (year)	Participants	Intervention	Exposures	Intervention findings	Percent change
	(n=15 control; n=15 intervention), US; Age (mean [SD]) years: control=21.5 (3.1) intervention=21.5 (3.3)	packaged in plastic or canned, storage of food in glass (containers provided), and replacement personal care products were provided for study duration.		period. No changes were observed with urinary concentrations of BPA or BPF.	
Kim et al. (2021)[21]	n= 51 (mothers; n= 26 in intervention group, n= 25 in control group), South Korea; mean age (SD): intervention: 35.8 (3.9) years, control: 35.1 (2.9) years	Behavioural RCT. Intervention group received interactive, web-based program on limiting exposure to bisphenols and phthalates through diet, personal care products, and health behaviours (including increasing intake of organic food, washing hands frequently, using glass or stainless-steel cookware, and reducing intake foods with high fat content, strongly-scented PCPs and cosmetics, new furniture and cars). Reinforcement and encouragement through texts/ calls. Control group received information about EDCs in the mail.	Urinary phthalates (metabolites of DEHP: MEHP, MEOHP, MEHHP), phenols (BPA, triclosan, MP, EP, PP)	Concentrations of MEHP, MEOHP, BPA, methyl-, ethyl, and propylparabens decreased. No changes in triclosan concentrations were observed.	↓ 3.8% MEHP; ↓ 16.3% MEOHP; ↓ 28.4%, BPA; ↓ 9.2% MP; ↓ 24.4% PP
Park and Chung (2021)[22]	n=30 females with menstrual pain, South Korea; mean age (SD): 22.1 (1.5) years	Dietary, community-based intervention (prospective noncontrolled experimental trial) to decrease fast and processed food consumption. Small group instruction, follow-up monitoring, and peer support via social network communication. Control: Baseline period before intervention.	Urinary BPA	BPA decreased in the 1st and 2nd menstrual cycles compared to baseline but not at the 3rd menstrual cycle	↓ 59 and 27 % BPA between baseline and first and third menstrual cycle, respectively
Sessa et al. (2021) [23]	n=130 school-age children (66 females), Italy; mean age (SD): intervention (n= 65): 9.09 (0.8) years; control (n = 65): 9.27 (0.8) years	Nonrandomized trial on plastic-free canteen food. Intervention group received one meal daily at school using a plastic-free cutlery; no changes for the control group. Duration of intervention: 5 days.	Urinary BPA	Reductions in BPA concentrations in intervention group at 3 and 6 months	↓ 9% BPA

Author (year)	Participants	Intervention	Exposures	Intervention findings	Percent change
Van der Meer et al. (2021)[24]	n = 218 (male and female); age: 52 years	Dietary, randomized controlled trial: Four different energy-restricted weight reduction intervention diets.	Urinary phthalates (MMP, MEP, MiBP, MnBP, MnHP, MEHHP, MEOHP, MECPP, MBzP, MiNP, MHiNP, MiDP) and phenols (BPA, BPF, BPS, MeP, EtP, PrP, nBuP, BzP)	Decrease in all high-molecular weight (HMW) phthalates post-intervention, except MnHP. Paraben and bisphenol concentrations remained similar comparing follow-up post-intervention to baseline.	↓ 25-35% for HMW phthalates.
Wu et al. (2021)[25]	n= 35 pregnant women, China; age years: 26–34	Intervention consisted of providing recommendations on (1) diet, including restricting consumption of canned and microwaved food and increase consumption of healthy food, including organic foods; (2) lifestyle, including restricting PCPs and food stored in plastic containers; (3) environment, including increasing physical activity and reducing exposure to second-hand smoke.	Urinary metabolites of DMP, DEP, DnBP, DnOP, BBzP, and DEHP, including ∑DEHP	Concentrations of all phthalate metabolites decreased, except for BBzP and MEHP	↓ 40% sum of molar concentration of all metabolites
Kim et al. (2020)[26]	n=93 (n=37 mothers; n=56 children recruited from 37 families), Korea; Age range: children 4–12 years; mothers 30–50 years Korea	Dietary, community-based intervention: participants asked to avoid canned, instant, and delivery food as well as plastic containers.	Urinary BPA and BPS	BPA reduced in both mothers and children; BPS reduced in mothers but not in children	Mothers: ↓ 53.1% BPA, ↓ 63.9% BPS; Children: ↓ 47.5% BPA, ↓ 20 % BPS
Sears et al. (2020)[27]	n=355 pregnant women recruited from antenatal clinics	Double-blinded RCT: Impact of paint stabilization and dust removal compared to reducing injury hazards on urinary phthalates Intervention: Reducing injury hazards included injury prevention devices, stair gates, cabinet locks, smoke detectors Control: Duration of treatment: Recurrent measure implementation from 32 weeks of gestation through to 3 years of life.	Urinary phthalate metabolite	Paint non-randomized & dust removal was associated with lower urinary DEPH, MCOP, MCNP but not u-MEP	↓ 25% DEHP
Dusanov et al. (2020)[28]	Men and women (overweight/obese),	Non-blinded RCT:	Serum POPs (n=15): organochlorine compounds,	No reduction in POPs post-intervention	Ø

