PESTICIDE USE AND PHYSICAL HEALTH OF US FARM WORKERS

Nabittun Nahar

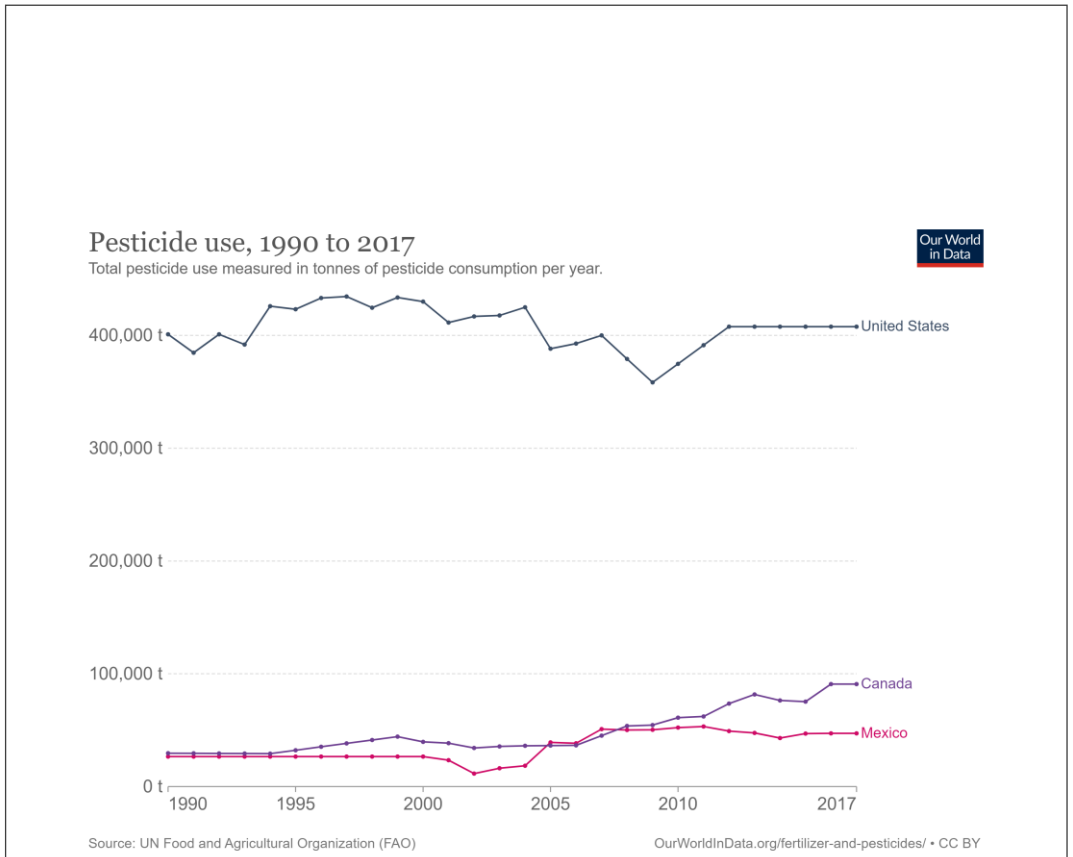
Background and Motivation

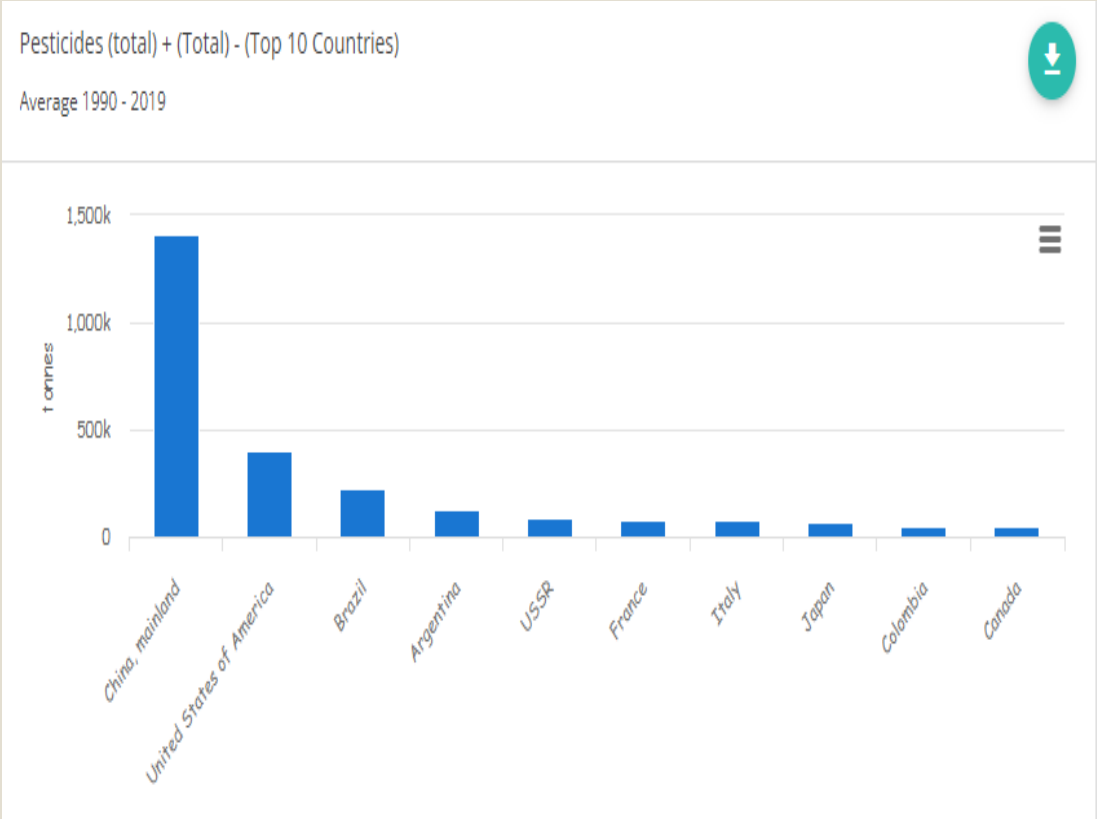
- About 3 million people are infected and 2000000 died from pesticide use each year (FAO-PAN, 2000)
- Many common diseases such as cancer, depression and neurological deficits, diabetes and respiratory disease are related to pesticides use (Tago, n.d.)
- In Sri Lanka “On average 14,500 individuals were admitted government hospitals and around 1500 individuals a year died from pesticide poisoning during the period 1986–1996” (Wilson and Tisdell 2001)
- If the farm owners don’t consider the negative health effects of pesticides or insecticides, they overvalue the benefit (Antle & Pingali, 1993)

Background & Motivation

- About 1.1 billion pounds of pesticides are used annually in the U.S. and over 20,000 pesticide products are marketed (NIOSH)
- Among the estimated two million agricultural workers in the United States, physicians diagnose 10,000 to 20,000 pesticide poisonings each year (NIOSH)
- The health cost of pesticide use is US$ 1.1 billion per year in the United States where the total cost is US$10 billion (Pimentel 2005)

Some pesticide facts..





Related Works

- **(Pena and Dixon 2021) "Pesticide Exposure and the Physical and Economic Health of US Crop Workers**
  - Pesticide exposure associated with 7% increase in wages
  - Exposure increases the probability of having health issue by 2.6%
  - increases the probability of having health issue by 4.3% for undocumented
- **(Lai 2017) Pesticide Use and Health Outcomes: Evidence from Agricultural Water Pollution in China**
  - Study the impact of a policy change (tax to subsidy on pesticide)
  - Dependence Activities of daily living (ADL) scores are higher in areas with higher pesticide use. a 10% increase in rice pesticide use raises ADL by 1%
  - A 10 % increase in pesticide use causes an increase in medical and family care costs $2.13 and $0.64 million.

