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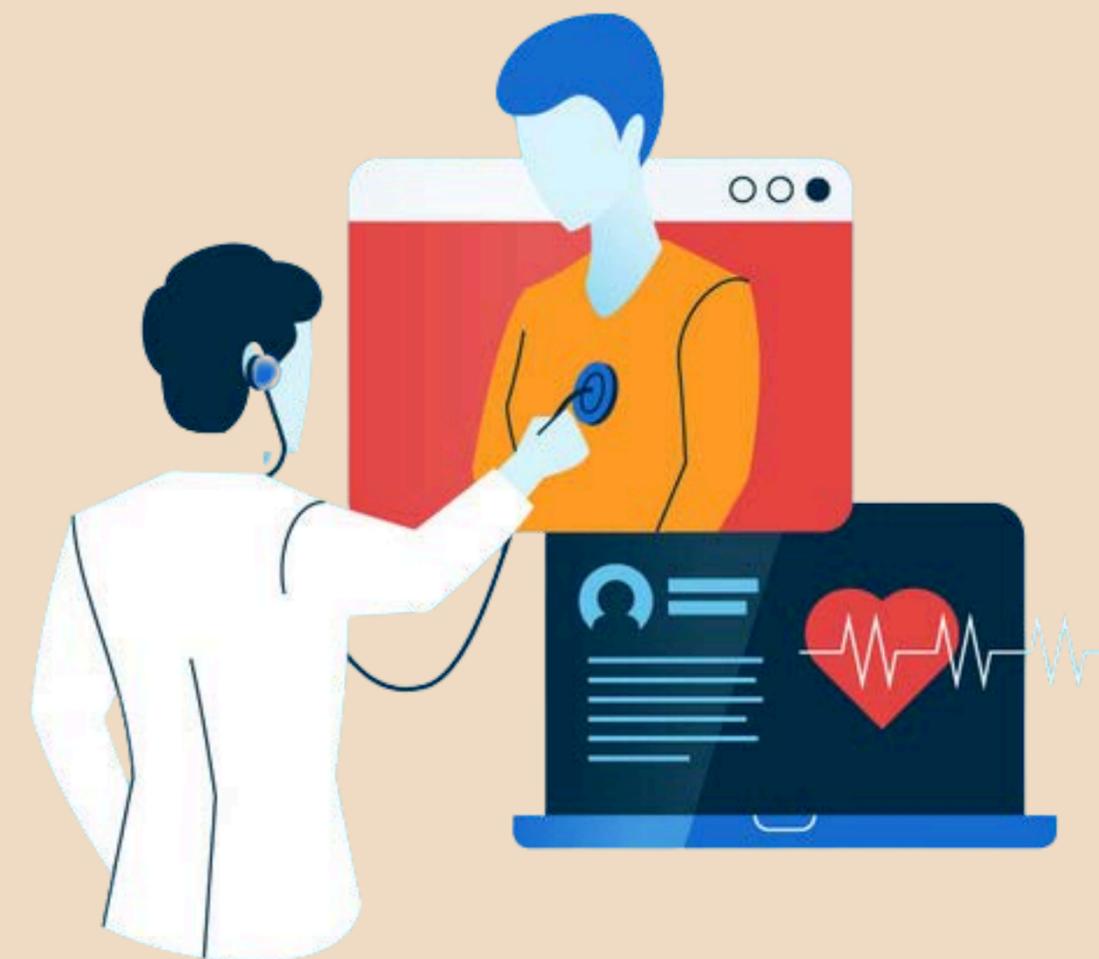
Società Italiana di Economia
Pubblica

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

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Introduction

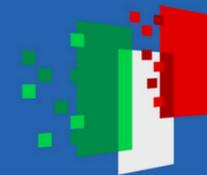
- **Health as a basic human right:** equal access to health services, regardless of demographic or geographical factors (Zweifel et al., 2009)
- **Inequalities from various factors:** health literacy, geographical barriers, socio-demographic conditions, and others (Leporatti et al., 2021)
- **Role of telemedicine:** improves accessibility via digital means
- **Conflicting evidence:** mixed impacts, as reduced utilization/costs (Walter et al., 2023) vs. increased low-quality visits (Dahlgren et al., 2024)



