

# Targeting vaccine information framing: a randomized trial

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## Motivation: contrasting vaccine hesitancy

Vaccine hesitancy:

“Delay or refusal of vaccines despite their availability”

- ▶ 8th biggest threat to public health even before Covid-19 (WHO, 2019), now even more relevant Covid
- ▶ Largely caused by **vaccine disinformation**

→ Policy challenge: creating information that contrasts vaccine hesitancy

Epidemiologists suggested **targeting informational campaigns to recipients' characteristics** for a long time (e.g. Brown et al., 2010)

## Disinformation, education and immigration background

Inconclusive evidence on the interaction of recipients' education, immigration status and vaccine disinformation

Different studies look at disinformation with **different framing**:

- ▶ **Highly educated** parents victims of **scientifically framed** disinformation, e.g. MMR scare  
(Anderberg et al., 2011; Chang, 2018)
- ▶ **Lowly educated** and **immigrant** parents victims of **emotionally framed** disinformation on social media  
(Puri et al., 2019; Hoffman et al., 2019; Dubé et al., 2018; Ahmed et al., 2018)

Can we mirror these framing and targeting techniques for truthful vaccine information?

## Testing the background-framing interaction

We frame a 650-words leaflet on the HPV vaccine as:











- ▶ **T1** - Emotional framing
- ▶ **T2** - Scientific framing
- ▶ **C** - Control: just reminder

In a **stratified RCT** in Sweden

to test which framing technique is more effective in raising vaccine uptakes depending on the recipient's:

- ▶ **Education** level: 4 strata → explore non-linearities
- ▶ **Immigrant** background: 1 stratum

# The experiment in a nutshell

When 	Where 	What
June-Aug 2021  Up to 3 reminders	 Home	 Invitation addressed to mothers and instructions to open:  1)  <b>Randomized leaflet:</b> C – uninformative placebo T1 – Emotionally framed T2 – Scientifically framed  2)  <b>First survey</b>
Sept-Oct 2021	 Schools	 The <b>HPV vaccine</b> is offered and inoculated
Nov 2021	 Home	 Invitation to answer a <b>second survey</b>

## Context (1): Human Papilloma Virus (HPV)

HPV is a family of viruses transmitted sexually. They cause:

- ▶ Cervical cancer (4th cause of death for women), anal, vulvar, penile, head-neck cancers
- ▶ Genital warts (pre-cancerous lesions)

□ Remains latent: most infections from asymptomatic individuals

Treatment can be very invasive and might not be successful

- ▶ The HPV vaccine is the main tool of primary prevention

## Context (2): the Stockholm county

HPV vaccine offered **for free** in **schools** at 12 years old:

- ▶ No **income effects**
- ▶ Minimal non-monetary costs of vaccination
- ▶ Fully voluntary
- ▶ Informational campaigns in schools centralized at county level  
→ uniform at baseline (we also collect survey data)

Admin records:

- ▶ To sample from the population (no selection)
- ▶ Objective vaccination record as outcome

We mirror vaccine disinformation in targeting specific concerns

Disinformation	Our content
1. Vaccines have frequent and serious <b>adverse effects</b>	1. The HPV vaccine is safe, with very <b>mild adverse effects</b>
2. The illness they prevent is <b>rare</b>	2. Most people enter in contact with HPV viruses already at a young age. HPV-induced cervical cancer is a <b>common cause of death</b> for women of <b>all ages</b>
3. The illness they prevent can be <b>easily treated</b>	3. HPV viruses can cause many cancers and pre-cancerous lesions. <b>Cancer treatment is highly invasive and distressing</b>
4. Vaccines cause <b>sterility</b> (common among non-EU immigrants)	4. The HPV vaccine does not cause sterility. <b>Cancer treatment can cause sterility</b>



We mirror disinformation's targeted framing techniques

## **T1. Emotionally charged testimonies of local cancer survivors**

### Leaflet extract

“The day she was diagnosed, the doctors told her that they would remove her womb to avoid the spread of cancer: she would not conceive again.

“My husband and I sit every night talking and crying, we are afraid I may not see our children grow up””

Lowly educated and extra-EU immigrants targeted by emotionally charged anecdotes

*(Wong, 2009; Hoffman et al., 2019; Hansen and Schmidtblaicher, 2021)*

We mirror disinformation's targeted framing techniques

## **T2. Statistical information, medical and statistical jargon**

### Leaflet extract

“High miscarriage risk is also caused by the removal of the cervix (thachalectomy), a possible intervention for early stage cancer, and by the removal of the uterus (hysterectomy), which implies permanent loss of fertility and is performed at advanced cancer stages”

Highly educated and extra-EU immigrants targeted by pseudo-scientific claims and debates, reinforced by confirmatory bias

*(Anderberg et al., 2011; Chang, 2018; Qian et al., 2020)*

## Vaccination outcome

We use two measures of the vaccination outcome:

### □ Primary

HPV vaccination record ( $\approx$  4 months after treatment)

From admin records

→ Full sample ( $N = 7616$ )

### □ Secondary

Self-reported intention to vaccinate

Measured with the first survey right after treatment

→ Respondents' sample ( $N = 2204$ )

# Stratified sample

Sample for the secondary outcome in brackets (survey respondents)

Stratum	Stratum definition	N	C units Placebo	T1 units Emotional	T2 units Scientific
1. Immigrants	Afghanistan, Iran, Iraq, Syria, Eritrea, Somalia	2548 (416)	611 (106)	961 (148)	976 (162)
<b>Swedish-born mothers</b>					
2. Educ-level-1	≤ <b>Compulsory schooling</b> 3 yrs high school	1627 (353)	393 (94)	616 (138)	617 (121)
3. Educ-level-2	(3 yrs high school, high school degree]	1413 (484)	337 (112)	535 (203)	541 (169)
4. Educ-level-3	(High school degree, Undergrad]	1009 (417)	243 (101)	385 (168)	381 (148)
5. Educ-level-4	> Undergrad degree	1019 (534)	242 (122)	387 (213)	390 (199)
<b>Total</b>		7616 (2204)	1826 (535)	2884 (870)	2905 (799)

## Estimation by Logit

In each stratum, we estimate a logit with a binary treatment  $T_i$ :

- $T_i = \{(T1 \text{ vs } C), (T2 \text{ vs } C), (T2 \text{ vs } T1)\}$
- For two outcomes:  $Y_i = \{\mathbb{1}\{\text{Vaccinated}_i\}, \mathbb{1}\{\text{Intends to vaccinate}_i\}\}$   
Sample restricted to respondents for the intention to vaccinate
- When  $Y_i = \mathbb{1}\{\text{Vaccinated}_i\}$ , the AME is an ITT. For the secondary outcome, an ATE for the selected subpopulation of survey respondents
- For precision and power: include municipality FE and baseline parents and child characteristics

Covariates

# Actual vaccinations (ITT, full sample)

Stratum	Stratum definition	Baseline uptake	T1 vs C Emotional	T2 vs C Scientific	T2 vs T1
1.	Immigrants	0.773	-0.016 (0.020)	-0.013 (0.020)	0.002 (0.017)
<b>Swedish-born mothers</b>					
2. Educ-level-1	Compulsory schooling 3 yrs high school	0.786	0.037 (0.025)	0.057** (0.024)	0.029 (0.021)
3. Educ-level-2	Up to high school	0.887	-0.048** (0.022)	0.004 (0.021)	0.041** (0.020)
4. Educ-level-3	Up to UG	0.905	-0.016 (0.026)	-0.021 (0.025)	-0.010 (0.023)
5. Educ-level-4	Graduate	0.930	0.003 (0.020)	0.005 (0.021)	-0.006 (0.018)

# Intention to vaccinate (ATE among respondents) Resp.

Stratum	Stratum definition	Baseline intention	T1 vs C Emotional	T2 vs C Scientific	T2 vs T1
1.	Immigrants	0.830	-0.039 (0.053)	-0.003 (0.047)	0.003 (0.048)
<b>Swedish-born mothers</b>					
2. Educ-level-1	Compulsory schooling 3 yrs high school	0.862	0.002 (0.045)	<b>0.115**</b> <b>(0.046)</b>	0.025 (0.036)
3. Educ-level-2	Up to high school	0.929	-0.021 (0.033)	0.022 (0.032)	0.029 (0.028)
4. Educ-level-3	Up to UG	0.931	0.036 (0.036)	-0.010 (0.035)	-0.042 (0.032)
5. Educ-level-4	Graduate	0.967	-0.003 (0.021)	-0.018 (0.025)	-0.008 (0.021)