Literature

- **(Crissman, et al., 2005) Farmers Health and Pesticide use: Evidence from Ecuadorian Potato production**
  - Using pesticides has a positive effect on yields but farmers and their families are suffering health and economic impacts from the use of toxic pesticide
  - Majority of poisonings were from occupational exposure among males (33/50)
  - Laboratory examinations revealed a significantly lower mean hemoglobin corrected red blood cell cholinesterase
  - Neuropsychological testing showed reduced performance on many tests among exposed farm members

- **(Sheahan, Barrett, and Goldvale 2017) Human Health and Pesticide Use in Sub-Saharan Africa**
  - cross analysis of four Sub Saharan African (SSA) countries to see correlation between pesticide use in crops, productivity, health outcomes, and increased health costs.
  - high incidence of sickness among agricultural workers

More literature

- (Variyam and Mishra 2005) The Well-Being of U.S. Farm Workers: A Look at Health
  - Data from the 1997-2002 National Health Interview Survey (NHIS).
  - cardiovascular disease, respiratory disease, and overweight

- (Antle and Pingali.1994) “Pesticides, Productivity, and Farmer Health: A Philippine Case Study”.
  - Eye, dermal, pulmonary, neurologic and kidney problems were found to be significantly associated with long-term pesticide exposure

From the Literature

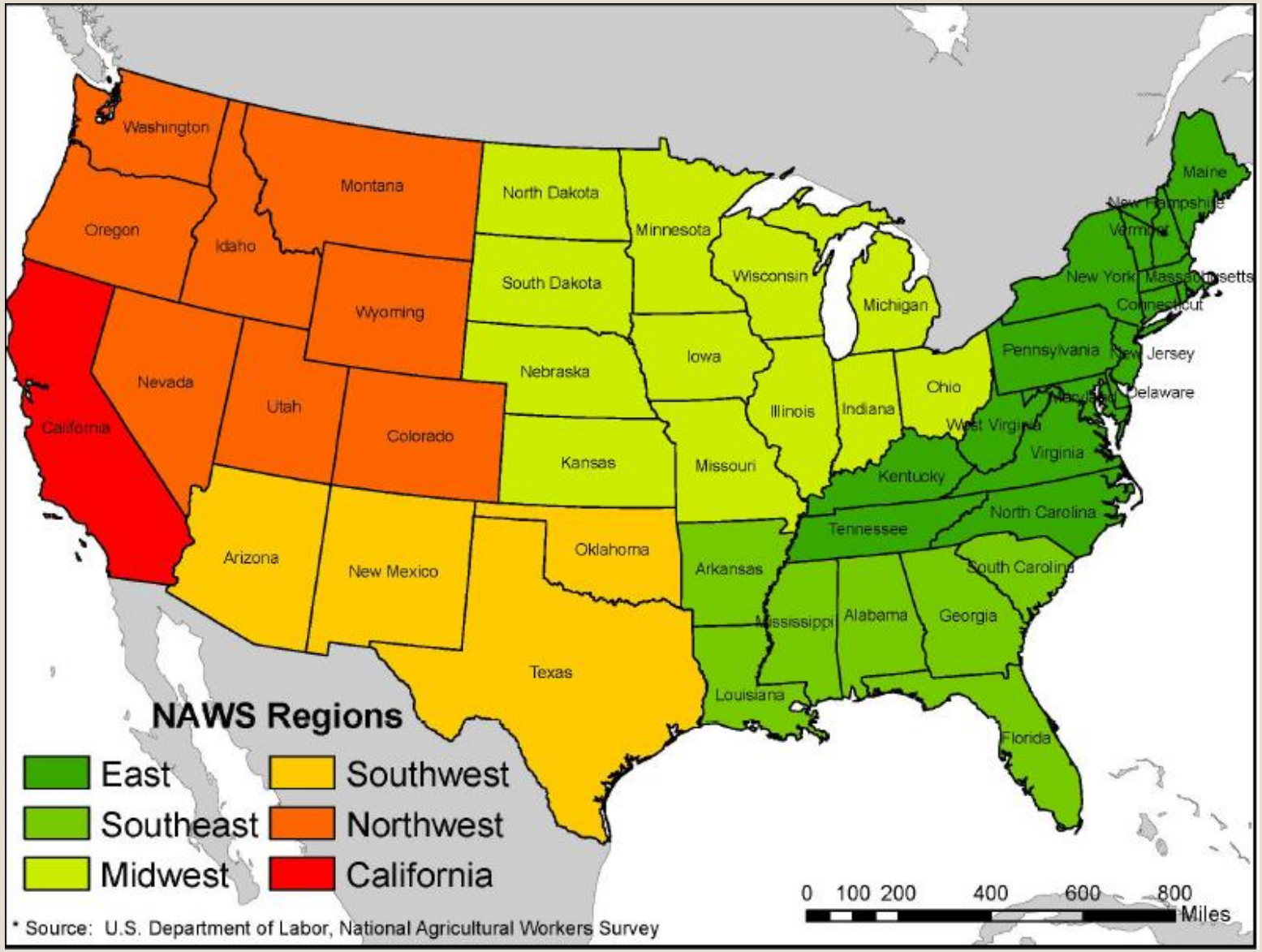
- The impact of pesticide on health has not been carefully examined in the national level in US. The focus has been, so far, from the point of view of agriculture science and medical science.
- We see a good number of research focused on health impact of pesticide exposure. However, a handful of papers look specifically to direct exposure where the harmful impacts of pesticide exposure is acute and more toxic.