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Objective

Analyze the effects of telemonitoring on cardiac 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)



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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)

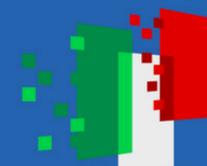
Italian Legal Context



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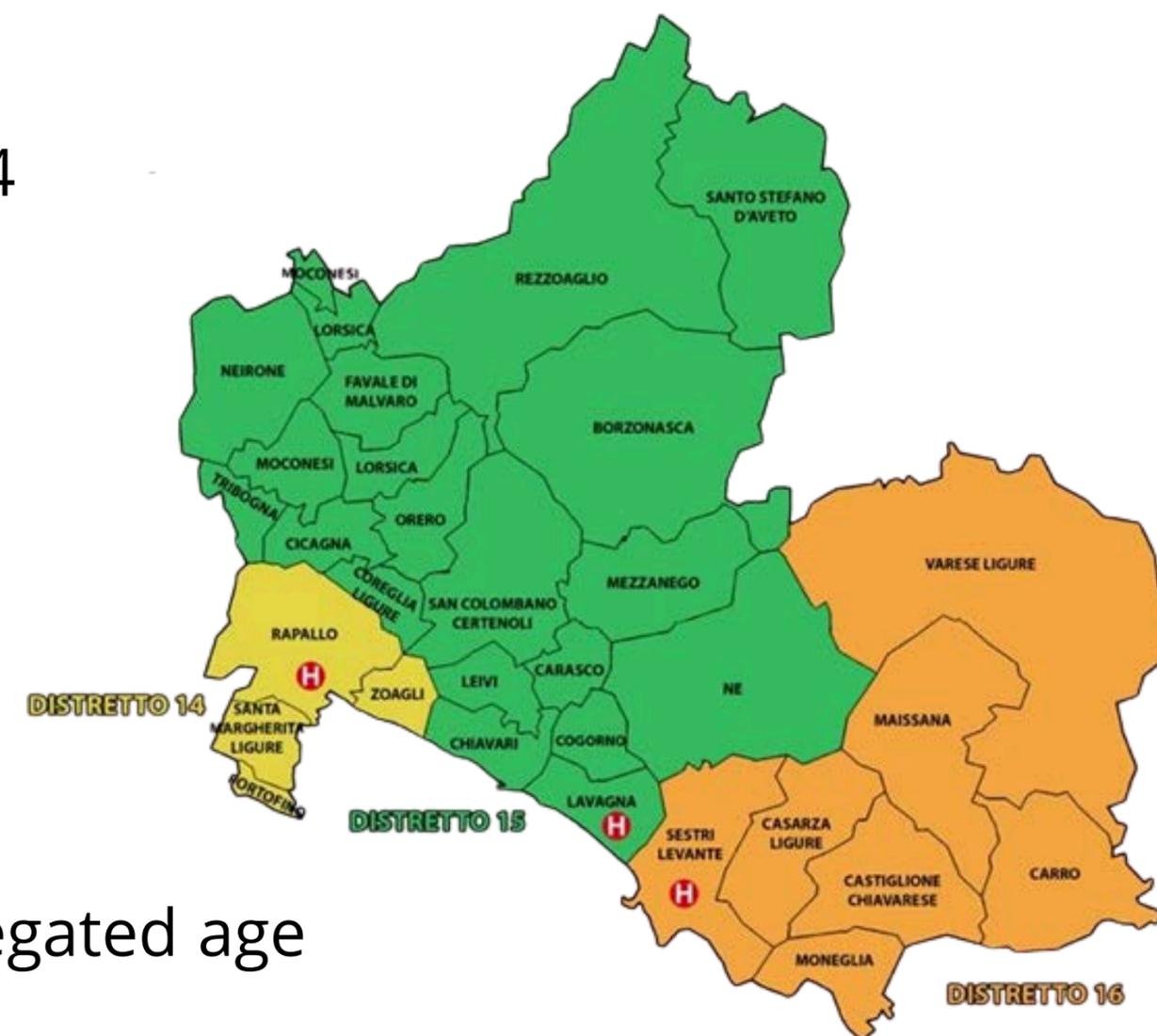
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Dataset Overview

