The Impact of Telemedicine on The Management of Chronic Conditions in Italy

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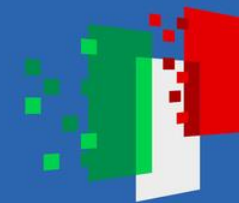
Introduction

- **Future sustainability of healthcare systems:** progressively aging population along with growing budget constraints → Management of chronic conditions

- **Role of telemedicine**: improves accessibility via digital means → during the COVID pandemic?

- **Conflicting evidence**: mixed impacts, as reduced utilization/costs (Zeltzer et al., 2023) vs. increased low-quality visits (Dahlgren et al., 2024)
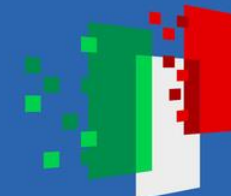
The literature does not agree on whether telemedicine services effectively substitute traditional in-person visits.

Objective

Analyze the effects of telemedicine on chronic patients in Liguria, focusing on:

- **Resource utilization**: impact on NHS resource consumption and costs

- **Substitute or complement**: Does telemedicine replace or supplement traditional visits?

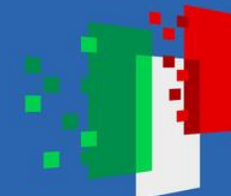Relevance of the case study:

- **Geographical conformation**: mountainous inland with extensive coastal region (Istat, 2021)

- **Demographic setting**: highest over-65s population in Europe, predicting future trends (Eurostat, 2020)

- **COVID-19 pandemic**

Related Literature

Telemedicine:

- *Benefits*: increased life expectancy (Bernstein et al., 2010); improved health (Singh et al., 2019); reduced costs (Patel et al., 2023)

- *Risks*: lower-quality treatments (Dahlgren et al., 2024); more follow-ups (Zeltzer et al., 2023); no cost savings (Snoswell et al., 2020)

Telemonitoring:

- *Benefits*: reduced hospitalizations (Agboola et al., 2015); better doctor-patient relationship (Miranda et al., 2023); improved quality of life (Voeller et al., 2022)

- *Risks*: temporary benefits (Agboola et al., 2015); false positives/misinterpretation (Hanley et al., 2018); no cost savings (Vasquez-Cevallos et al., 2018)
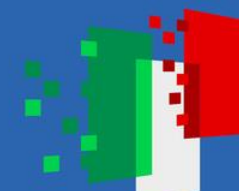
Italian Legal Context

Dataset Overview

- **Source**: healthcare administrative data from ASL 4

- **Time period**: 2019-2022

- **Data streams**:
  - ED visits
  - Drug records
  - Demographic data
  - Exemption records
  - Specialist services
  - Discharge data

- **Limitations**: no access to death/transfer data

- **Privacy Compliance**: data pseudonymized; aggregated age categories (0-45; 46-65; 65+)
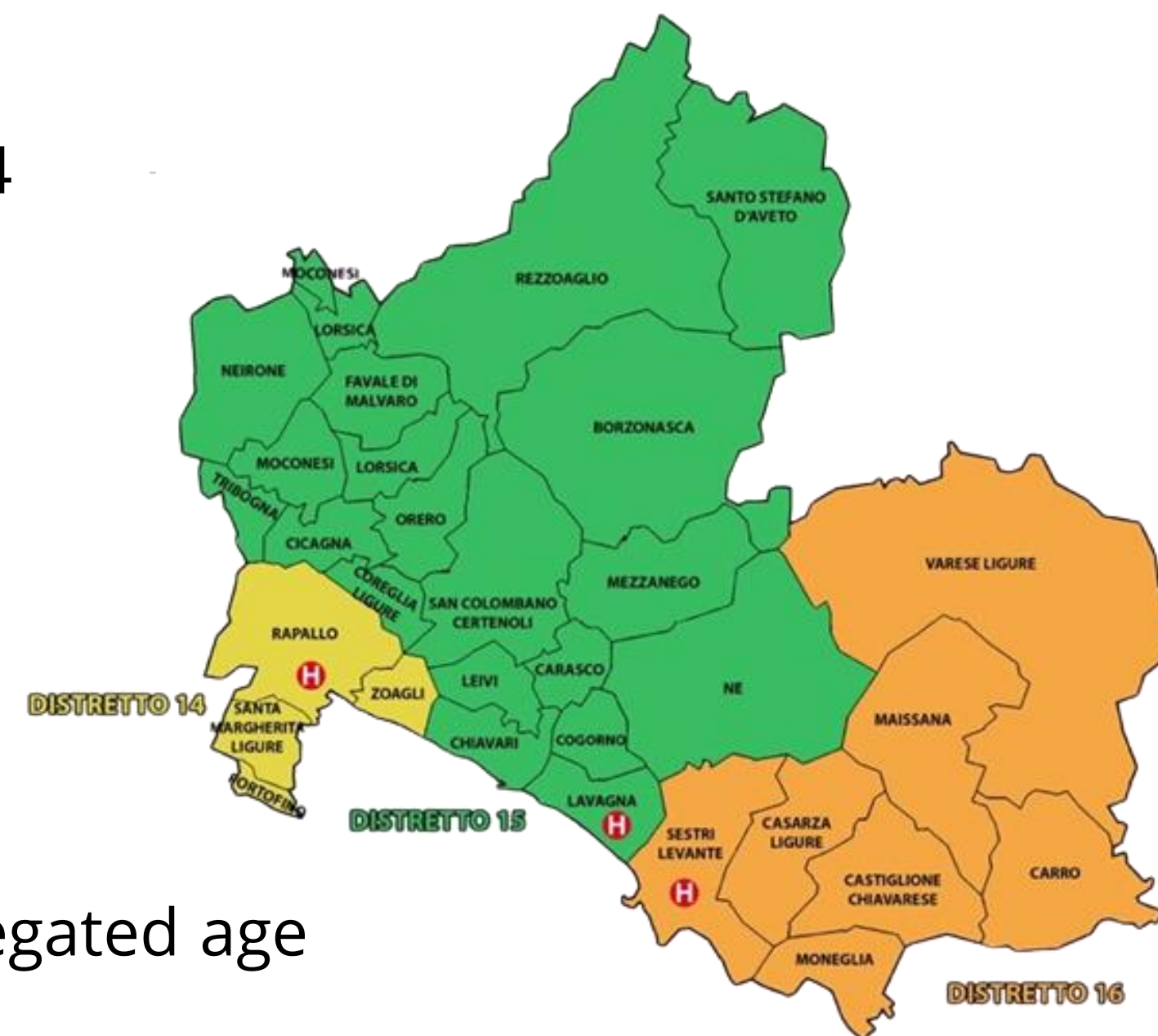
Dataset Overview