Research question

- How is the prevalence of health condition among US farmworkers related with pesticide exposure?
- Does the farmworkers health condition vary across regions?
- Is the type of crop related to a health condition?

Data

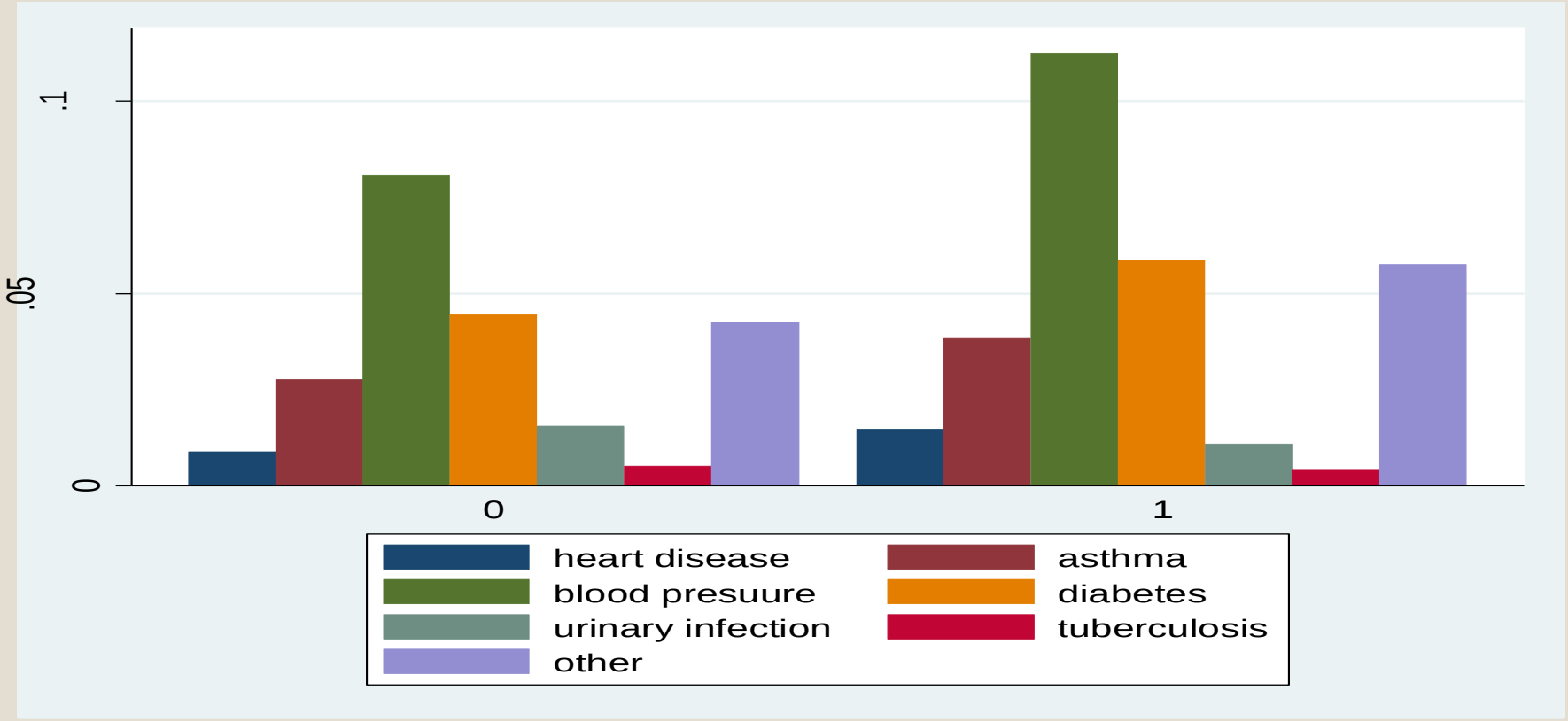
- National Agricultural Workers Survey (NAWS)
  - Publicly available and provided by the US Department of Labor
  - Demographic and economic variable
  - 1989-2018


