PHIRI

Population Health Information Research Infrastructure

PHIRI Federated Research Infrastructure

17th World Congress on Public Health – A World in Turmoil
Opportunities to Focus on the Public´s Health

ROBERT KOCH INSTITUT

IACS Instituto Aragonés de Ciencias de la Salud

www.phiri.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101018317

Principles of the PHIRI research infrastructure

- **Research Question**
- **Secondary use**
- **Sensitive Health Data**
- Common Data Model (**CDM**)
- Security & **privacy by design**
- **“Code meets data”**
- Enabling **rapid-cycle** analyses

- **Federated**
- **Open source** (software/stack)
- **Literate** statistical **programming**
- **Usability** (easy-to-use interfaces)
- **FAIR (stemming from R to F)**
- Aligned with advances towards **Federated Learning**

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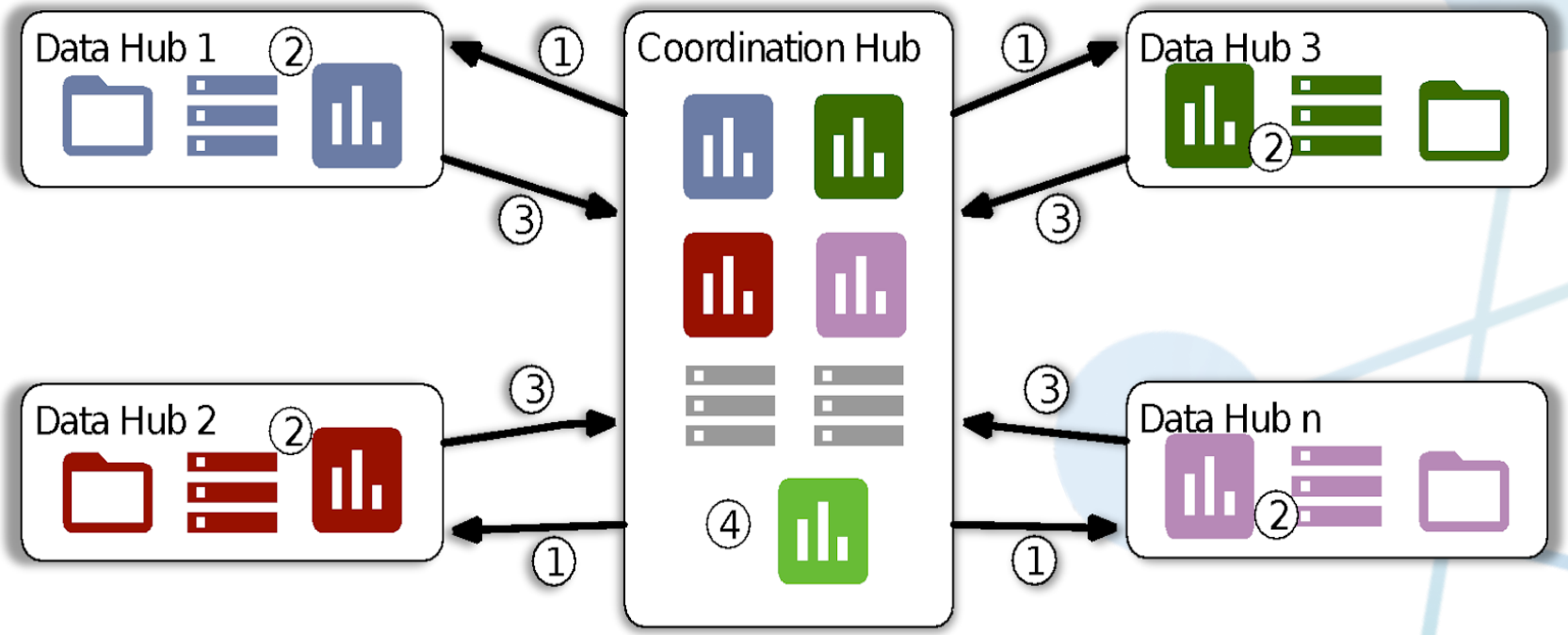
Federated architecture



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Federated, secondary use, “codes meets data” strong reliance on interoperability

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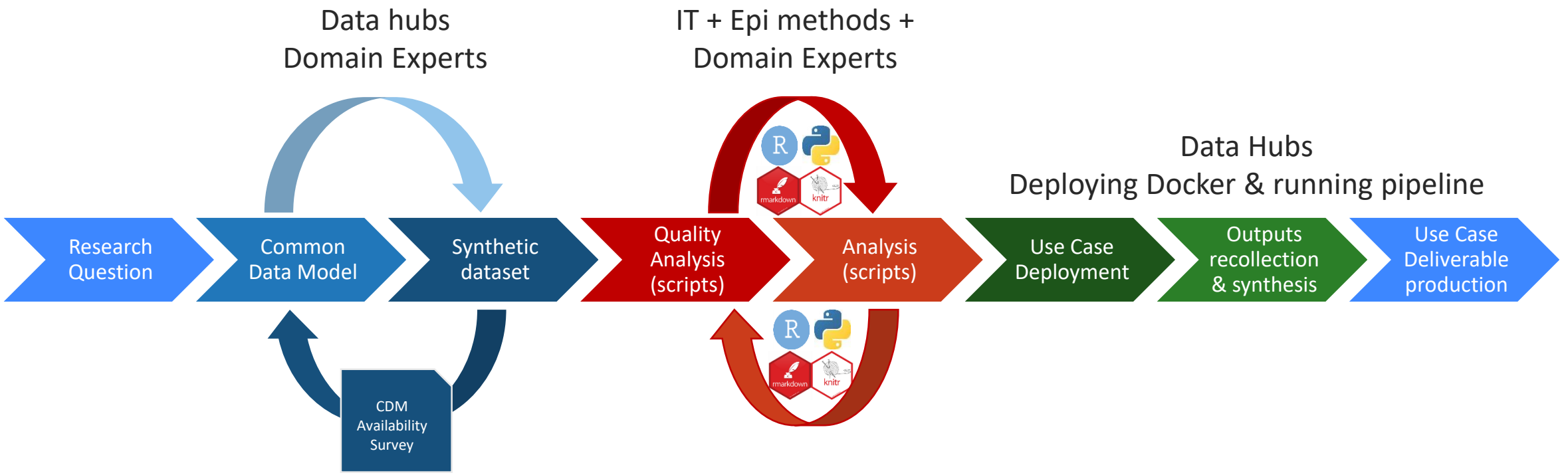
Strict workflow enabling LOST interoperability



Orchestration of research query and deployment

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Common data model

PHIRI Federated Analysis Application (Docker)

- Common Data Model
- Synthetic dataset
- Quality Analysis (scripts)
- Analysis (scripts)
- Outputs recollection & synthesis

Data model entity	Variable							Data Quality	ETL	
Associated entity in ERD	Label (var_label)	Name (var_concept)	Level (required/recommended/optional)	Classification/Encoding	Units	Format	Description	References to validation rules	Transformation at or	
patient	**patient_id**	patient identificator	required	private key ciphering function	none	string	patient pseudonymized identificator	SHA256	double hash function a following SHA256 proto (see patient cohort defi in next sheet)	
patient	**age_nm**	age	required	none	years	integer	patient's age at the moment	3-digits; min 18; max 80	it might need to be calc from 'birth_dt'	
patient	**socecon_lvl_cd**	socioeconomic level	recommended	quintile	quintiles	integer	patient's socioeconomic level (quintile)	min 1; max 5	it might need to be calc from 'income_lvl' or approximated through a combination of 'education_lvl' and othe variables	
patient	**country_cd**	country (residence)	required	ISO3166	none	string	patient's country of residence	ISO3166-3	conformance with ISO3166-3	field calculated at individual level
patient	**country_origin_cd**	country (origin)	recommended	ISO3166	none	string	patients' country of origin	ISO3166-3	conformance with ISO3166-3	field calculated at individual level
procedure	**ttm_type_cd**	type of treatment	required	types of treatment referred below or a combination of them	none	integer	type of treatment received by the patient	values restricted to existing categories	calculated following treatment type definition (see definitions in next sheets)	field calculated at individual level
procedure	**time_dx_to_surgery_nm**	[time til first surgery]	required	none	days	double	time from breast cancer diagnosis to first surgical procedure	no negative values allowed	it might be calculated as the difference between the date of the breast cancer diagnosis and the first surgical procedure related to the breast cancer treatment (see definitions in next sheets)	field calculated at individual level
procedure	**time_dx_to_radiotherapy_nm**	[time til first radiotherapy session]	required	none	days	double	time from breast cancer diagnosis to first radiotherapy session	no negative values allowed	it might be calculated as the difference between the date of the breast cancer diagnosis and the first radiotherapy session (procedure) (see definitions in next sheets)	field calculated at individual level
procedure	**time_dx_to_chemotherapy_nm**	[time til first prescription/administration of a chemotherapy treatment]	required	none	days	double	time from breast cancer diagnosis to first prescription/administration of a chemotherapy treatment	no negative values allowed	it might be calculated as the difference between the date of the breast cancer diagnosis and the prescription/administration of chemotherapy treatment (see definitions in next sheets)	field calculated at individual level
procedure	**time_dx_to_inmunotherapy_nm**	[time til first prescription/administration of a inmunotherapy (a.k.a biological) treatment]	required	none	days	double	time from breast cancer diagnosis to first prescription/administration of a inmunotherapy treatment	no negative values allowed	calculated as the difference between the date of the breas cancer diagnosis and the prescription/administration of inmunotherapy treatment (see definitions in next sheets)	field calculated at individual level
drug exposure	**time_dx_to_hormonotherapy_nm**	[time til first prescription/administration of a hormonotherapy treatment]	required	none	days	double	time from breast cancer diagnosis to first prescription/administration of a hormonotherapy treatment	no negative values allowed	calculated as the difference between the date of the breas cancer diagnosis and the prescription/administration of hormonotherapy treatment (see definitions in next sheets)	field calculated at individual level
observation period	**period**	[time period]	required	none	month	integer	natural month	yyyy-mm	calculated as the natural month in which each patient recieved any of the aforementioned types of treatment	field calculated at aggregated level

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Use Case B - Delayed care in cancer patients

This survey aims at mapping the availability of individual level data at each data hub to answer the research question posed by the Use Case B.

Research question:
Has there been any increase in surgical and/or co-adjuvant (i.e. radiotherapy, chemotherapy, inmunotherapy) treatments delay in elegible women diagnosed of breast cancer, as a consequence of the COVID19 crisis?

Cohort description:
Women, 18 years old or older, with a first diagnosis of breast cancer between 2017-01-01 until today.

Individual level data is required:

Common data model includes variables on:
patient identificator
age
socioeconomic level
country (residence)
country (origin)
type of treatment [surgery, radiotherapy, chemotherapy, inmunotherapy, hormonotherapy or a combination of several]
[time til first surgery] (days)
[time til first radiotherapy session] (days)
[time til first prescription/administration of a chemotherapy treatment] (days)
[time til first prescription/administration of a inmunotherapy (a.k.a biological) treatment] (days)
[time til first prescription/administration of a hormonotherapy treatment] (days)
[time period] (month)

You can explore the Common Data Model specification at: https://docs.google.com/spreadsheets/d/1xC4shJDgrT3ZnRRF5GZfOUvRdJhAaX5b261uR3JkSNs/edit?usp=sharing

!!! Note that you can comment directly on the Common Data Model through the link.

Your comments on any issue regarding the data model will be much appriciated!