## Results: summary

Three main takeaways:

- ▶ Scientific framing (T2) increases uptake for those with compulsory schooling (+5.7 p.p., or +7.25%)
- ▶ Emotional framing (T1) reduces uptake of high school graduates (-4.8 p.p., or -5.41%)
- ▶ Results from self-reported vaccination status only confirm the positive effect of T2

→ **Why?**

No spillovers

Causal forest



## Mechanisms: attentiveness and baseline hesitancy

We stratify the sample by whether subjects replied to the first survey

□ The **positive effect of T2 (scientific)** in stratum 2 is driven by **respondents** ( $\widehat{ATE}_{resp} = 0.161^{***}$ )

□ The **negative effect of T1 (emotional)** in stratum 3 is driven by **non-respondents** ( $\widehat{ITT}_{non-resp} = -0.057^*$ )

Compared to non-respondents, respondents are:

- 1 Slightly less vaccine hesitant at baseline (Hirani, 2021)
- 2 More attentive readers of the leaflet (new result)

Tests

Table

# Heterogeneity: diminishing returns to information

## □ 1. Causal forests:

Bigger, less dispersed effects with no previous knowledge of HPV

CITT graphs

## □ 2. Heterogeneity by child's gender:

▶ Results mostly **driven by boys** T1 T2

▶ Boys included just one year before intervention

(Little previous information compared to girls)

→ Hypothesis: **Diminishing returns** to information

Attention gets easily exhausted

## Conclusions: framing and education

Framing's effect is significant for **lowly educated parents**:

- ▶ Scientific framing (T2) raises uptake for mothers with compulsory schooling
- ▶ Emotional framing (T1) can be counterproductive  
Even when effective (CITT) it doesn't outperform scientific framing

### Policy recommendation

- ▶ Avoid emotional framing in vaccine informational campaigns

## Conclusions: attention and diminishing returns

Importantly for **large-scale informational campaigns**:

- ▶ The efficacy of T2 and undesirable effects of T1 depend on the receiver's baseline **hesitancy** and **attentiveness**
- ▶ Diminishing returns to information might explain low effect on highly educated parents

### Policy recommendations

- ▶ Avoid compounding several information campaigns
- ▶ Devise distribution channels that reach hesitant parents and where attention can be easily monitored (e.g. schools)

Thank you!

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# Appendix

The Covid-19 pandemic:

- ▶ Reduced attention towards other vaccination campaigns and other pathologies
- ▶ Challenged trust in science and health authorities
  - Contrasting expert opinions and policies generated confusion
- ▶ Increased volume of vaccine dis/misinformation:
  - Builds on concerns from before the pandemic
  - Likely negative spillovers on other vaccines (Carrieri et al., 2019)

## Vaccines and immunisation

Tory Shepherd

Sat 6 Jun 2020 21.00 BST



# 'It's psychologically easier': how anti-vaxxers capitalised on coronavirus fears to spread misinformation



📷 The anti-vaccination movement has been peddling widely debunked conspiracy theories that claim the coronavirus is a hoax. Photograph: Jordan Sigler/Alamy



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## Tens of thousands of teenage girls believed to have fallen ill with debilitating illnesses after routine HPV cervical cancer jab

- Medicines and Healthcare Products Regulatory Agency had 8,228 adverse reaction reports in 10 years - only estimated 10 per cent of real tally
- Side effects including chest and abdominal pains, exhaustion, breathing difficulties, fibromyalgia and postural orthostatic tachycardia syndrome
- Some have been left wheelchair-bound by apparent effects of vaccine
- Despite this MHRA said it had no concerns on numbers of HPV complaints

By **FIONA MACRAE** SCIENCE CORRESPONDENT FOR THE DAILY MAIL  
PUBLISHED: 16:15, 31 May 2015 | UPDATED: 16:49, 1 June 2015

### SPORTS FAN AND EX COUNTY CRICKETER WHO NOW STRUGGLES TO RUN

Five years ago, Katie Green played cricket for her county, excelled at rugby and was academically gifted.

Today, she tires easily and is on invalidity benefits thanks to a 'brain fog' so severe she finds work or study impossible.

Her mother Carol, a teacher, blames Katie's decline on the HPV jab she was given at 15.

Katie, of Upton-upon-Severn, Worcestershire, became groggy after the first dose and severely unwell shortly after the second, feeling dizzy, exhausted and lacking co-ordination.

Her energy levels have improved but she still gets tired after running a few steps.


GSK, which makes the Cervarix vaccine given to Katie, said it was 'rigorously tested' in clinical trials before its introduction and had been monitored ever since for safety and effectiveness.



© John Lawrence  
**Katie Green, 20, pictured, who now tires easily**


# Emotionally framed disinformation: example

T1

 collective\_evolution

#CEARTICLE

**“HER LIFE STOPPED WHEN SHE WAS 12” – ANOTHER EXAMPLE OF WHAT AN HPV VACCINE INJURY LOOKS LIKE**



AUTHOR ANNA RODGERS



Place a

collective\_evolution The picture above is of Chloe Brookes-Holder, who was a happy and healthy pre-teen. She danced almost daily, hoping to make it her career one day; she hiked and led an active lifestyle. That all changed after her second dose of an HPV vaccine. After taking the vaccine she started to

collective\_evolution The picture above is of Chloe Brookes-Holder, who was a happy and healthy pre-teen. She danced almost daily, hoping to make it her career one day; she hiked and led an active lifestyle. That all changed after her second dose of an HPV vaccine. After taking the vaccine she started to notice unusual symptoms, which later transformed into never-ending cycle of debilitating chronic health issues, like many others before and after her. You can view her current medical conditions, and her story on CE.

Below is another story that comes from Ireland. “Why did the HSE not give out that leaflet? If they had given out that patient information leaflet I would never have gotten the second injection, because it states on it that if you get sick after the first one, don’t get the second one.” –Fiona, HPV infected teen, 16, Ireland

If you have a young daughter (or son for that matter) who is soon to have the HPV vaccine, I highly recommend you watch this video (below), made by the Irish organization ‘Regret,’ which was named after a group of parents who deeply ‘regret’ their choice to let their daughters have this vaccine without doing their own independent research first. They regret that they relied on trusting the leaflets given to them by their schools and Doctors, and they now realize they missed out on so much vital and concerning information. They are now trying to make others aware of the risks they are taking by allowing their children to have this vaccine. They want you to have genuine informed consent.



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#### FOR IMMEDIATE RELEASE

Orthomolecular Medicine News Service, May 7, 2015

## Orthomolecular Treatment for Adverse Effects of Human Papilloma Virus (HPV) Vaccine

by Atsuo Yanagisawa, MD, PhD

(OMNS May 7, 2015) Immunization of adolescent girls with the human papilloma-virus (HPV) vaccine was initiated with the intention to prevent uterine and cervical cancer. The first HPV vaccine, called "Gardasil" (Merck) was approved in 2006, and a second vaccine called "Cervarix" (GSK) was introduced in 2007. By the end of 2013, approximately 130 million doses of Gardasil and 44 million doses of Cervarix had been distributed worldwide. In 2010, both vaccines were widely given to Japanese girls. In April 2013, Japan added both HPV vaccines to their government recommended vaccination schedule.

### High incidence of side effects

In June 2013, only 2 months after the law was issued, the Japanese government suspended the recommendation for these vaccines. A new study reported that the adverse events of Gardasil and Cervarix were 1.7 to 3.6 times higher than other vaccines. The government task force analyzed reports of HPV vaccine injuries. They examined 2,500 cases and found 617 (25%) cases to be "serious."

