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1. INTRODUCTION – THE INVISIBLE CHEMICAL BURDEN OF EVERYDAY LIFE

Chemical pollution is often associated with industrial emissions, contaminated rivers or hazardous waste sites. Yet for most Europeans, daily exposure to hazardous substances occurs much closer to home. It takes place in kitchens, bathrooms, living rooms, schools and workplaces through ordinary products used every day.

Modern consumer societies depend on thousands of synthetic chemicals that provide functionality, durability and convenience. However, many remain present in products throughout their lifetime and may be released during normal use. Consumers are therefore exposed not through exceptional events but through routine activities such as preparing food, cleaning the home, using cosmetics, buying toys, furnishing apartments or renovating buildings.

Unlike traditional forms of pollution, chemical exposure is largely invisible. People cannot see, smell or feel most hazardous substances. Exposure therefore tends to remain outside public perception despite increasing scientific evidence linking environmental chemicals to a growing range of health concerns.

This disconnect between everyday behaviour and chemical exposure creates a major policy challenge. While awareness regarding climate change, waste and biodiversity has increased substantially, chemical literacy remains comparatively low. Most citizens have little understanding of exposure pathways, hazardous substances or safer alternatives. At the same time, they are expected to navigate increasingly complex consumer markets and make informed purchasing decisions.

The challenge is therefore not simply environmental. It is also educational, social and increasingly medical.

2. CHEMICALS AND THE INDOOR ENVIRONMENT

Europeans spend approximately 80–90 percent of their lives indoors. Homes, schools, childcare facilities, offices and public buildings have therefore become the primary environments in which exposure occurs. While outdoor pollution often receives considerable attention, indoor exposure pathways are frequently overlooked.

A wide variety of hazardous substances can be found in everyday products used indoors. Flexible plastics may contain phthalates and other plasticisers. Food packaging may contain bisphenols and related compounds. Furniture, electronics and textiles have historically contained flame retardants. Cleaning products may contain fragrances, preservatives and surfactants with hazardous properties. Cosmetics and personal care products often contain complex mixtures of ingredients that are difficult for consumers to assess. Building materials, paints, flooring and insulation products can release substances into indoor air long after installation.

These substances reach the human body through several pathways. They can migrate into food and beverages, evaporate into indoor air, accumulate in household dust or be absorbed through the skin. Dust has emerged as a particularly important exposure medium because it acts as a reservoir for chemicals released from numerous products simultaneously.

Exposure is especially relevant for children. Young children spend considerable time on floors, frequently place objects in their mouths and have a higher intake of dust relative to their body weight. Their developing organs and hormonal systems are also more vulnerable to disruption. As a result, products intended for children, childcare environments and family homes deserve particular attention.

Indoor exposure is further complicated by the fact that citizens are rarely exposed to a single substance. Instead, they encounter complex mixtures originating from multiple products at the same time. This reality is often referred to as the “cocktail effect”, highlighting the limitations of evaluating chemicals one by one when real-life exposure occurs through combinations.

3. ENDOCRINE DISRUPTORS AND THE EMERGING PUBLIC HEALTH CHALLENGE

Among the many hazardous substances present in consumer products, endocrine-disrupting chemicals have received growing scientific and policy attention. EDCs interfere with the body’s hormonal system and may affect development, reproduction, metabolism and immune function.

Unlike traditional toxicological approaches that focused primarily on high-dose exposure, endocrine disruptors have challenged established assumptions about chemical safety. Scientific evidence suggests that effects may occur at very low concentrations and that timing of exposure can be as important as dose. Exposure during pregnancy, infancy and childhood may have consequences that only become visible years or even decades later.

Research increasingly associates EDC exposure with fertility problems, reduced sperm quality, obesity, diabetes, thyroid disorders, endometriosis, neurodevelopmental disorders and hormone-related cancers. While causal pathways are often complex,

the growing body of evidence has led scientists, medical professionals and policymakers to treat endocrine disruption as a significant public health concern.

The implications extend beyond individual health outcomes. Chronic diseases create substantial economic burdens through healthcare costs, reduced productivity and social welfare expenditures. Estimates discussed in European policy and scientific forums suggest that endocrine-disrupting chemicals may contribute to annual societal costs measured in hundreds of billions of euros.

4. CHEMICALS, HEALTH AND ENVIRONMENT – A ONE HEALTH CHALLENGE

The growing scientific evidence on hazardous chemicals demonstrates that environmental protection and human health cannot be addressed separately. Chemicals released into products, homes and ecosystems move across environmental compartments and ultimately contribute to human exposure. At the same time, chemicals released from households enter wastewater systems, waste streams, soils, rivers and marine environments, where they affect ecosystems and biodiversity.