- **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+)





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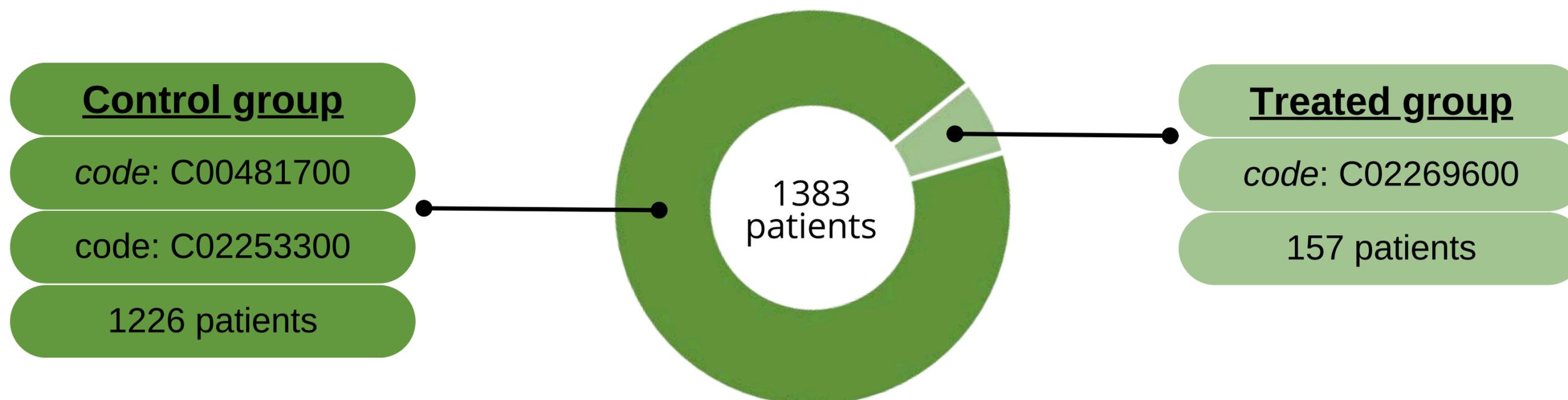
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Inclusion Criteria

- **Focus:** 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





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Empirical Strategy

- **Panel dataset:** annually and monthly panels to assess telemonitoring 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 exposure



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Econometric Approach

- **Variables:** count variables (ED visits, hospitalizations, specialist visits) and continuous variables (costs)
- **Challenges:** high frequency of zeros in data
- **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
- **Rejected approaches:** Difference-in-Differences; Inverse Probability Weighting



