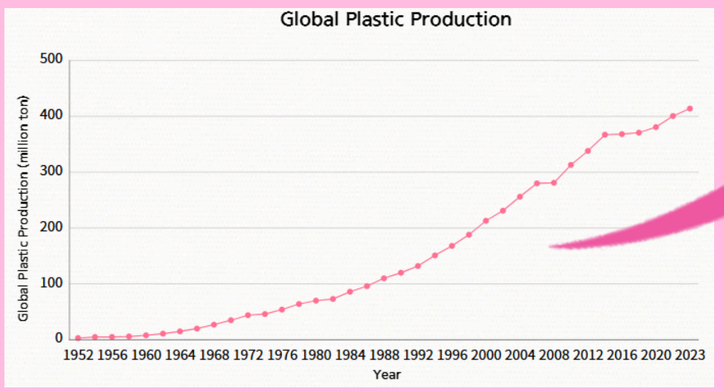
Breathe In, Breathe Out, Breathe..... PLASTIC???

Hea Jeong Kim[1,2], Andrew Chappell[3], Joel Rindelaub[1,2], Lisa I. Pilkington[1,2]
1. School of Chemical Sciences, The University of Auckland, New Zealand
2. Te Pūnaha Matatini, Auckland 1010, New Zealand
3. Public Health and Forensic Science (PHF Science), Christchurch 8041, New Zealand

Plastics?

- **Plastic** is in **almost everything we use in our daily lives**, from water bottles to kids' toys to clothing.
- Plastics are **strong, long-lasting, and lightweight**. They resist damage by water, heat, chemicals, and electricity. This is why plastics have become so popular since their invention.
- As shown in the graph below, the global plastic production is **rapidly increasing**.[1] The annual global plastic production in 2023 was about **413.8 million tonnes**,[2] and with this rapid growth rate, the global plastic production could double in the next two decades.



Aim of Research

- The overall aim of this research is to **measure microplastic exposure by analysing exhaled breath samples**.
- An **analytical methodology** to measure the microplastic exposure will be developed, validated, and applied to accurately quantify the exposure in Aotearoa New Zealand.
- This research will particularly focus on the microplastic exposure of the selected **13 most common polymers**.

Microplastics

- 13 common polymers: **PE, PET, PE, PVC, PS, PC, PU, PMMA, ABS, SBR, PLA, and PCL.**
- Plastics are strong and long-lasting, but they gradually **break down** into small particles by a continuous natural weathering process. Those small particles, **smaller than 5 mm,** are called **microplastics.**
- Humans are **exposed to microplastics through various pathways,** respiration (air),[3] drinking (water and beverages),[4] food chains,[5] and many different plastic-containing commercial products.[6]
- Research has shown that microplastics are **harmful to human body systems**,[7] including digestive systems, respiratory systems, and hormone systems.
- At this point, there is **no published research** that has been analysed the NZ population's exposure to the 13 common polymers in air samples.

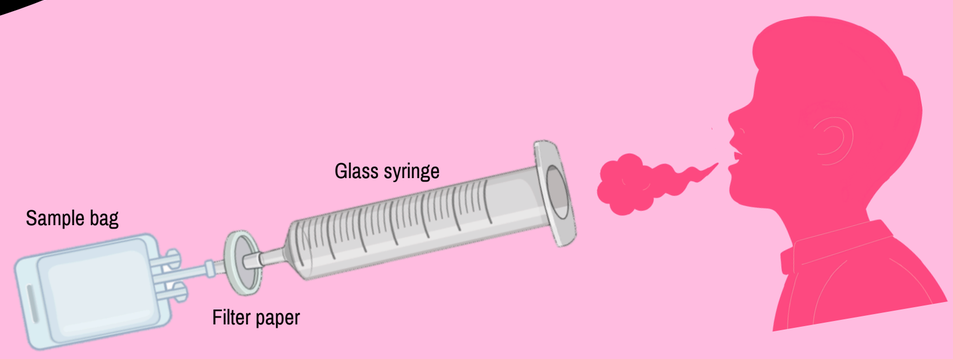
Method

- Pyrolysis-Gas Chromatography with Mass Spectrometry (Py-GC-MS) is being used to measure the nature and amount of microplastics.
- Py-GC-MS is an analytical method that **rapidly heats** (to 700 °C) a sample to **break the polymers present into smaller chemical fragments** that can be subsequently analysed.
- These smaller chemical fragments, which are unique to the different polymers, are separated by GC and identified by MS.

