

Supplementary information

Recent pesticide exposure affects sleep: a cross-sectional study among smallholder farmers in Uganda

Samuel Fuhrimann^{1*}, Iris van den Brenk¹, Aggrey Atuhaire², Ruth Mubeezi³, Philipp Staudacher^{4,5}, Anke Huss¹, and Hans Kromhout¹

¹Institute for Risk Assessment Sciences (IRAS), Utrecht University, Utrecht, The Netherlands

²Uganda National Association of Community and Occupational Health (UNACOH), Kampala, Uganda

³Makarere University, School of Public Health, Kampala, Uganda

⁴Eawag, Swiss Federal Institute of Aquatic Science and Technology, Überlandstrasse 133, 8600 Dübendorf, Switzerland

⁵Institute of Biogeochemistry and Pollutant Dynamics, CHN, Universitätsstrasse 16, ETH Zürich, 8092 Zürich, Switzerland

*Correspondence: Samuel Fuhrimann, Email: samuel.fuhrimann@swisstph.ch

Table S1 showing cheat sheet with 53 pesticide brand names probed for in the interview

Type	Active ingredient	Brand name	Substance group
Fungicide	Mancozeb	Dithane M45 Emthane Indofil Victor-Zeb Carbamate	Carbamate
	Mancozeb (+ Metalaxyl)	Fangocil Kingmill Ridomil Gold Victory	Carbamate + Phenylamide
	2,4-D	2,4-D	Alkylchlorophenoxy
	Glyphosate	Agro-Sate Force Up Green Fire Herbisate Pin-Up Round-All Round-Up Weed Go Weed Up Weedmaster	Phosphonoglycine
Herbicide	Paraquat	Afriparaquat Gramoxone Kuuparaquat	Bipyridylum
	Carbofuran	Agro-Furan Furadan Safuram	Carbamate
	Carbaryl	Sevin	Carbamate
	Chlorpyrifos	Ant-Killer DuDu All Troban	Organophosphate
Insecticide	Cypermethrin	Cyperlacer DuDu Cyper Ripcord Sherpa	Pyrethroid
	Deltamethrin	Decis	Pyrethroid
	Diazinon	Haozinon	Organophosphate
	Dichlorvos	Alga DDVP DuDu Force Dichlorbex Lava	Organophosphate
Insecticide	Dimethoate	Dime Force Rogor Superthoate Tafgor	Organophosphate
	Lambda-cyhalothrin	Lalaforce Karate Striker	Pyrethroid
	Profenofos	Rocket Profecron	Organophosphate
	Permethrin	Atom Decus Dragnet Umeme	Pyrethroid
Insecticide	Permethrin + Pirimiphos-methyl	Ambush	Organophosphate + Pyrethroid

Figure S2 Flow diagram of the number of participants throughout different stages of enrolment and reason for exclusion. Abbreviations: n, number of participants.

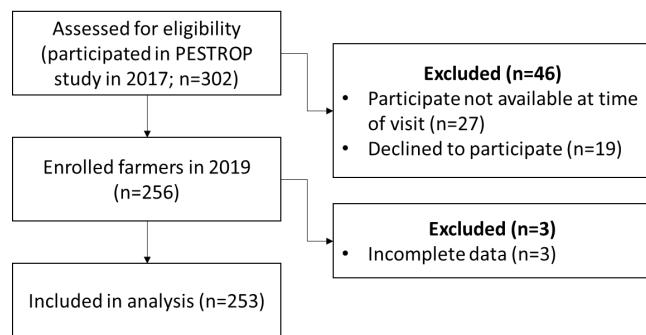


Table S3 showing the 30 reported active ingredients stratified in total use of the year, used more than a week ago and in the week before the study visit.