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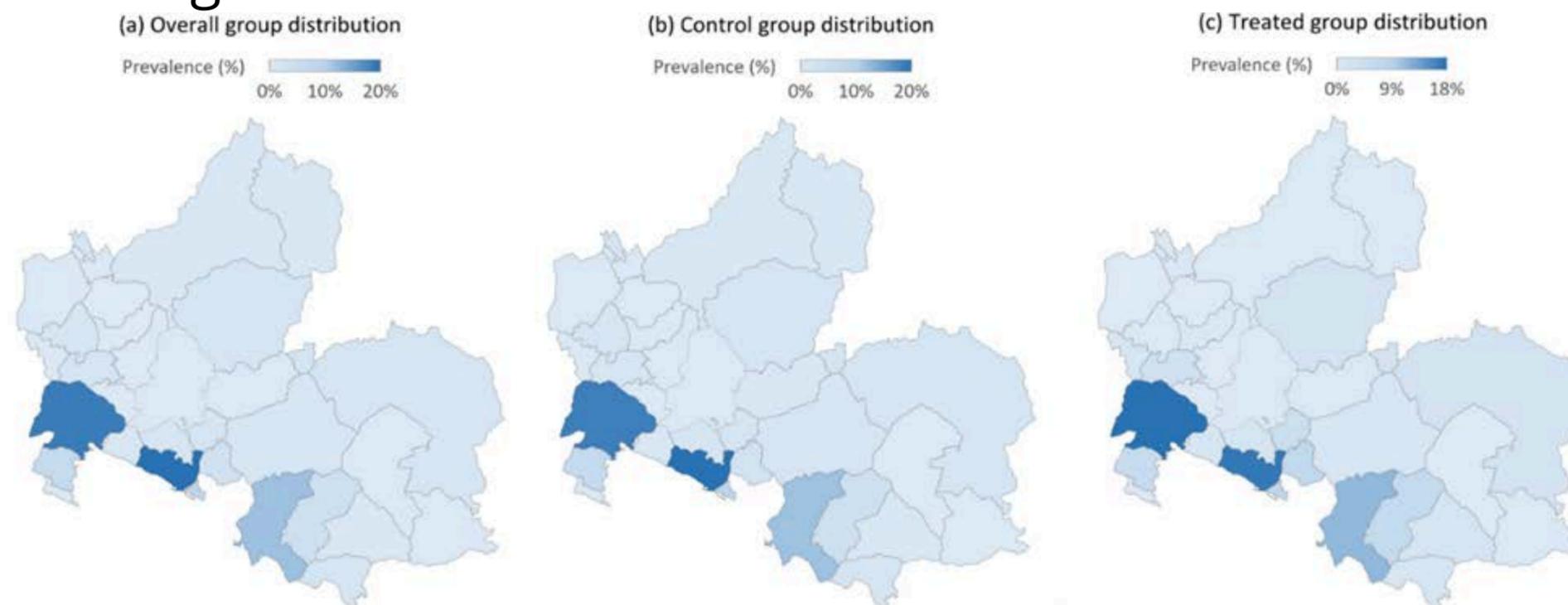


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Descriptive Statistics

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





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Descriptive Statistics

Independent variables insights - health status characteristics

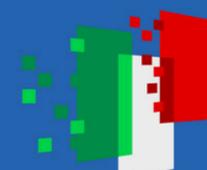
- **Homogeneity:** both groups show similar health status characteristics
- **Exemptions:** slightly higher in treatment group (1.411 vs 1.244)
- **Medications:** slightly higher in treatment group (6.108 vs 6.016)
- **Charlson Index:** higher comorbidity in control group (1.566 vs 1.443)
- **Telemedicine:** effective for both severe and less severe cases