Amazingly, the official task force then issued this statement:

*"We find no physical cause for the alleged and presumed adverse reactions in those vaccinated girls, so we cannot recommend any specific therapy. We conclude that their so-called adverse reactions are psychosomatic. The government should provide counseling to the girls so that they may be freed from their psychosomatic reactions."*

### Severity of side effects

When other health experts re-evaluated those cases, they determined 1,112 (44%) to be serious. The initial onset of symptoms occurred several weeks to a year after the HPV vaccine was given. They included: headache, dizziness, muscle weakness and pain, nausea, hypersomnia, learning difficulty, impaired writing, photophobia, tremors of arms, feet and fingers, joint pain, irregular menstruation, gait disturbance, memory loss, skin eczema and acne.

Girls who had adverse effects from the HPV vaccine were variously diagnosed with:

1. Higher brain dysfunction
2. Guillain-Barré syndrome
3. Multiple sclerosis
4. ADEM: acute disseminated encephalomyelitis
5. SSPE: subacute sclerosing panencephalitis
6. CRPS: Complex regional pain syndrome
7. POTS: Postural orthostatic tachycardia syndrome
8. Anti-phospholipid antibody syndrome
9. SLE: systemic lupus erythematosus
10. Rheumatoid arthritis
11. Chronic fatigue syndrome
12. Fibromyalgia
13. Cushing's syndrome (exposure to high level of cortisol)
14. Hashimoto's disease (immune system attacks the thyroid)
15. Hyperprolactinemia (high prolactin, induces breast development and lactation)

- To increase efficiency and power, we control for:
  - ▶ Baseline outcome proxied by # of MMR doses
  - ▶ Parents' education: scientific, medical, numerical, and high school grades
  - ▶ Parents' income, capital gains, civil status, occupation type, age
  - ▶ Child's gender, birth order, number of siblings
  - ▶ Father's Swedish nationality dummy
  - ▶ For immigrants: country of origin dummies, education level, Swedish survey dummy (for the secondary outcome)

## Respondents (R) and non-respondents (NR): differences

NR less vaccinated against MMR and more educated in health and science. Are they actually more hesitant?

To answer, we rely on comparing self-reported attitudes between R and RR (respondents to first and second survey):

- ▶ For all treatment groups, RR have more correct beliefs on vaccines  
→ baseline differences in hesitancy
- ▶ For all treatment groups, RR have higher trust in health authorities  
→ not responding depends on reluctance (Hirani, 2021)
- ▶ Only for T1 and T2, RR report reading a higher % of the leaflet  
→ Information generates interest and acts upon reluctance

## 2nd-time resp (RR) vs 1st-time resp (R), by treatment

	Control (C)			Emotional framing (T1)			Scientific framing (T2)		
	ASD	Replied once	Replied twice	ASD	Replied once	Replied twice	ASD	Replied once	Replied twice
First survey answers									
Believes vaccines cause the disease	0.217**	1.854	1.532	0.202***	1.867	1.567	0.158**	1.859	1.616
Believes vaccines weaken the immune system	0.179**	1.747	1.504	0.17***	1.859	1.604	0.165**	1.822	1.58
Trusts health authorities	0.236***	4.237	4.54	0.116**	4.353	4.5	0.123**	4.333	4.494
Searched vaccine info from unreliable sources	0.126*	0.229	0.158	0.028	0.182	0.198	0.04	0.215	0.192
% of leaflet read	0.04	7.705	7.878	0.161**	7.679	8.358	0.177**	7.634	8.371
Distraction question	0.15**	0.948	0.986	0.059	0.936	0.955	0.078	0.935	0.959
Heard of HPV before the study	0.107	0.824	0.878	0.088*	0.85	0.892	0.163**	0.828	0.906

# 1st-time respondents (R) vs non-respondents (NR)

Covariate	ASD	Non-respondents	Respondents
<b>Mother's characteristics</b>			
Age	0.254***	40.51	42.49
Married (dummy)	0.058**	0.63	0.669
Scientific educ. (dummy)	0.019	0.21	0.221
Medical educ. (dummy)	0.038**	0.147	0.128
Numerical educ. (dummy)	0.118***	0.15	0.214
Capital income (Thousands SEK)	0.014	341.682	25.115
Disposable income (Thousands SEK)	0.027*	3305.918	3753.373
Job in research	0.046**	0.003	0.007
Job in healthcare	0.108***	0.18	0.126
<b>Father's characteristics</b>			
Father is a researcher	0.038*	0.004	0.009
Father works in healthcare	0.083***	0.055	0.031
<b>Child's characteristics</b>			
Female (dummy)	0.026	0.484	0.502
Birth order	0.059***	1.035	1.021
Second dose of MMR (dummy)	0.121***	0.95	0.981
<b>Treatment status</b>			
T1	0.028	0.374	0.394
T2	0.041**	0.388	0.360

## 2nd-time respondents (RR) vs 1st-time respondents (R)

Covariate	ASD	Only answered survey 1	Answered both surveys
<b>Mother's characteristics</b>			
Age	0.017	42.45	42.574
Married (dummy)	0.033	0.662	0.685
Scientific educ. (dummy)	0.003	0.22	0.222
Medical educ. (dummy)	0.056*	0.136	0.11
Numerical educ. (dummy)	0.016	0.211	0.221
Capital income (Thousands SEK)	0.025	8.748	59.853
Disposable income (Thousands SEK)	0.065**	3679.519	3910.129
Job in research	0.039	0.006	0.011
Job in healthcare	0.104**	0.141	0.093
<b>Father's characteristics</b>			
Father is a researcher	0.013	0.009	0.008
Father works in healthcare	0.02	0.032	0.028
<b>Child's characteristics</b>			
Female (dummy)	0.008	0.504	0.498
Birth order	0.04	1.023	1.015
Second dose of MMR (dummy)	0.03	0.979	0.985
<b>Treatment status</b>			
T1	0.039	0.385	0.412
T2	0.033	0.353	0.375
<b>Answers to the first survey</b>			
Has heard of HPV before treatment	0.122***	0.835	0.894
% leaflet read	0.141***	76.696	82.634



We follow Athey & Wager (2019):

- ▶ Within each stratum, grow a forest with 10000 trees
- ▶ Find covariates that perform above average in determining branch splits
- ▶ Grow a causal forest (10000 trees) on those, obtain CITT for each observation  
(CITT: Conditional Intention To Treat effect)
- ▶ Separate the sample into two subsamples: CITT above and below average
- ▶ Compare means of covariates across the two subsamples

# Heterogeneity: causal forest (immigrant mothers)

Obtain CITT: individual Conditional ITT effects

Details

**Stratum 1** (Immigrant mothers):

Both treatments more effective if mothers are less educated, with no numerical, scientific or medical major, more vaccine skeptical

- ▶ Exactly the segment we want to reach
- ▶ Significant differences by country-of-origin

Details

# Heterogeneity: causal forest (Swedish-born mothers)

## Swedish-born mothers:

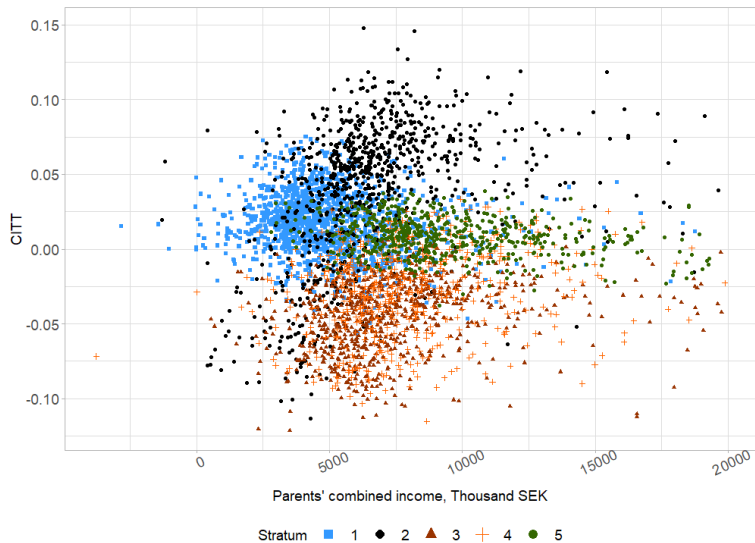
- ▶ Scientific framing (T2) CITTs resemble those of immigrants:
  - ▶ Negative correlation with parents' income and specialized education
  - ▶ **Stratum 2 (compulsory education)** is an exception: positive correlation
- ▶ Emotional framing (T1) CITTs higher for mothers who read more of the leaflet and have higher income , but it never outperforms scientific framing (T2)