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Synthetic dataset

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- **Synthetic Dataset**
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patient_id	ttm_type_cd	age_nm	time_dx_to_surgery_nm	time_dx_to_radiotherapy_nm	time_dx_to_chemotherapy_nm	time_dx_to_hormonotherapy_nm	time_dx_to_immunotherapy_nm	period	socecon_lvl_cd	country_cd	country_origin_cd	hospital_id
1	1	59	21	NA	NA	NA	4	1	0	ESP	ESP	20
2	2	60	13	15	NA	NA	6	21	0	ESP	ESP	27
3	2	54	53	2	NA	NA	104	20	0	ESP	ESP	68
4	5	51	6	3	3	NA	18	8	0	ESP	ESP	98
5	3	72	NA	NA	1	NA	33	11	0	ESP	ESP	67
6	2	59	1	0	NA	NA	13	17	0	ESP	ESP	89
7	4	52	1	NA	NA	10	21	17	0	ESP	ESP	90
8	2	67	0	17	NA	NA	0	10	0	ESP	ESP	45
9	5	51	28	41	0	NA	2	33	1	ESP	ESP	5
10	2	57	1	53	NA	NA	0	11	0	ESP	ESP	88
11	5	58	53	16	7	NA	96	19	0	ESP	ESP	68
12	4	49	4	NA	NA	10	15	22	0	ESP	ESP	57
13	4	36	20	NA	NA	6	3	12	0	ESP	ESP	16
14	1	52	19	NA	NA	NA	8	7	0	ESP	ESP	17
15	4	64	0	NA	NA	1	13	22	0	ESP	ESP	13
16	4	46	116	NA	NA	107	61	27	0	ESP	ESP	75
17	1	65	3	NA	NA	NA	7	5	0	ESP	ESP	80
18	5	50	5	2	4	NA	12	14	0	ESP	ESP	54
19	4	42	10	NA	NA	4	52	29	0	ESP	ESP	40
20	5	68	32	2	93	NA	0	2	0	ESP	ESP	33
21	2	51	0	14	NA	NA	0	31	0	ESP	ESP	39
22	3	54	NA	NA	14	NA	0	21	0	ESP	ESP	94
23	3	44	NA	NA	37	NA	4	22	1	ESP	ESP	12
24	4	61	76	NA	NA	222	33	31	0	ESP	ESP	16
25	4	71	0	NA	NA	0	6	9	1	ESP	ESP	51
26	2	70	2	0	NA	NA	15	20	0	ESP	ESP	3
27	1	67	38	NA	NA	NA	35	32	0	ESP	ESP	90
28	5	56	81	319	9	NA	81	20	0	ESP	ESP	69
29	4	58	4	NA	NA	5	37	6	0	ESP	ESP	50
30	1	52	91	NA	NA	NA	178	1	0	ESP	ESP	41
31	5	57	0	1	0	NA	1	10	0	ESP	ESP	38
32	3	57	NA	NA	0	NA	2	21	0	ESP	ESP	92
33	1	47	92	NA	NA	NA	0	10	0	ESP	ESP	89
34	2	75	12	30	NA	NA	7	12	0	ESP	ESP	42
35	3	55	NA	NA	9	NA	2	20	0	ESP	ESP	75
36	5	43	38	72	22	NA	6	18	0	ESP	ESP	67
37	2	44	76	59	NA	NA	0	29	0	ESP	ESP	66
38	2	55	11	15	NA	NA	0	20	0	ESP	ESP	87

breast_cancer_ttm_delays_synthe

Listo

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Data quality assessment

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- Common Data Model
- Synthetic dataset
- **Quality Analysis (scripts)**
- Analysis (scripts)
- Outputs recollection & synthesis

PHIRI delayed_ttm_breast_cancer

Using Python's **Pandas Profiling API**

Overview

Overview | Warnings 13 | Reproduction

Dataset statistics

Number of variables	13
Number of observations	19356
Missing cells	42583
Missing cells (%)	16.9%
Total size in memory	3.8 MiB
Average record size in memory	208.0 B

Overview | Warnings 13 | Reproduction

Warnings

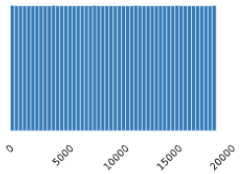
country_cd has constant value "ESP"	Constant
country_origin_cd has constant value "ESP"	Constant
time_dx_to_surgery_nm has 3909 (20.2%) missing values	Missing
time_dx_to_radiotherapy_nm has 11585 (59.9%) missing values	Missing
time_dx_to_chemotherapy_nm has 11558 (59.7%) missing values	Missing
time_dx_to_hormonotherapy_nm has 15531 (80.2%) missing values	Missing
patient_id has unique values	Unique
time_dx_to_surgery_nm has 1960 (10.1%) zeros	Zeros
time_dx_to_radiotherapy_nm has 1003 (5.2%) zeros	Zeros
time_dx_to_chemotherapy_nm has 1653 (8.5%) zeros	Zeros
time_dx_to_hormonotherapy_nm has 656 (3.4%) zeros	Zeros
time_dx_to_immunotherapy_nm has 3083 (15.9%) zeros	Zeros
socecon_lvl_cd has 17421 (90.0%) zeros	Zeros

Variables

patient_id
Real number ($\mathbb{R}_{\geq 0}$)

UNIQUE

Distinct	19356	Minimum	1
Distinct (%)	100.0%	Maximum	19356
Missing	0	Zeros	0
Missing (%)	0.0%	Zeros (%)	0.0%
Infinite	0	Negative	0
Infinite (%)	0.0%	Negative (%)	0.0%



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Analytical workflows

PHIRI Federated Analysis Application (Docker)

- Common Data Model
- Synthetic dataset
- Quality Analysis (scripts)
- **Analysis (scripts)**
- Outputs recollection & synthesis

Run Chunk | Run Above

```r
```{r load_libraries}
## 3. Load required libraries ####
library(DBI)
library(dplyr)
library(htmlTable)
library(magrittr)
library(utils)
library(tidyverse)
library(kableExtra)
library(wrapr)
library(plyr)


```
```

Run Chunk | Run Above

```r
```{r load_data}
con <- dbConnect(RSQLite::SQLite(), "/home/phiri/analysis-scripts/inputs/database/database.db")
df <- dbReadTable(con, "perinatal_health")

```
```

Run Chunk | Run Above

```r
```{r indicators}

indicator_names <- c()
n_per_year22<-df %>% filter(GA >= 22, VITAL != 4, VITAL!= 1, VITAL !=99) %>% group_by(year) %>% tally()
total_per_year22 <- df  %>% filter(GA >= 22) %>% group_by(year) %>% tally()
n_per_year22$indicator <- "aa_22weeks"

n_per_year24<-df %>% filter(GA >= 24, VITAL != 4, VITAL!= 1, VITAL !=99) %>% group_by(year) %>% tally()
total_per_year24 <- df  %>% filter(GA >= 24) %>% group_by(year) %>% tally()
n_per_year24$indicator <- "ab_24weeks"

