Development of a Study Quality Tool for Use in a Systematic Review of Literature Reporting Microplastic Exposure and Reproductive and Developmental Toxicity

S. Fitch, J. Rogers, S. Marty[1], R. Ellis-Hutchings[1], R. Becker[2], and D. Wikoff
1 Dow Chemical Company, Midland, MI; 2 American Chemistry Council, Washington, DC

Monday, March 20, 2023
10:45 AM – 12:30 PM
3559/P684
Reproductive and Developmental Toxicology II
Music City Center
Hall C

Abstract:

Microplastics (MPs) have been detected in air, water, soil and food, but understanding these exposures in the context of potential human health risks requires both hazard characterization and exposure evaluation. Initial reviews of hazard studies identified developmental and reproductive toxicity (DART) as potentially "critical effects" (effects exhibiting the lowest NOAEL/BMD). However, these reviews also highlighted that aspects of study reliability relating to these experimental investigations - particularly test article identity, exposure, dose-response, and relevance of mechanistic endpoints to adverse effects - impact confidence in hazard characterization. To better understand such impacts and to systematically gather, appraise, and integrate the relevant empirical evidence, a systematic review of the potential effects of MPs on DART outcomes in both epidemiological and experimental animal studies was conducted using a stepwise and highly refined approach to critical appraisal. This approach combines explicit and transparent determinations of risk of bias (systematic error), test article attributes and characterization information, based on the published Nano- and Microplastic Particle Toxicity Assessment Tool (PMID:35098152), with internal and construct validity evaluations for DART study conduct and reporting (based on subject matter expertise). The protocol was developed a priori and published online. The systematic literature search performed on December 17, 2021 resulted in identification of 9 publications that met the inclusion criteria; no relevant epidemiological studies were identified. These included studies that evaluated MP exposure in mice (ICR, BALB/C, or C57BL/6 strains) via drinking water, gavage, or intratracheal instillation with exposure periods ranging from 18 days (gestational exposure) to 90-days. Studies used a variety of MP test materials, varying in shape (microspheres or irregular), polymer (polyethylene or polystyrene), and size (ranging from 5 to 45µm). Four studies assessed female reproductive effects, 6studies assessed male reproductive effects, and 4 studies assessed developmental toxicity. The measured parameters in the developmental toxicity studies were limited to outcomes such as offspring organ weight and body weight. None of the identified studies followed published standardized and harmonized OECD/EPA test guidelines. Following application of the internal and construct validity tools, only 4 of 9 studies were shown to achieve sufficient internal construct validity to proceed to the second stage of critical appraisal — the evaluation of sufficiency for risk assessment. The appraisal for applicability in risk assessment showed that none of these studies meet all the criteria to be considered sufficient for hazard characterization; in each study one or more key criteria were not met (statistical analysis, dose-response relationship, concentration range, reporting of an effect threshold or adequate data to derive one, test particle relevance). Therefore, the available body of literature did not meet the minimum standards of validity and confidence for use in hazard characterization of MPs for potential human health risks. This systematic review and evidence appraisal methodology enables more precise understanding of the current state of the science and illustrates opportunities for developing the additional information needed for improving the scientific basis of MPs hazard characterization, exposure evaluations, and risk assessments.