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Human and farm animal exposure to pesticides – Silicone wristbands to study non-dietary routes of exposure

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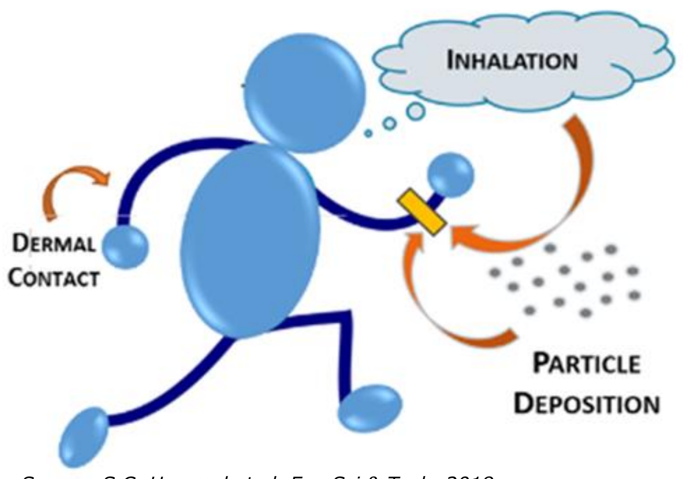
Background



Source: S.C. Hammel et al, Env Sci & Tech, 2018

- **Wristbands** can provide insight into **pesticide exposure**, especially for **inhalation and dermal route**
- **Almost no data** on environmental exposure to pesticides, **specially for animals.**

Aim: To measure multiple pesticides in silicone wristbands worn by humans and animals. Determine mixtures and exposure determinants

Methods

Wristband sampling

- Precleaned silicon wristbands worn for one week by **715 humans** and **152 farm-animals** as part of the SPRINT field campaign
- During spraying season
- Study performed across **10 EU countries and Argentina**, in close proximity to conventional and organic farms.

Extraction and chemical analysis

-**Extracted with 20 mL of ethyl acetate**, containing internal standards (diazinon-D10, bentazone-D6), **for 1 hour** using a head-over-head shaker.

-The entire extract was aliquot-wise **transferred** into a 12 mL **glass tube** and **evaporated under nitrogen at 40° C**.

-**177 pesticides** (including some metabolites) were analyzed in the extracts **using LC-MS/MS**.