n_per_year28<-df %>% filter(GA >= 28, VITAL != 4, VITAL!= 1, VITAL !=99) %>% group_by(year) %>% tally()
total_per_year28 <- df  %>% filter(GA >= 28) %>% group_by(year) %>% tally()
n_per_year28$indicator <- "ac_28weeks"
```

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```

Containerised solution ready for deployment

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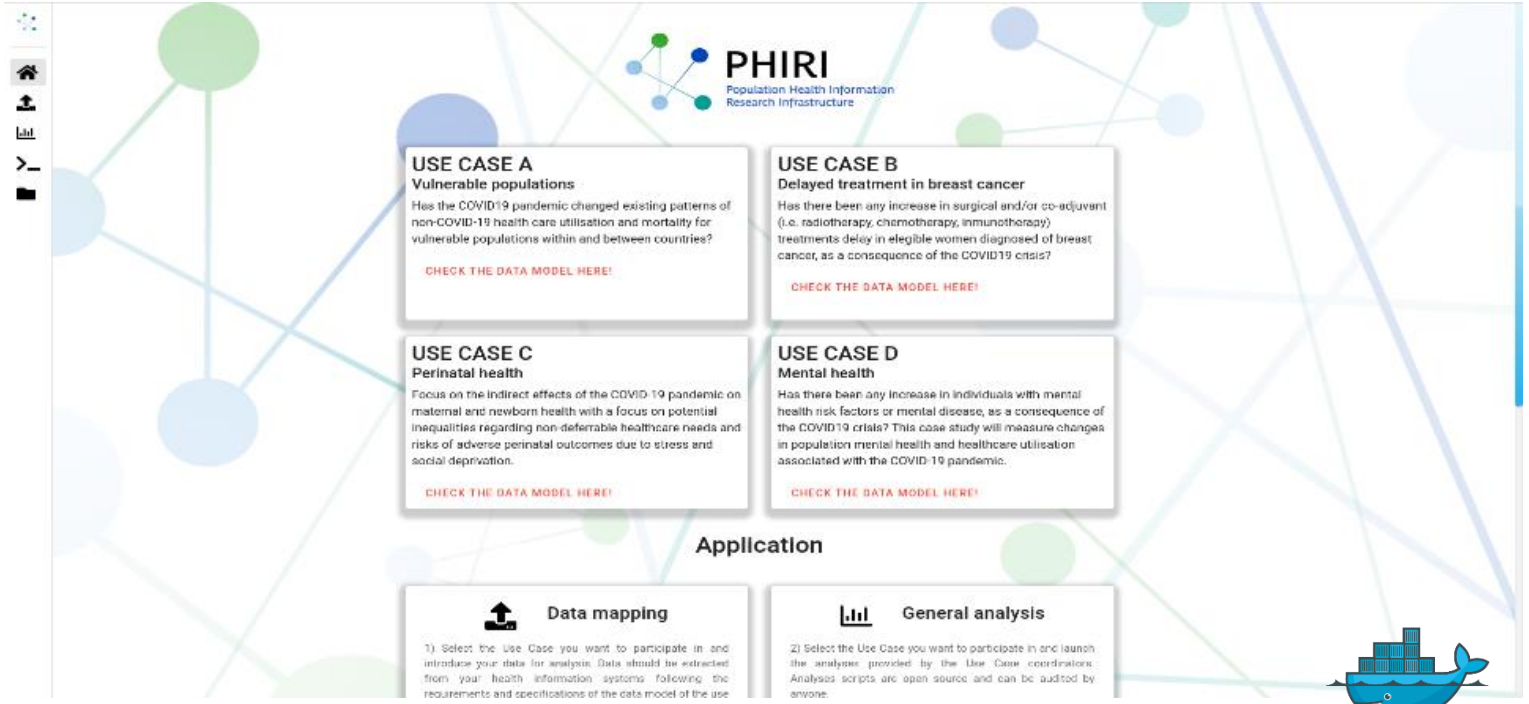
- Common Data Model
- Synthetic dataset
- Quality Analysis (scripts)
- Analysis (scripts)
- **Use Case Deployment**



docker

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Running local analyses and results devolution

PHIRI Federated Analysis Application (Docker)

- Common Data Model
- Synthetic dataset
- Quality Analysis (scripts)
- Analysis (scripts)
- Outputs recollection & synthesis

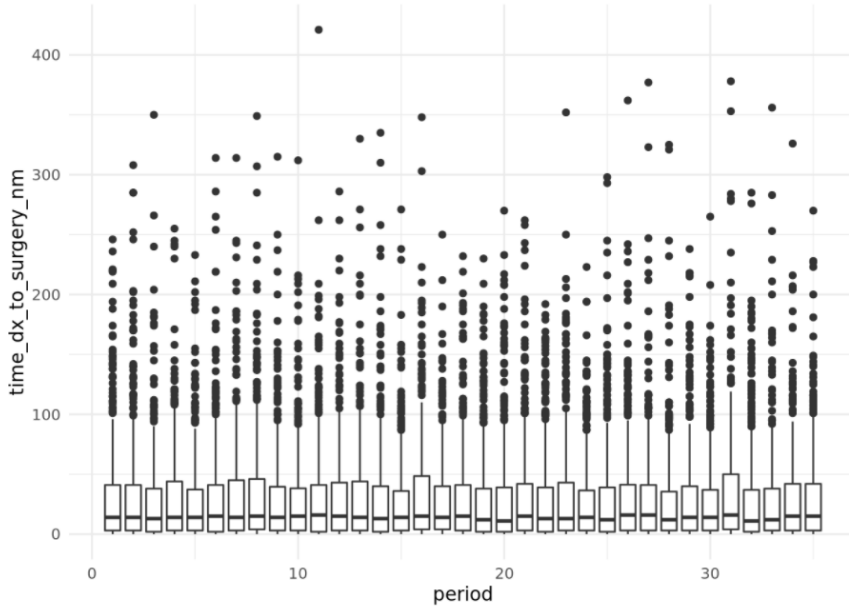
Use Case B report example with synthetic data

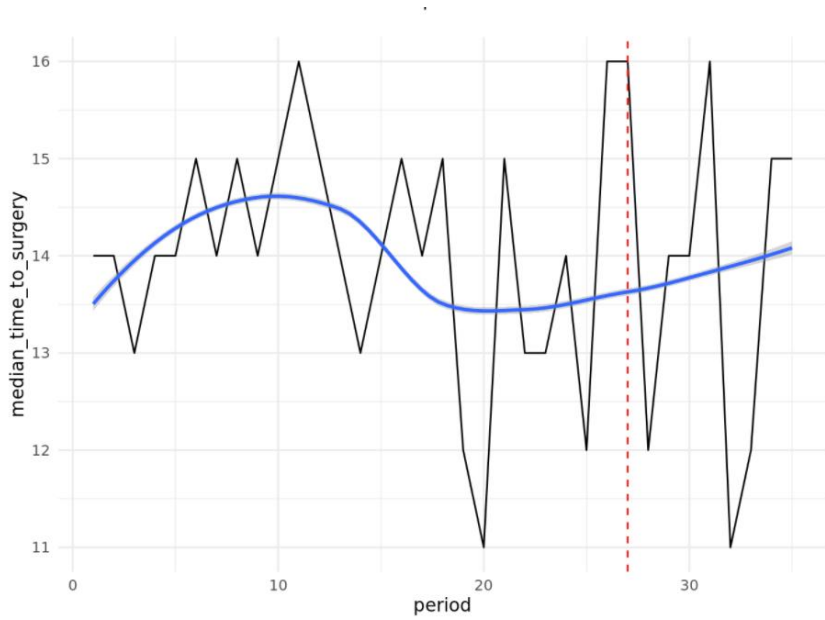
Estupiñán-Romero, Francisco; González-Galindo, Javier; Bernal-Delgado, Enrique

16/6/2021

Exploratory Analysis (Local)

Distribution of times from diagnosis of breast cancer to treatment





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Population Health Information Research Infrastructure

Thank you for your attention

Enrique Bernal-Delgado, IACS, ES
Martin Thissen, RKI, DE
Follow us on Twitter: @PHIRI4EU

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Use Cases measuring the impact of COVID-19 on population health

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PHIRI – Outcomes & Services

BUILDING A FEDERATED RESEARCH INFRASTRUCTURE WITH USE CASES

HEALTH INFORMATION PORTAL

HEALTH INFORMATION TOOLS AND GUIDELINES

EUROPEAN SCHOOL ON HEALTH INFORMATION

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- Data sources and publications
- International guidelines, initiatives and projects
- Training material and courses
- Ethical and legal tools

- Bi-weekly COVID-19 expertise exchange
- Research methodologies to assess the impact of Covid-19
- Foresight: modelling and scenarios

- Foresight methodologies to assess the wider impact of COVID-19
- Infodemic management training
- Data hubs developer training

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Research Use Cases on COVID-19 – Objectives

4 real life research use cases measuring the impact of COVID-19 on population health

- Direct and indirect determinants of COVID-19 infection and outcomes in vulnerable population groups with reference to inequalities
- COVID-19 related delayed care in breast cancer patients
- The impact of COVID-19 on perinatal health and perinatal health inequalities
- COVID-19 related changes in population mental health

Demonstrate how a broad variety of data (e.g. administrative and survey data) can be reused in a distributed way across Europe:

a) **Conduct research** through use cases of immediate relevance on the consequences of the COVID-19 pandemic on European population health