Author (year)	Participants	Intervention	Exposures	Intervention findings	Percent change
	Norway; aged 35–70 years (n = 133)	Intervention: Consumption of fatty fish (salmon) and nuts Control: Usual diet with avoidance of fatty fish/nuts Duration: 6 months	dioxin-like PCBs, non-dioxin-like PCBs		
Dallio et al. (2018)[29]	n=120 (29 females with non-alcoholic fatty liver disease (NAFLD) (n = 60); 32 females in healthy control group); mean age (SD): NAFLD: 57 (11) years, controls: 54 (13) years	Pre-post Participants provided guidance on following a BPA-free diet, including avoiding canned beverages and food, choosing glass containers instead of plastic, avoiding plastics numbered 3 and 7, and limiting microwave cooking, especially with plastic	Blood (plasma) and urinary BPA	There was a significant reduction in BPA plasma levels* but not in urinary BPA levels in NAFLD participants; one participant reported not following the BPA-free dietary guidelines properly	↓ 62 % plasma BPA; Ø BPA concentrations
Galloway et al. (2018)[30]	n=94 adolescents, UK; age range: 17–19 years	Dietary, community-based: Participants asked to minimize their intake of processed and packaged foods to reduce exposure to BPA. Duration: 7 days.	Urinary BPA	No significant change in BPA levels postintervention, but those with the highest BPA concentrations at the start were more likely to have a decrease in BPA.	Ø
Correia-Sá et al. (2017; 2018) [31,32]	n=112 [57 females; n= 69 in healthy diet group (2 samples dropped from BPA analysis due to contamination concerns), n=43 in regular diet group]; mean age (SD): 10.4 (3.3) years; range: 4–18 years	Nonrandomized trial: Participants assigned to groups based on BMI, with those considered overweight/obese assigned to the healthy diet group and those considered normal weight/underweight assigned to maintaining their regular diet; the healthy diet group was counselled on balanced nutrition and consuming less packaged and processed foods	Urinary BPA and metabolites of DMP, DEP, BBzP, DCHP, DnPEP, DiBP, DnBP, DEHP, DiNP, DiDP, DnOP, including ∑DiBP, ∑DEHP, ∑DiNP, ∑DiDP	There were no significant differences in BPA concentrations between the two groups, although BPA concentrations were lower in the healthy diet group; concentrations of phthalates were nonsignificantly lower in the healthy diet group (15–33%), except DEP, with only ∑DEHP reaching statistical significance.	↓ 18 % BPA and ↓ 28 % ∑DEHP metabolites in healthy diet group
Ley et al. (2017)[41]	n=154 pregnant women (76 control, 78 intervention); median gestational age: 23 weeks	Behavioural, randomized controlled trial: Groups provided with commercially available wash products (liquid and bar soap, toothpaste and dishwashing liquid). Exposed arm: contained triclosan and triclocarban and non-exposed arm: contained no triclosan and triclocarban.	Urinary triclosan and triclocarban	Exposed group exhibited higher concentrations of triclosan compared to the non-exposed group	↑ 179% in the TC arm while there was ↓ 40% decrease in the non-TC arm.

Author (year)	Participants	Intervention	Exposures	Intervention findings	Percent change
Harley et al. (2016)[33]	n= 100 adolescent girls; age range: 14–18 years	Community-based participatory research intervention study: Coupons and replacement products provided without EDCs listed on the ingredients.	Urinary phthalates (MEP, MnBP, MiBP), phenols (TCS, BP-3, MP, EP, BP, PP)	Intervention was associated reduction in urinary MEP, MP, and PB and increased BP. No significant changes in MnBP or MiBP and EP.	↓ 27.4% MEP; ↓ 43.9% MP, and ↓ 45.5% PP. ↑ 101.7% BP.
Kahleova et al. (2016)[42]	N=74 men and women with type 2 diabetes mellitus (T2DM)	Non-blinded RCT. Intervention: Vegetarian diet (no fish or meat) Control: Isocaloric conventional antidiabetic diet Duration of treatment: 12-week intervention period	Serum POPs (PCBs)	No reduction in serum POP levels with vegetarian versus conventional diet. Reduction in serum level POPs with reduction in HbA1c – independent of BMI.	
Chen et al. (2015)[34]	n=30 children/adolescents (female and previously exposed to high levels of phthalates), Taiwan; median age (range): 9.7 (4–13) years	Multifaceted intervention with seven interventions: refraining from cosmetics and PCPs, use of plastic containers and nutrition supplements and medication, microwaved food, consuming food in plastic bags or wrapped in plastic, certain building materials, and to wash their hands prior to consuming food.	Urinary metabolites of DEHP, BBzP, DEP, DMP, and DPB	Phthalate metabolites were lower post-intervention for the compliant (n=23) group; limiting plastic cup use lowered metabolites of DBP and DEHP; increased handwashing reduced DMP and DMBP metabolites; low shower gel and shampoo reduced DEP and DBP metabolites, respectively, avoiding fragrances reduced DBP and DEP metabolites.	↓ 31–72 %, depending on phthalate metabolite in compliant group
Bae et al. (2015)[35]	n=60 (n=4 males; n=56 females), Korea; Age (mean [SD]) years: 73.1 (4.2)	Participants consumed two soymilk beverages per visit from glass bottles, cans, or a combination of a glass and canned beverage.	Urinary BPA	BPA concentrations were significantly lower after consuming 2 beverages from glass containers comparted to 2 canned and 1 glass and 1 canned beverage.	↓ 94 % BPA when 2 beverages were consumed from glass compared to 2 from cans
Sathyanarayana et al. (2013)[36]	N=40 (families from 10 households; parent and 2 or more children aged 4–8 years)	Dietary, two-arm randomized study: Impact of 5-day complete dietary replacement compared to education on urinary phthalates and BPA Intervention: Dietary replacement consistent of fresh/organic food, catered foods prepared without plastics Control: Education alone, conducted via handouts. Duration of intervention: 5 days.	Urinary BPA and metabolites of DEHP, including ∑DEHP, DBP, DEP, and BBzP	Increase in urinary DEHP and BPA concentrations in intervention group, no change in control group. Unexpected. Due to food contamination: high concentrations of DEHP in ground coriander and milk.	↑ DEHP (MEHP: 1670 %, MEHHP: 2524 %, MEOHP: 2297 %, MCEPP: 2470 %) and ↑ 100 % BPA among the intervention group
Carwile et al. (2011)[37]	n=75 university student and staff volunteers (n=24	Dietary, randomized crossover trial: First 5-days one group consumed fresh soup and the other group consumed	Urinary BPA	Increased BPA following canned soup consumption	↓ 95 % BPA concentration after fresh soup phase