Diabetes

Patients with severe cardiac conditions requiring pacemakers, defibrillators, loop recorders, or CCM

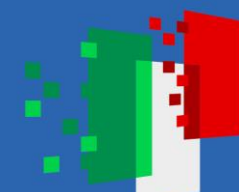- **Identification**: specialist service codes during hospitalization or follow-up
- **Exclusion**: non-residents to prevent data inconsistencies due to high tourist influx
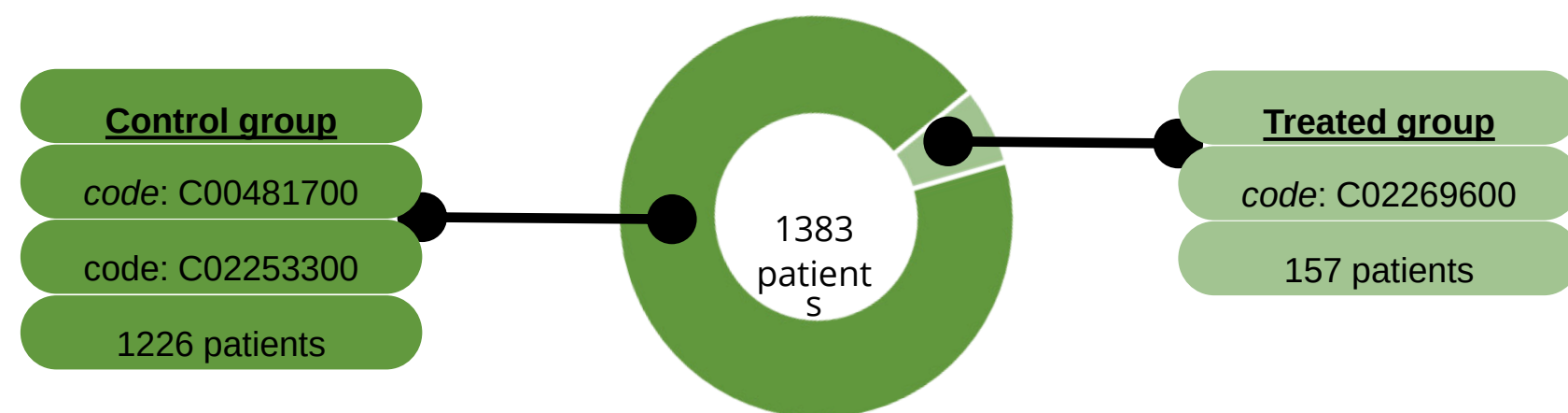
Three criteria:

- primary recovery codes for hospital admissions and emergency department admissions (i.e. 285, 294, 295, 250)
- the use of specific drugs coded A10A*, N03AX16 or N03AX12,
- exemptions 013.250

6486 patients

- 6205 subjected to several/no traditional visits
- 281 had access to telemedicine as a second visit or remote control of devices.