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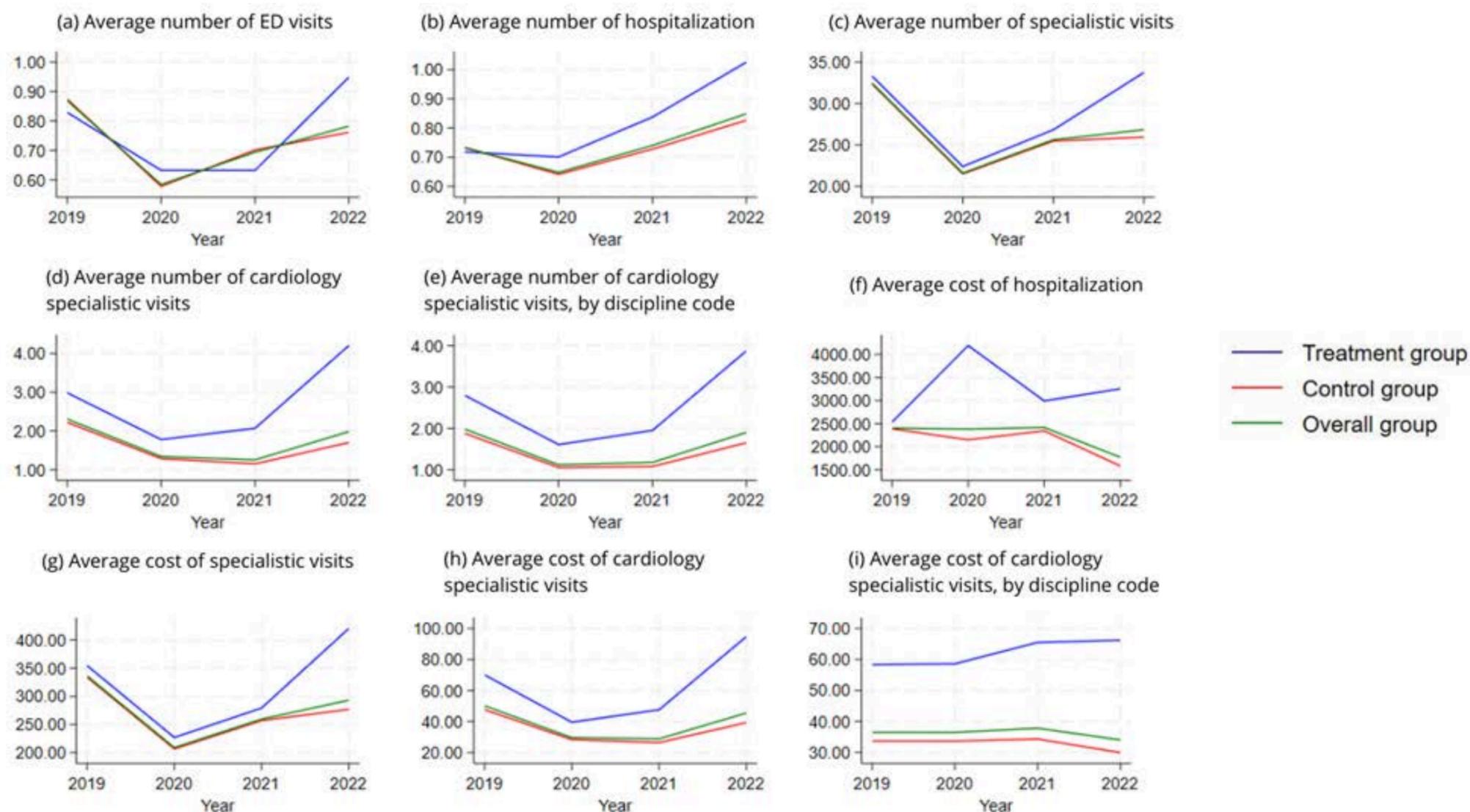
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Descriptive Statistics