b) **Pilot activities** for the benefits and added value of a federated research infrastructure by bringing together data from different European countries

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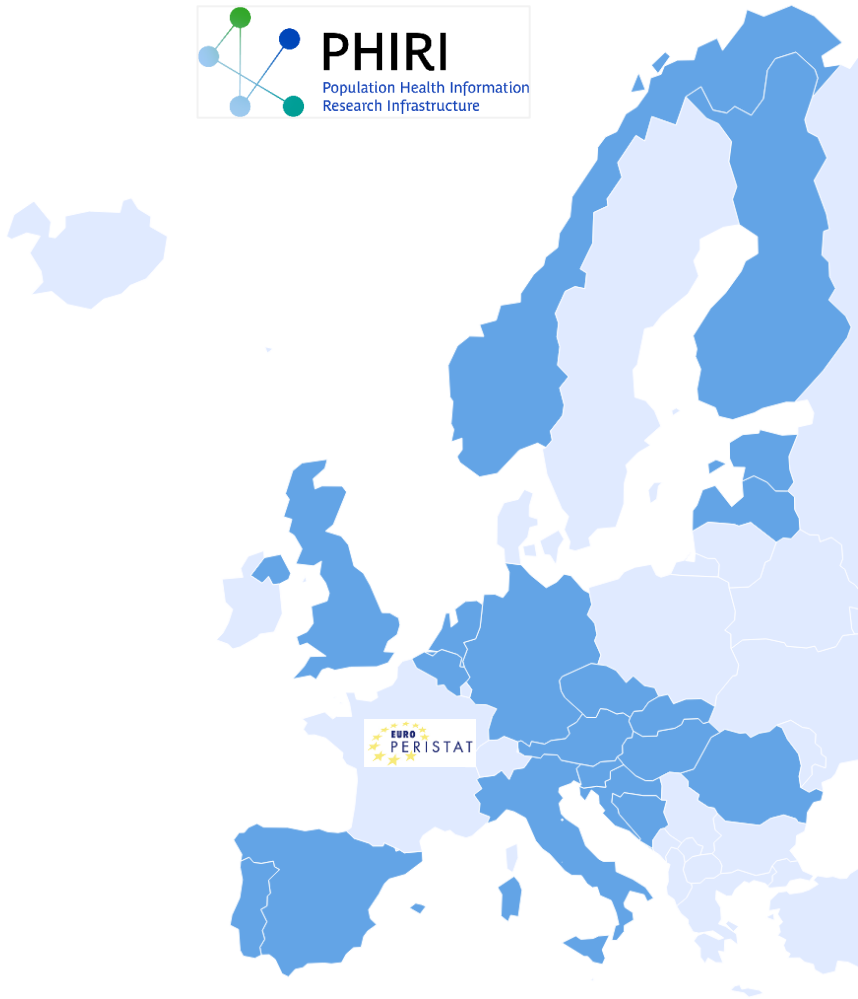
Research Use Cases on COVID-19 – Achievements

→ In **almost 20 data hubs**, data is mobilized and ready to be analyzed in a distributed manner



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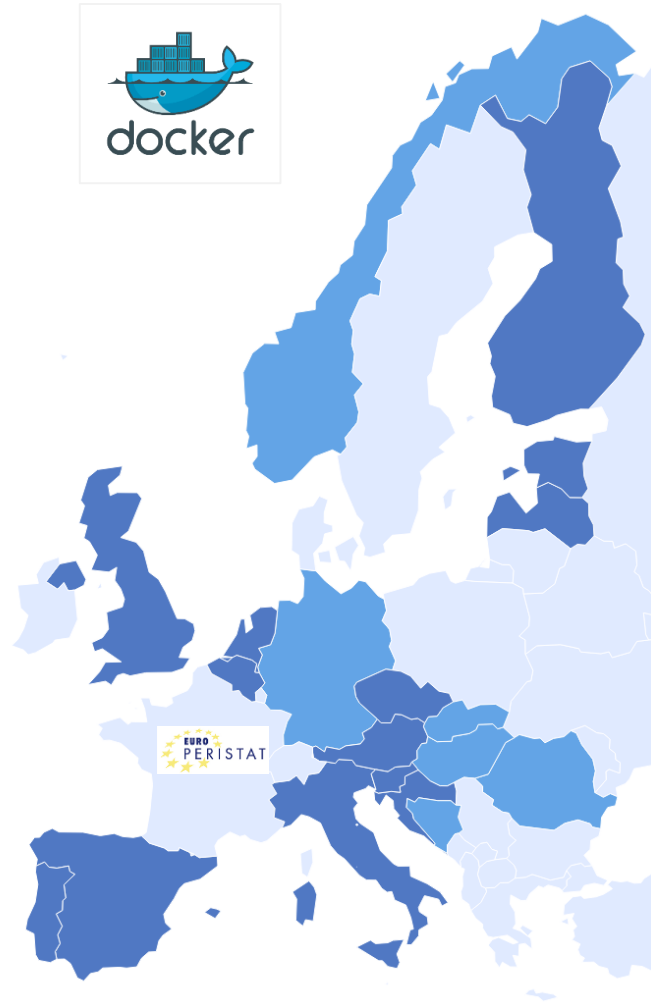
Research Use Cases on COVID-19 – Achievements

- In **almost 20 data hubs**, data is mobilized and ready to be analyzed in a distributed manner

- In **13 data hubs**, the PHIRI-app Docker is already deployed and tested*



*__BUT__ there are some other countries or institutions that have also downloaded and deployed the Docker that we know of outside of the PHIRI project

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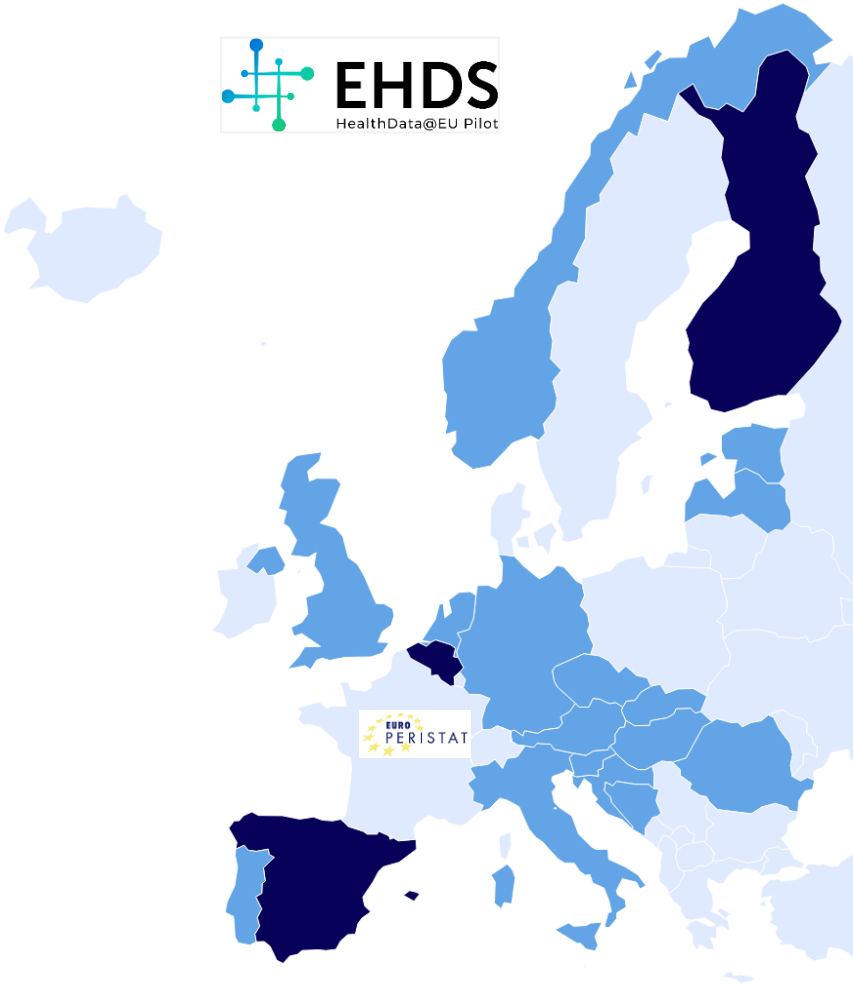
Research Use Cases on COVID-19 – Achievements

- In **almost 20 data hubs**, data is mobilized and ready to be analyzed in a distributed manner
- In **13 data hubs**, the PHIRI-app Docker is already deployed and tested
- There is already **overlap** between the PHIRI data hubs and the **health data access bodies (HDAB)** in the EHDS2
  - Majority of PHIRI use cases data hubs will be HDAB in the future



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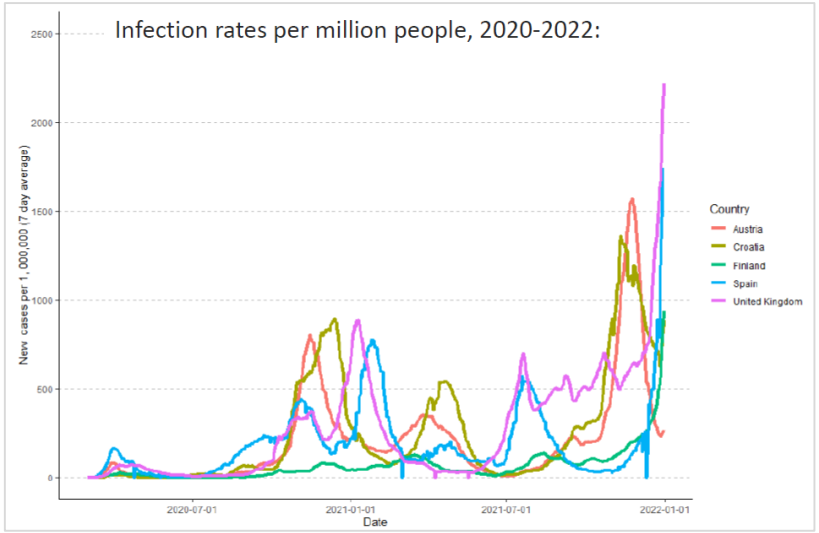
Research Use Cases on COVID-19 – Results

Has the COVID19 pandemic changed existing patterns of non-COVID-19 health care utilisation for (vulnerable) populations within and between countries?

- Heart attack and strokes (Cohort 1)
- Hip and knee replacements (Cohort 2)
- Serious trauma admissions (Cohort 3)

	Associated entity in ERD	Label (var_label)	Name (var_concept)	Classification/Encoding	Units	Format	Description
basics	patient	**patient_id**	patient identificator	private key ciphering function	none	string	patient pseudonymized identificator
	patient	**sex**	sex				
	patient	**age_nm**	age	none	years	integer	patient's age as of 2019-01-01
	observation period	**period**	[time period]	none	month	integer	natural month
cohort 1	heart event	**acute_event_heart**	major vascular event - heart attack	ICD10:I21			
	date heart event	**date_event_heart**	date - heart attack	date	date_DMY_nr	YYYY-mm-dd	
	stroke event	**acute_event_stroke**	major vascular event - stroke	I60-I64			
	date stroke event	**date_event_stroke**	date - stroke		date_DMY_nr	YYYY-mm-dd	
cohort 2	procedure	**ttm_type_cd**	type of treatment	types of treatment referred	none	integer	type of treatment received by the patient
	procedure	**surgery_elective_hip**	elective surgery, hip joint replacement	OPCS codes in UK W37-W39			
	procedure	**surgery_elective_knee**	elective surgery, knee joint replacement	OPCS codes in UK W40-W42			