Control group

code: C00481700

code: C02253300

1226 patients

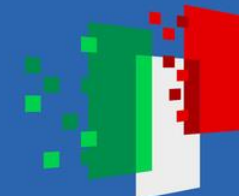1383 patients

Treated group

code: C02269600

157 patients

Empirical Strategy

- **Panel dataset**: annually and monthly panels to assess telemonitoring/televisit impact

- **Outcome variables**: proxies for resource consumption and associated costs
  - Number of ED visits
  - Number of hospitalisations
  - Number of specialistic visits
  - Number of cardiology specialist visits
  - Cost of hospitalisations
  - Cost of specialistic visits
  - Cost of cardiology specialist visits

- **Independent variables**
  - **Demographics**: gender, age group
  - **Health status**: exemptions, comorbidities, medication usage
  - **Treatment type**: telemonitoring/ televisit exposure

Econometric Approach - for cardiovascular patients

- **Outcome Variables**: ED visits, hospitalizations, specialist visits and costs

- **Empirical strategy**: Tobit model with random effects to address data censoring and unobserved heterogeneity

$$y_{it}^* = \beta_0 + \beta_1 X_{it} + \delta Exposure_{it} + \lambda(Exposure_{it} * time_t) + time_t + \alpha_i + u_{it}$$

- **Validation**: Poisson model with random effects used for robustness checks

Econometric Approach - for diabetic patients

- **Variables**: ED visits, hospitalizations, specialist visits

→ When average treatment effects vary over time and over cohort

→ **Empirical strategy**: Heterogeneous DID since the extension in large-scale of telemedicine in ASL 4 have been actionable at different times
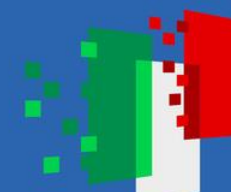
Descriptive Statistics

Independent variables insights - demographic characteristics

- **Predominance of males**: 66.88% in treatment group vs. 59.79% in control group

- **High prevalence of individuals over 65**: 92.74% in control group, 72.61% in treatment group with a wider age distribution