Author (year)	Participants	Intervention	Exposures	Intervention findings	Percent change
	males; n=51 females), US; Age (median [range]) years: 27 (22–56)	canned soup, after 2-day washout, treatments were reversed.			
Carwile et al. (2009)[38]	n = 77 university students (36 females; n=41 males), UK; median age: 19 years, range 18–23	Nonrandomized crossover: Comparison of BPA levels when using stainless steel bottles for cold beverages and avoiding drinking water from polycarbonate water dispensers to exclusive use of consuming cold beverages from polycarbonate bottles.	Urinary BPA	Consumption of beverages from poly-carbonated beverages significantly increased exposure to BPA.	↓ 20 % BPA with stainless steel compared to polycarbonate bottle use
Janjua (2008)[39]	n=32 (15 males; 17 females) Age [mean(sd)] years: male 26 (2) female=65(12) Copenhagen, Denmark	Participants had a sunscreen composed of 10% w/w of the chemical sunscreens benzophenone-3 applied to the whole body	Urinary and blood plasma benzophenone-3	Concentration of benzophenone-3 was below the limit of detection prior to application of the sunscreen and was detectable at the end of the intervention period. Maximum plasma levels were achieved 4 h after application for the females and 3 h for the males.	
Lu et al. (2006)[40]	N=23 school-age children	Prospective nonrandomized experimental study: Impact of food replacement with organic substitutes. Control: Conventional diet Duration: 5 days.	Urinary organophosphorus pesticide metabolites: metabolites for malathion and chlorpyrifos.	Reduction organophosphorus pesticide metabolites (MDA, TCPY, IMPY, DEAMPY, CMHC) in organic diet group.	

Intervention studies with n>30 participants were included. This table was adapted from reviews by Corbett et al. 2022 (Table 1); Martin et al. 2022 (Tables 3-4); Sieck et al. 2024 (Table 1); Yang et al. (Tables 1-3).

Annex 2 Graphical representations of survey outcomes

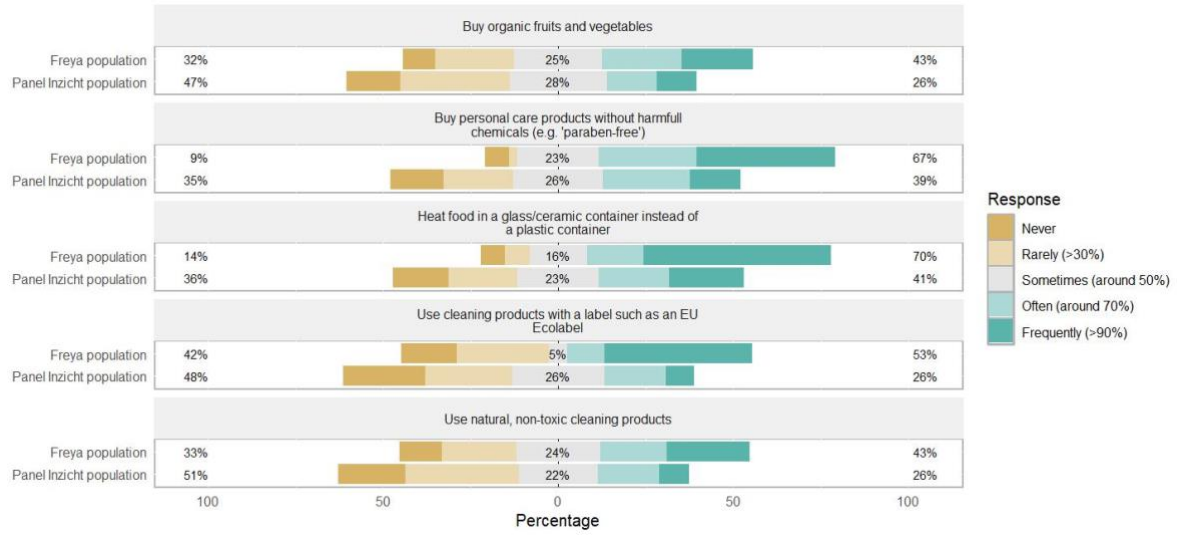


Figure S1: Frequencies of current behaviour to reduce exposure to EDCs, by subpopulation Freya and PanelInzicht.

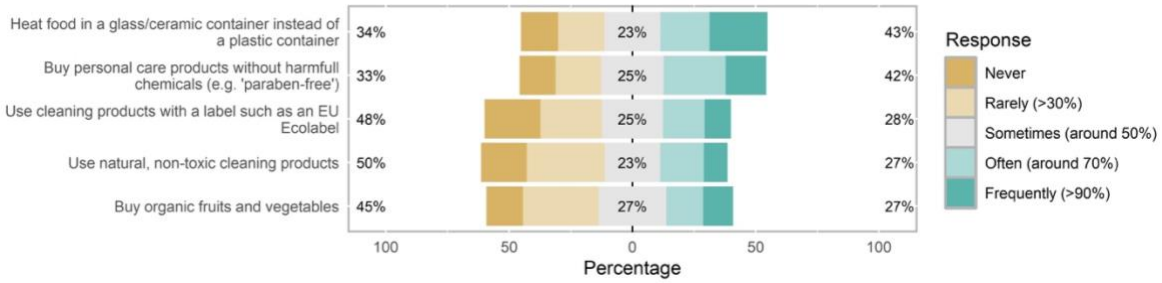


Figure S2: Frequencies of current behaviour to reduce exposure to EDCs in all respondents (PanelInzicht and Freya subpopulations combined; shown separately in Figure S1).