This interconnectedness is increasingly reflected in the One Health concept, which recognises that human health, animal health and environmental health are fundamentally linked.

The findings of LIFE ChemBee strongly support this perspective. The project focused on household exposure and consumer behaviour, yet many of the identified substances are also environmental contaminants. Citizens are therefore both receptors and indirect sources of emissions.

A One Health approach allows policymakers to view exposure reduction not only as environmental protection but also as preventive healthcare, pollution prevention and long-term economic investment.

5. THE EUROPEAN CHEMICALS POLICY FRAMEWORK – PROGRESS AND REMAINING GAPS

Europe has established one of the world's most advanced chemicals management systems. REACH introduced the principle that manufacturers and importers are responsible for demonstrating the safety of chemicals. The Classification, Labelling and Packaging Regulation improved communication of hazards. Numerous restrictions have been introduced for particularly harmful substances, and the Chemicals Strategy for Sustainability established the ambition of creating a toxic-free environment.

These achievements should be recognised. Many hazardous substances have been phased out or restricted. Information requirements have increased. Public awareness has improved. Compared with many regions of the world, European consumers benefit from comparatively high levels of protection.

Nevertheless, significant challenges remain.

Scientific understanding often develops more rapidly than regulatory processes. Emerging concerns regarding endocrine disruption, mixture effects and

persistent substances frequently require years of assessment before regulatory decisions are reached. During this period, exposure may continue.

Transparency also remains insufficient. While consumers possess certain information rights, practical access to understandable chemical information remains limited. Product labels rarely provide enough information to support informed choices. Many consumers assume that products placed on the market are inherently safe, yet they often lack the means to verify this assumption.

Another challenge concerns cumulative exposure. Regulatory systems typically evaluate individual substances, while citizens experience exposure to multiple chemicals simultaneously. This disconnect between regulation and real-world exposure remains an important gap.

Finally, the current system still places substantial responsibility on consumers. Citizens are expected to understand complex information, identify safer alternatives and navigate markets that often remain opaque. This raises legitimate questions regarding fairness and effectiveness.

The ultimate objective of chemicals policy should not be to transform every consumer into a toxicologist. Rather, it should be to ensure that safer products become the norm and that hazardous substances are systematically replaced wherever feasible.

6. CHEMICAL LITERACY AS A MISSING DIMENSION OF HEALTH LITERACY

Public health campaigns have successfully increased awareness regarding nutrition, physical activity, smoking and alcohol consumption. By contrast, chemical literacy remains underdeveloped despite its growing relevance for everyday health.

Many citizens are unaware of basic exposure pathways. They may not understand how substances migrate from packaging into food, how dust accumulates hazardous chemicals, or how product choices influence exposure patterns. Ingredient lists, safety information and regulatory terminology are often inaccessible to non-specialists.

The experience of LIFE ChemBee suggests that this knowledge gap can be addressed. Participants consistently demonstrated strong interest in understanding exposure sources and practical reduction measures. Once provided with accessible information, many were able to identify problematic products and adopt alternatives.

Chemical literacy should therefore be viewed as an extension of health literacy. Just as citizens learn about healthy diets or exercise, they should have opportunities to learn about safer consumption, indoor environmental quality and exposure reduction.

Importantly, chemical literacy is not about creating fear. Effective communication focuses on practical solutions, achievable improvements and informed decision-making. Citizens respond more positively to empowerment than to alarmism.

7. FROM AWARENESS TO ACTION – WHAT LIFE CHEMBEE DEMONSTRATED

LIFE ChemBee was developed to explore whether citizens can meaningfully contribute to reducing exposure to hazardous chemicals. The project brought together partners from eight European countries and combined awareness raising, education, digital tools and community engagement.

The scale of participation exceeded expectations. Project communication activities reached more than 4.4 million citizens across Europe. Nearly 25,000 people registered for Chemical Ambassador courses and more than 3,600 completed training. The CheckED web tool supported almost 10,000 household assessments, while approximately 1,500 users conducted follow-up checks documenting behavioural changes over time. These figures demonstrate a substantial public demand for information about hazardous chemicals and healthier living environments.

The project also generated valuable insights into how behavioural change occurs. Participants reported replacing plastic kitchenware with glass, wood or stainless steel alternatives, reducing the use of canned foods, choosing safer cosmetics, simplifying cleaning routines and paying greater attention to product ingredients. Many households adopted practical measures such as improved ventilation, reduced use of synthetic fragrances and increased use of non-toxic alternatives.

Digital tools further enhanced engagement by providing personalised information and immediate support for decision-making. The CheckED tool emerged as one of the project's most significant innovations. By translating scientific knowledge into practical household guidance, it enabled citizens to connect abstract chemical risks with everyday choices. Participants valued the ability to assess their own environments and monitor progress over time.