(a) Overall group distribution

(b) Control group distribution

(c) Treated group distribution

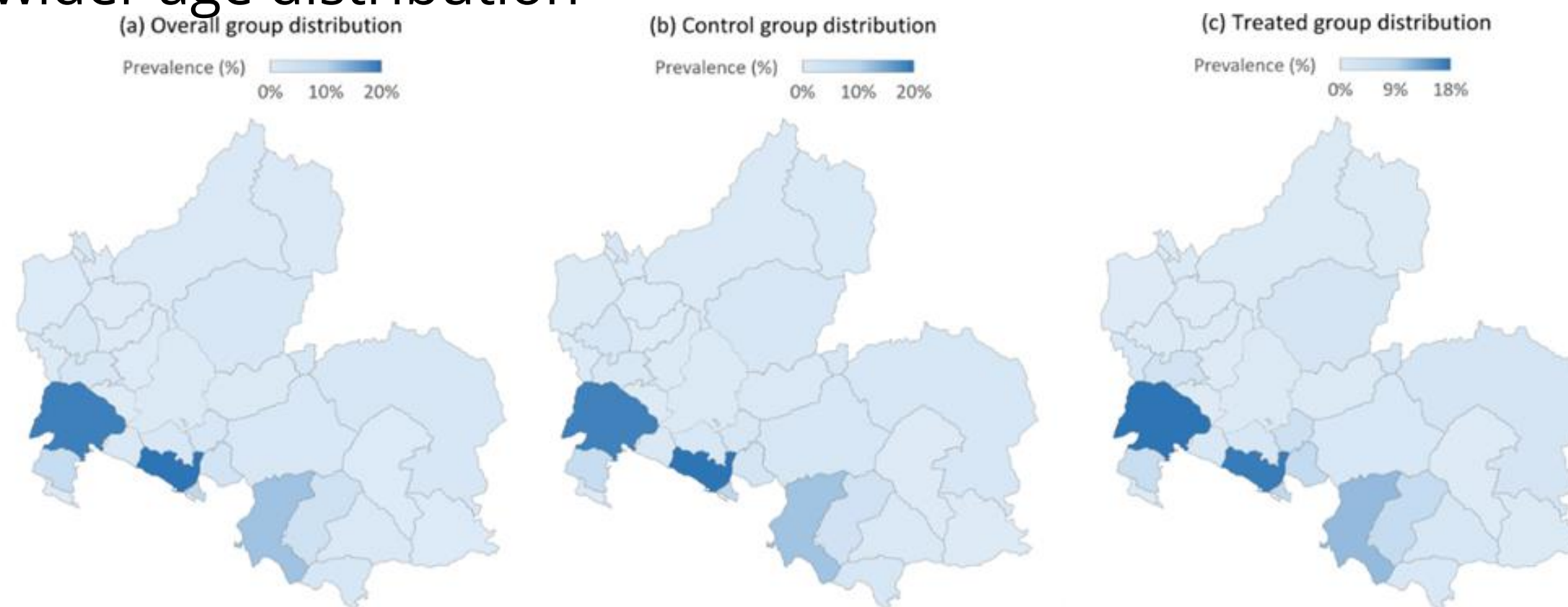# Descriptive Statistics – cardiovascular patients
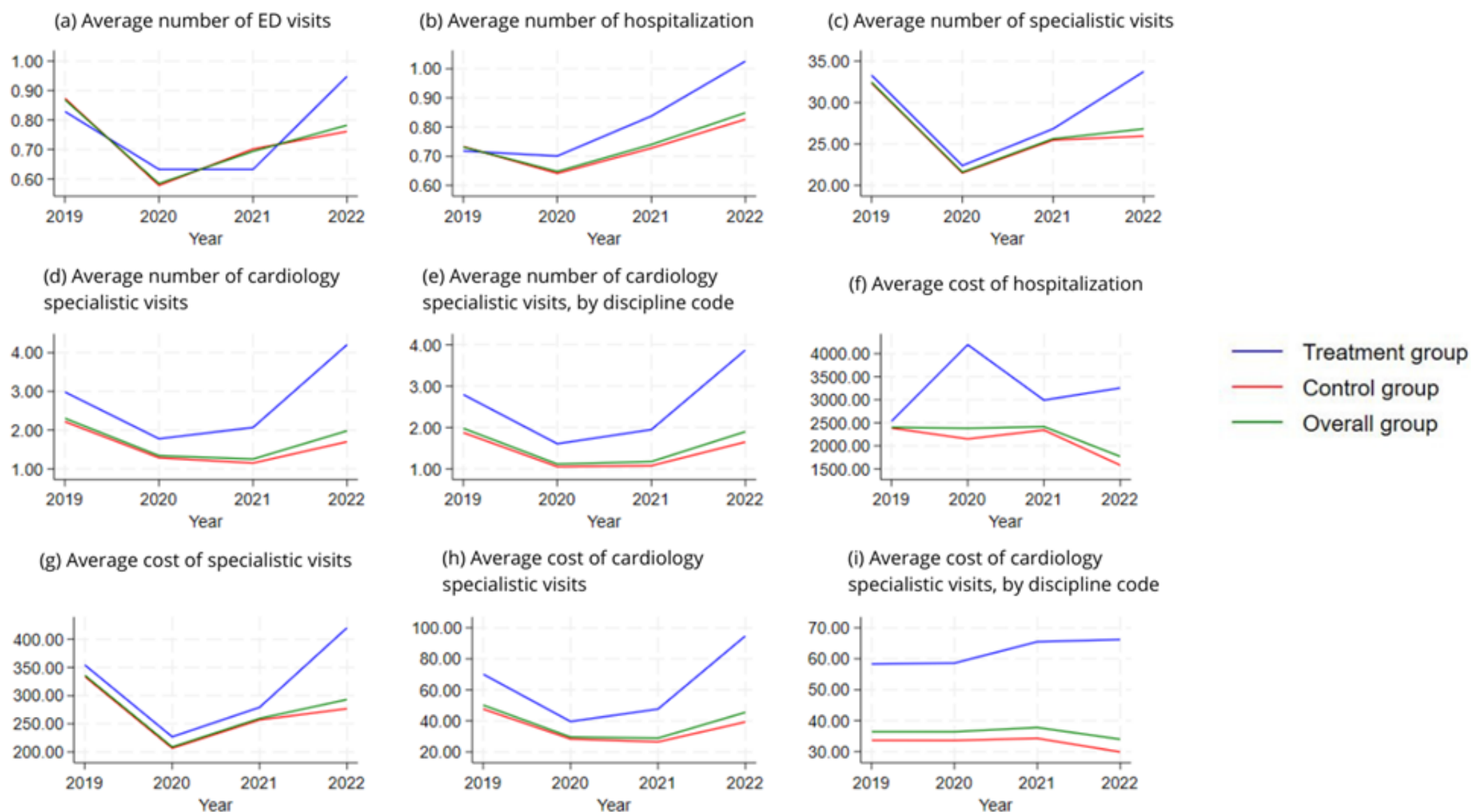
Outcome trends

(a) Average number of ED visits
(b) Average number of hospitalization
(c) Average number of specialistic visits
(d) Average number of cardiology specialistic visits
(e) Average number of cardiology specialistic visits, by discipline code
(f) Average cost of hospitalization
(g) Average cost of specialistic visits
(h) Average cost of cardiology specialistic visits
(i) Average cost of cardiology specialistic visits, by discipline code

Treatment group
Control group
Overall group

Regression Results – cardiovascular patients

Utilisation of health services - margins of Tobit model per year

Margins of Tobit model per year – utilisation of health services

Variables	Number of ED visits	Number of hospitalisations	Number of specialistic visits	Number of cardiology specialist visits	Number of cardiology specialist visits, by discipline code
Exposure	0.016* (0.009)	-0.012 (0.009)	0.439** (0.204)	0.247*** (0.016)	0.221*** (0.015)
Demographic characteristics	YES	YES	YES	YES	YES
Health status characteristics	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES
Observations	41,937	41,937	41,937	41,937	41,937
Number of patients	1,039	1,039	1,039	1,039	1,039

