

Peer Review

Review of: "Human Health Risks from Textile Chemicals: A Critical Review of Recent Evidence (2019–2025)"

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This manuscript, titled *"Human Health Risks from Textile Chemicals: A Critical Review of Recent Evidence (2019–2025)"*, presents a thorough and much-needed synthesis of current knowledge on human exposure to hazardous chemicals through textiles. It effectively builds on the foundation laid in the authors' previous work by integrating a wealth of recent scientific literature and offering a broad perspective on emerging risks, exposure pathways, and regulatory challenges. The review is impressively detailed, clearly structured, and deeply relevant to both the scientific community and public health stakeholders.

The review stands out for its multidisciplinary scope. The authors not only summarize toxicological and exposure data for a wide array of chemical groups—such as phthalates, per- and polyfluoroalkyl substances (PFAS), metals, azo dyes, bisphenols, formaldehyde, microfibers, nanoparticles, and allergens—but they also contextualize these findings within evolving regulatory frameworks and societal trends, such as the growth of the sustainable textile market. This broader framing lends the paper a policy-relevant dimension that is too often missing from environmental toxicology reviews.

One of the most compelling aspects of the manuscript is its focus on dermal exposure as the dominant pathway of concern. This is backed by substantial empirical evidence, particularly for sensitive populations such as infants, toddlers, and pregnant women. Studies cited throughout the review provide convincing support for the role of everyday garments such as infant socks, school uniforms, and even face masks as important contributors to cumulative chemical exposure. The use of estimated daily intakes (EDIs), hazard quotients (HQs), and cancer risk assessments brings a quantitative dimension to the review, making it easier for the reader to understand the severity and urgency of the problem.

The authors have done an excellent job of identifying key regulatory gaps and inconsistencies between regions. For example, the comparison between stricter European Union bans under REACH and the more

lenient or fragmented regulatory environment in countries like the United States or Brazil is especially important. The reported detection of carcinogenic aromatic amines and elevated bisphenol concentrations in Brazilian textile products, particularly those intended for children, underscores the global inequities in consumer protection. To enhance this discussion, I recommend that the authors include a visual comparison such as a regulatory map or summary table highlighting the chemical restrictions currently in place across major markets. This would help readers visualize the disparities and better understand how local regulatory environments influence health risks.

In addition, the manuscript introduces important developments in analytical chemistry, including techniques like automated thermal desorption gas chromatography/mass spectrometry (ATD-GC/MS), total oxidizable precursor assays (TOP), and oxidative conversion methods for PFAS. These techniques are enabling researchers to detect a wider array of contaminants and their precursors in textile products. However, the review could do more to convey the practical value of these tools to non-specialist audiences. For example, a brief table comparing these techniques in terms of detection limits, cost, accessibility, and suitability for routine monitoring or regulatory compliance could be extremely helpful for practitioners, including regulators, public health researchers, and third-party laboratories. Clarifying which methods are most feasible for implementation in lower-resource settings would also enhance the global relevance of the review.

From a data presentation standpoint, the paper would benefit from the inclusion of several well-placed figures or summary graphics. Given the extensive data on concentrations, detection frequencies, and risk estimates across chemical groups, I recommend adding the following: (1) a bar chart or boxplot comparing median concentrations of key chemicals (e.g., DEHP, PFOS, chromium, BPS) across different textile types and age groups; (2) a timeline graphic showing trends in detection or substitution of regulated chemicals between 2019 and 2025; and (3) a matrix summarizing which textile items (such as socks, swimsuits, underwear) are associated with which chemical classes and corresponding health outcomes. These figures would serve as useful visual aids and improve accessibility for a broader audience.

Regarding the manuscript's length, the authors could consider editorial streamlining in a few areas to maintain clarity without losing substance. For instance, certain subsections in the results (such as those on phthalates and PFAS) contain detailed summaries of multiple studies with overlapping findings. These could be consolidated by grouping studies with similar outcomes and presenting shared metrics together, followed by a comparative analysis or interpretation. This would reduce redundancy while preserving the

richness of the review. Similarly, some long sentences summarizing multiple concentration values could be shortened or supported by tabular summaries.

The discussion section is particularly strong in addressing mixture toxicity, emerging contaminants, and the limitations of current certification schemes such as OEKO-TEX and GOTS. It is both timely and necessary to emphasize that so-called sustainable or “eco-friendly” clothing does not automatically ensure chemical safety. The reported presence of formaldehyde and other hazardous residues in garments labeled as sustainable challenges consumer assumptions and suggests that regulatory oversight and product certification must evolve in parallel with market trends. Including a brief overview of what substances are currently covered under these labels, and where they fall short, would further strengthen this point.

The review also touches on global disparities in manufacturing and enforcement, but this could be expanded slightly. Countries with weaker environmental and occupational safety standards often bear a disproportionate burden of textile chemical pollution, both during production and through importation of second-hand or off-regulation products. More explicit mention of these dynamics, along with their public health implications, would add depth to the already important discussion of environmental justice and global regulatory coherence.

Lastly, the conclusion appropriately calls for interdisciplinary collaboration, improved biomonitoring, and pre-market chemical screening. The authors’ recommendations are both pragmatic and well-supported. However, including a few concrete suggestions, such as the creation of international databases for textile chemical content or standardized exposure models incorporating microplastic and nanoparticle migration, would make the proposed path forward even more tangible.

In summary, this manuscript is a highly valuable and timely contribution to the field of environmental health and textile safety. It bridges research, regulation, and real-world implications in a way that is rarely achieved in review articles. With the addition of visual data summaries, a few editorial refinements for clarity and conciseness, and deeper elaboration on global regulatory comparisons and practical applications of detection methods, this work could serve as a go-to reference for years to come. It is well-suited for publication and will undoubtedly support informed decision-making by researchers, policymakers, and industry professionals.

Declarations

Potential competing interests: No potential competing interests to declare.