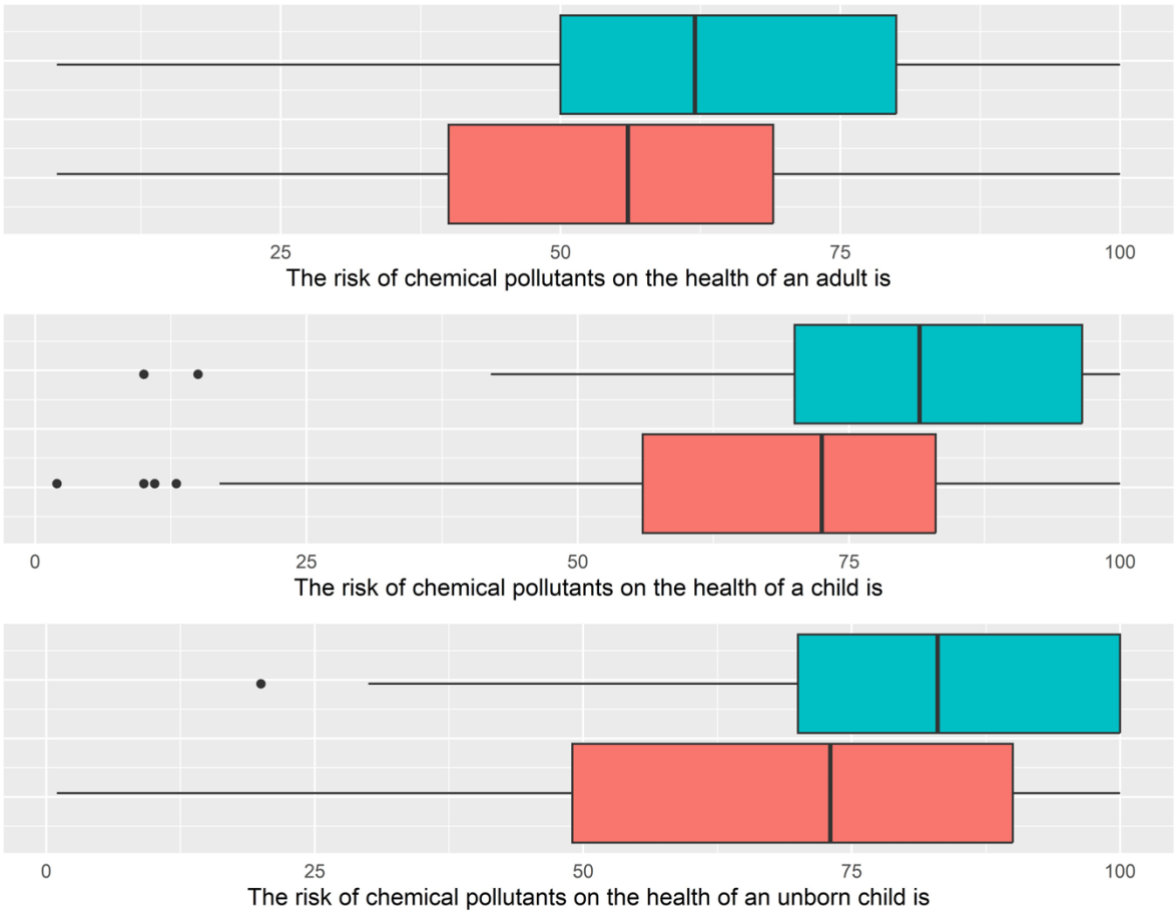


Figure S3: Perceived risk of chemical pollutants for an adult, child and unborn child for the PanelInzicht subpopulation (red) and Freya subpopulation (blue).

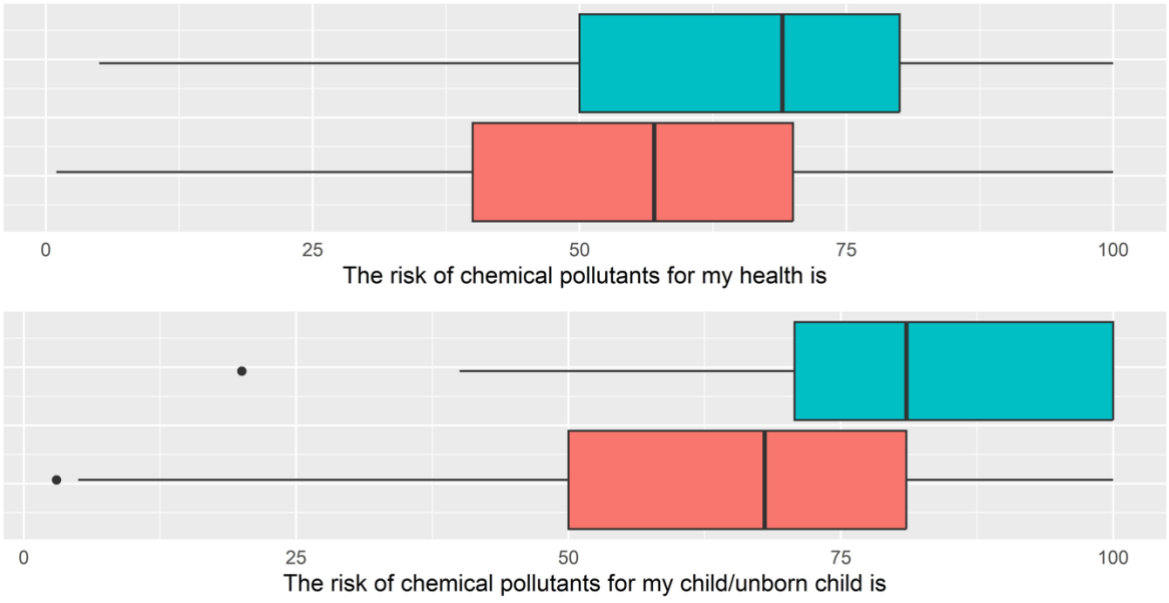


Figure S4: Perceived susceptibility: how big is the risk for my health and for my child/unborn child? The answers of the PanelInzicht subpopulation (red) and the Freya subpopulation (blue).

Annex 3 Selected strategies to reduce exposure to EDCs

Child Health and Development Studies (CHDS), US cohort: Tips for reducing exposures to EDCs (environmental chemicals) for study participants included in the 'MyCHDSReport' [107] [Link]

Home

What you can do in your home

Tip: Mouse over each tip to see how it relates to you.

Cleaning

Try to keep dust levels low. For example, wipe surfaces with a damp cloth and use a vacuum with a HEPA (high-efficiency particulate air) filter to prevent dust from recycling into the air.

Don't use air fresheners, and try to use products that are fragrance-free.

Use simple cleaning products, such as water, baking soda, and white vinegar.

Use nontoxic alternatives to toilet bowl deodorizers, such as lemon juice, borax, baking soda, and white vinegar.

Furnishings

Place rugs in doorways to avoid tracking pollutants into your home and take off your outdoor shoes at the door.