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$
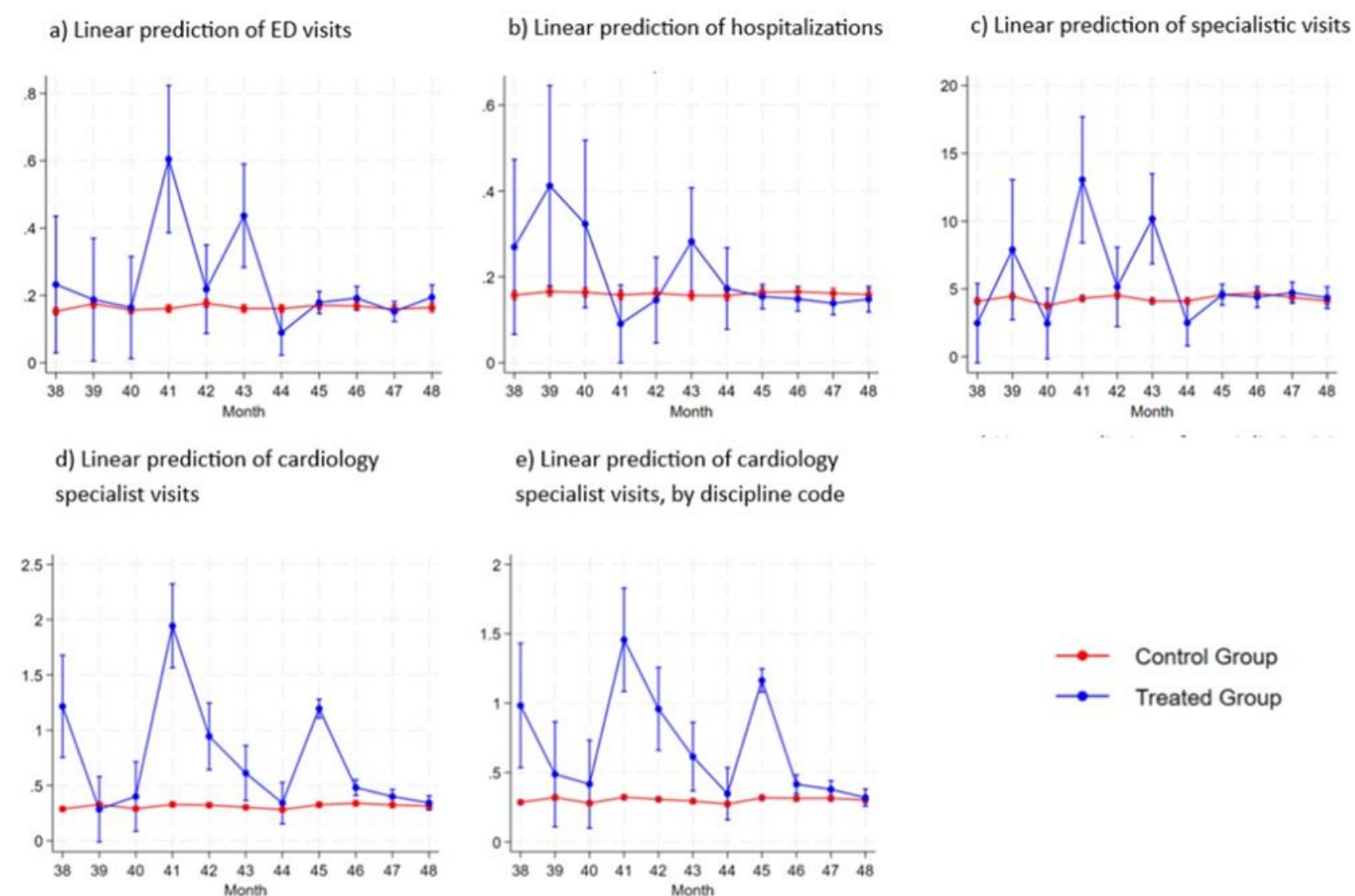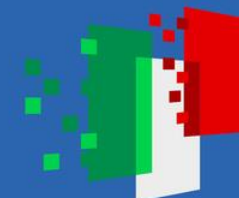
Regression Results – cardiovascular patients