Shimadzu Pyrolyser (EGA/PY-3030D) with GCMS-QP2050

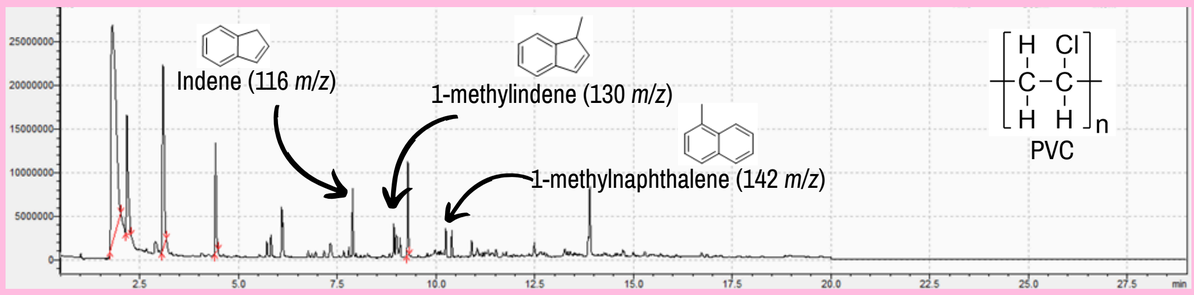
Sample Collection

- Microplastics from **exhaled breath samples** were collected by trapping them onto **filter paper**.
- To do this, the participants were asked to exhale into a glass syringe that was joined to the filter paper and the sample collection bag, as shown in the diagram below.
- Exhaled breath samples have been collected from **46 participants** between November ~ December 2024.



Analysis So Far

- A **Py-GC-MS method** to analyse the selected **13 polymers** has developed.
- This has been included:
  - Establishing an **internal standard** (anthracene-d_{10}) to allow for **accurate analysis**.
  - Establishing the **smaller chemical fragments** that can be analysed to **quantify** each of the targeted polymers (see the pyrogram below for the fragments identified for PVC).



Next Steps

- Preparation of **calibration curves** to quantify the microplastics present in the collected samples.
- **Validate** the method to ensure quantification estimates are accurate.
- Analyse the **collected exhaled breath samples**.
- Analyse data to **understand airborne microplastic exposure in NZ**.

Research Impact

- This research will provide a means to **analyse the level of exposure to airborne microplastics in Aotearoa NZ**.
- The results of this research will help us gain a **better understanding and awareness of plastic exposure in our lives**.
- With this information, the **NZ government**, its organisations and agencies will have **accurate and detailed information regarding plastic exposure in NZ**, which could be used to inform policies and regulations.

References

1. Geyer, R.; Jambeck, J. R.; Law, K. L. Production, Use, and Fate of All Plastics Ever Made. Science Advances 2017, 3 (7), e1700782. https://doi.org/10.1126/sciadv.1700782. **2.** Plastics Europe. Plastics – the Fast Facts 2024; 2024. https://plasticseurope.org/wp-content/uploads/2024/11/PE_TheFacts_24_digital 1pager.pdf. **3.** Prata, J. C. Airborne Microplastics: Consequences to Human Health? Environ. Pollut. 2018, 234, 115–126. https://doi.org/10.1016/j.envpol.2017.11.043. **4.** Karami, A.; Golieskardi, A.; Keong Choo, C.; Larat, V.; Galloway, T. S.; Salamatinia, B. The Presence of Microplastics in Commercial Salts from Different Countries. Sci. Rep. 2017, 7 (1), 46173. https://doi.org/10.1038/srep46173. **5.** Mamun, A. A.; Prasetya, T. A. E.; Dewi, I. R.; Ahmad, M. Microplastics in Human Food Chains: Food Becoming a Threat to Health Safety. Sci. Total Environ. 2023, 858, 159834. https://doi.org/10.1016/j.scitotenv.2022.159834. **6.** Bouwmeester, H.; Hollman, P. C. H.; Peters, R. J. B. Potential Health Impact of Environmentally Released Micro- and Nanoplastics in the Human Food Production Chain: Experiences from Nanotoxicology. Environ. Sci. Technol. 2015, 49 (15), 8932–8947. https://doi.org/10.1021/acs.est.5b01090. **7.** Lee, Y.; Cho, J.; Sohn, J.; Kim, C. Health Effects of Microplastic Exposures: Current Issues and Perspectives in South Korea. Yonsei Med. J. 2023, 64 (5), 301–308. https://doi.org/10.3349/ymj.2023.0048.

THE UNIVERSITY OF AUCKLAND
Te Whare Wānanga o Tāmaki Makaurau
NEW ZEALAND

Te Pūnaha Matatini
Complexity is at our heart