T1: CITT by income CITT by job

T2: CITT by income CITT by job

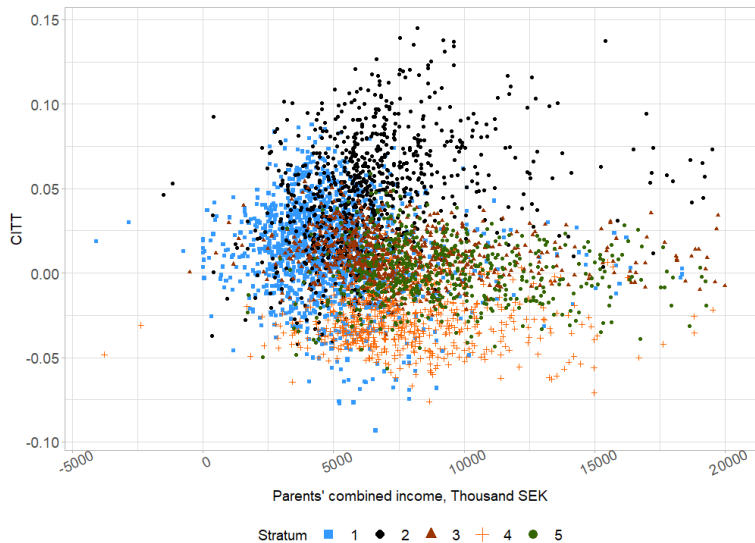
# CITT of T1 by income

Main results



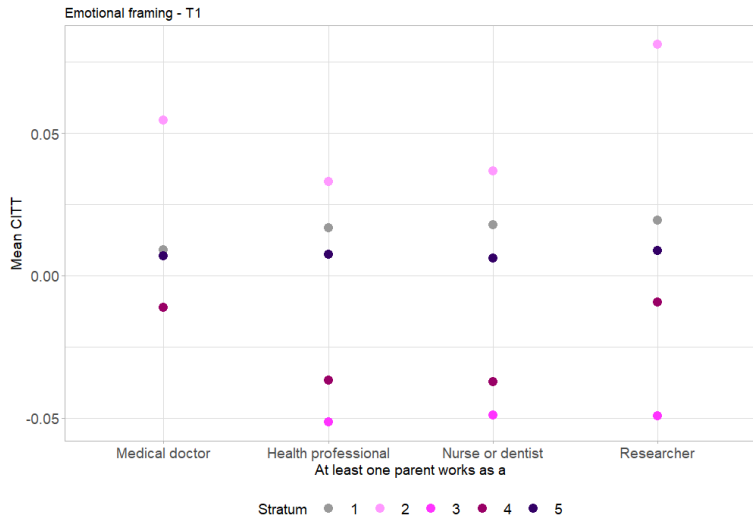
# CITT of T2 by income

Main results



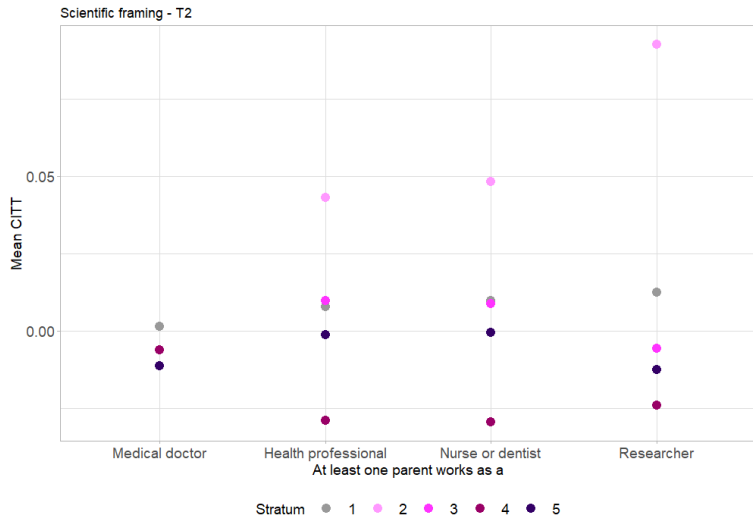
# CITT of T1 by occupation

Main results

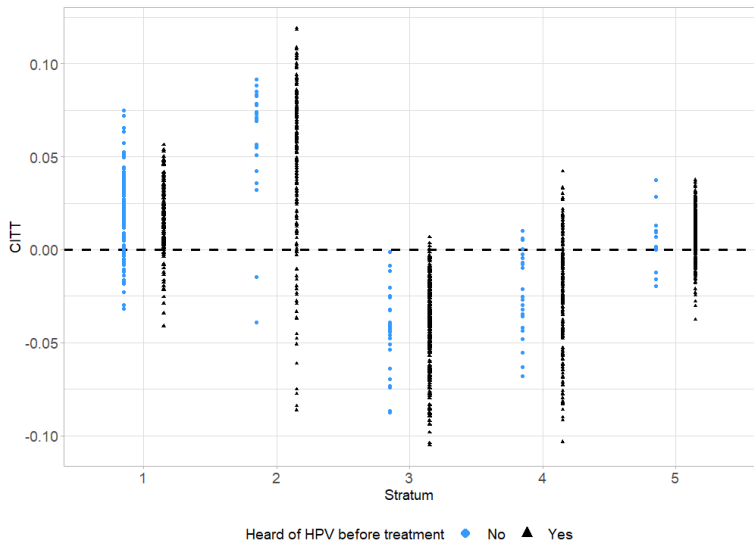


# CITT of T2 by occupation

Main results

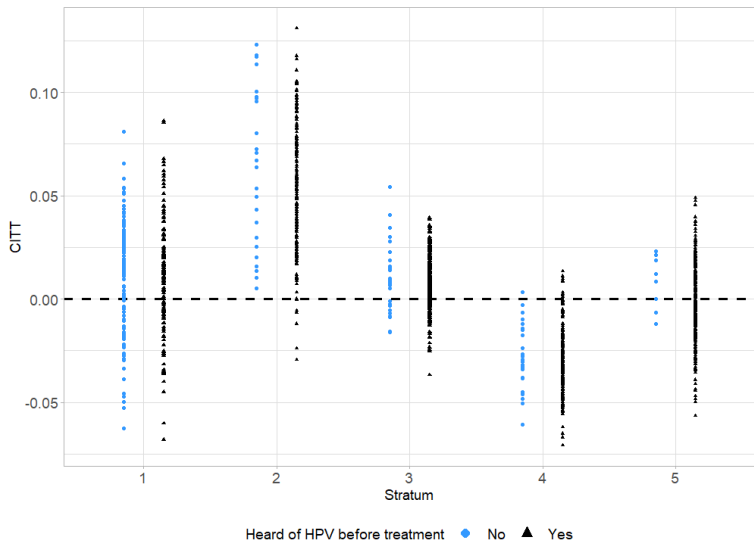


# Previous knowledge: effect of emotional framing (T1)





## Previous knowledge: effect of scientific framing (T2)



We ask how much subjects agree with the following statements (scale 1-5):

- 1 Vaccines weaken and overload the immune system
- 2 Vaccines can cause the disease against which they protect
- 3 Vaccines can produce serious side effects

The secondary outcome is the mean of the 3 answers

## Balance tables

Define the Average Standardized Difference for a generic covariate  $X$  as:

$$ASD = \frac{|\hat{E}[x | T = 1] - \hat{E}[x | T = 0]|}{\sqrt{\hat{V}[x | T = 1] + \hat{V}[x | T = 0]}}$$

where  $T = \{0, 1\}$  denotes the treatment status. A commonly accepted threshold for balance is 0.10.

We also present balance between the inattentive and the attentive mothers, where attention is proxied by participation in the first survey,  $P = \{0, 1\}$ . Note that for secondary outcomes, we rely on the attentive sample only.