Active ingredient	Chemical group	Type	Total user last year	Used more than a week ago	Used last week
Glyphosate*	Phosphonoglycerine	Herbicide	151 (59.7)	120 (47.4)	31 (12.3)
Cypermethrin*	Pyrethroid	Insecticide	123 (48.6)	85 (33.6)	38 (15)
Mancozeb*	Dithiocarbamate	Fungicide	102 (40.3)	70 (27.7)	32 (12.6)
2,4-D*	Alkylchlorophenoxy	Herbicide	73 (28.9)	63 (24.9)	10 (4)
Profenofos*	Organophosphate	Insecticide	72 (28.5)	55 (21.7)	17 (6.7)
Abamectin#§	Anthelmintic drug	na	38 (15)	19 (7.5)	19 (7.5)
Acetamiprid#§	Neonicotinoid	Insecticide	38 (15)	19 (7.5)	19 (7.5)
Don't know product\$	na	na	32 (12.6)	30 (11.9)	2 (0.8)
Chlorpyrifos*	Organophosphate	Insecticide	30 (11.9)	24 (9.5)	6 (2.4)
Lambda-Cyhalothrin*	Pyrethroid	Insecticide	25 (9.9)	21 (8.3)	4 (1.6)
Dichlorvos*	Organophosphate	Insecticide	22 (8.7)	17 (6.7)	5 (2)
Amitraz\$	Amidine	Insecticide	19 (7.5)	13 (5.1)	6 (2.4)
Dimethoate*	Organophosphate	Insecticide	18 (7.1)	12 (4.7)	6 (2.4)
Bio pesticide##	na	na	14 (5.5)	14 (5.5)	0 (0)
Thiomethoxam\$	Neonicotinoid	Insecticide	9 (3.6)	5 (2)	4 (1.6)
Deltamethrin*	Pyrethroid	Insecticide	9 (3.6)	7 (2.8)	2 (0.8)
Fertilizer##	na	na	8 (3.2)	7 (2.8)	1 (0.4)
Paraquat*\$	Bipyridylum	Herbicide	8 (3.2)	8 (3.2)	0 (0)
Diazinon*	Organophosphate	Insecticide	6 (2.4)	6 (2.4)	0 (0)
Metalaxyl\$	Phenylamide	Fungicide	5 (2)	4 (1.6)	1 (0.4)
Azadirachtin\$	Strobilurin	Insecticide/Fungicide	4 (1.6)	3 (1.2)	1 (0.4)
Copper oxychloride\$	Inorganic compound	Fungicide	3 (1.2)	2 (0.8)	1 (0.4)
Propamocarb* hydrichloride	Carbamate	Insecticide	3 (1.2)	2 (0.8)	1 (0.4)
Atrazine\$	Triazine	Herbicide	3 (1.2)	3 (1.2)	0 (0)
Carbaryl*	Carbamate	Insecticide	3 (1.2)	3 (1.2)	0 (0)
Azoxystrobin\$	Strobilurin	Fungicide	2 (0.8)	2 (0.8)	0 (0)
Carbofuran*	Carbamate	Insecticide	2 (0.8)	2 (0.8)	0 (0)
Mesotrion\$	Triketone	Herbicide	2 (0.8)	2 (0.8)	0 (0)
Carbendazim*	Carbamate	Insecticide	1 (0.4)	0 (0)	1 (0.4)
Fomesafen\$	Organochlorine	Herbicide	1 (0.4)	0 (0)	1 (0.4)
Quizalofop-P-ethyl\$	Aryloxyphenoxypropionate	Herbicide	1 (0.4)	0 (0)	1 (0.4)
Tetramethrin	Pyrethroid	Insecticide	1 (0.4)	0 (0)	1 (0.4)
Human drug##	na	na	1 (0.4)	1 (0.4)	0 (0)
Imidacloprid\$	Neonicotinoid	Insecticide	1 (0.4)	1 (0.4)	0 (0)

*15 active ingredients which were included in the 53 pesticide products which was specifically asked for;

#always applied together in the same pesticide product; ##not considered in regression analysis as no pesticide or active ingredient was unknown; \$15 active ingredients grouped under “others” in regression analysis (Table 3)

Table S4 Spearman correlation coefficients between the six active ingredients / chemical group (non-user=0, past year=1, past week=2) selected for the regression model

	2,4-D	Glyphosate	Mancozeb	Organophosphate and carbamates	Pyrethroids	Other active ingredients
2,4-D	1	0.46	0.21	0.19	0.24	0.05
Glyphosate		1	0.34	0.24	0.39	0.27
Mancozeb			1	0.30	0.43	0.36
Organophosphate and carbamates				1	0.49	0.17
Pyrethroids					1	0.09
Other active ingredients						1

Table S5 Multivariate logistic regression analysis of the 6-items and their association with unspecific pesticide use in the week before the study visit stratified between woman and man.

