

# Characterising Neonicotinoid Insecticide Exposures Among the Irish Population Using Human Biomonitoring

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## Key Findings:

1. NNIs detected in 76% of urine samples from the general Irish population
2. All exposures were less than 0.1% of the Acceptable Daily Intake (ADI)

## Introduction:

Neonicotinoid and neonicotinoid-like insecticides (NNIs) are a major class of pesticides that can be used as plant protection products, flea treatments, or indoor fly treatments (Figure 1) [1]. In 2018, NNIs were the most widely used class of insecticide in the world, with a market value of almost \$5 billion [2].

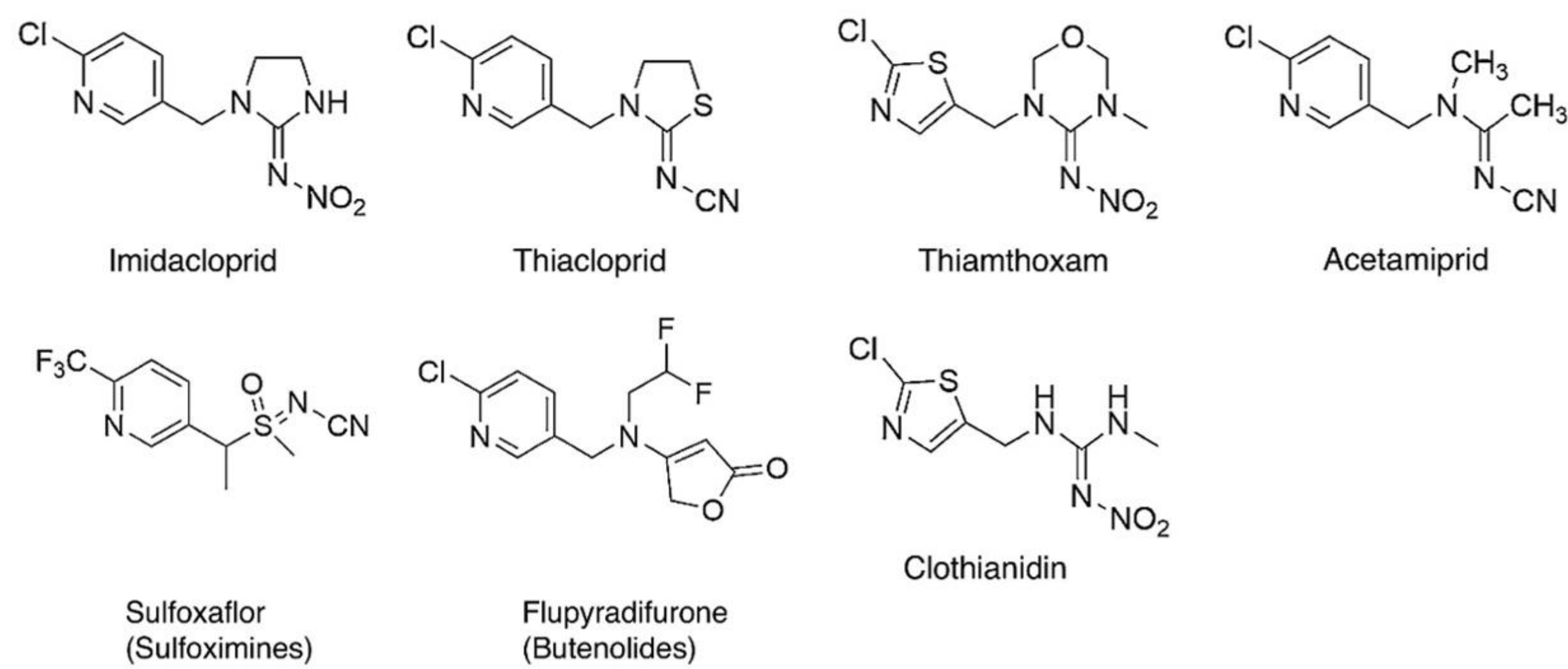


Figure 1: The main NNIs that have been used in Ireland and the EU are imidacloprid (IMI), thiacloprid (THIAC), thiamethoxam (THIAM), acetamiprid (ACE), sulfoxaflor (SULF), flupyradifurone (FLUP), and clothianidin (CLO) [3].



Figure 2: CLO, IMI, THIAM, and SULF have had their use restricted [5-8] due to adverse effects on pollinators. THIAC was restricted due to potential carcinogenicity of its metabolites [9].

Many NNIs have had their use restricted as plant protection products (Figure 2). As of 2024, only FLUP and ACE are still fully approved for use as plant protection products, while IMI is approved for use as a flea treatment for pets [3, 4].

Human biomonitoring (HBM) assesses chemical exposures by analysing biological matrices, such as urine or blood (Figure 3) [10]. In Ireland, there has been no HBM study of NNIs conducted.