The foam in furniture can contain flame retardants. Fix rips in furniture so foam isn't exposed. Ask for furniture that doesn't contain flame retardants, including in the foam.

Choose furniture made from naturally flame-resistant fabrics and padding such as wool, hemp, polyester, latex, down, or leather.

Choose rug pads made from felt, jute, or rubber rather than foam.

Building Materials

Insulation may contain flame retardants. When buying new materials, ask for products that don't contain organohalogen flame retardants.

PCBs were banned in 1979, but building materials manufactured before then may still contain these chemicals. Avoid touching caulk or surfaces near caulk in pre-1979 buildings. Follow EPA guidelines for managing PCB-containing materials when renovating older buildings.

Food

The food you eat and how you prepare it

Tip: Mouse over each tip to see how it relates to you.

Selection

Eat organic foods whenever possible. They tend to have less pesticides in them.

Chemicals used in food cans can get into your food. Choose fresh or frozen instead of canned food or drinks.

If you are fishing, observe signs about eating the fish. In the grocery store, bluefish and striped bass can have high levels of PCBs. Swordfish and shark can have high levels of mercury. Consult a fish consumer guide like the Environmental Defense Fund Seafood Selector or the Monterey Bay Aquarium Seafood Watch to learn how to make the best choices when eating fish.

PCBs, banned pesticides, and PBDE flame retardants accumulate in fat. Trim off skin and fat from fish and meat and let fat drain off after cooking. Choose low-fat dairy.

Cooking

Use pots and pans that are stainless steel, enameled, cast iron, or anodized aluminum and avoid nonstick coatings.

Processed foods tend to have more worrisome chemicals than fresh foods. Cook more meals at home with fresh, less-processed ingredients.

To make coffee, use an unbleached filter with a ceramic or glass holder and serve in a ceramic, glass, or stainless steel cup or pitcher.

Packaging

Grease-repellent food packaging is a source of exposure to PFCs, so minimize food stored in food packaging such as pizza boxes and microwave popcorn bags.

Chemicals may leach out of plastic containers into your food or drinks. Use stainless steel or glass containers for food and drinks. Avoid microwaving food in plastic containers. Brew coffee with an unbleached filter and a ceramic or glass holder instead of a plastic coffee maker.

Clothing

How to choose your clothes and how to take care of them

Tip: Mouse over each tip to see how it relates to you.

Treated Clothing

Choose clothing, rugs, and furniture made from natural, untreated materials whenever possible. Avoid things labeled as "stain or water resistant" or "wrinkle-proof."

Avoid using clothing treated with permethrin (bug repellant).

Flame Retardants

Some children's pajamas contain flame retardants. For children, buy snug, flame retardant-free pajamas. Look for pajamas made of naturally flame-resistant fabrics such as wool, hemp, or polyester to keep children safe without exposing them to flame retardants.

Pests

How to control pests and weeds in a healthy way

CHDS tested for pesticides that aren't used anymore. The pesticides used today are regulated by the Environmental Protection Agency, but their long-term effects on health aren't always known. Try to avoid using pesticides, and encourage your neighbors and community to do the same.

Tip: Mouse over each tip to see how it relates to you.

In your home

Control household pests without commercial pesticides by sealing the holes that pests use to get into your home and use borax or sticky traps that do not contain commercial pesticides.

Avoid using clothing treated with permethrin (bug repellant).

Do not use mothballs. Clean woolens at the end of the season and put them away in sealed containers or bags. Use cedar products instead of mothballs. If you have stored clothing in mothballs, open the containers outside and let the clothes air out thoroughly before wearing them.

In your lawn and garden

Use organic practices for gardening and lawn care, and ensure that any professional care service you employ also takes the organic route.

Prevent weeds without using herbicides by planting groundcover on open spaces and control weeds by pulling them out. Encourage your neighbors and your community to use organic practices.

On you or your pet

Do not apply insect repellents to infants; instead use nets over strollers and baby carriers. For kids, only use products with <30% DEET. DEET is recommended for ticks, which carry serious disease. It is considered safer than permethrin when used properly.

Wear long-sleeved shirts and long pants instead of using insect repellent when the risk of disease from ticks and mosquitoes is low.

In places where ticks and mosquitos carry disease, DEET can protect you. Avoid using DEET in combination with permethrin because these chemicals may be harmful when mixed. For kids, only use products with <30% DEET.

Once indoors, check for ticks and wash insect repellent off your cloths and skin.

Use gloves when applying topical flea and tick control products on your pets and avoid touching their fur after treatment, or consider alternative treatments.

Eliminate head lice by using a special fine-toothed comb, rather than chemical shampoos.

Reduce Existing Exposure

1. *Air the Home*
   - Air the home regularly (**grade C**) for a minimum of 10 minutes twice a day per room (**expert consensus**)
   - Air when doing housework, do-it-yourself work, pest treatment, cooking food, and using room fragrances (**expert consensus**)
2. *Ventilation* (***expert consensus***)
   - Verify the ventilation systems in the home:
     - Clean the ventilation grills regularly.
     - Do not block the ventilation grills.
     - Have the controlled mechanical ventilation system maintained every 3 years by a qualified professional.
3. *Dust* (***grade C***)
   - Do not use a broom, prefer a vacuum cleaner. If the home is old and may have lead, a high efficiency filter is recommended (HEPA filter: high efficiency particulate absorbance).
   - Clean with a clean microfiber cloth.
4. *Handwashing* (***grade C***)
   - Wash hands before each meal and after every contaminating procedure (smoking, pest treatment, cleaning, renovation work, etc.) with soap and water, even if gloves were worn.

Reduce Emissions Inside the Home

1. *Smoking*
   - Create a no-smoking environment at home: do not smoke at home – promote smoking cessation for all persons living there (**expert consensus**).[168]
2. *Prevent Carbon Monoxide Poisoning by Following the Guidelines of the French Ministry of Health*[118,119]
   - Each year (or twice a year for solid fuel), have the combustion devices verified and the flues mechanically swept by a qualified professional.
   - Follow instructions for use: Never use mobile space heaters continuously,
   - Never use power generators, barbecues, or braziers indoors, including in the garage or basement,
   - Do not use a running automobile in a confined place.
3. *Cleaning and Repair/Do-it-yourself work*(***expert consensus***)
   - Wear gloves.
   - Adhere to the conditions for use.