Outcome trends





Regression Results

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

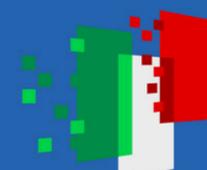
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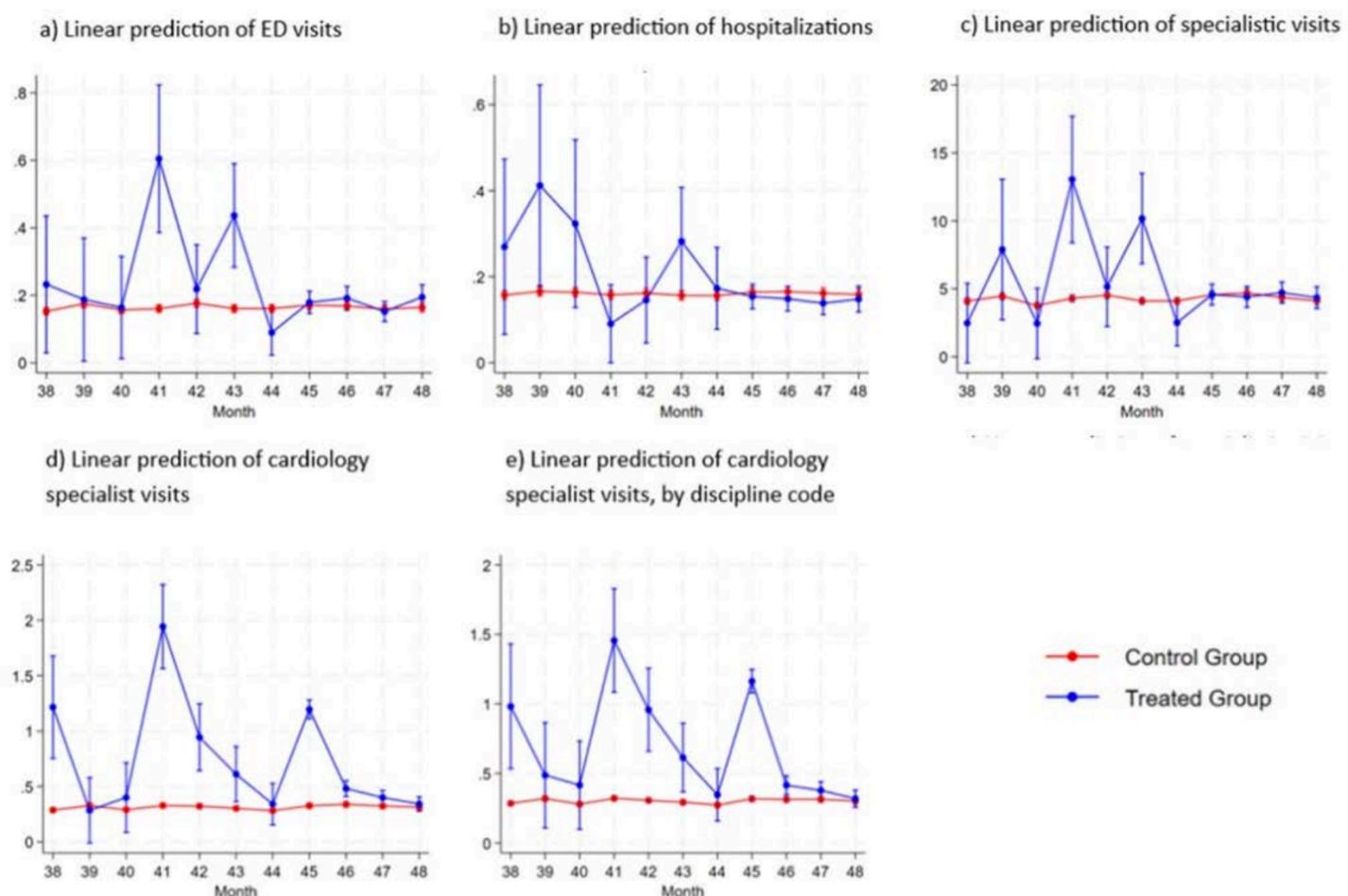


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Regression Results

Utilisation of health services - margins of Tobit model per month

Margins of Tobit model per year – utilisation of health services





Regression Results

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*** (37.23)	2.264 (2.668)	5.365*** (0.388)	-0.291 (0.402)
Demographic characteristics	YES	YES	YES	YES
Health status characteristics	YES	YES	YES	YES
Year fixed effects	YES	YES	YES	YES
Observations	41,937	41,937	41,937	41,937
Number of patients	1,039	1,039	1,039	1,039

