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Impact of microplastics and other toxics on human health

Submission from: Cancer Epidemiology Division, Cancer Council Victoria

Committee: Community Affairs References Committee

Cancer Epidemiology Division, Cancer Council Victoria

The Cancer Epidemiology Division at Cancer Council Victoria is a research-intensive department that undertakes epidemiological research into the risk factors for cancer, and biological pathways underpinning these risks. Led by Professor Roger Milne, the Cancer Epidemiology Division is staffed by a committed team of 35-40 employees, with broad diversity in skills and experience, including five senior researchers. The Division is highly productive, generating approximately 120 peer-reviewed scientific articles each year. The Division's senior researchers are benchmarked amongst Australia's highest performing cancer researchers.

Notably, the Cancer Epidemiology Division runs two large and comprehensive Australian cohort studies:

The *Melbourne Collaborative Cohort Study* was established by Cancer Council Victoria between 1990-1994 by recruiting 41,513 Melbourne residents (59% female) aged 40-69 years. Questionnaires assessing demographics and key cancer risk factors were completed at baseline and each of two waves of follow-up approximately three and 10 years later. All participants gave a blood sample at baseline and 65% gave a second blood sample at wave 2 of follow-up (10 years later).

The *Australia Breakthrough Cancer (ABC) Study* was established by Cancer Council Victoria in 2014-2018 by recruiting 56,336 Australians (59% female) aged 40-74 years from around the country. Questionnaires assessing demographics and key cancer risk factors were completed at baseline and are repeated as part of follow-up every three years. Ten thousand participants provided a blood sample at baseline and approximately 50% of those subsequently provided a faecal sample at wave 1 or 2 follow-up. An additional 15,000 participants have provided synchronous blood and faecal samples at wave 1 or wave 2 follow-up. Participants that provided a faecal sample also completed a food frequency questionnaire at the same wave of follow-up, as well a day-of-sample questionnaire that included cigarette, probiotic, antibiotic and other medication use.

For both cohorts, cancer and death outcomes (including cause of death, and therefore deaths due to cardiovascular disease) are ascertained by annual record linkage carried out by the Australian Institute of Health and Welfare.

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The biological specimens collected by cohort studies such as the Melbourne Collaborative Cohort Study and the ABC Study are critical resources required to generate high-quality evidence of the potential role that micro- and nanoplastics (MNPs) and plastic-associated chemicals (PACs), including per- and polyfluoroalkyl substances (PFAS) play in the development of cancer in humans.

Comments in relation to the Terms of Reference

The impact of microplastics, toxics and forever chemicals on human health, with particular reference to:

- *cardiovascular impacts, including links between microplastic accumulation in arterial plaque and increased risks of heart attack, stroke and cardiovascular mortality*

There are major gaps in the evidence base relating to the effect of specific MNPs and PACs on human health. A recent umbrella review[1] recommended (i) urgently prioritising primary research on MPs in humans by developing accurate and reliable measurement techniques; (ii) urgently developing methods to evaluate the impact of thousands of other plastic-associated chemicals on human health; and (iii) broadening the evidence base by increasing investment in human observational cohort studies, including longitudinal cohorts, thereby expanding the scope of plastic-associated chemical exposures and health outcomes assessed.

Most human studies have used small sample sizes, inconsistent methodologies, and inadequate exposure assessment, making it difficult to establish causality or quantify risk. Prospective cohort studies provide high-quality evidence of causation in humans where randomised trials are not possible. In cohort studies, biospecimens are collected from disease-free participants at baseline and/or over follow-up, and participants are followed for new disease diagnoses, enabling the temporal relationship between exposures measured in biospecimens and disease to be established. Prospective cohort studies have been instrumental in establishing the carcinogenicity of cigarette smoking for lung cancer, human papillomavirus for cervical cancer, and Helicobacter pylori for gastric cancer, for example.

Thus, there is an urgent need for research that quantifies MNPs and PACs in biological specimens collected by Australian prospective cohort studies, to establish whether these contaminants increase the risk of cardiovascular disease.

- *links between endocrine disrupters and increased rates of cancer in young people, fertility issues, hormone dysregulation, respiratory diseases, inflammatory conditions and immune system dysfunction*

Epidemiological data from Australia and other high- income countries have documented a significant increase in early-onset colorectal cancer,[2,3] as well as in distal colonic and rectal cancers.[3,4] The increase in distal tumours may reflect regional physiological differences.[4] Rather than forming a continuous epithelial lining (as in the proximal colon), mucus in the distal colon tends to coat stools, leaving sections of mucosa exposed.[5]

Recent experimental evidence from animal models suggests that MNPs may impair mucus production by downregulating mucin gene expression, reducing goblet cell numbers, and increasing intestinal permeability.[5] These effects are likely to be particularly pronounced in the distal colon. Disruption of this barrier allows MNPs to come into contact with the colon epithelium, promoting inflammation and potentially carcinogenesis.[5,6] The gut mucosa also provides the epithelium protection against certain bacteria, some of which have been shown to increase the risk of colorectal cancer.[7,8]

MNPs and PACs have been hypothesised to disrupt the gut microbiome and play a role in the development of cancer – particularly early onset colorectal cancer. However, evidence is lacking to inform health policy, environmental regulation and public health messaging. To date, no high-quality, prospective cohort studies have collected appropriate biological samples and been able to accurately and reliably measure the exposures to scale.

It is critical to establish research that quantifies MNPs and PACs in biological specimens collected by Australian prospective cohort studies, to establish whether these contaminants increase the risk of cancer, including early onset colorectal cancer.

- *the adequacy of current research, monitoring and measurement standards for microplastic contamination in Australia*.

Currently there is no established gold-standard for measuring MNPs and PACs at scale in human biological samples. Uncertainty exists regarding the amount and variety of plastic contamination that is directly related to the instruments used for collection of biological samples in cohort studies.

Thus, there is a pressing need to develop methods and protocols for quantifying MNPs and PACs in biological samples at scale, that is, measuring these exposures in hundreds of biological samples at a time. These methods need to be reproducible and cost-efficient, to facilitate the necessary epidemiological studies into the potential effects of MNPs and PACs on human health.

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Concluding comments

Changes to global systems, driven by industrialisation and plastic-dependent packaging, have increased human exposure to MNPs, as well as PACs.[9,10] These exposures are increasingly recognised as potential carcinogens,[11,12] yet their long-term effects on cancer risk in humans remain poorly understood.[13,14] This is, at least in part, because few cohort studies have collected appropriate biological samples and been able to accurately measure these exposures at scale.

We call upon the Government to release additional funds into the health and medical research sector to enable multi-disciplinary research bringing together experts in epidemiology, environmental chemistry, advanced microscopy, microbiome science, metabolomics, gastrointestinal health, cardiology and environmental science to investigate the effect of MNPs and PACs on human health. There is a particular need for research in human cohort studies, which provide insights into real-world level of exposure to these contaminants.

References

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