RECOMMENDATIONS

General Recommendations

A synthesis of these guideline are presented elesewhere.[76]

- Reduce the number **(grade B)**, frequency of use **(grade B)**, and quantity applied **(expert consensus)** of all cosmetic products used by women in the perinatal period for themselves, but also for their children **(grade B)**.
- Prefer simple products, with a short list of ingredients, without perfume, and rinsable **(expert consensus)**.
- Avoid the use of essential oils **(expert consensus)**.
- Products with trustworthy ecolabels (eg, Cosmebio, Ecocert, Nature & Progress, Cosmos, Natrue) can be preferred **(expert consensus)**.
- Smartphone apps can be used by women, once they have been informed of the value of reducing cosmetic use and of the apps' limitations **(expert consensus)**.

Pregnant and Breastfeeding Women

- Avoid the use of perfumes, nail polish/remover, and hair coloring **(expert consensus)**.
- Air out rooms after the use of volatile cosmetic products, especially sprays and aerosols **(expert consensus)**.

Martin et al. 2022[13] review of exposure-reduction intervention studies

	Strategies
Dietary	• Choose fresh or frozen foods instead of canned, processed, or packaged foods. Avoid drinking beverages from cans or plastic bottles. • Cook more meals at home, instead of eating fast food or takeout. • Buy organic produce, meat, and dairy products, when possible. • Avoid microwaving food and beverages in plastic containers. • Store food and beverages in glass, stainless steel, or ceramic containers, instead of plastic.
Behavioral	• Check the labels of personal care and beauty products. Choose products that do not contain phthalates, parabens, or fragrances. • Minimize use of personal care products and cosmetics. • Use mineral-based sunscreens, containing zinc oxide or titanium dioxide, instead of chemical sunscreens. • Avoid perfume, cologne, scented body sprays, and other products with fragrance. • Limit use of nail polish and nail polish remover.
Residential	• Reduce household dust using a wet mop or cloth, or HEPA filter vacuum. • Wash your hands regularly, avoid using antibacterial or scented hand soaps. • Choose safer cleaning products. Avoid products that contain scents or fragrances, harsh chemicals, or antibacterial/antimicrobial chemicals. • Avoid scented products including air fresheners, candles, detergents, and soaps.

Figure: “Dietary, behavioural, and residential tips to reduce exposure to EDCs” from Martin et al. (2022).

FIGO, HEAL, USCF (2020) [Link]

UK: Royal College of Obstetricians & Gynaecologists. Bellingham, Michelle, and Richard M. Sharpe. "Chemical exposures during pregnancy: Dealing with potential, but unproven, risks to child health." *Scientific Impact Paper 37* (2013) [108]. [Link]

"9. Dealing with current uncertainty about the risks posed by environmental chemicals

Under normal lifestyle and dietary conditions, the level of exposure of most women to individual environmental chemicals will probably pose minimal risk to the developing fetus/baby. However, women who are pregnant are exposed to hundreds of chemicals at a low level. Potentially, this exposure could operate additively or interactively and raises the possibility of 'mixtures' effects. On present evidence, it is impossible to assess the risk, if any, of such exposures. Obtaining more definitive guidance is likely to take many years; there is considerable uncertainty about the risks of chemical exposure. The following steps would however reduce overall chemical exposure:

● use fresh food rather than processed foods whenever possible

● reduce use of foods/beverages in cans/plastic containers, including their use for food storage

● minimise the use of personal care products such as moisturisers, cosmetics, shower gels and fragrances

● minimise the purchase of newly produced household furniture, fabrics, non–stick frying pans and cars whilst pregnant/nursing

● avoid the use of garden/household/pet pesticides or fungicides (such as fly sprays or strips, rose sprays, flea powders)

● avoid paint fumes

● only take over–the–counter analgesics or painkillers when necessary

● do not assume safety of products based on the absence of 'harmful' chemicals in their ingredients list, or the tag 'natural' (herbal or otherwise).

It is unlikely that any of these exposures are truly harmful for most babies, but in view of current uncertainty about risks, especially those relating to 'mixtures', these steps will reduce environmental chemical exposures."

Danish guidelines (translated) (2020) [Link]

Pregnant: 10 good tips for pregnancy without unwanted chemicals

You should pay extra attention to hormone-disrupting substances and other unwanted chemicals when you are pregnant or trying to become pregnant.

1. Avoid tobacco smoke

Pregnancy and smoking do not go together. We recommend that you both stop smoking yourself and avoid tobacco smoke from others as far as possible.

The body reacts to tobacco smoke, which exposes the fetus to a cocktail of problematic chemicals. It risks harming the child.

A healthy pregnancy begins with quitting smoking. It also increases the chance of getting pregnant.

In general, go for a good indoor climate. Among other things, you can pay attention to airing out or limiting particles in the air from, for example, stove smoke, smoke from candles and mados.

Therefore, endocrine disruptors are problematic

2. Say no thanks to alcohol

Pregnancy does not harmonize with alcohol.

Alcohol is harmful to health and can cause, among other things, nerve damage and brain damage. If you drink alcohol, you also increase the risk of miscarriage.

To be on the safe side, it is a good idea to avoid alcohol already when you are trying to get pregnant.

The cocktail effect: That's why you need to know it

3. Create a good indoor climate

A healthy indoor climate is important when you are pregnant.

In your home, chemicals evaporate from many sources, for example furniture, electronics and building materials. The chemicals bind to the dust and are found in the air.

Dust must be vacuumed and wiped off at least once a week.

Air out with a draft twice a day so that you air the chemicals out of your home.

4. Have good chemistry at work

Pregnant women must inform the workplace as soon as possible of the happy circumstances if they are exposed to harmful chemicals in connection with work.

A healthy working environment must be created by the pregnant woman and the management in cooperation.