# Balance, overall sample

Covariate	ASD: T1 vs C	Mean (C)	Mean (T1)	ASD: T2 vs C	Mean (T2)
<b>Mother's characteristics</b>					
Age	0.019	41.095	40.933	0.014	40.977
Married (Dummy)	0.009	0.591	0.597	0.002	0.592
Capital income (Thousands SEK)	0.018	-7.571	519.213	0.017	63.581
Disposable income (Thousands SEK)	0.019	3,222.662	3,613.435	0.023	3,313.980
Scientific educ. (Dummy)	0.019	0.205	0.215	0.023	0.218
Medical educ. (Dummy)	0.018	0.134	0.143	0.021	0.145
Numerical educ. (Dummy)	0.008	0.163	0.167	0.012	0.157
Job in research (Dummy)	0.008	0.005	0.004	0.030	0.002
Participant (Dummy)	0.010	0.294	0.300	0.031	0.274
<b>Child's characteristics</b>					
Child order	0.022	1.029	1.024	0.041	1.040
Female (Dummy)	0.031	0.475	0.497	0.027	0.494
First dose MMR (Dummy)	0.010	0.905	0.901	0.033	0.891

# Balance, attentive/secondary outcomes sample

Covariate	ASD: T1 vs C	Mean (C)	Mean (T1)	ASD: T2 vs C	Mean (T2)
<b>Mother's characteristics</b>					
Age	0.013	42.518	42.420	0.016	42.401
Married (Dummy)	0.015	0.640	0.630	0.006	0.636
Capital income (Thousands SEK)	0.006	17.652	7.921	0.022	64.070
Disposable income (Thousands SEK)	0.039	3,634.945	3,749.006	0.040	3,786.175
Scientific educ. (Dummy)	0.019	0.205	0.216	0.065	0.243
Medical educ. (Dummy)	0.071	0.104	0.136	0.067	0.134
Numerical educ. (Dummy)	0.001	0.211	0.212	0.001	0.210
Job in research (Dummy)	0.054	0.013	0.006	0.072	0.004
<b>Child's characteristics</b>					
Child order	0.027	1.019	1.014	0.042	1.028
Female (Dummy)	0.028	0.499	0.479	0.051	0.535
Second dose of MMR (Dummy)	0.012	0.915	0.920	0.016	0.915
0.921					

## Balance: attention across treatment arms

Covariate	Average Standardized Difference	Mean (inattentive)	Mean (attentive)
<b>Mother's characteristics</b>			
Age	0.254	40.401	42.437
Capital income (thousands SEK)	0.012	295.868	30.613
Disposable income (thousands SEK)	0.030	3,272.236	3,734.676
Married (Dummy)	0.084	0.577	0.635
Scientific educ. (Dummy)	0.023	0.210	0.223
Medical educ. (Dummy)	0.041	0.147	0.128
Numerical educ. (Dummy)	0.127	0.143	0.211
Job in research (Dummy)	0.046	0.002	0.007
<b>Child's characteristics</b>			
Child order	0.064	1.035	1.020
Female (Dummy)	0.027	0.485	0.504
First dose MMR (Dummy)	0.072	0.889	0.919

# Intention to vaccinate results by response

Results

Stratum	Stratum definition	Baseline uptake	T1 vs C		T2 vs C		T2 vs T1	
			Emotional	Scientific	Resp	Non- resp	Resp	Non- resp
1.	Immigrants	0.773	-0.066 (0.086)	0.022 (0.034)	-0.009 (0.072)	0.028 (0.034)	0.047 (0.057)	-0.01 (0.029)
<b>Swedish-born mothers</b>								
2. Educ-level-1	≤ 3 yrs high school	0.786	0.051 (0.051)	0.026 (0.030)	0.163*** (0.048)	0.033 (0.029)	0.091** (0.039)	0.016 (0.025)
3. Educ-level-2	Up to high school	0.887	-0.037 (0.036)	-0.054* (0.033)	0.016 (0.031)	0.011 (0.029)	0.048 (0.029)	0.052* (0.028)
4. Educ-level-3	Up to UG	0.905	-0.024 (0.039)	-0.016 (0.038)	0.024 (0.036)	-0.017 (0.038)	0.013 (0.035)	-0.020 (0.034)
5. Educ-level-4	Graduate	0.930	-0.033 (0.029)	0.044 (0.032)	-0.016 (0.028)	0.019 (0.035)	-0.010 (0.026)	-0.006 (0.029)

# Baseline uptake and intention to vaccinate

		Baseline uptake		Intention to vaccinate
Stratum		Whole sample	Respondents	Respondents
1.	Immigrants	0.773	0.934	0.83
<hr/>				
<b>Swedish-born mothers</b>				
2.	Educ-level-1 $\leq 3$ yrs high school	0.786	0.809	0.862
3.	Educ-level-2 Up to high school	0.887	0.929	0.929
4.	Educ-level-3 Up to UG	0.905	0.941	0.931
5.	Educ-level-4 Graduate	0.930	0.951	0.967

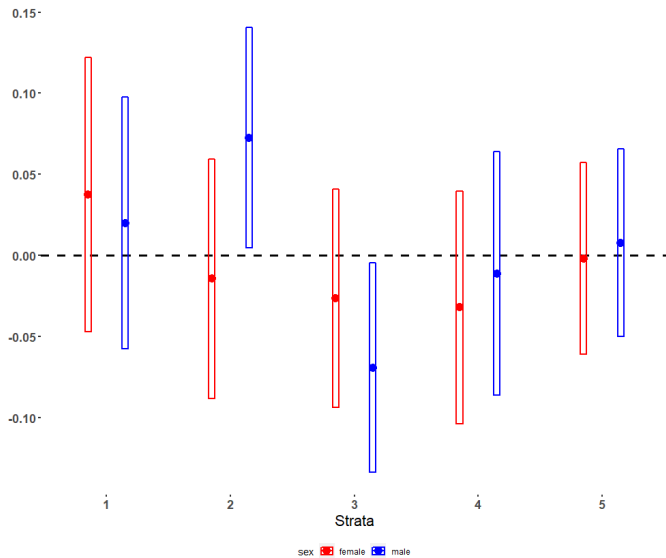


# Main results by Logit (AME)

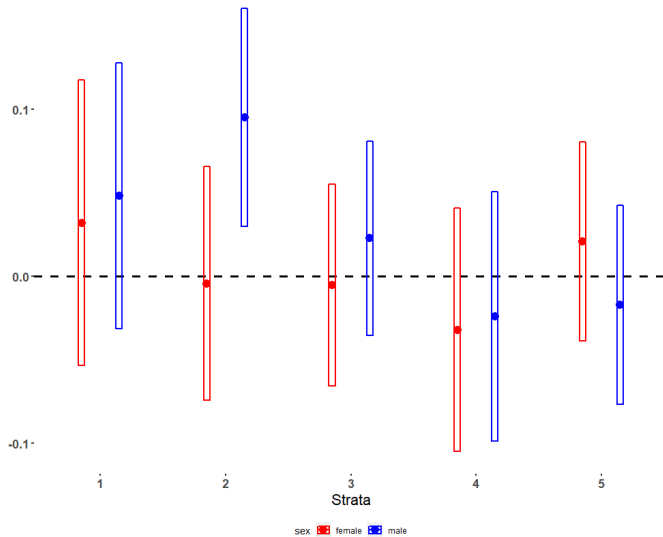
LPM

Stratum	Stratum definition	Baseline uptake	T1 vs C Emotional	T2 vs C Scientific	T2 vs T1
1.	Immigrants	0.773	0.022 (0.027)	0.035 (0.028)	0.000 (0.024)
<b>Swedish-born mothers</b>					
2. Educ-level-1	≤ 3 yrs high school	0.786	0.036 (0.024)	<b>0.056**</b> <b>(0.023)</b>	0.029 (0.021)
3. Educ-level-2	Up to high school	0.887	<b>-0.050**</b> <b>(0.024)</b>	0.004 (0.021)	<b>0.041**</b> <b>(0.020)</b>
4. Educ-level-3	Up to UG	0.905	-0.016 (0.027)	-0.022 (0.026)	-0.010 (0.023)
5. Educ-level-4	Graduate	0.930	0.003 (0.021)	0.005 (0.023)	-0.006 (0.018)

# T1: ITT by sex



## T2: ITT by sex



## Qualitative evidence on other mechanisms

In the endline survey, we ask subjects to (i) state the importance and (ii) assess the likelihood of the following events happening (referred to them directly):

- ① Their child can become a parent in the future
- ② Their child does not have sex before marriage
- ③ Their child develops a cancer (separately: before and after turning 35)
- ④ Their child develops another serious health issue (separately: before and after turning 35)
- ⑤ Their child needs to undergo distressing and invasive medical procedures in the future

We have many zero results and we randomize at the individual level.