Utilisation of health services - margins of Tobit model per month

Margins of Tobit model per year – utilisation of health services

Regression Results – cardiovascular patients

Total Cost of health services - margins of Tobit model per year

Margins of Tobit model per year – total cost of health services

Variables	Cost of hospitalisations	Cost of specialistic visits	Cost of cardiology specialist visits	Cost of cardiology specialist visits, by discipline code
Exposure	136.8***	2.264	5.365***	-0.291
	(37.23)	(2.668)	(0.388)	(0.402)
Demographic characteristics	YES	YES	YES	YES
Health status characteristics	YES	YES	YES	YES
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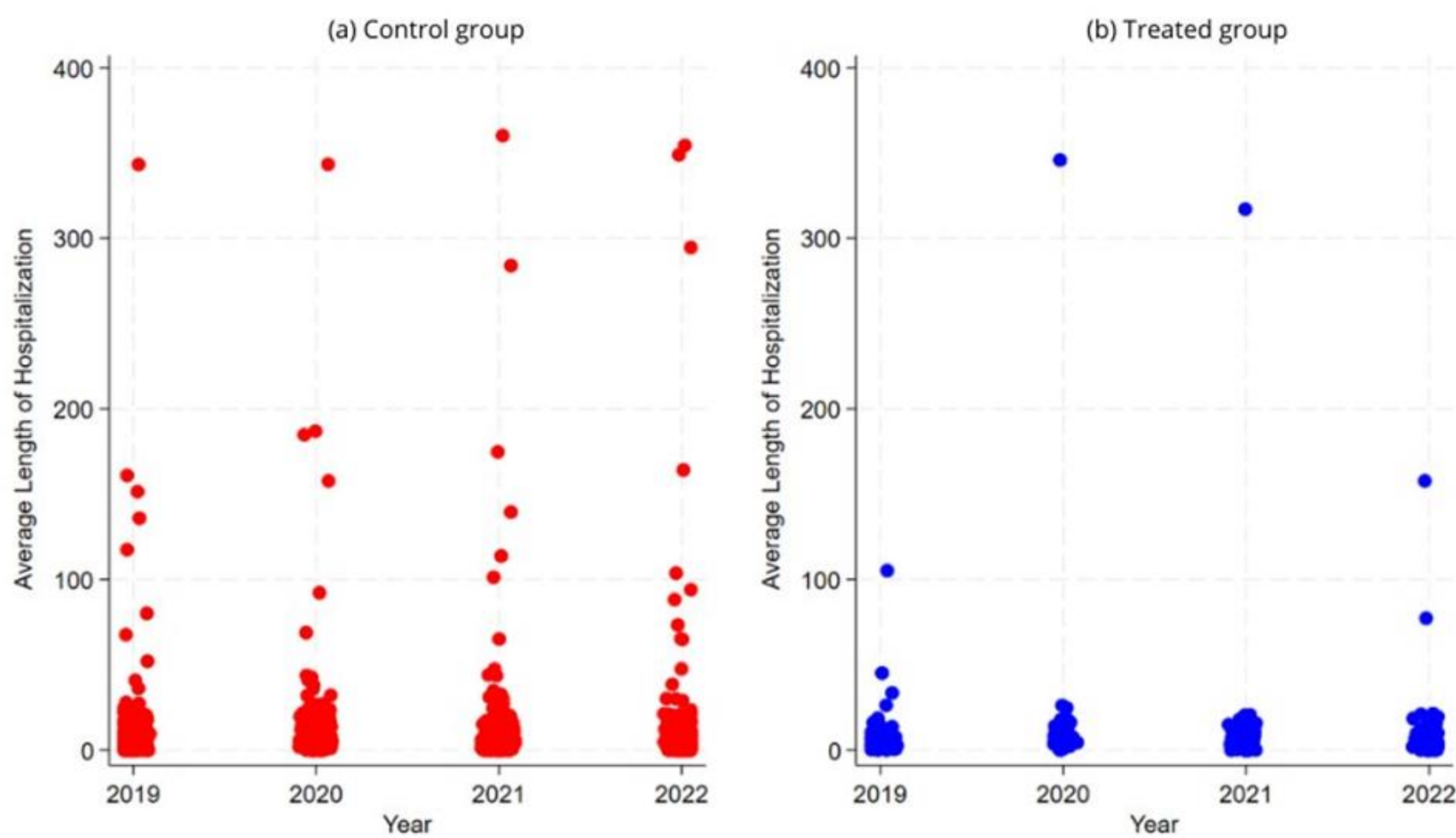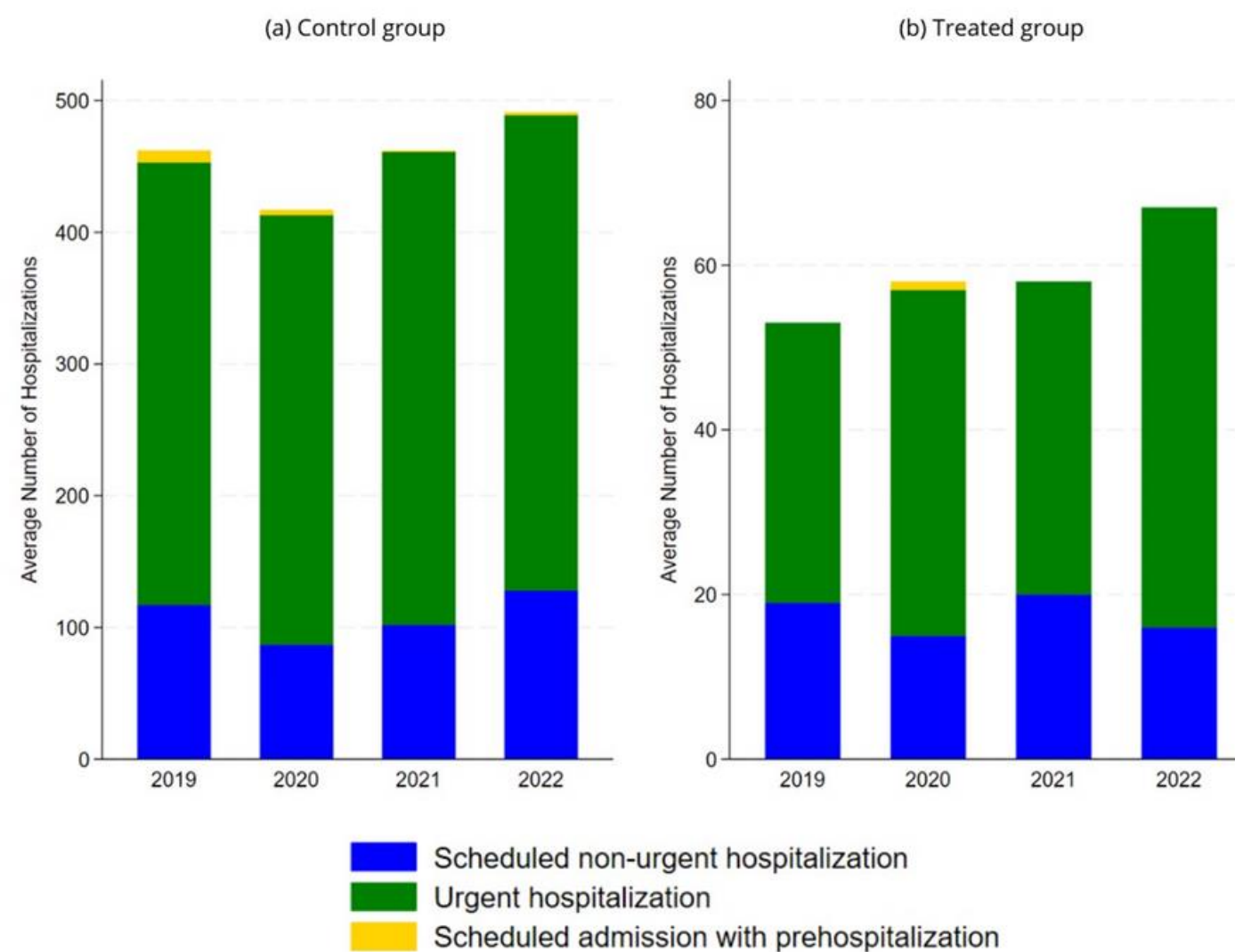
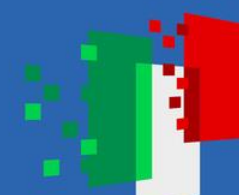# Descriptive Statistics – cardiovascular patients