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8. KNOWLEDGE ACQUISITION DOES NOT AUTOMATICALLY LEAD TO COMMUNITY ACTION

One of the most interesting findings emerging from LIFE ChemBee concerns the changing nature of public engagement.

The project successfully attracted large numbers of participants and generated substantial interest in chemical safety. However, the anticipated snowball effect, in which trained ambassadors would systematically educate large numbers of additional citizens, proved more limited than originally expected.

This does not indicate a lack of interest. On the contrary, participants were highly motivated to learn about hazardous substances and protect their families. Many actively used project materials, digital tools and household assessments. Yet relatively few adopted long-term roles as community organisers or activists.

This finding reflects broader societal trends observed across many civil society sectors. Traditional forms of volunteering and grassroots mobilisation have become more difficult to sustain. Citizens increasingly seek information for personal decision-making rather than collective action. Environmental and health concerns are often addressed through individual consumption choices rather than community campaigns.

In this sense, ChemBee captured an important social reality. Contemporary citizens remain concerned about environmental health, but they engage differently than previous generations. They prefer self-learning, digital support, practical guidance and solutions that fit within busy everyday lives.

Future awareness programmes should recognise this shift. Community engagement remains important, but it should be complemented by digital tools, personalised information and easily accessible support mechanisms. The goal is not to recreate participation models from previous decades but to adapt environmental communication to contemporary social behaviour.

This finding also has significant policy implications. If citizens increasingly engage as informed consumers rather than activists, the burden of achieving a toxic-free environment cannot be placed primarily on individual action. Structural measures become even more important.

9. WHY CONSUMER ACTION ALONE WILL NEVER BE ENOUGH

The central question addressed by LIFE ChemBee was whether end users matter.

The evidence clearly shows that they do.

Citizens can reduce certain exposures. They can choose safer products, modify behaviours and create healthier household environments. Education and awareness therefore remain essential components of prevention strategies.

However, the project equally demonstrates the limits of consumer responsibility.

Consumers cannot analyse the chemical composition of products. They cannot regulate industrial supply chains. They cannot determine which substances are authorised for use in consumer goods. Even highly motivated participants frequently encountered information gaps, limited transparency and uncertainty regarding product safety.

The conclusion is therefore unavoidable: behavioural change alone cannot deliver a toxic-free environment.

10. TOWARDS A PREVENTIVE CHEMICALS POLICY

The lessons emerging from LIFE ChemBee point towards a broader transformation in policy thinking. Historically, chemicals policy has often focused on managing risks after products reach the market. Increasingly, however, the objective should be prevention. Hazardous substances should be identified earlier, substituted where possible and avoided by design.

This shift requires cooperation across policy domains. Chemicals policy, consumer policy, health policy, education policy and environmental policy should be viewed as interconnected components of a common objective.

Healthcare professionals can play a larger role in communicating exposure risks and prevention measures. Educational institutions can integrate chemical literacy into broader sustainability and health curricula. Public authorities can promote safer alternatives through procurement and awareness programmes. Businesses can invest in transparency and substitution. Regulators can accelerate implementation of existing policy commitments.

Most importantly, toxic-free products should become the default option rather than a premium choice available only to highly informed consumers.

11. POLICY RECOMMENDATIONS FOR A TOXIC-FREE LIVING ENVIRONMENT

The experience of LIFE ChemBee demonstrates that reducing exposure to hazardous chemicals requires action at multiple levels of governance and society. The following recommendations are addressed to European institutions, national governments, health authorities, educational institutions, local authorities and market actors.

11.1. Recommendations for European Institutions

- **Accelerate the implementation of the Chemicals Strategy for Sustainability**
  The ambition of achieving a toxic-free environment remains highly relevant and should continue to guide European chemicals policy. Existing commitments regarding endocrine disruptors, persistent chemicals and hazardous substances in consumer products should be implemented without delay. Regulatory processes need sufficient resources to keep pace with scientific developments and emerging evidence.

- **Strengthen regulation of endocrine-disrupting chemicals**
  Scientific evidence increasingly links endocrine disruptors to chronic diseases, reproductive disorders and developmental impacts. Regulatory frameworks should further strengthen identification, restriction and substitution of endocrine-disrupting substances across product groups, while applying the precautionary principle where scientific concerns are well founded.

- **Address combined and cumulative exposure**
  Citizens are exposed to complex mixtures of substances originating from numerous products and

environments. Future risk assessment approaches should increasingly consider cumulative and combined exposure scenarios rather than evaluating substances solely on an individual basis.