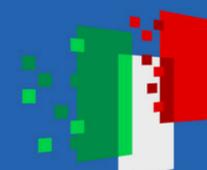
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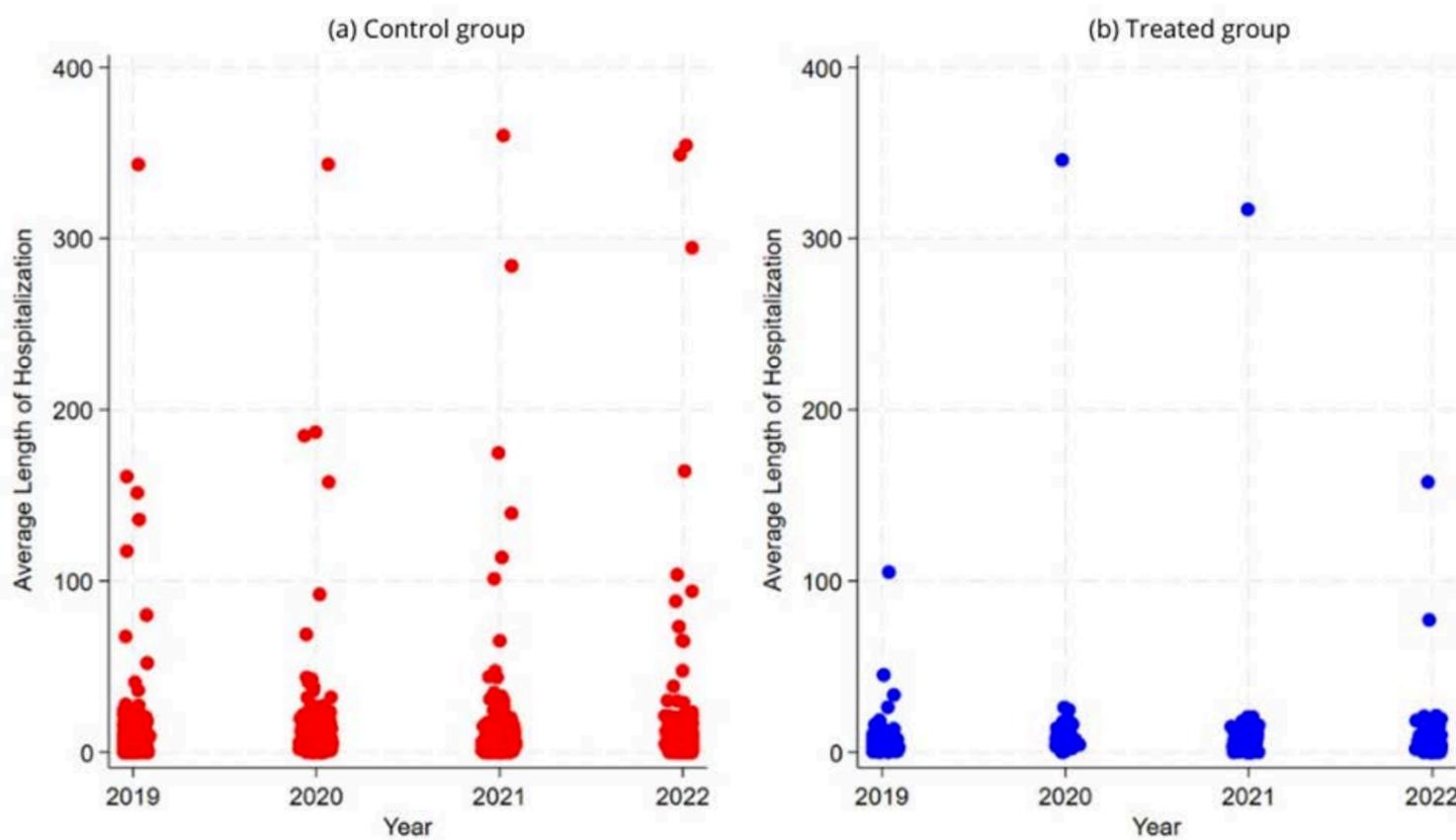