cohort 3	condition	**acute_event_trauma**	hospital admission for trauma based on	ICD10: S720, S721, S722, S723,	none	string	Based on scientific analysis by New
	Date of event	**date_event**	date of admission	date	date_DMY_nr	YYYY-mm-dd	date of admission
	Optional:						
optional	patient	**educ_cd**	highest completed education level	quintile or top/bottom	quintiles	integer	patient's highest completed education
	patient	**socecon_lvl_cd**	socioeconomic level	quintile or top/bottom	quintiles	integer	patient's socioeconomic level (quintile)
	patient	**country_cd**	country (residence)	ISO3166	none	string	patient's country of residence
	patient	**district_cd**	district (residence)	e.g. Eurostat NUTS			
	patient	**country_origin_cd**	country (origin)	ISO3166	none	string	patients' country of origin (country of



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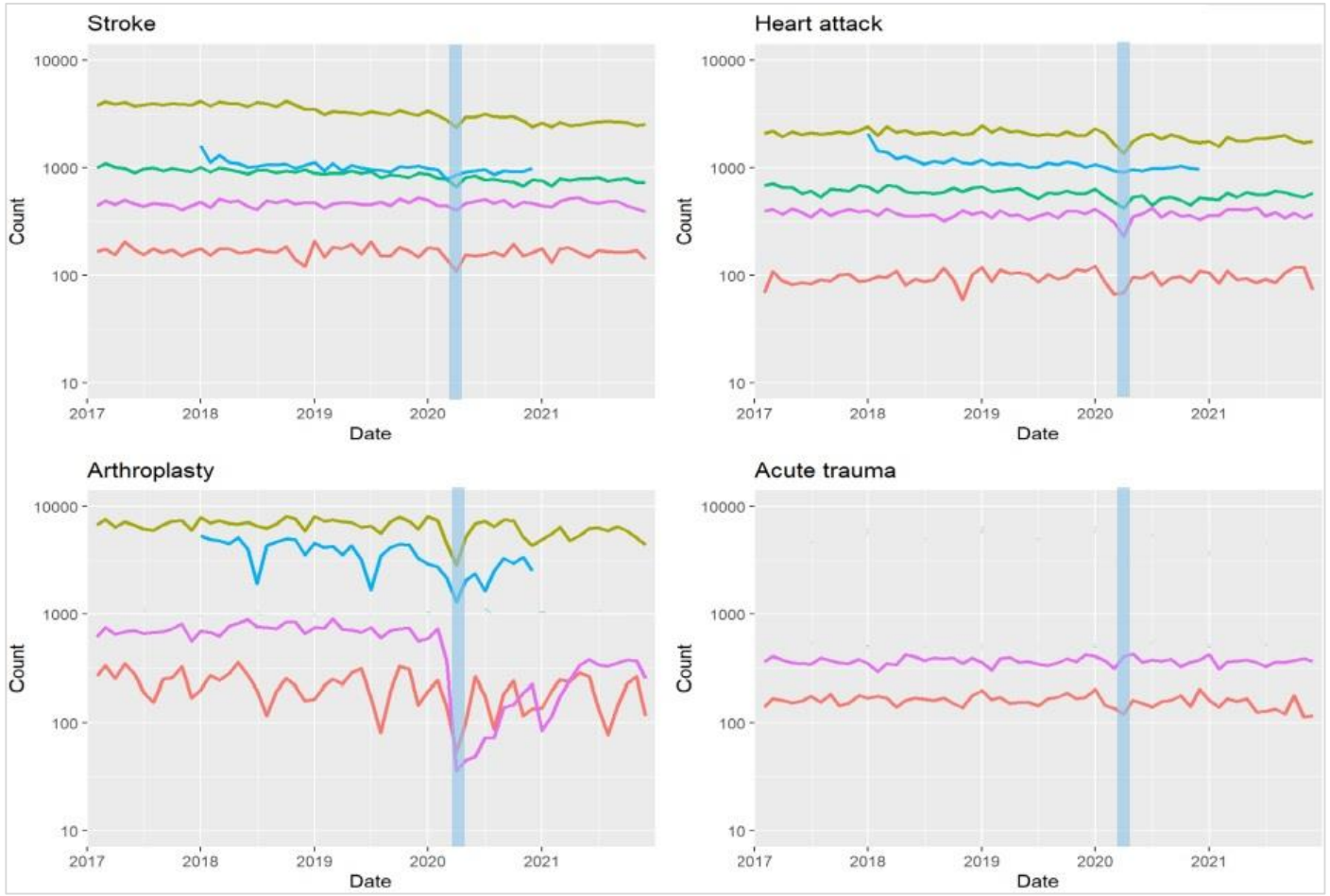
Research Use Cases on COVID-19 – Results



Raw event counts

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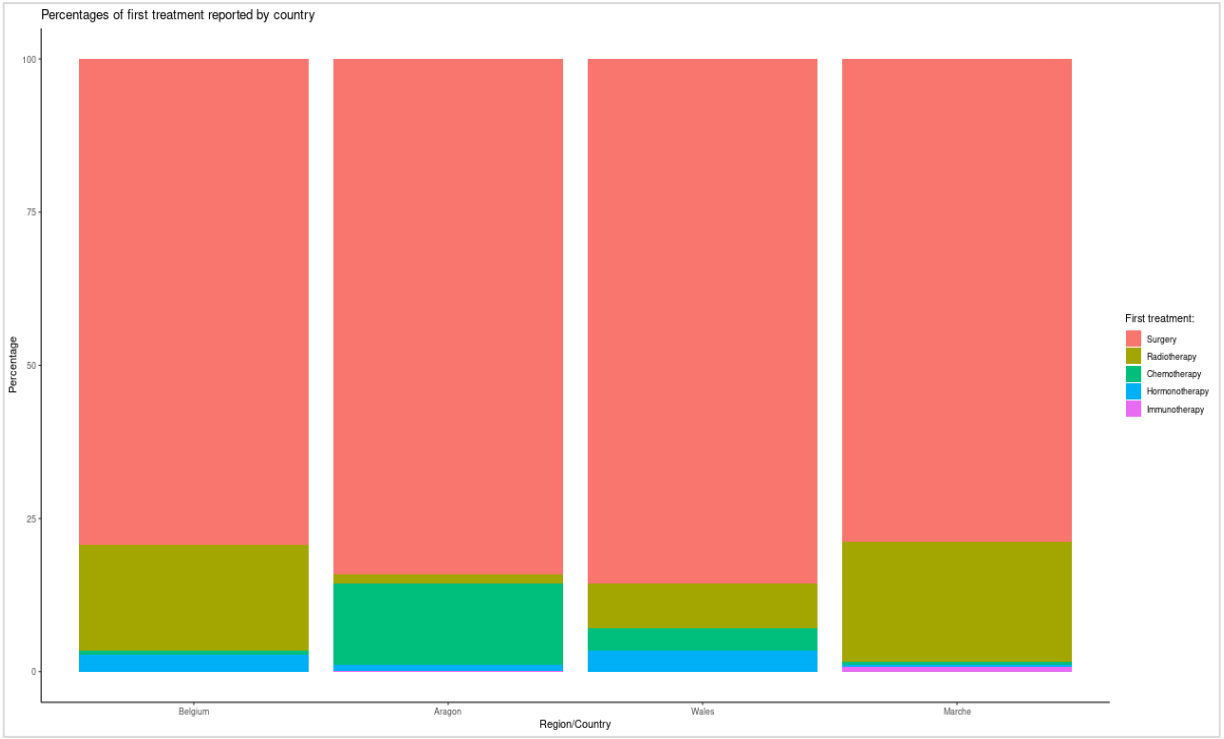
Research Use Cases on COVID-19 – Results

Was there any delay in the treatment of breast cancer patients associated with the COVID-19 pandemic?

Data hubs participation: N = 4

Aragon (AR, Spain), Wales (WA, United Kingdom), Belgium (BE), Marche (MA, Italy)



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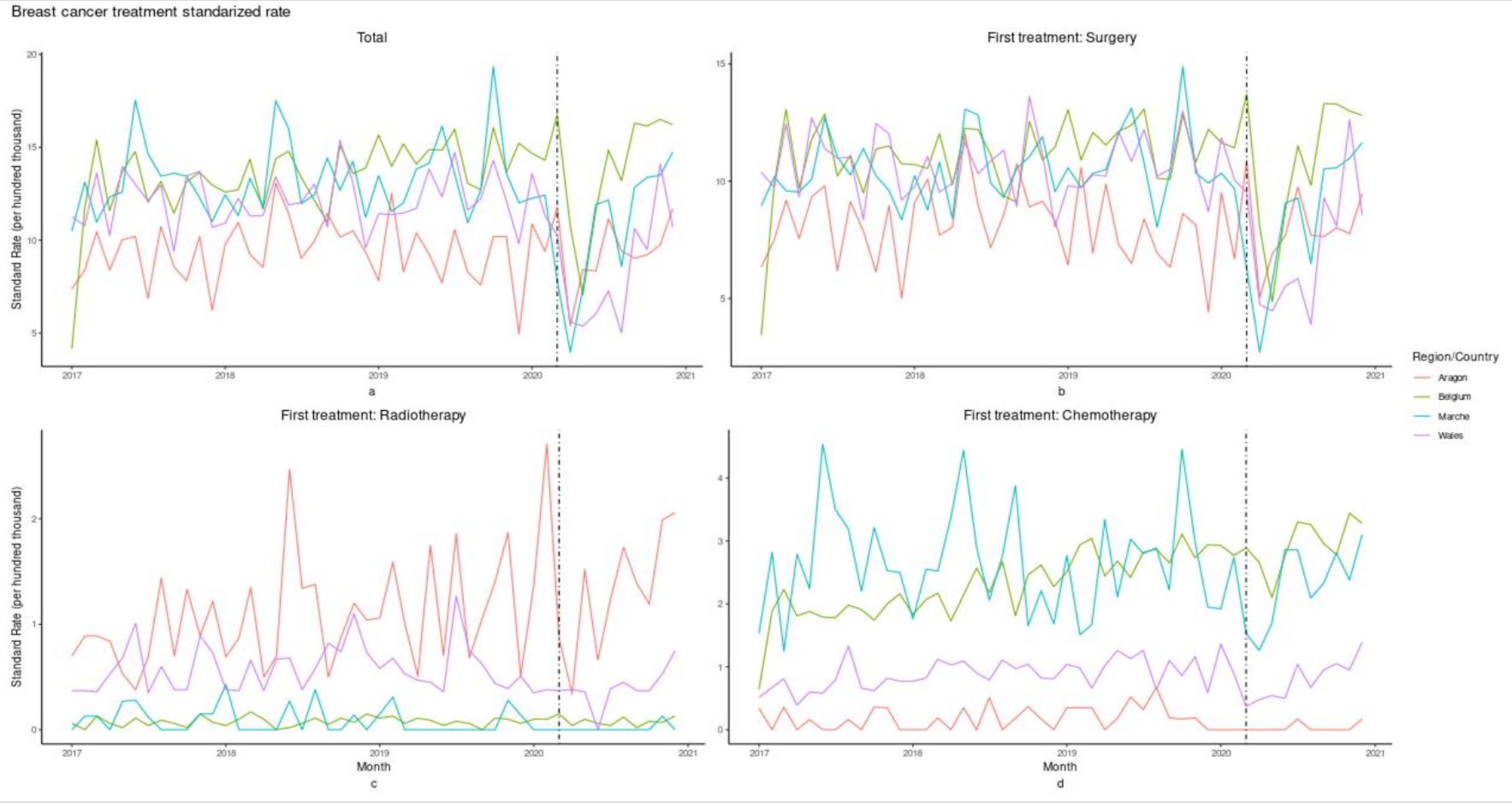
Research Use Cases on COVID-19 – Results



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Research Use Cases on COVID-19 – Results

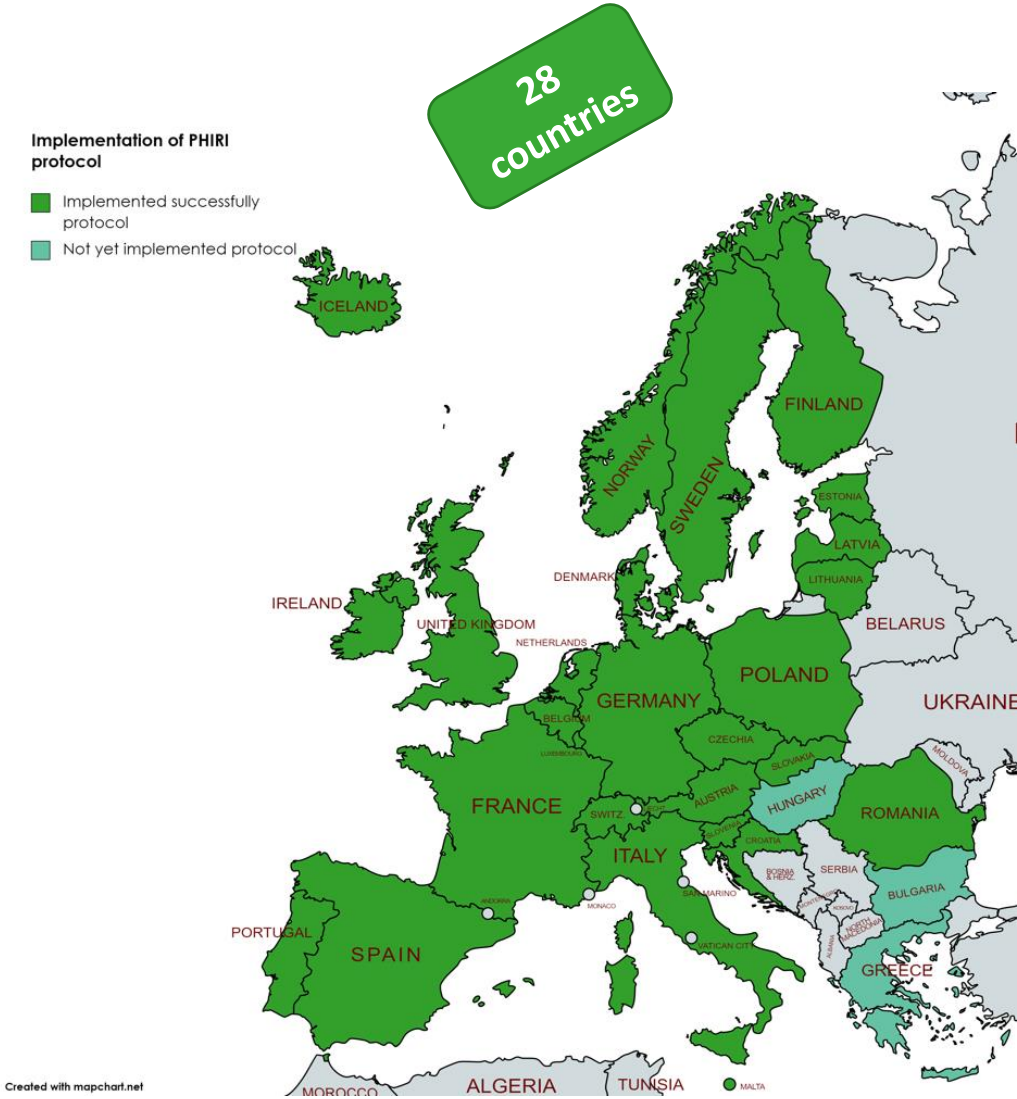
Were population indicators of maternal and newborn health affected by the pandemic/lockdown?

Stillbirth (baby born without signs of life)

- 3-4 per 1000 births (15-18,000 babies per year in Europe)
- High health and psychological burden for parents, costs for families and society

Preterm birth (birth before 37 weeks of gestation)

- Affects about 350,000 births per year in Europe, few effective prevention strategies
- Principal cause of infant death
- Long-term neurodevelopment impairment and other health problems among survivors



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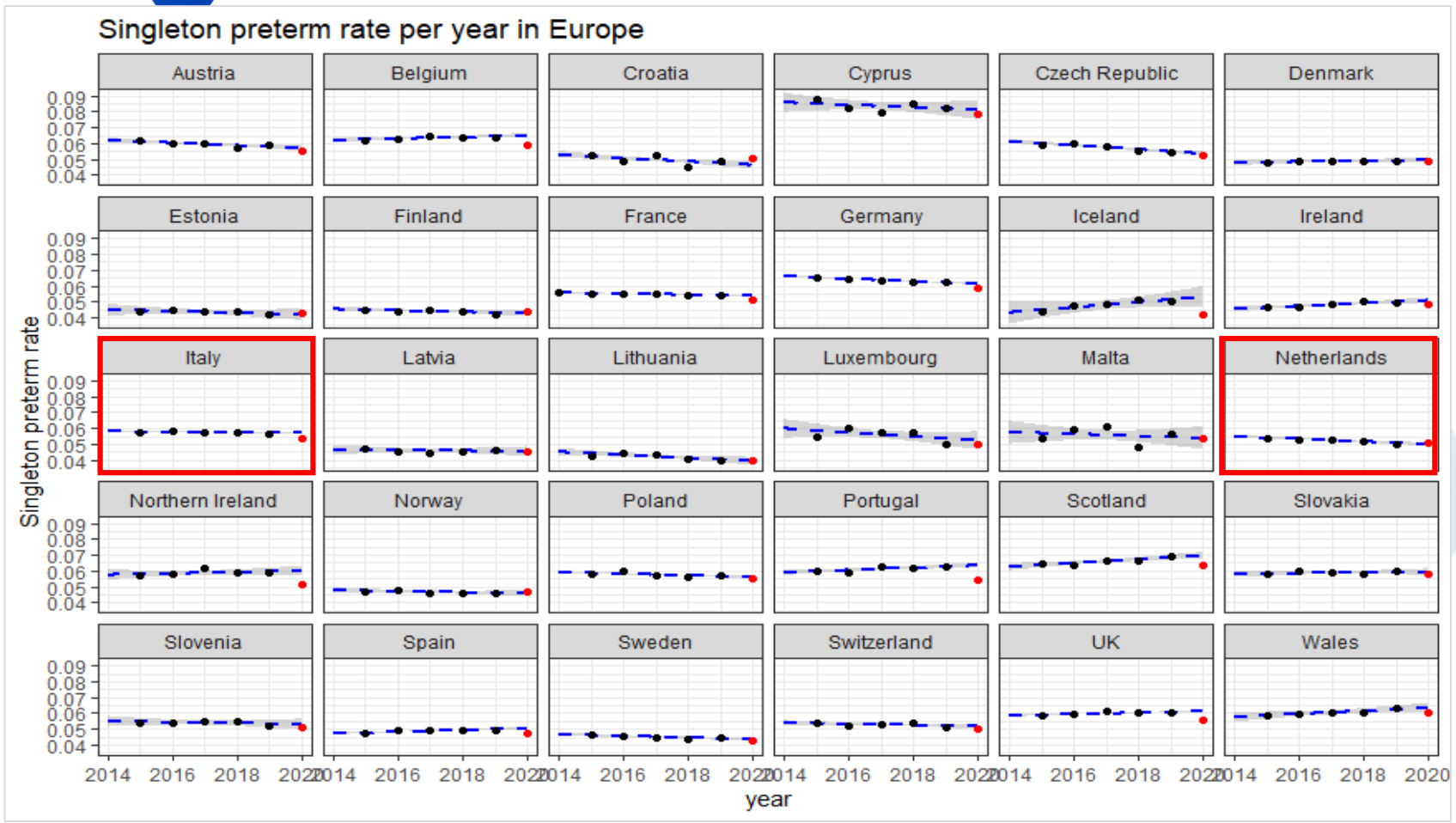
Research Use Cases on COVID-19 – Results



Pooled estimate
RR=0.96 (0.96 to 0.98) = 4% decrease in preterm birth

High heterogeneity
I^2 = 77.5% (proportion of total variation in effect estimate due to between-study heterogeneity)

Range of effects = 10% decrease in preterm birth to moderate increase of 3 to 4%.

Countries with stronger effects: Portugal – Belgium – UK – Spain – Italy – France

Countries with no effects: Nordic and Baltic countries, Netherlands

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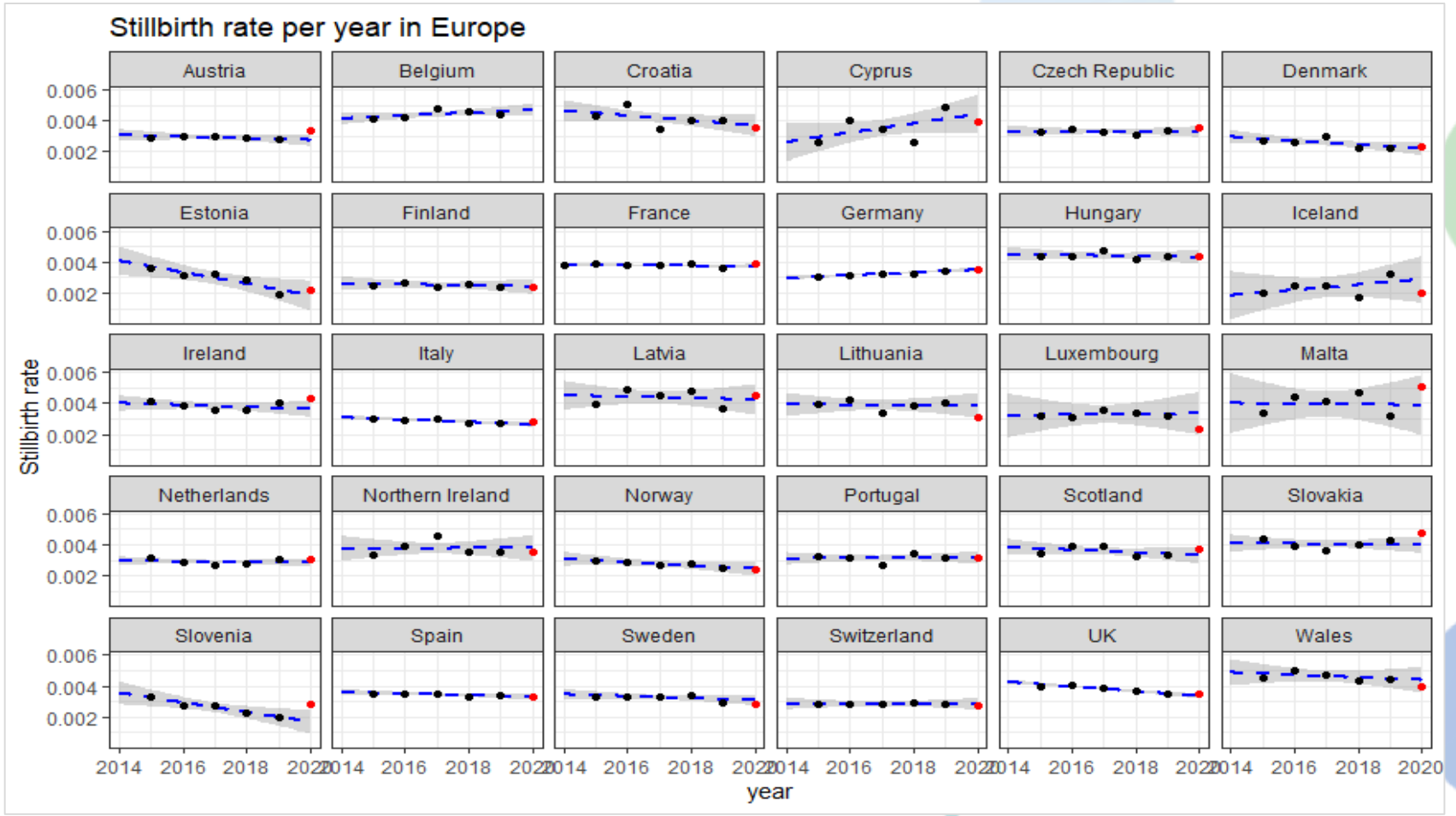
Research Use Cases on COVID-19 – Results

Estimate of pooled effect
RR=1.05 (1.02 to 1.08) = 5% increase in stillbirth

Lower heterogeneity