- **Improve transparency and the consumer right to know**
  Consumers require accessible and understandable information about hazardous substances contained in products. Existing information rights should be strengthened through digital tools, harmonised information systems and improved enforcement. Product information should become easier to access and interpret throughout the entire product lifecycle.

- **Promote safe and sustainable-by-design products**
  European product policies should accelerate the transition from risk management towards prevention. Hazardous substances should be substituted wherever technically and economically feasible. Safer products should become the default market option rather than a niche choice available only to highly informed consumers.

11.2. Recommendations for National Governments

- **Integrate chemical exposure reduction into public health strategies**
  Environmental exposure to hazardous chemicals should be recognised as a public health issue. National prevention programmes addressing chronic diseases, reproductive health and child health should include chemical exposure reduction as a complementary preventive measure.
- **Strengthen market surveillance and enforcement**
  Legislation only delivers benefits when implemented effectively. National authorities should receive sufficient resources to monitor compliance, investigate problematic products and enforce restrictions on hazardous substances.
- **Support consumer-oriented information services**
  Governments should support accessible advisory services, online platforms and information campaigns that translate scientific knowledge into practical guidance for households. Citizens require trusted sources of information that are independent, understandable and scientifically robust.
- **Promote substitution and innovation**
  National innovation programmes, research funding and business support mechanisms should encourage development of safer alternatives and support companies transitioning away from hazardous substances.

11.3. Recommendations for Local and Regional Authorities

- **Promote toxic-free public environments**
  Municipalities can contribute significantly through procurement policies, management of public buildings, childcare facilities and schools. Public authorities should prioritise safer products and materials wherever possible.

- **Integrate hazardous substances into sustainability strategies**
  Local sustainability, health and climate programmes should explicitly address hazardous substances and indoor environmental quality. Chemical safety should become a visible component of broader environmental and health agendas. Public Procurement shall be used as a core instruments to avoid hazardous substances in products and materials entering the supply chain.

- **Support community-based awareness initiatives**
  Although participation patterns are changing, local authorities remain important partners for awareness raising and citizen engagement. Support for local NGOs, community centres and educational initiatives can help maintain public access to trusted information.

11.4. Recommendations for the Health Sector

- **Recognise environmental exposure as a determinant of health**
  Healthcare professionals increasingly encounter health conditions potentially influenced by environmental factors. Exposure to hazardous chemicals should be recognised as one of the determinants of health alongside nutrition, physical activity and other lifestyle factors.

- **Strengthen environmental health education**
  Medical, nursing and public health curricula should include training on endocrine disruptors, hazardous substances and environmental determinants of health. Health professionals require the knowledge and confidence to address patient concerns and communicate practical prevention measures.

- **Incorporate chemical literacy into health promotion**
  Public health campaigns should increasingly include information on exposure reduction, safer consumption patterns and healthy indoor environments. The objective is not to create anxiety but to empower citizens through practical and evidence-based guidance.

11.5. Recommendations for Producers, Retailers and Market Actors

- **Increase transparency throughout supply chains**
  Consumers increasingly expect information regarding product composition and potential health impacts. Companies should proactively improve transparency and communication regarding chemicals used in products.

- **Prioritise substitution of hazardous substances**
  Where safer alternatives exist, companies should move beyond minimum compliance and actively pursue substitution. Early action can reduce regulatory uncertainty while strengthening consumer trust.

- **Design products with health protection in mind**
  Product design should consider not only functionality and cost but also potential impacts on human health and indoor environments. Safe and sustainable-by-design principles provide an important framework for future innovation.

- **Support informed consumer choices**
  Retailers and producers should contribute to consumer education by providing reliable, understandable and accessible information that enables informed purchasing decisions.

12. FINAL REFLECTION

LIFE ChemBee began with a simple question: do end users matter?

The project's answer is nuanced but clear.

End users matter because they make daily decisions that influence exposure. They matter because they are willing to learn, adapt and protect their families. They matter because their choices can drive demand for safer products and healthier living environments.

But the project also demonstrates that end users cannot solve the problem alone.

Citizens increasingly seek information and practical guidance, yet they operate within markets and regulatory systems over which they have limited control. Their willingness to act should therefore be matched by equally strong commitments from policymakers, industry, health authorities and educational institutions.

The transition towards a toxic-free living environment will not be achieved by consumers acting in isolation. It will be achieved through a shared commitment to prevention, transparency, innovation and protection.

In this sense, the most important lesson of LIFE ChemBee extends beyond hazardous chemicals themselves.

It demonstrates that environmental protection and human health are inseparable. Protecting citizens from hazardous substances is not only a matter of chemicals policy. It is a matter of public health, social responsibility and sustainable development.

A toxic-free living environment is therefore not merely an environmental ambition. It is an investment in healthier people, healthier communities and a healthier future.

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