Washington
Oregon
California
Idaho
Nevada
Montana
Wyoming
Utah
Arizona
Colorado
New Mexico
North Dakota
South Dakota
Nebraska
Kansas
Oklahoma
Texas
Minnesota
Iowa
Missouri
Arkansas
Louisiana
Wisconsin
Illinois
Michigan
Indiana
Ohio
Kentucky
Tennessee
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
West Virginia
Pennsylvania
New York
Maine
Vermont
New Hampshire
Massachusetts
Connecticut
New Jersey
Delaware
Maryland
NAWS Regions
East
Southeast
Midwest
Southwest
Northwest
California
0 100 200 400 600 800
Miles
* Source: U.S. Department of Labor, National Agricultural Workers Survey

Definition of variables

Variables	Definition
Health condition	0=did not experience, 1=Experienced at least once
Pesticide exposure	0=did not handle and mix, 1= handled and mixed
Water for hand wash provided	0=No 1=yes
Gender	0=male 1=female
Race	1=White, 2=black, 4=American Indian, Alaskan native, & Indigenous, 5= Asian 6=Native Hawaiian 7=other 95=Don't know 96=refuse 9=not answered
Legal status (leglppl)	1=citizen 2=legalization applicant 3 =family program 4=other work authorization=5=unauthorized
Wage	Wage earned per week (last payment)
Experience (Yrs_FW)	Years since started FW /No of years working as FW
Education(high-grade)	1=grade 1 till year 3 at college (16), 0= No 95=preschool
Training	1=yes 0=No
Speak English (Eng_spk)	1=Not at all 2=A little 3=Somewhat well 4=well 95=don't know
Health insurance/cost by employer	1=Yes 0=No
Crop type	1 Field crops 2 Fruits and Nuts 3 Horticulture 4 Vegetables 5 Misc.
Task	1= pre-harvest 2=harvest 3=post-harvest 4=semi-skilled 5=supervisor 6=other
Region	1=East 2=SE, 3=Midwest 4=SW 5=NW 6=CA

Average health condition among US farmworkers



Source: Authors calculation from NAWS(2002-2018)