I^2 = 20.3% (proportion of total variation in effect estimate due to between-study heterogeneity)

Range of effects = No decreases significant / Austria higher stillbirth rates



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Research Use Cases on COVID-19 – Results

Has the mental health status (depression/anxiety) of the general population changed during the COVID-19 pandemic?

Table 3: Proportion of respondents reporting having negative feelings by age and gender, EU27 (%)

		Summer 2020			Spring 2021		
		Tense	Lonely	Depressed	Tense	Lonely	Depressed
Men	18–34 years	34	25	21	46	35	34
	35–49 years	30	21	19	41	31	32
	50+ years	22	18	15	28	26	23
Women	18–34 years	45	30	28	52	38	40
	35–49 years	38	22	27	49	34	39
	50+ years	24	18	17	35	30	29

Notes: *Green = lowest value, red = highest value. All differences between the two time periods are statistically significant. Any discrepancies between the figures in the text and table are due to rounding.*

Source: Living, working and COVID-19 e-survey data. Mental health and trust decline across EU as pandemic enters another year. EuroFound, 2021.

Results from 6 data hubs:

- Aragon (IACS)
- Austria
- Croatia
- Finland
- Romania
- Wales

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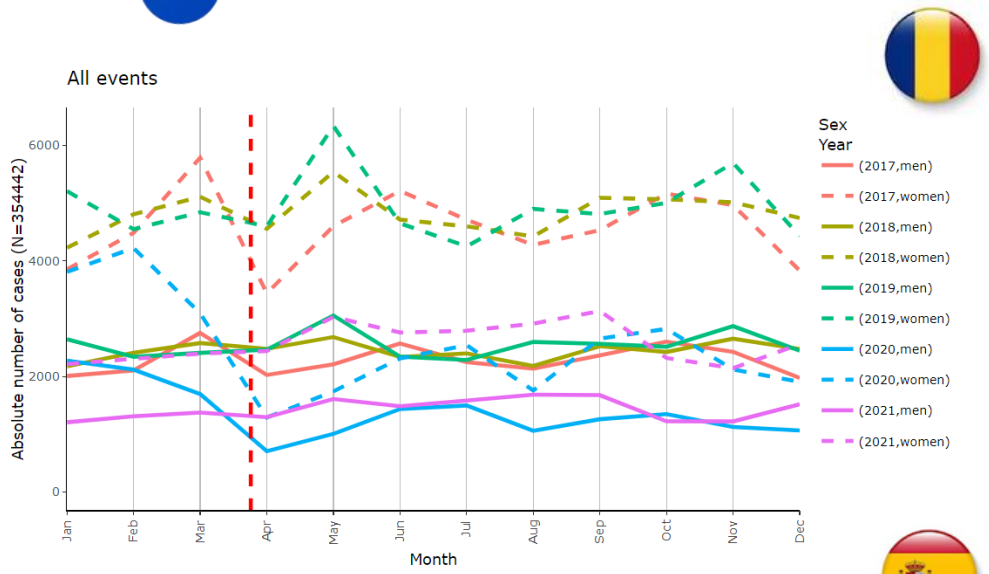
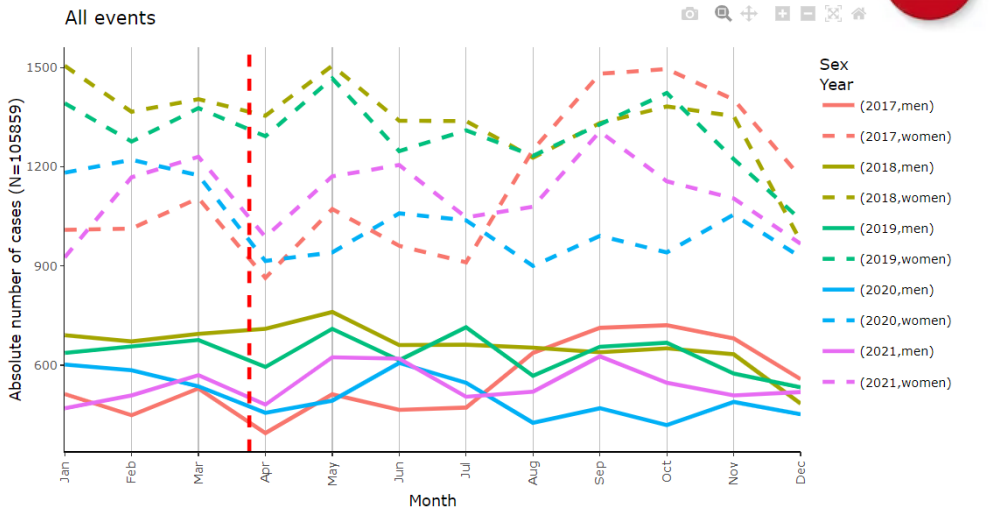
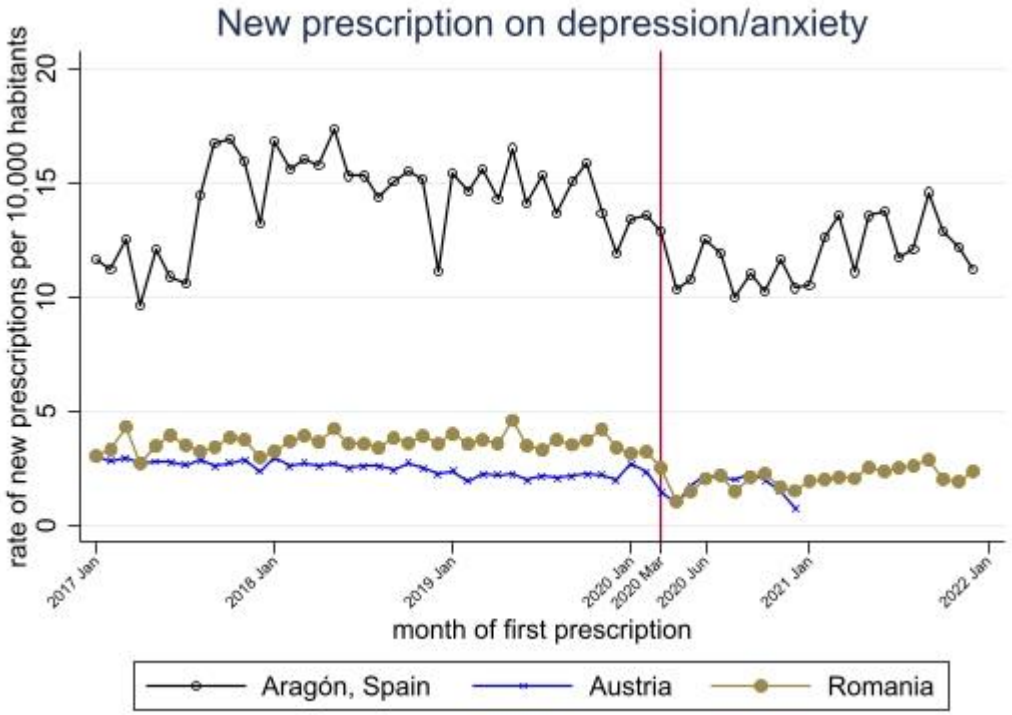
Research Use Cases on COVID-19 – Results





Cross-country comparison: preliminary analysis of new prescriptions



Research Use Cases on COVID-19 – Implications

Target Groups

1. Facilitate research by making scalable, reproducible methods available

2. Use Case outputs feed into the federated research infrastructure
   - Data models, analytical pipelines and reporting solutions published in a public open access repository (Zenodo) → live-demo to replicate the use cases (HIP)

3. FAIRified use cases analysis results publication in the data portal
   - Aggregated data and metadata, for the development and the analysis results of the use cases

1. Providing outcomes to guide policy makers in preparedness and response scenarios

2. We will ensure the development of a format for the timely dissemination of use case results to the targeted groups, e.g. through scientific publications, fact sheets, policy briefs and via webinars, trainings etc.

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Population Health Information Research Infrastructure

Thank you for your attention

Enrique Bernal-Delgado, IACS, ES
Martin Thissen, RKI, DE
Follow us on Twitter: @PHIRI4EU

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Population Health Information
Research Infrastructure

PHIRI FRI steps towards Federated Learning

17th World Congress on Public Health – A World in Turmoil
Opportunities to Focus on the Public´s Health

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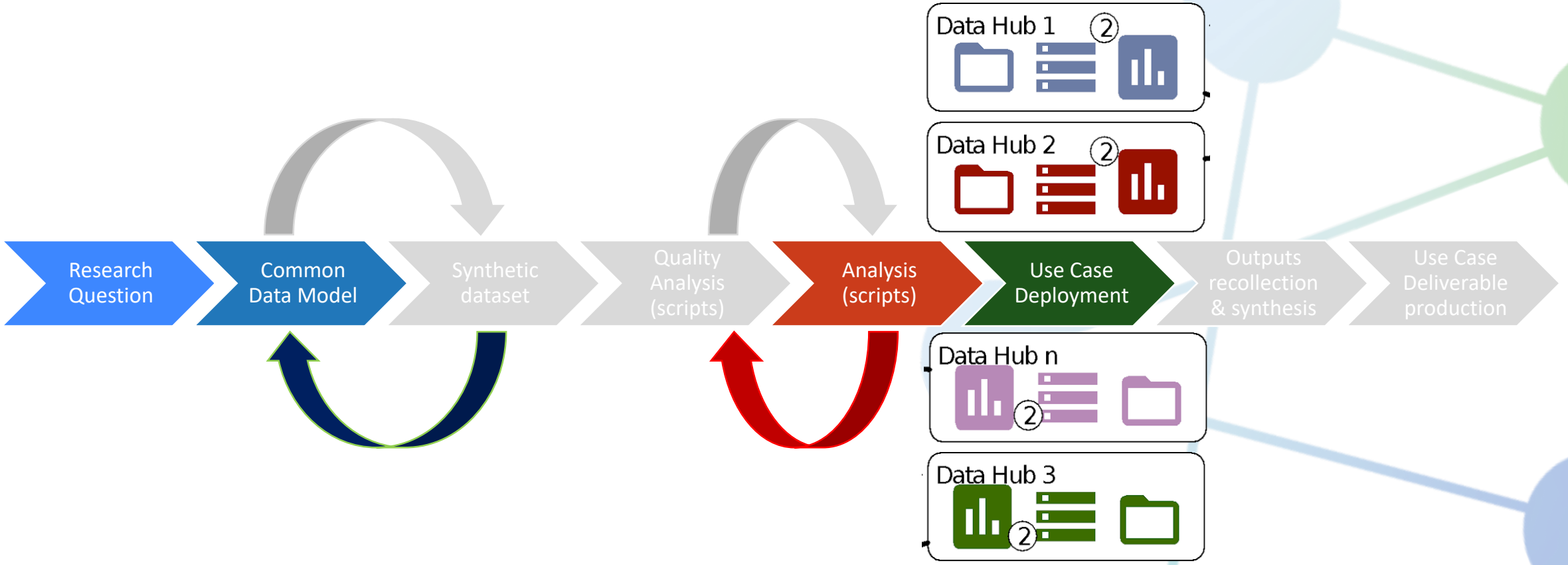