Statistical analysis

-Values were **imputed** to account for left-censored data

-**Multivariate regression** to identify exposure determinants

Results

Concentrations - Humans

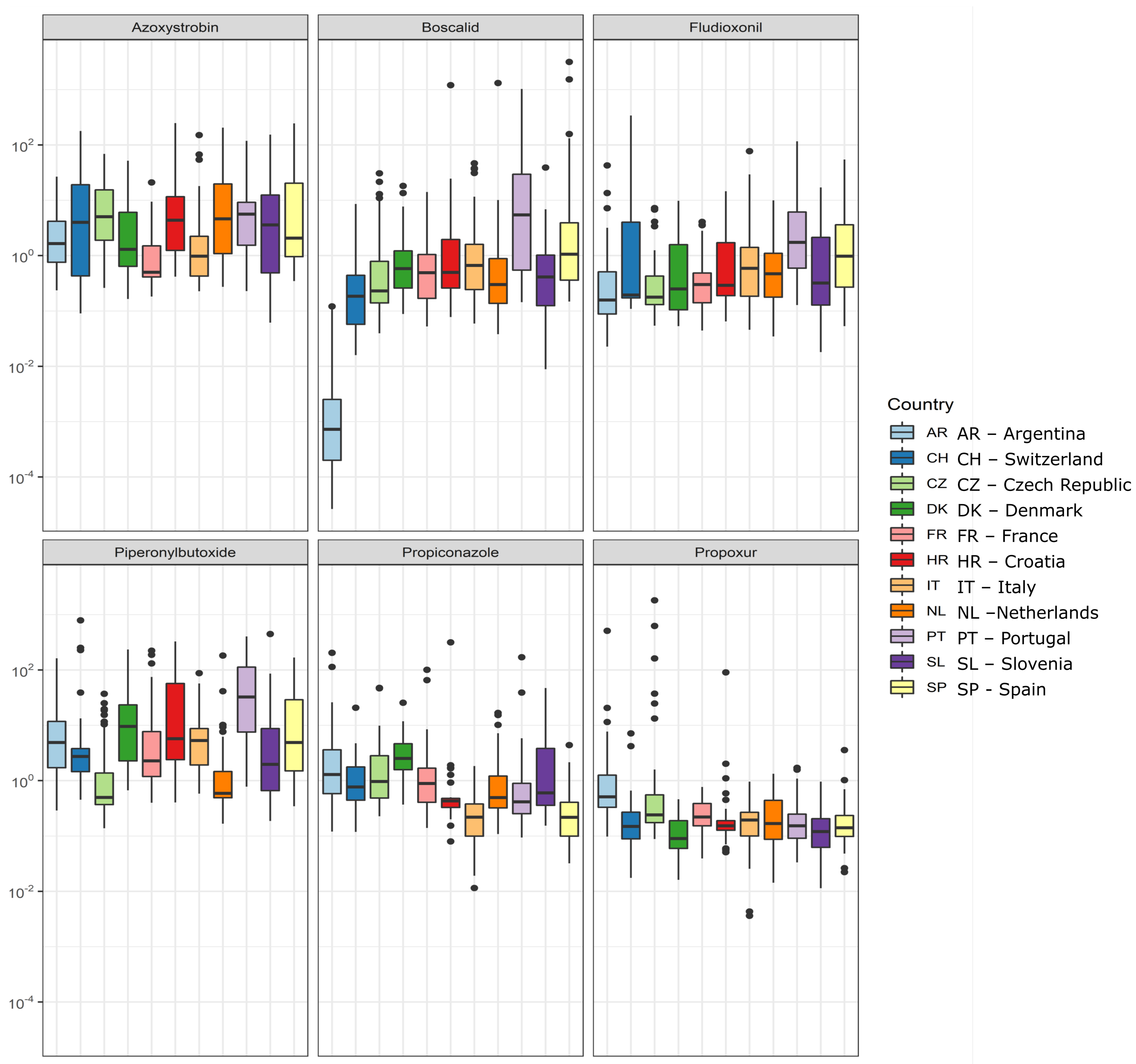


Fig 1. Measured concentrations (in ng/g wristband) for the **top-6 most detected pesticides** in human wristbands, from people living close to conventional farming. Summary statistics in boxplots (min, max, 1st and 3rd quartile and median). Boxplots grouped by country. From left to right -> AR, CH, CZ, DK, FR, HR, IT, NL, PT, SL, SP

❖ There are **statistically significant differences between countries**, although these are quite variable for each pesticide.

❖ **For some pesticides**, such as boscalid, exposure is **very similar across all EU countries.**

❖ Overall, occurence and concentrations were higher when **living close to conventional farms vs living close to organic farms**. [not shown in Fig.1]