Not exposed

Variable	Obs	Mean	Std. Dev.
total_health	25597	.1876392	.4724711
pesticide	25597	0	0
region			
2	25597	.1490018	.3560972
3	25597	.1253663	.3311402
4	25597	.06114	.2395916
5	25597	.1337266	.340365
6	25597	.3953588	.4889372
age	25597	36.78115	13.13365
race	25597	4.581318	2.878701
gender	25597	.2338555	.4232896
legappl	25597	3.57202	1.661578
wage	25597	394.7756	172.3145
healthins	25597	15.11861	33.71519
handwash	25597	1.036059	2.498505

Exposed

Variable	Obs	Mean	Std. Dev.
total_health	6373	.2507453	.5419196
pesticide	6373	1	0
region			
2	6373	.1842147	.3876896
3	6373	.1128197	.3163971
4	6373	.1142319	.3181177
5	6373	.169308	.3750532
6	6373	.3033108	.4597244
age	6373	39.82834	12.14058
race	6373	4.138083	2.910263
gender	6373	.0577436	.2332763
legappl	6373	2.830064	1.705616
wage	6373	489.8595	210.1408
healthins	6373	9.312726	26.8066
handwash	6373	1.042366	2.892144

Not exposed

education	25597	7.356253	3.970543
training	25597	.0536782	.2253859
task			
2	25597	.2423331	.4285031
3	25597	.1440794	.3511771
4	25597	.2432707	.4290656
5	25597	.0007423	.0272351
6	25597	.1214595	.3266669
crop			
2	25597	.3513302	.4773952
3	25597	.2258858	.4181725
4	25597	.2504981	.4333084
5	25597	.0479353	.2136336
yrsffw	25597	13.62773	11.93562
engs_peak	25597	2.128296	1.142193

Exposed

education	6373	8.532559	4.211501
training	6373	.1289816	.3352059
task			
2	6373	.1071709	.3093546
3	6373	.0663738	.2489538
4	6373	.4434332	.4968289
5	6373	.0014122	.0375558
6	6373	.1558136	.362707
crop			
2	6373	.3313981	.4707528
3	6373	.2088498	.4065188
4	6373	.1206653	.3257635
5	6373	.0597835	.2371038
yrsffw	6373	18.96501	12.26431
engs_peak	6373	2.722893	1.148748

Empirical strategy

- **Model**

$$Health_{irt} = \gamma_i + \theta_t + \beta_1 X_{irt} + \beta_2 X_{irt} + \cdots \ldots \ldots + \beta_9 X_{irt} + \epsilon_{irt}$$

- Adding the variables,

$$\text{Health}_{\text{irt}} = \gamma_{\text{i}} + \mu_r + \theta_{\text{t}} + \nu_1 \text{Pesticide}_{\text{irt}} +$$

$$\beta_1 \text{region}_{\text{irt}} + \beta_2 \text{crop}_{\text{irt}} + \beta_3 \text{Education}_{\text{irt}} + \beta_4 \text{training}_{\text{irt}} + \beta_5 \text{healthins}_{\text{irt}} +$$

$$\beta_6 \text{handwash}_{\text{irt}} + \beta_7 \text{experience}_{\text{irt}} + \beta_8 \text{wage}_{\text{irt}} + \beta_9 \text{legal}_{\text{irt}} + \epsilon_{\text{irt}}$$

- Health is the probability of suffering from at least one sickness

Results

heart	Coef.	Robust Std. Err.	z	P>|z|
wage	.0000473	.0001134	0.42	0.676
training	.0902373	.0872057	1.03	0.301
crop1	.1370719	.0717662	1.91	0.056
crop2	.0040071	.0680765	0.06	0.953
crop3	.0173149	.0725024	0.24	0.811
crop5	.0227637	.1133456	0.20	0.841
yrsffw	.0207193	.0018523	11.19	0.000
education	.0111314	.0045633	2.44	0.015
handwash	-.0187356	.0364437	-0.51	0.607
pesticide	.0433738	.0550781	0.79	0.431
healthins	.0008077	.0007479	1.08	0.280
region1	.0448995	.0837101	0.54	0.592
region2	.0917445	.0781431	1.17	0.240
region3	-.0675066	.0900135	-0.75	0.453
region4	.0685254	.0927264	0.74	0.460
region6	-.1646755	.0784091	-2.10	0.036
_cons	-2.979668	.	.	.