PHIRI workflow (*Data hub's perspective*)



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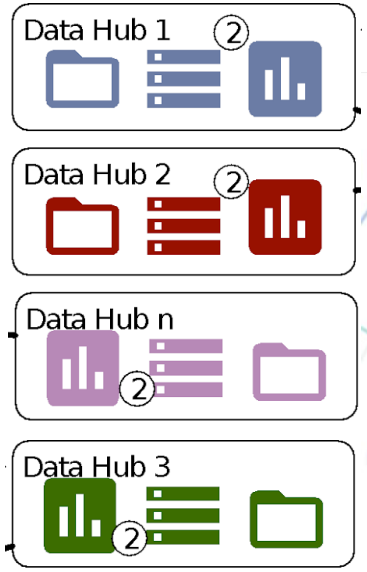
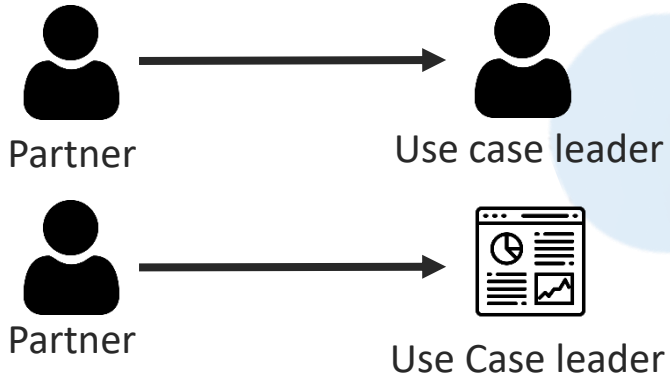
PHIRI workflow (Data hub's perspective)

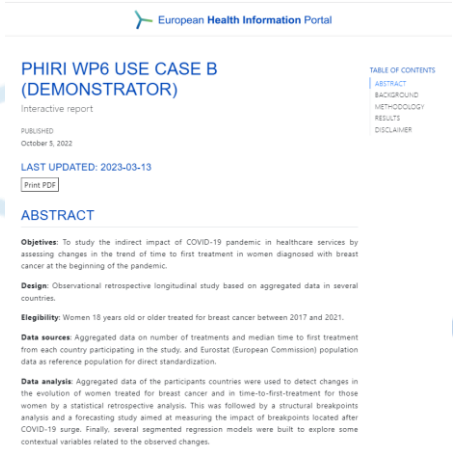
Use Case Deployment

Outputs recollection & synthesis

Use Case Deliverable production







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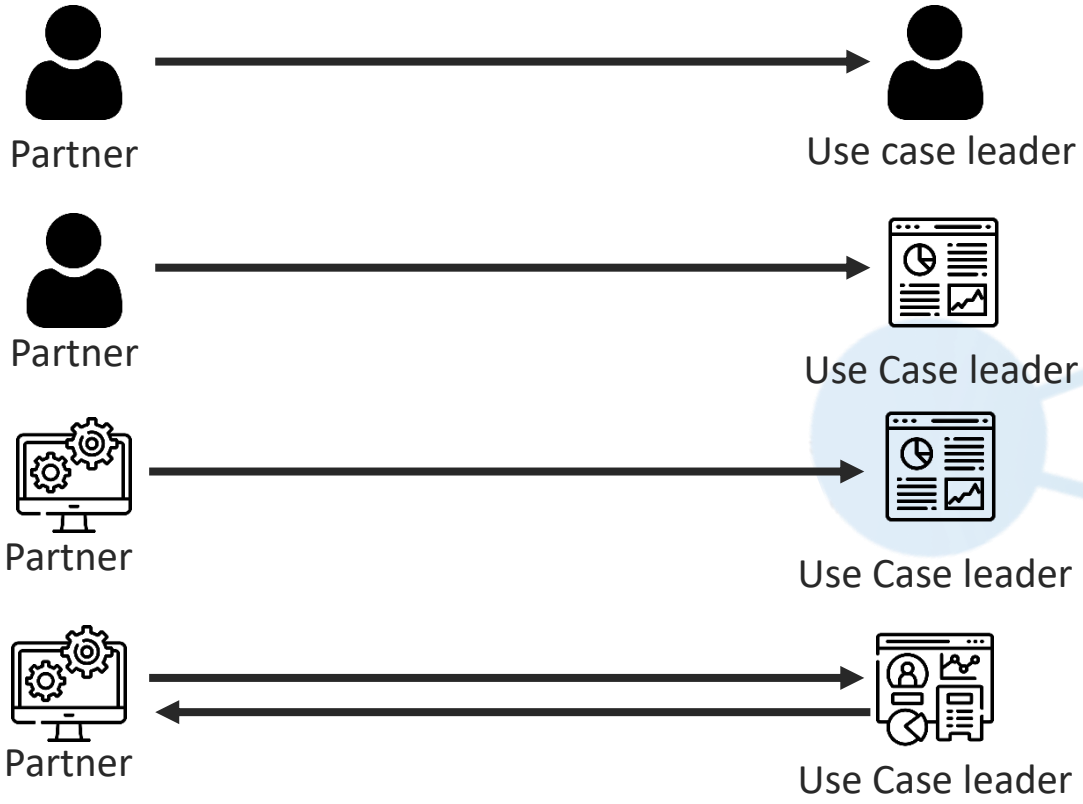
Steps towards Federated Learning

- Handling secure interactions (*communications)*:



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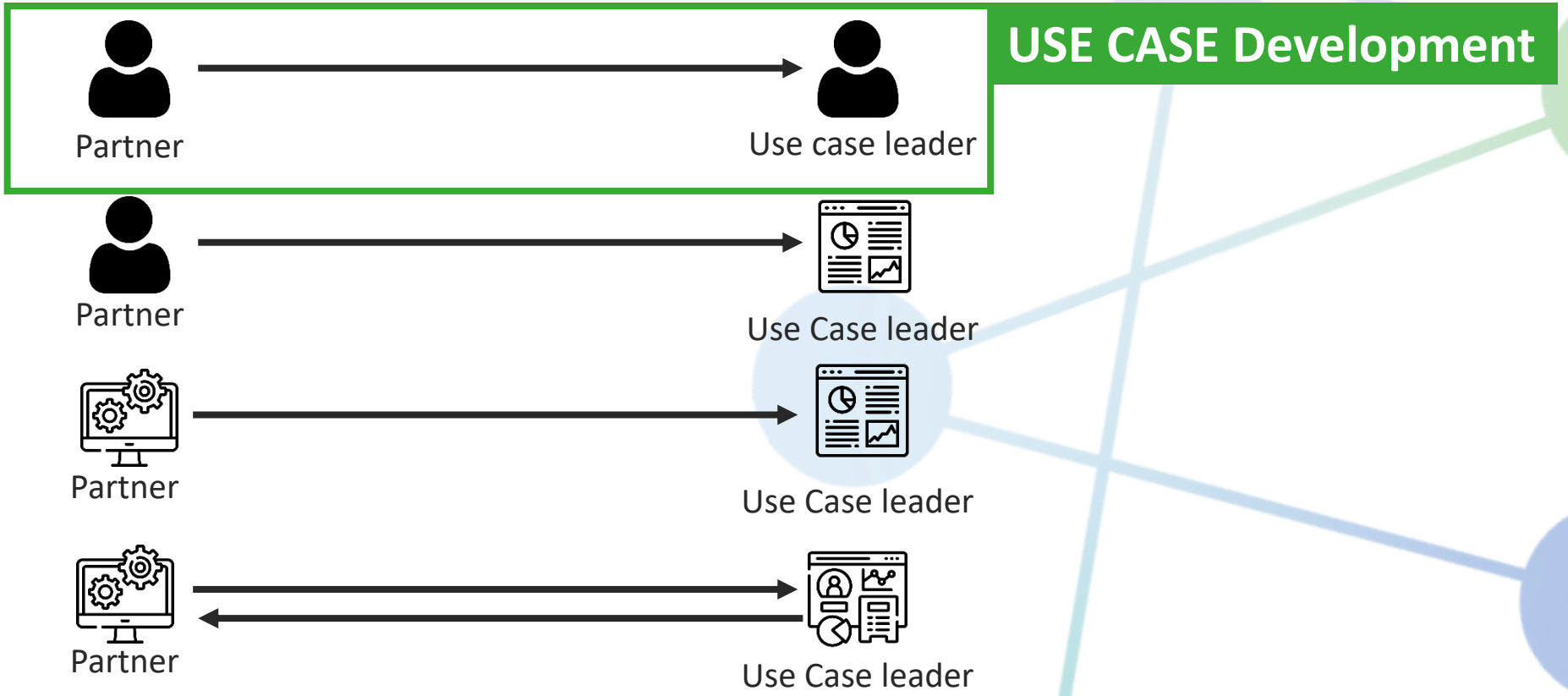

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Step-by-step plan towards Federated Learning

- Handling secure interactions (*communications*):
  - **TIER 0 – HUMAN to HUMAN interactions**
    - Example*: Each participant partner execute the analyses and* ***sends an e-mail with a) the data quality report and b) the aggregate data attached to the use case leader*** *for each use case in which they are participating*
  - TIER 1 – HUMAN to MACHINE interaction (with user interface)
    - Example: *Each participant partner execute the analyses, logs into a website (i.e. health information portal) with user authentication and upload the data quality report and the aggregated data to enable further meta-analysis or comparison by use case leaders*
  - TIER 2 – MACHINE to MACHINE one-way (automating retrieval of the outputs)
    - Example: *Each participant partner execute the analysis and press "Send outputs" to submit the data quality report and the aggregated outputs to a common repository enabling further meta-analysis or comparison by use case leaders*
  - TIER 3 – MACHINE to MACHINE two-way (distributing algorithms – federated learning)
    - Example: *Each participant partner configures an environment where the required data is available for analyses, and manages authorization for the deployment and execution of analytical algorithms on their data and the authorization for sharing their outputs*

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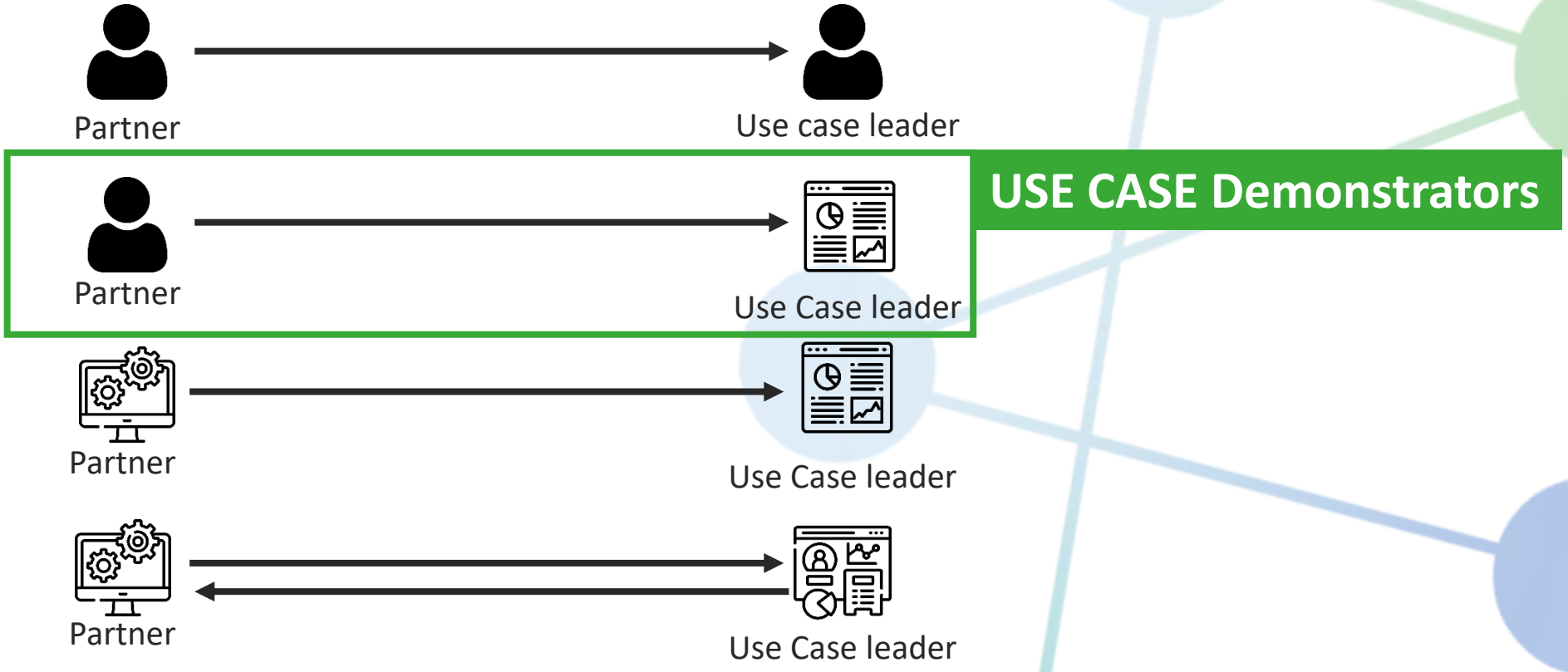

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Population Health Information Research Infrastructure

PHIRI app Demonstrator

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HOME - SERVICES STYLE I - FEDERATED DEMONSTRATORS - PHIRI USE CASE B DEMONSTRATOR

PHIRI USE CASE B DEMONSTRATOR

PHIRI has developed a variety of tools that can be immediately reused by researchers interested in doing research reusing observational data. These tools have been implemented and tested to support the development of a variety of studies on the indirect effects of the COVID19 pandemic [https://www.phiri.eu/wp6].

Tools in PHIRI are digital objects that researchers can download, adapt and apply to their own research questions. Among those digital objects you will find common data models, including synthetic data sets, quality assessment scripts and analytical algorithms and the PHIRI app.