5. Choose products with the Swan label and the flower

Eco-labelled products with the Swan label or the flower meet strict requirements regarding which chemicals may be in products. They are good choices for a green lifestyle.

Swan-labelled care products are free of substances that are on the EU's list of suspected hormone-disrupting substances, including parabens.

You can also check the chemistry in your care products with the Kemiluppen app.

Ecolabels: Get to grips with the Swan label, the flower and all the others

The cocktail effect - A podcast for pregnant women about unwanted chemistry

Is it okay to use cosmetics and care during pregnancy? Do strollers and baby mattresses contain unwanted chemicals? What should I even look for in products?

This is what pregnant Tanja examines in the three-episode podcast "The Cocktail Effect".

Listen now

6. Drop the hair color and limit the cosmetics

Hair dyes can contain chemical substances that are highly allergenic and suspected of being hormone disruptors. Therefore, do not dye your hair when you are pregnant.

As a general rule, you should also use cosmetics as little as possible. Feel free to choose eco-labeled products without perfume.

The Kemiluppen app helps you check your personal care products for unwanted chemicals.

Hair colour: How to avoid unwanted chemistry

7. Be aware of paint and spray products

Spray products can expose you to large amounts of chemicals. It happens when you inhale the small droplets (aerosols) that form in the air.

If you paint and set up your home, you may be exposed to unwanted chemicals through inhalation and through the skin.

Chemicals labeled as dangerous, for example harsh cleaning agents, should be completely avoided.

Paint: How to choose the safest one

8. Avoid mercury in large predatory fish

Mercury is found in large predatory fish such as fresh tuna, halibut and shark. The heavy metal affects the development of the brain in young children and fetuses in particular.

Fish are generally healthy. For example, cod, plaice and herring are good to eat.

9. Eat a varied diet

In general, eat varied and preferably organic. Avoid spraying and environmental toxins.

How to avoid pesticides in fruit and vegetables

10. Only use medication as agreed with your doctor

In the worst case, pregnant women may risk that the medication will harm the fetus.

You should therefore only take medicine in consultation with your doctor. This also applies to headache pills, other painkillers and natural medicines.

Headache pills: Think before you take the next one

10 practical tips for avoiding environmental chemicals in everyday life (Table 1; [60]) – Translated from German.

1. Eat healthily: as fresh, unpackaged, seasonal and organically grown foods as possible.
2. Use glass or porcelain dishes instead of plastic. Avoid heating plastic in the microwave or washing it in the dishwasher.
3. Cast iron or stainless steel contains fewer pollutants than non-stick cookware.
4. Use cosmetics sparingly, especially nail polish and hair dye. Avoid products with questionable preservatives such as parabens. Sunscreens should, if possible, not contain questionable UV filters (e.g. benzophenone-3/oxybenzone) and should not be used after the expiration date.
5. Ventilate several times a day. Mop floors more often and do not wear street shoes in the apartment.
6. Prefer cleaning products with an eco-label. Avoid scented candles and air fresheners. Candles made from beeswax are a better alternative.
7. Allow new furniture to air out for 1-2 weeks before use.
8. It is better to have any renovation work that needs to be done during pregnancy done by a family member or friend.
9. Wash clothes or textile products before first use and prefer products with an eco-label, such as Oeko-Tex Standard 100.
10. Unpainted solid wooden toys are preferable. Avoid plastic toys that smell chemical or perfumed.

Guidelines for counselling pregnant women regarding environmental chemicals (Table 2; [60]) – Translated from German.

Define the term environmental chemicals	As a general rule, talk to all women who are planning a pregnancy or who are already pregnant about the issue of environmental chemicals during pregnancy. Explain the term "environmental chemicals" and identify possible sources, while avoiding a pushy or fear-inducing attitude.
	Example: We can encounter a wide variety of chemicals in everyday life in food, cosmetics, cleaning products, but also textiles, children's toys and furniture. Some of these so-called environmental chemicals can affect health. This should be avoided, especially during the sensitive period of pregnancy. *Question: Are you interested in information on how to avoid environmental chemicals in your daily life?*
Provide *strategies to avoid* environmental chemicals	Give examples of practical instructions for avoiding environmental chemicals (see Table 1). If possible, involve your partner as well.
	Example: Often it is just small things that can reduce contact with environmental chemicals. *If you have the choice, prefer organic food and food that comes in glass rather than plastic packaging.* *Use cosmetics sparingly.* *When buying everyday items, look for quality seals such as TÜV or Oeko-Tex Standard 100 seals.* *If possible, leave furniture assembly or renovation work to your partner.*
Provide additional *sources of information* on environmental chemicals	The WECF *Nestbau* project provides comprehensive information on sources of chemicals and practical tips for avoidance (https://nestbau.info/ and brochure "Beware! Pollutants in everyday life").
	Cosmetics, cleaning products and everyday objects can be quickly and easily checked for environmental chemicals using free *mobile apps* (e.g. ToxFox, CodeCheck, Scan4Chem). These apps also provide detailed information on individual pollutants.
	General information and current political developments are published on the websites of the *Federal Environment Agency* (https://www.umweltbundesamt.de/) and the *Federal Institute for Risk Assessment* (https://www.bfr.bund.de/de/start.html).

Endocrine Society: What You Can Do About EDCs [link]

You can act now to prevent your exposure to some of the endocrine-disrupting chemicals (EDCs) all around us and take steps toward making the world safer for all.

Get Smart at Home

You can't control every chemical that you come into contact with each day. But you can make more informed choices about what you eat, drink, bring into your home, and decide to keep or throw away.