Outcome trends - detailed analysis of hospitalisations

Average Length of Hospitalisation per year

Average Number of Hospitalisation by type per year

Heterogeneity Checks

| Outcome	Exposure- Baseline annual model	Age			Gender		Charlson	
		0-45	46-65	>65	Female	Male	Charlson_0	Charlson >0
Number of ED visits	0.016* (0.008)	0.058 (0.042)	-0.002 (0.015)	0.026*** (0.009)	0.032* (0.018)	0.009 (0.009)	0.019 (0.013)	0.012 (0.011)
Number of hospitalisations	-0.012 (0.008)	-0.042 (0.044)	-0.033 (0.016)	0.004 (0.010)	-0.012 (0.016)	-0.012 (0.010)	0.001 (0.010)	-0.022* (0.011)
Number of specialistic visits	0.439** (0.204)	0.516 (0.856)	-0.239 (0.355)	0.662*** (0.245)	0.545 (0.395)	0.401* (0.220)	0.238 (0.339)	0.480* (0.249)
Number of cardiology specialist visits	0.247*** (0.015)	0.176* (0.106)	0.305*** (0.043)	0.225*** (0.017)	0.256*** (0.024)	0.242*** (0.019)	0.294*** (0.027)	0.227*** (0.019)
Number of cardiology specialist visits, by discipline code	0.221*** (0.015)	0.186 (0.114)	0.280*** (0.042)	0.195*** (0.017)	0.216*** (0.025)	0.221*** (0.017)	0.278*** (0.028)	0.197*** (0.018)
Cost of hospitalisations	136.8*** (37.230)	-125.3 (349.9)	398.7*** (116.4)	36.17 (41.14)	-79.80 (65.45)	215.7*** (46.01)	68.02 (50.52)	158.6*** (49.91)
Cost of specialistic visits	2.264 (2.668)	0.235 (13.82)	1.427 (3.440)	3.036 (3.231)	5.464 (5.213)	1.040 (3.104)	0.220 (4.967)	2.489 (3.177)
Cost of cardiology specialist visits	5.365*** (0.388)	1.882 (3.500)	6.845*** (1.023)	4.993*** (0.444)	5.757*** (0.627)	5.183*** (0.497)	5.571*** (0.685)	5.199*** (0.476)
Cost of cardiology specialist visits, by discipline code	-0.291 (0.402)	0.779 (3.435)	-0.986 (1.059)	-0.0914 (0.461)	0.0978 (0.666)	-0.465 (0.511)	-0.0999 (0.755)	-0.400 (0.478)