PHIRI has also developed this interactive demonstrator that will enable you to participate in one the research PHIRI projects. If you are interested in the delay of treatments in breast cancer women during the period of movement restrictions in April 2020, you will be able to run your analyses locally using the PHIRI methodology and compare your results with those in the rest of the countries.

Take first a look at the current comparative analyses. Now, see how you have to proceed using the PHIRI App. Now, download the PHIRI App, run your analyses and upload your results. Enjoy the journey.

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European **Health Information** Portal

PHIRI WP6 USE CASE B (DEMONSTRATOR)

Interactive report

PUBLISHED
October 5, 2022

LAST UPDATED: 2023-03-13

Print PDF

ABSTRACT

Objetives: To study the indirect impact of COVID-19 pandemic in healthcare services by assessing changes in the trend of time to first treatment in women diagnosed with breast cancer at the beginning of the pandemic.

Design: Observational retrospective longitudinal study based on aggregated data in several countries.

Elegibility: Women 18 years old or older treated for breast cancer between 2017 and 2021.

Data sources: Aggregated data on number of treatments and median time to first treatment from each country participating in the study, and Eurostat (European Commission) population data as reference population for direct standardization.

Data analysis: Aggregated data of the participants countries were used to detect changes in the evolution of women treated for breast cancer and in time-to-first-treatment for those women by a statistical retrospective analysis. This was followed by a structural breakpoints analysis and a forecasting study aimed at measuring the impact of breakpoints located after COVID-19 surge. Finally, several segmented regression models were built to explore some contextual variables related to the observed changes.

DESCRIPTIVE ANALYSIS

International comparison of the age distribution of women diagnosed with breast cancer who underwent treatment during the study period.

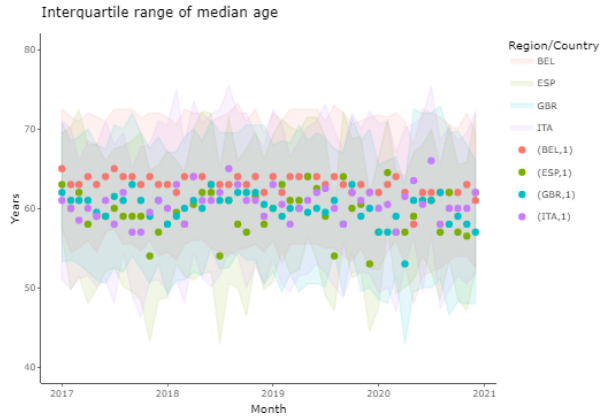

Figure 1: Median age and IQR by country each period

International comparison of the first treatment after a breast cancer diagnosis by type in percentage.

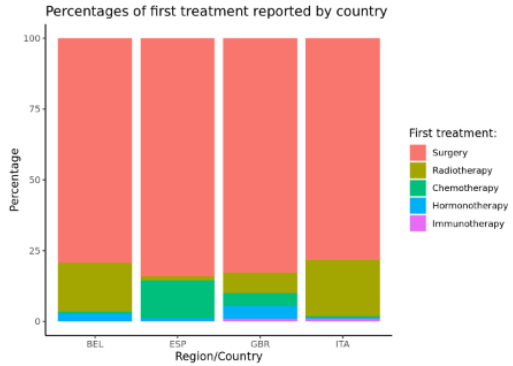

Figure 2: Barplot (in percentage) for the first treatment by country

TABLE OF CONTENTS
ABSTRACT
BACKGROUND
METHODOLOGY
RESULTS
Descriptive analysis
Breakpoints
Forecast
Regression Models
DISCLAIMER

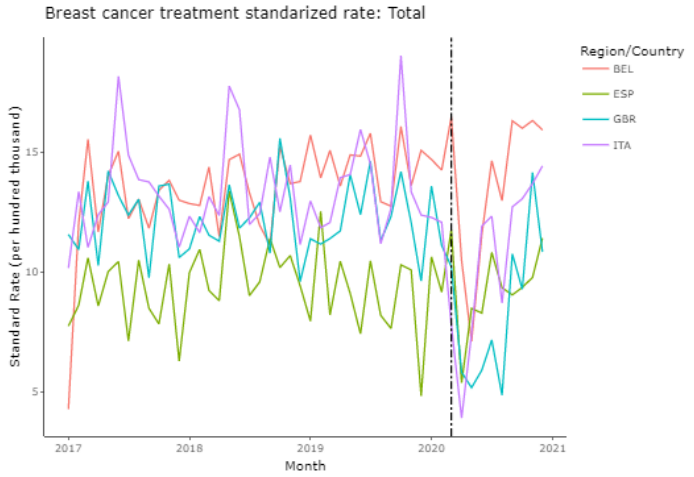

Figure 3: Breast cancer treatment standarized rate

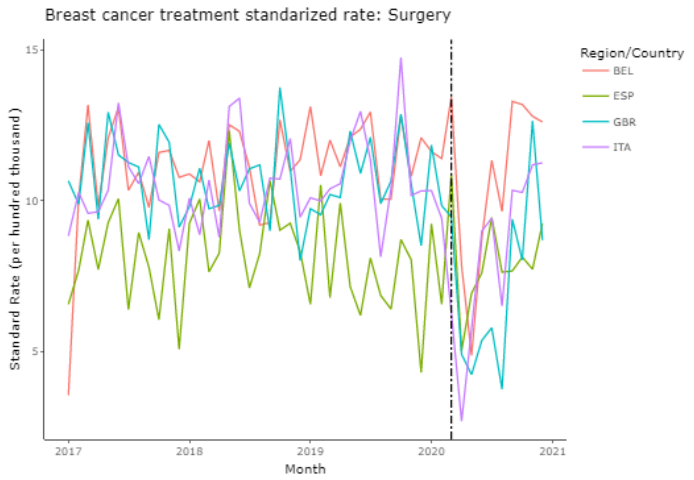

Figure 4: Breast cancer treatment standarized rate

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