- **Learn about common EDCs and where they're found**. You might see that old toy and beloved flame-retardant couch in a new light. In modern products, "non-stick" or "stain-resistant" may raise a red flag for your further investigation.
- **Seek alternatives**. Some merchants, like Trader Joe's grocery store, list a yes or no status for certain EDCs (like BPA) for their products. If where you shop doesn't give you this information already, we encourage you to ask for it.
- **Read the labels**. On plastic bottles, a #1, #2, or #4 in the recycling sign means that the product is free of BPA, a still commonly-used EDC. Shower curtains, raincoats, flooring, and outdoor furniture will be similarly labeled for PVCs, as will canned food with BPA-free liners. Labels for cleaning supplies, facial washes, and detergents also indicate the presence or absence of some EDCs known to be a potential risk, such as phthalates.
- **Keep it fresh**. Minimize consumption of processed foods as much as possible, and use filtered as opposed to bottled water.
- **Watch out for leaching**. Avoid storing canned or plastic-packaged foods in hot areas, like the trunk of a car on a summer day. Also, avoid microwaving or heating food in plastic containers. EDCs could leach out of the container and into your food and body.
- **Reduce pesticide use**. At home, try tactics like plugging holes under the sink to reduce pests and prevent the need for pesticides. For produce, wash fresh fruit and vegetables with tap water to remove most chemicals.
- **Learn more from other groups.** The **Environmental Working Group** has important advice for reducing your exposure to EDCs, and the **Pediatric Environmental Health Toolkit** is useful for all parents as well as healthcare providers.

Speak to Lawmakers and Your Community

As more science about EDCs becomes available and people understand EDCs and their risks, policymakers are considering different approaches. The Endocrine Society can help identify which bills need your help and how you can participate in Endocrine Society advocacy campaigns.
If you have more ideas on what else we can do together, especially in your community, please reach out to us at **advocacy@endocrine.org**.

European Society of Endocrinology & European Hormone and Metabolism Foundation (ESE Foundation) 2023: "10 recommendations for good hormone health" [79]

European Society of Endocrinology
www.ese-hormones.org

European Hormone and Metabolism Foundation
www.ese-foundation.org

Recognising the Key Role of Hormones in European Health: the Milano Declaration – Annex I

10 recommendations for good hormone health

In May 2022, on the first European Hormone Day, the European Society of Endocrinology (ESE) and the European Hormone and Metabolism Foundation (ESE Foundation) published the Milano Declaration, 'Recognising the Key Role of Hormones in European Health'. The declaration highlights the important role of hormones in public health, and provides recommendations to decision-makers on how to strengthen national and European health policies.

This Annex complements the Milano Declaration by providing 10 recommendations on how each of us can take relatively simple steps to ensure better hormone health. It should be considered alongside any specific recommendations issued by your local health authorities. If you have any questions, please speak to your doctor.

ADOPT A HEALTHY LIFESTYLE

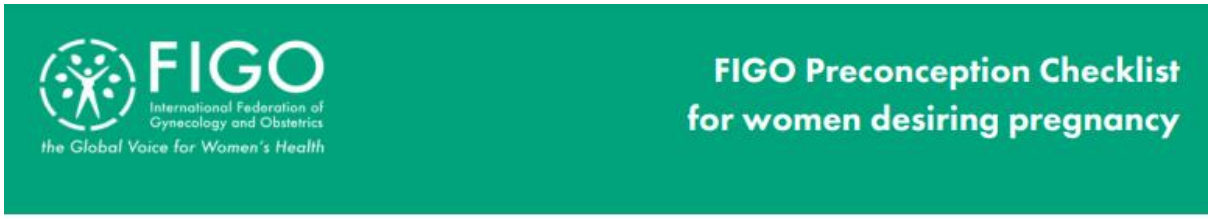
...

REDUCE EXPOSURE TO ENDOCRINE DISRUPTORS

Endocrine disrupting chemicals can be found in plastic packaging, in the air and in cosmetic products

7. **Plastic packaging** is a common source of endocrine disruptors. To reduce exposure, look for BPA-free and BPS-free labels. Use glass or stainless steel containers instead of plastic containers and bottles. Drink tap water instead of bottled water. And never microwave plastic!
8. **The air in and outside the house** can contain endocrine disrupting properties. To minimise exposure at home, regularly vacuum, dust and ventilate to reduce the presence of dust particles.
9. **Care products and cosmetics** can have an endocrine disrupting effect. Check the ingredients and try to avoid buying cosmetics that contain endocrine disrupting chemicals such as phthalates, parabens and triclosan.

FIGO's Preconception Checklist (extracts): described in Benedetto et al. 2024 [74]



This checklist is designed for girls/women* to complete together with their healthcare professional to assess their health status before getting pregnant and provide a basis for their healthcare professional to give advice on the best possible way to prepare for conception.

Date of birth: Blood type:

Has your mother/father/siblings had health problems such as hypertension, diabetes, thrombosis, genetic diseases or others? Yes ☐ No ☐ Don't know ☐

Nutrition

For assessment, use the FIGO Nutrition Checklist for pre-pregnancy/early pregnant women (https://survey.figo.org/c/kuxayx3e)

Weight: kg, Height: m^2, BMI: kg/m^2

If your BMI is higher than 30kg/m^2 or lower than18.5 kg/m^2, refer to a dietician.

...

Lifestyle variables

a) Do you smoke tobacco? Yes ☐ No ☐

If you have replied YES, you should stop smoking before trying to get pregnant. If you smoke regularly, you may need to be assessed in more detail by an expert

b) Do you consume alcoholic drinks? Yes ☐ No ☐

If you have replied YES, you should avoid drinking alcohol when trying to get pregnant. If you consume alcohol regularly, you may need to be assessed in more detail by an expert

c) Do you use substances/illicit drugs? Yes ☐ No ☐

If you have replied YES, and your use is occasional you should stop. If you use regularly, you may need to be assessed in more detail by an expert

d) Do you think you are exposed to any toxic environmental chemicals? Yes ☐ No ☐ Don't know ☐

If you have replied YES, you should be given specific advice on how to avoid/reduce exposure

e) Do you practice regular physical activity? Yes ☐ No ☐

Please remember that moderate physical activity of at least 30 minutes a day, 5 days a week, for a minimum of 150 minutes of moderate exercise per week is usually recommended before and during pregnancy

freia
PROJECT

SAFEGUARDING WOMEN'S REPRODUCTIVE HEALTH AGAINST ENDOCRINE DISRUPTORS

www.freiaproject.eu

The FREIA project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 825100 (FREIA). This output reflects the views only of the author(s) and the European Union cannot be held responsible for any use which may be make of the information contained therein.