diabetes	Coef.	Robust Std. Err.	z	P>|z|
wage	-.0000844	.0000885	-0.95	0.340
training	-.0238922	.0512717	-0.47	0.641
crop1	-.0350827	.0455729	-0.77	0.441
crop2	-.0325199	.0379633	-0.86	0.392
crop3	-.0137801	.0413584	-0.33	0.739
crop5	.0153211	.0647217	0.24	0.813
yrsffw	.02941	.0012832	22.92	0.000
education	-.0249984	.0057009	-4.38	0.000
handwash	-.003768	.0057128	-0.66	0.510
pesticide	.0203172	.0327086	0.62	0.534
healthins	-.0002941	.0004722	-0.62	0.533
region1	.0290284	.0545423	0.53	0.595
region2	.102345	.0501568	2.04	0.041
region3	.1301846	.0542832	2.40	0.016
region4	.2853415	.0545414	5.23	0.000
region6	.0350371	.0423161	0.83	0.408
_cons	-2.337144	.	.	.

asthma	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
wage	-.0001798	.0001358	-1.32	0.185	-.0004459	.0000863
training	.1818549	.055213	3.29	0.001	.0736395	.2900703
crop1	.0972878	.0499333	1.95	0.051	-.0005796	.1951552
crop2	-.0198956	.0438008	-0.45	0.650	-.1057437	.0659524
crop3	.0807389	.0444582	1.82	0.069	-.0063976	.1678754
crop5	.0855979	.0715063	1.20	0.231	-.0545519	.2257476
yrsffw	.0041759	.0013221	3.16	0.002	.0015846	.0067673
education	.0327136	.0039333	8.32	0.000	.0250045	.0404226
handwash	.002424	.0053032	0.46	0.648	-.0079701	.0128182
pesticide	.088979	.0380263	2.34	0.019	.0144488	.1635092
healthins	-.000836	.0005155	-1.62	0.105	-.0018463	.0001743
region1	.0886721	.0536307	1.65	0.098	-.0164422	.1937864
region2	-.0789141	.0581025	-1.36	0.174	-.1927929	.0349647
region3	-.0119993	.0573221	-0.21	0.834	-.1243486	.1003501
region4	-.0981466	.0711574	-1.38	0.168	-.2376126	.0413194
region6	-.0782933	.0489825	-1.60	0.110	-.1742972	.0177106
_cons	-2.279736	.	.	.	.	.

Results

tuberculosis	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
year						
2003	-.038364	.1135072	-0.34	0.735	-.2608342	.1841061
2004	-.0800692	.1213306	-0.66	0.509	-.3178728	.1577345
2005	-.1013482	.1340039	-0.76	0.449	-.3639909	.1612945
2006	-.3577878	.1964848	-1.82	0.069	-.742891	.0273154
2007	-.3507781	.1985947	-1.77	0.077	-.7400167	.0384604
2008	-.3338431	.1682626	-1.98	0.047	-.6636317	-.0040544
2009	-.3295272	.1639116	-2.01	0.044	-.650788	-.0082664
2010	-.306864	.1826288	-1.68	0.093	-.66481	.0510819
2011	-.2530648	.1728255	-1.46	0.143	-.5917967	.085667
2012	.0326997	.1395983	0.23	0.815	-.2409079	.3063074
2013	-.3857277	.1950865	-1.98	0.048	-.7680903	-.0033652
2014	-.1531232	.1285691	-1.19	0.234	-.4051141	.0988677
2015	-.4610597	.1624952	-2.84	0.005	-.7795445	-.1425749
2016	-.246374	.1480226	-1.66	0.096	-.5364929	.0437449
2017	-.4723322	.2068604	-2.28	0.022	-.8777711	-.0668933