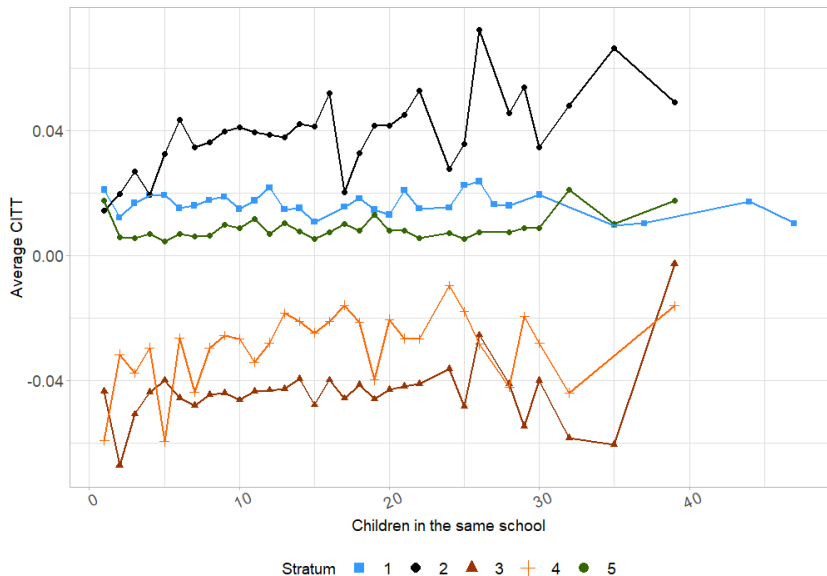
Can this be due to spillovers within schools?

- ▶ We correlate individual CITTs with the number of children in the same school
- ▶ If due to spillovers, we would expect a negative correlation between the number of children and the individual effect

We find no evidence of any correlation

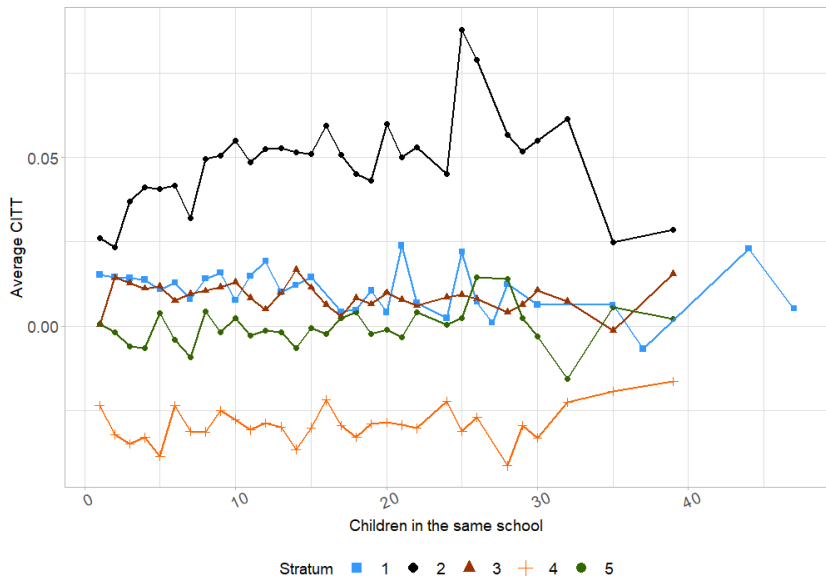
# Spillover test: emotional framing (T1)

Results



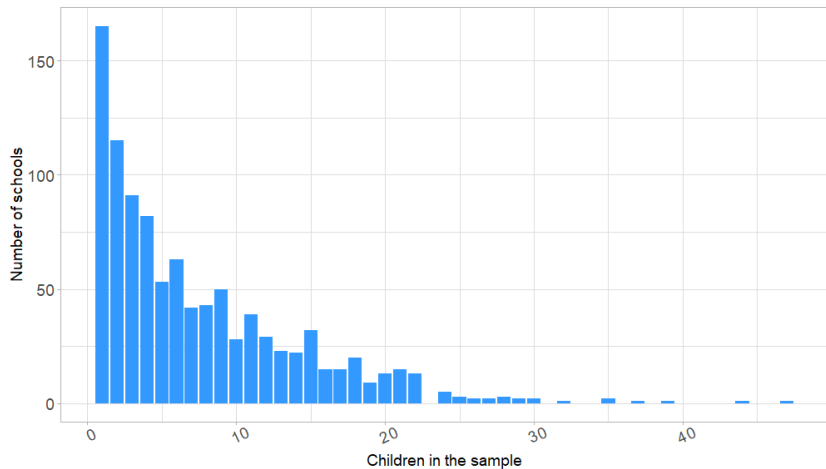
# Spillover test: scientific framing (T2)

Results



# Distribution of schools by # children

Results

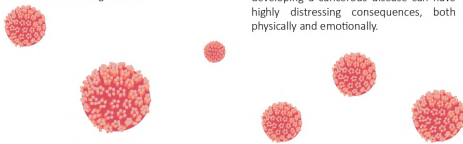




## Information sheet

### HPV

HPV is a virus that comes in many types. It is **highly infectious: contact** between skin, mouth and genitals is sufficient for transmission. Approximately **8 in 10** adults have had some type of HPV in their life, often when they were **young**, between 25 and 35 years. Some types are particularly dangerous for both sexes, since they can lead to **cancer of the cervix, the vulva, the anus, the penis and the mouth**. Some cause genital warts: while benign, they can be distressing. HPV causes almost all cases of cervical cancer, for which **538 women were diagnosed and 222 died** in Sweden in 2018. Every year, about 800 women and 300 men develop a cancer attributable to HPV: men are mostly affected by penis, anus and head-neck cancers. After infection, the virus remains in the body and never goes away: **asymptomatic** individuals (the majority) can infect others. Symptoms usually appear when cancer has arisen, and the consequences can be **extremely painful**. When children grow up and become sexually active, they can catch HPV, and risk developing a cancerous disease and infecting others.



### The vaccine

Luckily, you can do something to avoid it. In September, your child will be offered the vaccine against HPV within the national vaccination programme. The vaccine is free, administered in school, and protects against 9 HPV types that are known to cause most cases of cancer and precancerous lesions. Two doses of the vaccine are administered with a 6 months' interval. It is **safe and effective** against HPV: we know it from numerous clinical studies that have been done for its approval by the European Medical Agency (EMA), and other health authorities. Because the vaccine **does not contain HPV DNA**, it is impossible for it to infect with HPV and cause disease. In Sweden, thanks to vaccination registers, possible adverse effects are closely monitored. They are typically mild, such as pain in the inoculation site and, very rarely, light fever. On the other hand, the consequences of catching HPV are not as rare, and developing a cancerous disease can have highly distressing consequences, both physically and emotionally.



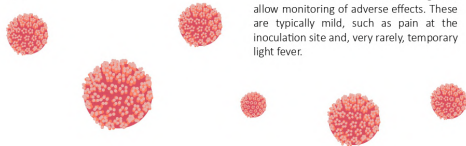
## This is important

Michaella had cervical cancer. As an adverse effect of radiotherapy, she went into menopause and became **sterile at 36 years**, but she recounts: "My doctor told me his youngest patient was **17 years old**. Then I thought, I have 3 children [...]. But if you are 17, what can you do?". Even when they do not cause sterility, therapies still **increase the risk of miscarriage**. Malin was diagnosed at 29 years: she discovered it reading a Medical certificate stating that she had a "**cancer for which a cure is probably not possible**". After unsuccessful chemotherapy, she was offered a 10-hour surgery, which led to many complications, from intestinal problems to severe infections (lung, kidney, and urethra infections): she was constantly at the hospital, admitted to **intensive care**, and underwent three surgeries in eight months. Katarina was **diagnosed while pregnant** with her second child. The day she was diagnosed, doctors told her that she would need to give birth within two weeks and that **her uterus would be removed** to avoid the spread of cancer: **she would not conceive again**. She says "My husband and I sit every night, talking and **crying** [...], we are afraid that I may not see our children grow up. [...] The night before the scheduled birth and surgery, I stood in the shower caressing my pregnant belly, crying because this was my **last day as a pregnant woman in my life**". Her child was born one month prematurely and needed intensive care. Even though she has now recovered, she says that "after 11 months [...], I feel depressed and burnt out, some days I cry a lot [...]" . Joakim's wife wasn't as lucky: she **passed away leaving behind 2 kids, 2 and 5 years old**. All their testimonies are available at *Nätverket mot gynekologisk cancer*.