Standard errors in parentheses
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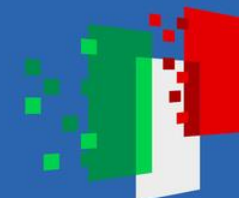
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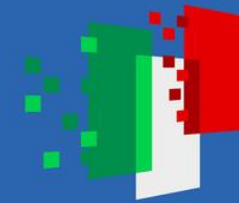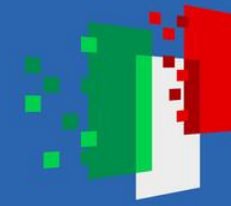
Heterogeneous DID results – diabetic patients

	ED Accesses	Hospitalizations	Diabetes Hospitalizations	Other Hospitalizations	Traditional Visits
Cohort 2021 Year 2020	0.093 (0.147)	0.184* (0.101)	0.044 (0.075)	0.238** (0.112)	-6.934** (3.259)
Year 2021	0.124 (0.145)	0.082 (0.126)	0.034 (0.069)	0.019 (0.131)	17.314*** (3.537)
Year 2022	-0.010 (0.143)	0.044 (0.106)	0.007 (0.085)	0.140 (0.126)	12.264** (4.960)
Cohort 2022 Year 2020	-0.052 (0.096)	0.088 (0.077)	-0.043 (0.057)	0.240** (0.121)	-4.181 (3.242)
Year 2021	0.377*** (0.107)	0.232*** (0.087)	0.194*** (0.071)	0.142 (0.106)	19.740*** (4.582)
Year 2022	0.214** (0.102)	0.155* (0.086)	0.086 (0.080)	0.160* (0.093)	7.106* (3.819)
Number of Obs	23396	23394	23394	23394	23396

DID results – diabetic patients

DID results – diabetic patients

DID results – diabetic patients

Conclusions and Limitations

Results

- **Increased NHS resource use**: higher service utilization

- **Complementary role**: telemedicine supports, rather than replaces, traditional care

- **Unmet care demand**: highlights previously unmet healthcare needs
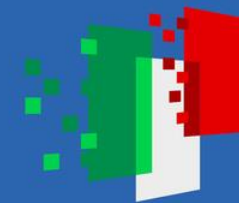
Limitations

- **Short implementation period**: only one-two years of data

- **Group imbalance**: uneven distribution between treatment and control groups

- **Data gaps**: missing death and transfer information

- **Broad age groups**: may impact analysis precision

Policy Implications

- **Integration with traditional care**: integrate telemedicine with traditional care

- **Targeted programs**: focus on the elderly and those with comorbidities

- **Geographical focus**: invest in telecommunication for regions like Liguria

- **Ongoing evaluation**: support long-term studies to measure impact

- **Adaptive implementation**: continuously refine telemonitoring practices.
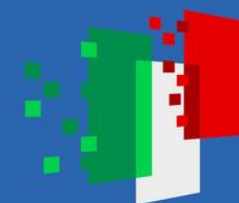
→ Future steps: → **Other outcomes:** adherence to drug therapy

Thanks for the attention!

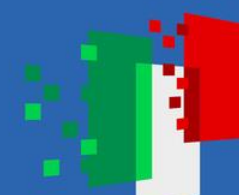Finanziato dall'Unione europea
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Robustness Check

Margins of Poisson model per year: consistency of results verified

Margins of Poisson models per year

Variables	Number of ED visits	Number of hospitalisations	Number of specialistic visits	Number of cardiology specialist visits	Number of cardiology specialist visits, by discipline code	Cost of hospitalisations	Cost of specialistic visits	Cost of cardiology specialist visits	Cost of cardiology specialist visits, by discipline code
Exposure	0.021* (0.011)	-0.013 (0.013)	0.520*** (0.074)	0.146*** (0.012)	0.121*** (0.011)	137.773*** (7.044)	0.083*** (0.008)	2.742*** (0.082)	1.032*** (0.195)
Demographic characteristics	YES	YES	YES	YES	YES	YES	YES	YES	YES
Health status characteristics	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	41,937	41,937	41,937	41,937	41,937	41,937	41,937	41,937	41,937
Number of patients	1,039	1,039	1,039	1,039	1,039	1,039	1,039	1,039	1,039

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Descriptive Statistics – cardiovascular patients

Independent variables insights - health status characteristics

- **Homogeneity**: both groups show similar health status characteristics

- **Exemptions**: slightly higher in treatment group (1.411 vs 1.244)

- **Medications**: slightly higher in treatment group (6.108 vs 6.016)

- **Charlson Index**: higher comorbidity in control group (1.566 vs 1.443)

- **Telemedicine**: effective for both severe and less severe cases