wage	.000087	.0001498	0.58	0.561	-.0002065	.0003806
training	.3965217	.1002863	3.95	0.000	.1999642	.5930792
crop1	-.150591	.1111867	-1.35	0.176	-.3685129	.0673309
crop2	.0057817	.0753634	0.08	0.939	-.1419278	.1534911
crop3	-.118524	.0948851	-1.25	0.212	-.3044954	.0674475
crop5	.0067205	.1450742	0.05	0.963	-.2776197	.2910606
yrsffw	.0014465	.0024374	0.59	0.553	-.0033308	.0062237
education	-.0038674	.0083276	-0.46	0.642	-.0201892	.0124543
handwash	.0086583	.0054327	1.59	0.111	-.0019896	.0193063
pesticide	-.0791548	.0815487	-0.97	0.332	-.2389872	.0806776
healthins	.0015764	.0008425	1.87	0.061	-.0000748	.0032277
region1	-.2602815	.1150726	-2.26	0.024	-.4858196	-.0347434
region2	-.266172	.1107567	-2.40	0.016	-.4832511	-.049093
region3	-.397219	.1289134	-3.08	0.002	-.6498846	-.1445535
region4	-.3694757	.1587003	-2.33	0.020	-.6805227	-.0584288
region6	-.1359528	.0792429	-1.72	0.086	-.2912661	.0193605
_cons	-2.385581	.	.	.	.	.

More results

Blood pressure

wage	-.000058	.0000663	-0.87	0.382
training	.1966494	.0402188	4.89	0.000
crop1	.086336	.0359376	2.40	0.016
crop2	-.0896261	.0312126	-2.87	0.004
crop3	.022117	.0334508	0.66	0.508
crop5	-.1731109	.0572925	-3.02	0.003
yrsffw	.0315322	.0008707	36.21	0.000
education	.0008976	.0030809	0.29	0.771
handwash	-.0792007	.0586144	-1.35	0.177
pesticide	.0348923	.0270919	1.29	0.198
healthins	-.000074	.000374	-0.20	0.843
region1	.1658011	.0428758	3.87	0.000
region2	.1196153	.0414097	2.89	0.004
region3	.1048921	.0444637	2.36	0.018
region4	.0887256	.0503024	1.76	0.078
region6	.0999011	.0355042	2.81	0.005
_cons	-2.074625	.0828455	-25.04	0.000

Urinary infection

wage	-.0003305	.0001482	-2.23	0.026
training	.2548768	.0706779	3.61	0.000
crop1	-.0874366	.0737632	-1.19	0.236
crop2	-.0095137	.0542598	-0.18	0.861
crop3	.2169278	.0532895	4.07	0.000
crop5	.1554048	.0900412	1.73	0.084
yrsffw	-.0030624	.001805	-1.70	0.090
education	.0176279	.003863	4.56	0.000
handwash	-.0065541	.0017746	-3.69	0.000
pesticide	-.1080063	.0528051	-2.05	0.041
healthins	-.0009316	.0006287	-1.48	0.138
region1	-.0151804	.0756617	-0.20	0.841
region2	-.0945356	.0769168	-1.23	0.219
region3	.0072821	.0743269	0.10	0.922
region4	-.0647954	.0977305	-0.66	0.507
region6	.1070943	.0588423	1.82	0.069
_cons	-2.359156	.	.	.

Conclusion and future work

- ❑ Further exploitation of the NAWS dataset
- ❑Include mental health as well
- ❑Finding more representative dataset with specific sickness caused by a particular chemical so that I can find a strong causal relationship.
- ❑Extending the work to a particular area to understand the factors and dynamics more.