Sleep problems 6-items	Days p. used [#]	Adjusted OR (95% CI) ^{##}	p-value
Woman (n 104)	Not sprayed last week	1 3.14 (1.12-9.25)*	0.0319
	last week		
Man (n 149)	Not sprayed last week	1 1.82 (0.91-3.79)*	0.0963
	last week		

**p*-value below 0.05; [#]reference 1, non-sprayer during the year prior to the study visit; ^{##}model adjusted for age, currently consuming alcohol, body mass index, and sleep disturbance during the past week; Ad. OR: adjusted Odds Ratio; CI: confidence interval

Table S6 Multivariate logistic regression analysis of the eight and their association with unspecific number of pesticide use days in the week before the study visit

Sleep problems 6-items indices Individual items##	Days spraying last week#	Ad. OR (95% CI)##	p-value
6-items	0	1	
	> 2	3.21 (1.33-7.82)	0.009**
	1 and 2	1.99 (1.04-3.85)	0.038*
Enough sleep, feel rested upon waking	0	1	
	1 and 2	1.34 (0.79-2.27)	0.2796
	> 2	1.49 (0.79-2.85)	0.2215
Awakening short of breath or headache	0	1	
	1 and 2	0.77 (0.25-2.36)	0.6387
	> 2	0.38 (0.05-1.78)	0.2575
Trouble falling asleep	0	1	
	1 and 2	1.06 (0.49-2.33)	0.8758
	> 2	0.57 (0.18-1.62)	0.3110
Awaken during sleep	0	1	
	1 and 2	1.04 (0.54-1.99)	0.9086
	> 2	0.83 (0.35-1.88)	0.6573
Trouble staying awake during day	0	1	
	1 and 2	1.64 (0.72-3.81)	0.2385
	> 2	1.02 (0.33-2.9)	0.9697
Amount sleep needed	0	1	
	1 and 2	2.22 (1.3-3.84)*	0.0038
	> 2	2.93 (1.52-5.74)*	0.0015

*p-value below 0.05; #reference 1, non-sprayer during the year prior to the study visit; ##model adjusted for sex, age, currently consuming alcohol, body mass index, and sleep disturbance during the past week; Ad. OR: adjusted Odds Ratio; CI: confidence interval

Table S7 Multivariate logistic regression analysis of the 6-items and its association with six active ingredients/pesticide groups in the year and week before the study visit

Active ingredients/ Chemical group	User	Adjusted OR (95% CI)	p-value
2,4-D	Non-user	1	
	Last year	0.92 (0.44-1.87)	0.81
	Last week	0.84 (0.16-4.61)	0.84
Glyphosate	Non-user	1	
	Last year	1.29 (0.64-2.59)	0.48
	Last week	3.75 (1.24-11.8)	0.02*
Mancozeb	Non-user	1	
	Last year	2.28 (1.12-4.71)	0.02*
	Last week	2.51 (0.86-7.55)	0.09*
Organophosphates and carbamates	Non-user	1	
	Last year	0.7 (0.33-1.45)	0.35
	Last week	0.5 (0.16-1.48)	0.22
Pyrethroids	Non-user	1	
	Last year	1.33 (0.67-2.64)	0.41
	Last week	1.64 (0.55-4.94)	0.37
Other active ingredients	Non-user	1	
	Last year	1.31 (0.38-4.36)	0.66
	Last week	0.86 (0.29-2.51)	0.79

*p-value below 0.05; #reference 1, non-sprayer during the year prior to the study visit; ## model adjusted for sex, age, currently consuming alcohol, body mass index, and sleep disturbance during the past week; Ad. OR: adjusted Odds Ratio; CI: confidence interval