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Polystyrene micro and nanoplastic exposure is associated with increased fasting glucose in high-fat diet-fed mice: a systematic review and meta-analysis

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Introduction

Micro - and nanoplastics (MNPs) are widespread environmental contaminants detected even in remote ecosystems, but their potential effects on metabolic health remain insufficiently characterized. This systematic review and meta-analysis evaluated the association between polystyrene MNP exposure and fasting blood glucose levels in high-fat diet (HFD)-fed mice.

Objectives

To evaluate the association between exposure to polystyrene MNPs and fasting blood glucose levels in HFD-fed mice through a systematic review and meta-analysis.

Methodology

PubMed, Web of Science, and Scopus were systematically searched for controlled experimental studies published between January 2014 and December 2024. Eligible studies compared HFD-fed mice exposed to polystyrene MNPs with HFD-fed control groups. Standardized mean differences (SMDs) with 95% confidence intervals (CIs) were pooled using a random-effects model with restricted maximum likelihood estimation.
Risk of bias was assessed using SYRCLE's tool.

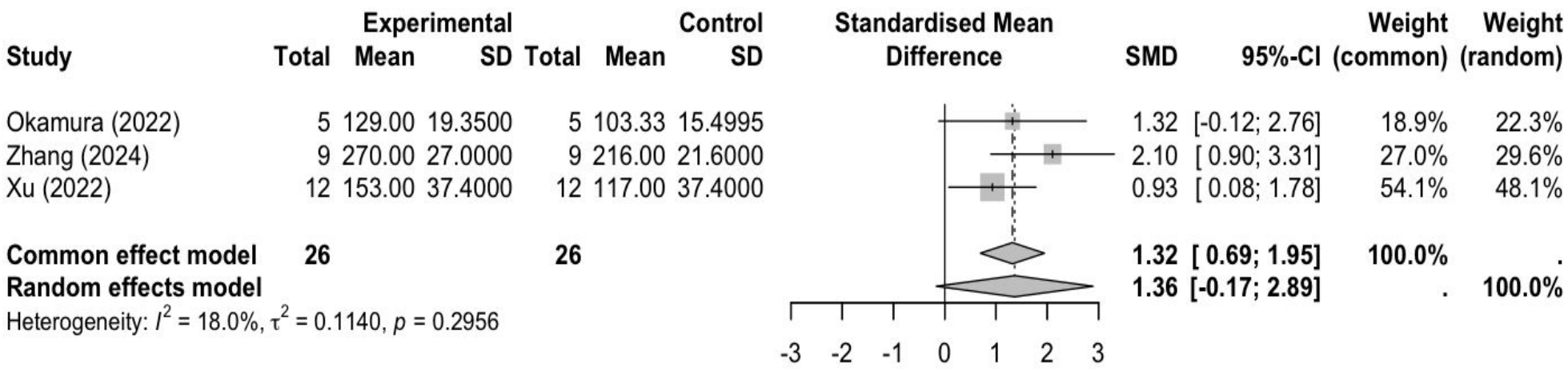
Results and Conclusions

Three studies comprising 54 mice met the inclusion criteria, with 27 animals in the experimental groups and 27 in the control groups. All included studies reported increased fasting blood glucose following MNP exposure, with individual effect sizes ranging from SMD = 0.93 to 2.10. The pooled effect was SMD = 1.36 (95% CI: -0.17 to 2.89; p = 0.081), indicating a positive but statistically non-significant effect. Heterogeneity was low (I = 18%; p = 0.296). Sensitivity analyses showed consistent directionality of the pooled effect despite variations in particle size (80 mm to 5 um), dose (0.1-80 mg/kg/day), and exposure duration (12-14 weeks). Potential mechanisms underlying these metabolic effects include adipose tissue dysfunction, gut microbiota dysbiosis, and systemic inflammation (Figure 1). Polystyrene MNP exposure was associated with a positive but statistically non-significant increase in fasting blood glucose under HFD conditions. These findings suggest a potential metabolic effect of MNP exposure, although the available evidence remains insufficient to establish a statistically significant association. Further experimental studies with larger sample sizes and standardized exposure protocols are needed to clarify the metabolic consequences of MNP exposure.

Acknowledgments

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Figure 1. Forest plot of the meta-analysis evaluating fasting blood glucose levels after exposure to polystyrene micro/nanoplastics.



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