Concentrations – farm-animals and cats

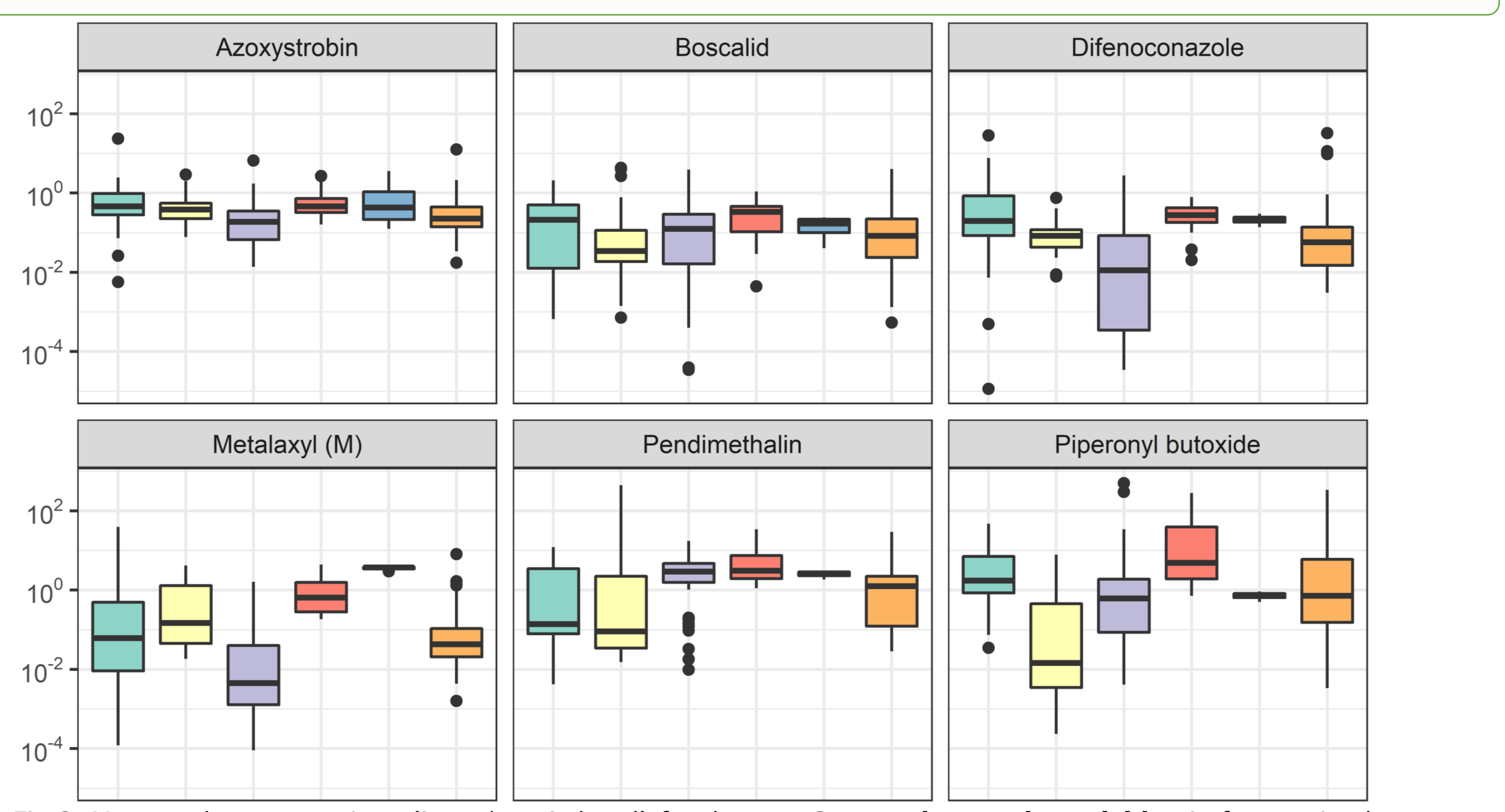


Fig 2. Measured concentrations (in ng/g wristband) for the **top-6 most detected pesticides** in farm-animal wristbands. Summary statistics in boxplots (min, max, 1st and 3rd quartile and median). Boxplots grouped by animal type. From left to right -> cat, chicken, cow, goat, pig and sheep.

❖ There are **statistically significant differences between species**, although these are quite variable for each pesticide and for each species comparison.

❖ The **highest concentrations** (> 100ng/g) **belong to pendimethalin** (herbicide) **and piperonyl butoxide** (insecticide synergist).

Determinants of exposure – human wristbands

	Azoxystrobin	Boscalid	Fipronil	Fipronil sulfone	Fludioxonil	Piperonyl butoxide	Propoxur
Pets last 12 months = Yes	-7 [-30,21]	9 [-18,47]	**374** *** **[222,599]**	**300** *** **[179,472]**	8 [-17,43]	**72** *** **[29,129]**	**68** *** **[34,111]**
Distance to agricultural field (0-250m)	-6 [-32,30]	28 [-9,84]	-23 [-52,23]	0 [-35,53]	**60** ** **[14,125]**	39 [-2,98]	14 [-12,49]
Pesticide use at **home** = Y	23 [-25,104]	-22 [-54,32]	-9 [-55,84]	-14 [-55,64]	17 [-29,95]	**101** ** **[19,241]**	-3 [-35,45]
Frequency of organic vegetables and fruit consumption	**-0.5** *** **[-0.7,-0.3]**	**-0.46** *** **[-0.6,-0.2]**	0.01 [-0.2,0.3]	0 [-0.3,0.2]	**-0.2** * **[-0.4,-0.05]**	0 [-0.2,0.1]	0 [-0.2,0.09]
Work in agricultural sector = Y	12 [-14,48]	**55** ** **[15,109]**	-22 [-47,15]	-10 [-37,28]	28 [-3,70]	26 [-5,70]	-4 [-24,19]
Responsible for **spraying application**	**91** *** **[35,171]**	**51** * **[4,119]**	40 [-13,129]	31 [-16,105]	-2 [-31,39]	-23 [-46,9]	-13 [-34,14]

* p< 0.05; ** p< 0.01; *** p< 0.001 / We are showing **percentage change (transformed beta coefficients)** and confidence intervals, so **no sign** indicates an increase and **minus (-)** sign indicates a decrease; Underlined – likely to be related to biocide use. Time spent indoors, cleaning frequency and being a smoker did not come out as significant determinants in the model. / Y = YES.

❖ Multivariate analysis shown that, for some pesticides, **having pets and spraying or working in agricultural sector elevates concentrations**.

❖ For azoxystrobin, boscalid and fludioxonil, the **frequent consumption of organic vegetables and fruit**, indicated a **reduction** of these pesticide concentrations.

Detection, ranges and mixtures

- We **detected 171** out of 177 pesticides
- The average concentrations ranged **from 0.5 to 117 ng/g in humans and 0.2 to 487 ng/g in farm-animals and cats.**
- In **humans**, the most **common mixture** detected in 30% of the wristbands consisted of fludioxonil, boscalid, fipronil, azoxystrobin and piperonyl butoxide
- In **animals**, the **predominant mixture** observed in >30% wristbands consisted of pendimethalin and piperonyl butoxide

Conclusions

Multiple pesticides were captured in both wristbands worn by humans and animals, which allowed study of **exposure patterns in subgroups within a population**.

Common pesticide mixtures were identified in humans and animal wristbands

In future studies, **wristbands can be used to support informed decisions e.g. on prioritizing** human biomonitoring analytical strategy and to study **environmental exposure to pesticide mixtures and associations with health enpoints**.

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