## Information sheet

### HPV

HPV is a family of viruses causing **dysplastic (cancerous) diseases**, localized primarily in the anogenital area and aerodigestive tract, in both genders. It is transmitted by skin and mucosae contact. Persistent HPV infection significantly increases the risk of **cervical and anal, vulvar, penile, and oropharyngeal cancers**, as well as benign lesions such as anogenital warts. It is estimated that **80%** of the sexually active population has contact with HPV, especially **between 25 and 35 years old**. Upon contact, the virus remains latent, so that asymptomatic individuals (the majority) can transmit it. Symptoms typically appear when cancer has arisen. HPV is responsible for nearly 100% of cervical cancers: in Sweden, in 2018, the crude incidence rate was **11.2 per 100.000 women**, and the death rate **4.5**. Other cancers are also known to be caused by HPV (in Sweden, c.a. 80% of anal, 50% of penis, and 60% of oropharyngeal cancers, which are the main cancers HPV causes in men). Each year, approximately 800 women and 300 men in Sweden develop a cancer attributable to HPV.



### The vaccine

There is a vaccine that your child will be offered for free in September under the national vaccination programme, and that has proven to have **almost 100% efficacy** against cervical cancer and other cancerous diseases caused by nine types of HPV. The vaccine is administered in a two-dose series at a six-month interval. The vaccine **does not contain viral DNA**, and acts by

triggering an immune response that is effective against the real viruses; therefore, the vaccine cannot cause infection or disease. As part of numerous tests carried out for the approval of the drug by the European Medical Agency and other authorities, efficacy was proven with one-sided tests that assessed the increase in immune response indicators, with a significance of 97.5% and a statistical power of at least 90%. The approval process also required extensive data collection on the onset of any adverse effects, from mild to serious. Swedish vaccination registers allow monitoring of adverse effects. These are typically mild, such as pain at the inoculation site and, very rarely, temporary light fever.



## This is important

Gynecological cancers are typically treated with combinations of **radiotherapy, chemotherapy** and, if the cancer is not too spread, **surgery**. These can have serious side effects, in the short-term and even permanent. Both radio and chemotherapy affect the immune system, which increases risk of infections, affect normal cells in the treated area, and decrease blood cells' count. In particular, the reproductive system, affecting patients' **fertility**, bowels, the bladder and the urethra, (possibly causing urinary incontinence). If they affect ovaries, they can induce sudden menopause, causing **temporary or permanent sterility**. The damage to tissues, and in particular vaginal stenosis (dryness, fragility and adhesions), as well as the increased risk of pelvic fractures, **increases the risk of miscarriages** in future pregnancies even if fertility is not affected. Higher miscarriage risk is also caused by the removal of the cervix (thachelectomy), a possible intervention for early stage cervical cancer, whereas removal of the uterus (uterectomy), which in Sweden is only performed at very advanced stages, implies permanent loss of fertility. Treatments' side effects typically require in turn more treatment, possibly invasive. The modalities of treatment and the emotional consequences can be highly distressing. HPV-induced cancers **can affect people of all ages**. In 2018 in Sweden, for instance, there were 80 new cases of cervical cancer in girls between 15-29 years old (incidence rate 8.1 per 100.000 girls in the age group), and 2 deaths (death rate 0.11 per 100.000). In the age group 30-44, 202 new cases and 17 deaths (incidence rate 21.9 and death rate 1.8, per 100.000), and above 60 years old, 276 new cases and 203 deaths (incidence rate 12 and death rate 8.8, per 100.000). You can consult these and other statistics on the *WHO International Agency for Research on Cancer's website*.

# C, Uninformative placebo

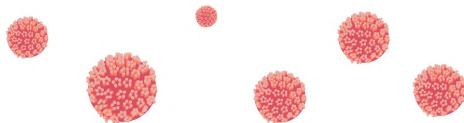
## Information sheet

### HPV

The HPV vaccine is one of the vaccines offered to school children under the **national vaccination programme in Sweden**, in grade 5. It has previously been offered to girls, but starting in fall 2020 it is offered on the same terms to boys. The other vaccines that are part of the program are: **rotavirus** infection, **diphtheria, tetanus, whooping cough, polio**, infections caused by **Haemophilus influenzae type B, measles, mumps, rubella** and serious diseases caused by **pneumococcus**. The HPV vaccine has been included in the national vaccination programme in 2010: Elevhälsan started offering it in school for free in the fall of 2012. The Swedish child vaccination program is governed by the **Communicable Diseases Act** and regulations issued by the Public Health Agency of Sweden. The administration of the national vaccination programme directly in schools via Elevhälsan is specific of the Nordic countries. It is meant to ensure every child living in Sweden, regardless of his or her characteristics or those of his/her family, has equal and free access to vaccinations.

### The vaccine

The vaccine that your child will be offered in **September** protects against nine types of HPV. It is administered via two shots in the upper arms, which are given at least six months apart. However, adults taking the HPV vaccine and immunodepressed children receive three doses. The second dose is given one to two months after the first dose and the third dose is given four months later. Previously, the national vaccination programme offered a vaccine that covered only four types of HPV: girls who got a first shot of this first vaccine can continue with the current one, although there is no recommendation to also be vaccinated with the most recent vaccine among those who already completed all doses of the first vaccine. The HPV vaccine is offered in **more than 90 countries**, but in most of them it is not free. In nine other countries, as in Sweden, the vaccine is also offered to boys, while in most countries it is still only offered to girls.



### This is important

The Swedish national vaccination programme has been instrumental in **eradicating many diseases**, which for this reason are now referred to as “preventable”. The programme was officially established in the **1940s**. However, public vaccination campaigns were not a new phenomenon: already in the 1800s, there were public campaigns of vaccination against smallpox, which at the time was a **great technological advance** for medicine. Between 1750 and 1800, it is estimated that approximately 300,000 people died of smallpox, and the most affected were children below 10 years of age. Eventually, smallpox was eradicated in Sweden and the vaccine was removed from the national vaccination programme in 1976. Another major threat to childhood health used to be tuberculosis. A vaccine was introduced in 1940 and was offered to all children until 1975. After that, since the incidence of **tuberculosis** fell notably, the vaccine was only offered to immunodepressed children. Indeed, the national vaccination programme follows **two different vaccination schedules** depending on the **needs of the individual child**: particularly vulnerable children receive more vaccines than those normally included for all children. The vaccine against diphtheria and tetanus was also added to the national vaccination programme in the 1940s, although the most recent vaccination schedule was introduced in 2007. The main change concerned the measles vaccine – it was first introduced as a standalone vaccine in 1971, and then in 1982 it was replaced by the **trivalent vaccine against measles, mumps and rubella**, which is still in use. More recently, in 1993, the vaccine against Haemophilus influenzae type b also became part of the national vaccination programme. The HPV vaccine, which was previously only available for a fee (although subsidised), was finally introduced as part of the national vaccination programme **as recently as 2010**, initially just for girls.

## Baseline variables from administrative data (1/2)

### For both parents:

- ▶ Demographic variables: is married (dummy), was born in Sweden (dummy), country of origin, age;
- ▶ Education variables: highest educational attainment, grade at national high school examination, graduation year, has received medical education (dummy), has received scientific education (dummy), has received a numerical education (dummy);
- ▶ Labour variables: is an active worker (dummy), is retired (dummy), is a medical doctor (dummy), , has an occupation in healthcare (dummy), is a nurse or a dentist, has an occupation in research;
- ▶ Economic variables: disposable income (earned from labour income and any property income in the 12 months before treatment), capital income (net financial gains in the 12 months before treatment), amount of government transfers received in the 12 months before treatment;

## Baseline variables from administrative data (2/2)

**Only for immigrant parents:** has received any medical education (dummy), has received any scientific education (dummy), has received any numeric education (dummy), has received a formal degree in Sweden, years since immigration date. *Note:* the educational variables are extracted from immigration registers and are meant to account for the education received prior to immigration.

