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Microplastics in Seafood: How Much Are People Eating?

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With discarded plastics making up more than 80% of the trash that accumulates in some locations,[1] microplastics (MPs) have become ubiquitous in the environment. Generally defined as synthetic polymers less than 5 mm in diameter,[2] MPs have been found in fish, shellfish, crustaceans, mollusks, and even mammals.[3] In a systematic review and meta-analysis recently reported in *Environmental Health Perspectives*, investigators estimated the level of MP contamination in seafood and, consequently, how much people may ingest each year.[3]

It is not clear whether MP consumption harms human health, although particles may carry potential hazardous plastic constituents, microorganisms, and adsorbed chemicals.[3] "In order to assess whether the uptake of microplastics via food can indeed pose a risk to our health, first we need to quantify this exposure, and, second, determine whether this exposure is high enough to have a detrimental effect," says lead study author Evangelos Danopoulos, a doctoral student at Hull York Medical School in England. "Systematic reviews and meta-analyses can play a key function in the risk assessment process."

The systematic review included 50 primary peer-reviewed papers—all field studies that sampled mollusks, crustaceans, fish, and echinoderms for MP contamination—and 19 studies were used in the meta-analysis. The authors developed a novel risk of bias (RoB) quality assessment tool to evaluate all aspects of experimental design, execution, and reporting for each paper. Among other inclusion criteria, studies must have sampled commercially relevant seafood species and used one of four validated procedures to assess the chemical composition of MPs.

The studies measured contamination in terms of MP particles per gram of organism wet weight or per individual organism. Over half the reviewed studies sampled mollusks, reporting a range of 0–10.5 MPs/g. Mollusks collected in Asia tended to be the most contaminated. In addition, mollusks collected directly from fishing waters were more contaminated than those purchased from markets. The reasons for this finding are not entirely clear, Danopoulos says, but one possibility is that harvested mollusks are sometimes put through a flushing process known as depuration before they are commercially available.

For crustaceans, the range was 0.14–8.6 MPs/g, but there were many gaps in the study data. Among fish, anchovies had a range of 0.35–2.3 MPs/individual, and sardines had 0.23–4.63 MPs/individual. Four studies analyzed larger fish; two reported the absence of MPs, one did not find contents that were significantly different from the control samples, and only one found MPs, reporting a content of 2.9 MPs/g. However, the authors rated the latter study as having a high RoB, meaning it was not rigorously conducted, according to the RoB matrix. One study on echinoderms found 0.82 MPs/individual or 1 MP/g in edible tissue.

The investigators estimated a maximum human uptake of MPs from seafood to be a maximum of 53,864 particles annually. They based this calculation on global consumption estimates[4] of 15.21 kg/person per year for fish, 2.65 kg/person per year for mollusks, and 2.06 kg/person per year for crustaceans (echinoderms were not listed in the consumption data set they used). The authors acknowledge that seafood consumption varies widely by country, depending on geography and culture. Given the variation

Investigators used a novel risk of bias tool to identify high-quality studies of microplastics in crustaceans, mollusks, echinoderms, and fish. Images, left to right: © iStockphoto/Kateryna Kukota, © iStockphoto/Don White, © iStockphoto/79mtk, © iStockphoto/Photosiber.

in MPs' sizes, the authors did not attempt to estimate the total mass consumed.

"The most striking finding for me was that every single study identified the presence of microplastics in [at least part of] their samples," Danopoulos says. With samples coming from four phyla comprising more than 20 families collected from all around the world, living in different habitats and different environmental compartments—all were found to be positive, at some level, for MP contamination. "Microplastics contamination is indeed ubiquitous," he says. He also notes that the most abundant polymers identified in seafood (polyethylene and polypropylene) are the ones that have been most heavily produced in the last 15 years.

"This is an interesting analysis," says Thavamani Palanisami, a senior lecturer at Australia's University of Newcastle. "The maximum uptake . . . is very high and could be due to methodological issues. Nevertheless, if I am a fish eater, I would be worried [about] even one MP in my diet." Palanisami, who was not involved in the current study, recently published an analysis of MP consumption from all dietary sources in which he estimated humans could be eating up 5 g per week.[5]

"This is the first systematic review of the literature on microplastics in seafood, which is important in its own right," says Dave Love, an associate scientist at the Johns Hopkins Bloomberg School of Public Health who also was not involved in the study. "If regulatory agencies were to inspect seafood for microplastics—which they do not currently do as part of routine testing—there would need to be expert guidance on where to set the bar or the numbers of microparticles per gram of tissue allowable. Before that, however, we probably need more health effects studies to decide if microplastic exposure warrants any regulatory action."

Danopoulos and colleagues also recently published systematic reviews of microplastics exposure from salt[6] and drinking water.[7] They estimated potential human exposures via salt at 0–6,110 MPs/year.[6] For drinking water, they estimated that people might be consuming up to 458,000 MPs/year for tap water and 3,569,000 MPs/year for bottled water, based on average water consumption.[7] "The results of all three systematic reviews," Danopoulos says, "can be used in an aggregate exposure framework from all three mediums, which will give us an estimate of high confidence on human microplastics exposures."

Wendee Nicole is an award-winning Houston-based writer. Her work has also appeared in *Discover*, *Scientific American*, and other publications.

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