## Aim:

The EIRE 'neonicotinoid Insecticide exposuREs' project aims to conduct the first HBM study of NNIs in Ireland. Urine samples from the general Irish population were analysed for NNIs using a previously published method [11].

## Methods:

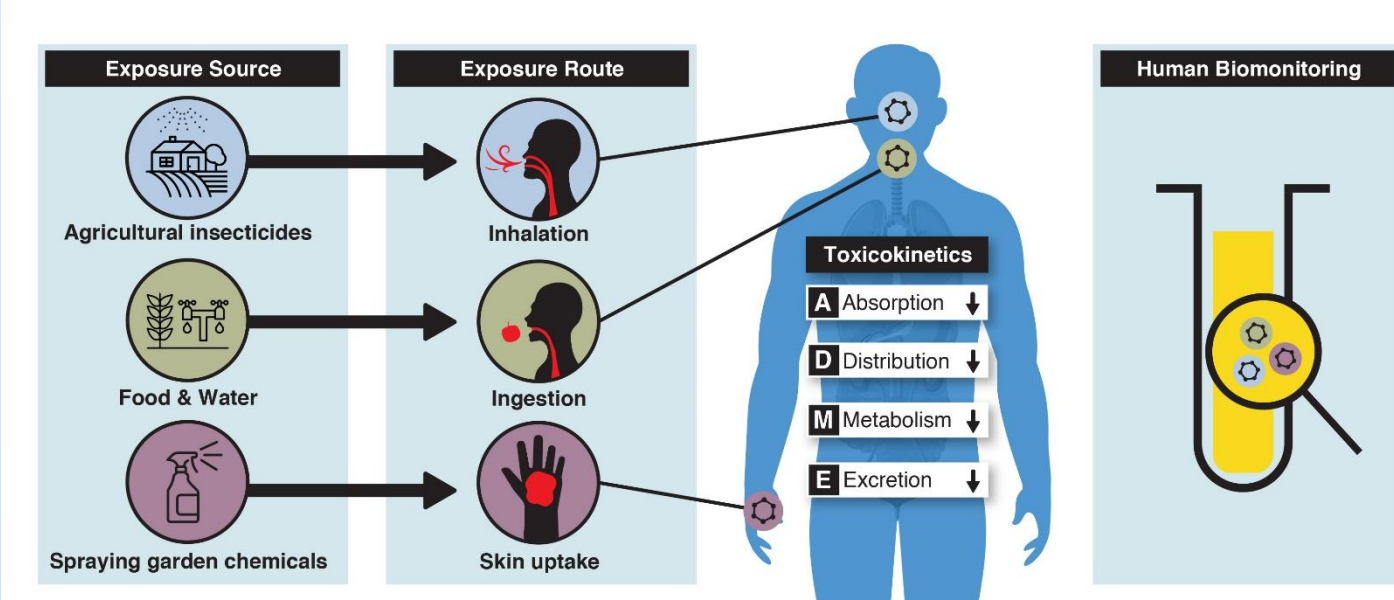


Figure 3: Principle of HBM in the EIRE study. HBM was used to assess exposure to NNIs from all exposure routes by analysing urine samples for NNIs.

Urine samples (n=227) were collected from farm and non-farm families in Ireland to investigate glyphosate exposures from 2019 to 2020 [12].

These samples were analysed for selected NNIs and their metabolites (Table 1).

Table 1: The method used in the EIRE study.

NNI	LOQ (ug L <sup>-1</sup> )	LOQ Metabolite(s) (ug L <sup>-1</sup> )
ACE	0.06	0.15 (DME-ACE)
IMI	0.19	0.24 (IMI-Olefin) 1 (4/5 OH-IMI)
THIAC	0.11	0.12 (4OH-THIAC)
THIAM	0.3	0.18 (DME-THIAM)
CLO	0.83	1.2 (DME-CLO)
FLUP	0.07	0.17 (5OH-FLUP) 0.2 (DFE-FLUP)
SULF	0.26	No metabolites in method

Maximum combined concentrations of parent compounds and metabolites were compared with Acceptable Daily Intakes (ADIs) [3, 12, 13].

## Results:

NNIs were detected in 76% of 227 urine samples from the Irish population, indicating a potential for widespread exposure. Exposure to all investigated NNIs was confirmed (Figure 4).