**Child:** is female (dummy), is adopted (dummy), birth order (relative to the mother's children), number of MMR vaccine doses received at baseline.

**School:** anonymized code, anonymized code for the municipality where it is located.

## Other variables from the first survey

We elicit information on:

- ▶ Previous knowledge of the HPV vaccine
- ▶ How much of the leaflet they actually read (in %)
- ▶ Sources from which they passively received information on the HPV vaccine
- ▶ Sources where they actively searched information on the HPV vaccine
- ▶ Presence of a health professional in parents' close network
- ▶ If they intend to search for additional information, and from which source

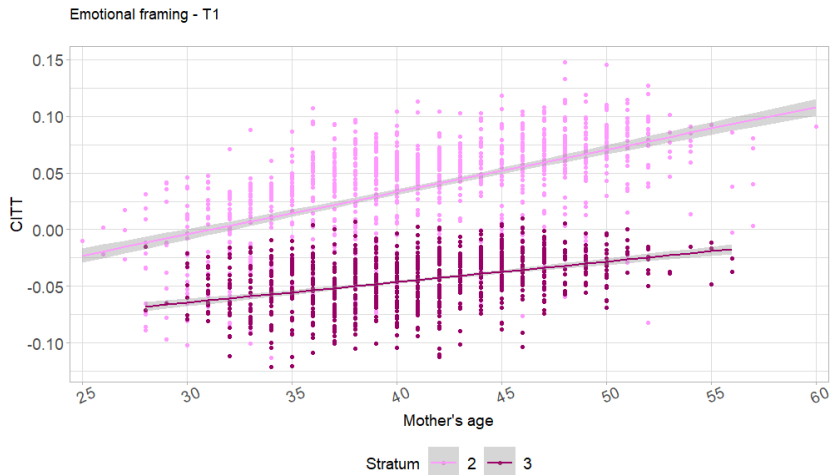
## Did Covid-19 impact our results?

Eichengreen, Aksoy & Saka (2021) show that in past epidemics:

- ▶ **Result 1:** Exposition to epidemics between ages 18 and 25:
  - ▶ Decreases trust in scientists
  - ▶ Translates into lower uptake of childhood vaccinations
- ▶ **Result 2:** The effect is not found among health professionals

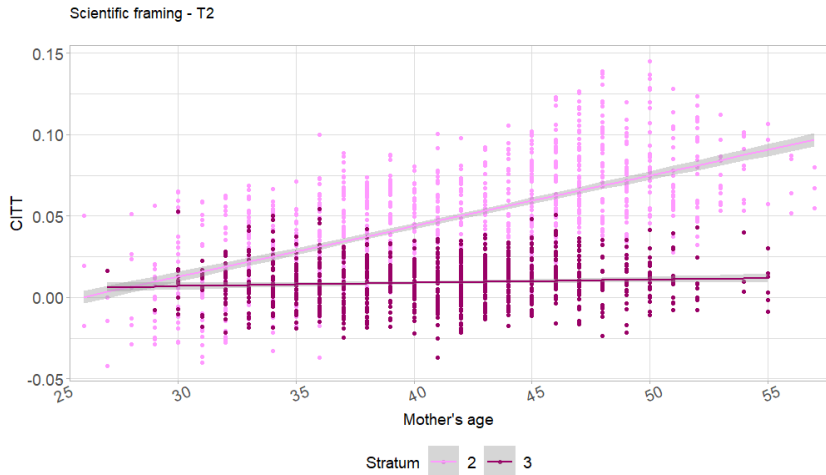
We can check if these results are mirrored by our CITTs from the causal forest

# CITT of T1 by age: strata 2 and 3



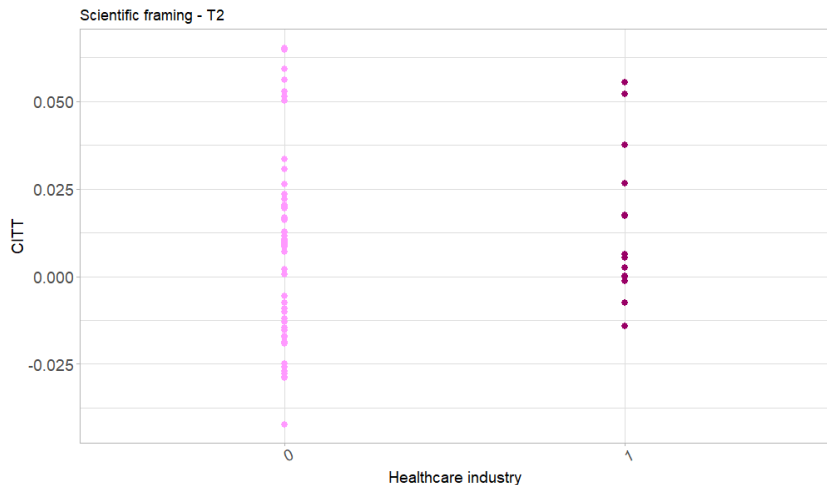


# CITT of T2 by age: strata 2 and 3



# CITT of T2 by occupation

Restricting to mothers below age 30 in stratum 2



**Any questions?****You are welcome to contact us!****Questions on information delivery**

Statistics Sweden reporting service  
010-479 63 30  
enkat@scb.se  
SCB, INS/IHU, 701 89 Örebro  
www.scb.se

**Opening hours**

Monday-Thursday: 8.00 – 21.00  
Friday: 8.00 – 17.00  
Sunday: 16.00 – 21.00

**Questions on the study**

Lisen Arnheim Dahlström  
lisen.arnheim.dahlstrom@ki.se  
Alice Dominici  
alice.dominici@eui.eu

**Vill du svara på svenska?**

På hemsidan kan du välja huruvida du vill svara på svenska eller engelska. Du kan svara på frågorna här:

**www.insamling.scb.se**

Logga in med ditt användarnamn och lösenord. Du behöver inte svara på alla frågor på en gång utan kan också logga in flera gånger.

**SCB describes Sweden**

Statistics Sweden provides society with statistics for decision-making, debate and research. We do this on behalf of the government, authorities, researchers and the business community. Our statistics contribute to a fact-based public debate and well-founded decisions.

## Guardians' attitudes and willingness to vaccinate children against HPV

Dear guardian,

You are receiving this letter because researchers at Karolinska Institute want to investigate attitudes of guardians towards the HPV vaccination in the context of the national vaccination program, and the role of information.

You are one of 7,616 guardians who were randomly selected to participate in the survey. In September, you will be offered to vaccinate your child against HPV as part of the national vaccination program.

You have received an information sheet about the HPV vaccine in this envelope. The information sheet is available in several versions. The information sheet that guardians receive is randomly selected. The researchers assure that the information you receive is always truthful: if you want to know more about the study or the information you received, contact the researchers Lisen A. Dahlström or Alice Dominici. We would be grateful if you could read the short information sheet and then answer some questions.

The survey is conducted by Statistics Sweden on behalf of Karolinska Institute. On the next page, you will find more information about the survey.

**Your answers are important**

It is voluntary to participate in the survey, but we hope you want to participate, because your answers are very important. You help to give a complete picture of the willingness to vaccinate and we are interested in all opinions.

**How you can answer**

**First, read the information sheet on the HPV vaccine** contained in the envelope. Then, go to **www.insamling.scb.se** to answer the questions. Online, you can answer in Swedish or English.

Your credentials are:

Användarnamn:	<input type="text"/>
Lösenord:	<input type="password"/>

If you instead choose to answer on paper, you can send the paper form in the postage-free reply envelope that you received in this letter.

You can log in several times and save your progress each time.

Sincerely,

Joakim Stymne  
General Director SCB

Lisen Arnheim Dahlström  
*Principal Investigator, Karolinska  
Institute*  
Alice Dominici, *Project leader,  
Karolinska Institute*