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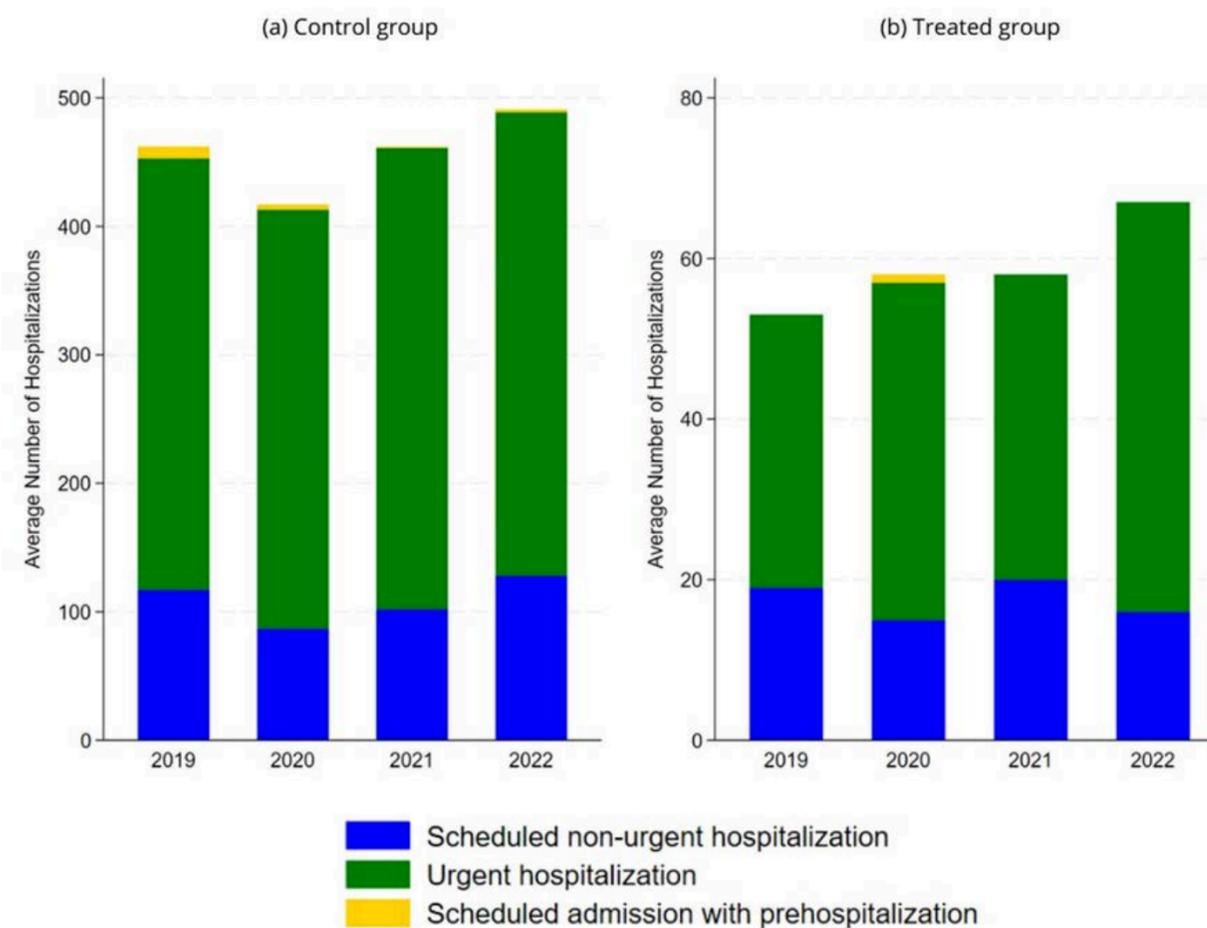
Descriptive Statistics

Outcome trends - detailed analysis of hospitalisations

Average Length of Hospitalisation per year



Average Number of Hospitalisation by type per year





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



Heterogeneity Checks

Margins of Poisson model per year: consistency of results verified

Margins of heterogeneity checks in the Tobit model per year

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)

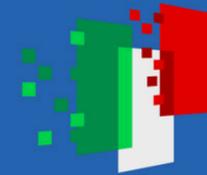
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Conclusions and Limitations

Results

- **Increased NHS resource use:** higher service utilization with telemonitoring
- **Complementary role:** telemonitoring supports, rather than replaces, traditional care
- **Unmet care demand:** highlights previously unmet healthcare needs

Limitations

- **Short implementation period:** only one year 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



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Policy Implications

- **Integration with traditional care:** integrate telemedicine with traditional care, especially early on
- **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.



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