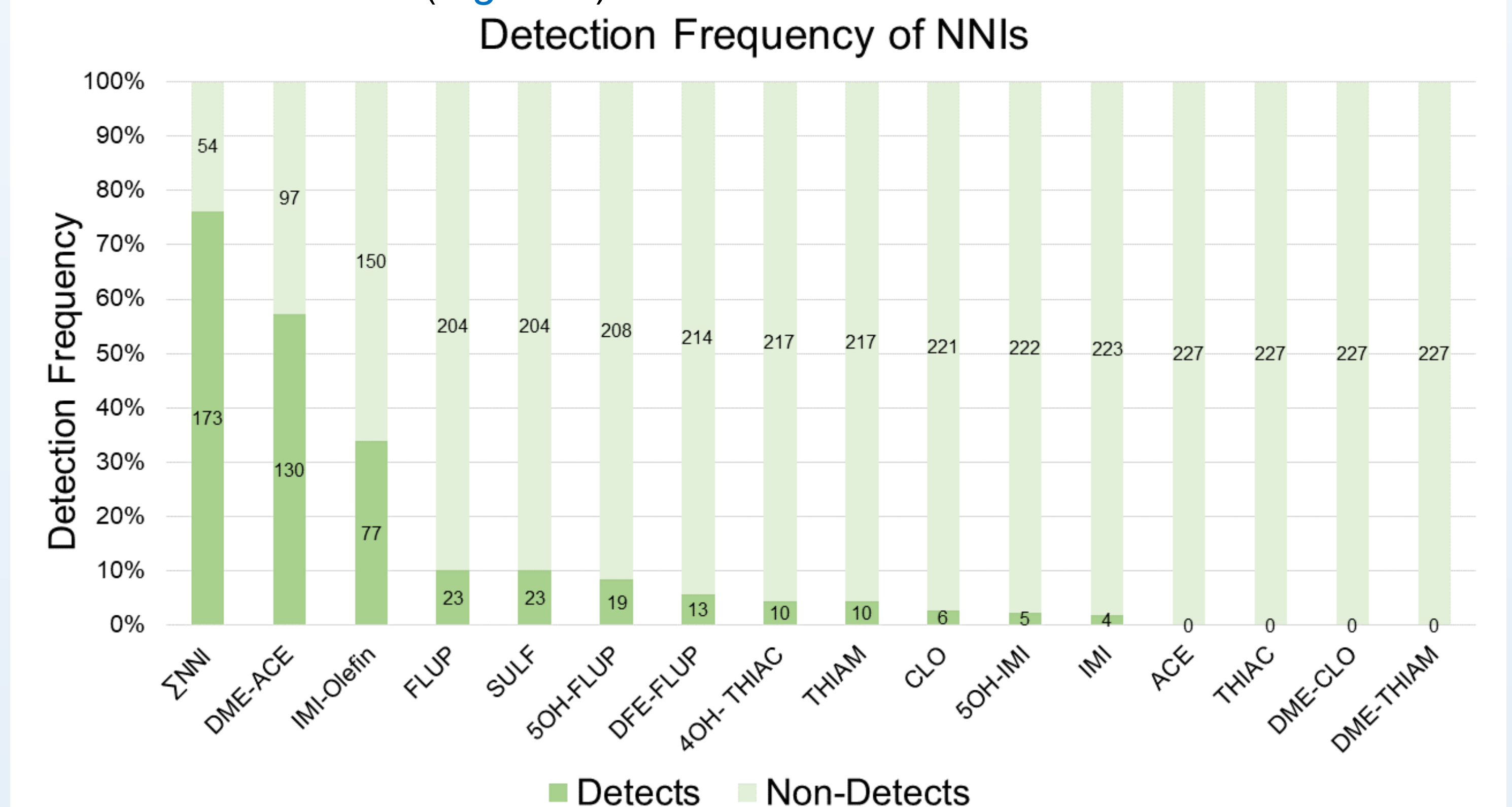


Figure 4: Frequencies of samples with concentrations above the LOQ (Detects) and samples with concentrations below the LOQ (Non-Detects) in the study population. DME-ACE and IMI-Olefin, metabolites of ACE and IMI respectively were the two most widely detected analytes.

Max combined concentration of parent compounds and specific metabolites were a small fraction of ADIs (Table 2), indicating low exposure among the study population.

Table 2: The max combined concentration of NNIs is shown along with how this relates to the ADI.

NNI	Children		Adults	
	Max Conc. (ug L <sup>-1</sup> )	%ADI	Max Conc. (ug L <sup>-1</sup> )	%ADI
ACE	15.44	0.0595	14	0.0384
IMI	9.6	0.0063	12.63	0.0072
FLUP	3.95	0.0015	7.44	0.0044
SULF	1.85	0.0027	0.97	0.0014
THIAM	1.46	0.0061	2.69	0.0069
THIAC	1.08	0.0235	0.83	0.0084
CLO	1.37	0.0009	0.99	0.0004

## Discussion:

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- Largest HBM study of NNIs in the EU
- Similar levels to previous studies [11,14,15]

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- First HBM study of NNIs in Ireland
- First time quantifying FLUP in an EU population

## Future Studies

Future HBM studies of NNIs should focus on quantifying exposures among users and subgroups susceptible to higher exposures of NNIs including gardeners, pet shelter workers, and families with pets that use NNIs

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