From Crisis to Continuity:
The Role of Telemedicine in Shaping Adherence to Treatment during the Covid-19 Pandemic

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Introduction

- **Telemedicine:** healthcare delivery via telecommunication, improving accessibility and reducing inequalities *(Leporatti et al., 2021)*

- **COVID-19 impact:** accelerated adoption, especially for vulnerable patients with chronic conditions *(Predieri et al., 2020; Bitar & Alismail, 2021)*

- **Conflicting evidence:** mixed results—reduced utilization and costs *(Walter et al., 2023)* vs. increased low-quality visits *(Dahlgren et al., 2024)*

- **Non-adherence:** enhanced communication can reduce unintentional non-adherence, addressing issues like forgetfulness *(Gadkari & McHorney, 2012; Basit et al., 2020)*
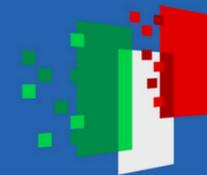
Objective

Two main goals:

- **Impact of COVID-19:** analyze patient behavior during and after the pandemic
- **Impact of telemedicine:** assess how telemedicine affects medication adherence in post-pandemic patients
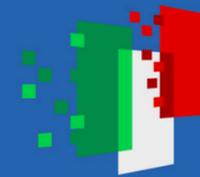
Relevance of the case study:

- **Geographical conformation**: mountainous inland with extensive coastal region *(Istat, 2021)*
- **Demographic setting**: highest over-65s population in Europe, predicting future trends *(Eurostat, 2020)*

Related Literature

Adherence & COVID-19:

- Challenges in obtaining medications *(Kadir M., 2020; Baum et al., 2021)*
- Reduced adherence, particularly among patients with chronic conditions *(Di Novi et al., 2022; Bitar & Alismail, 2021)*
- Frequent changes in treatment adherence, driven by increased risk *(McQueenie et al., 2019; Vordenberg et al., 2020)*
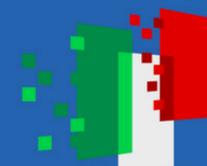
Adherence & telemedicine:

- Addressing unmet healthcare needs, particularly in the post-pandemic period *(Huerne & Eisenberg, 2024)*
- Improved communication, minimizing therapy discontinuity *(Basit et al., 2020; Miller, 2002; Gadkari & McHorney, 2012).*

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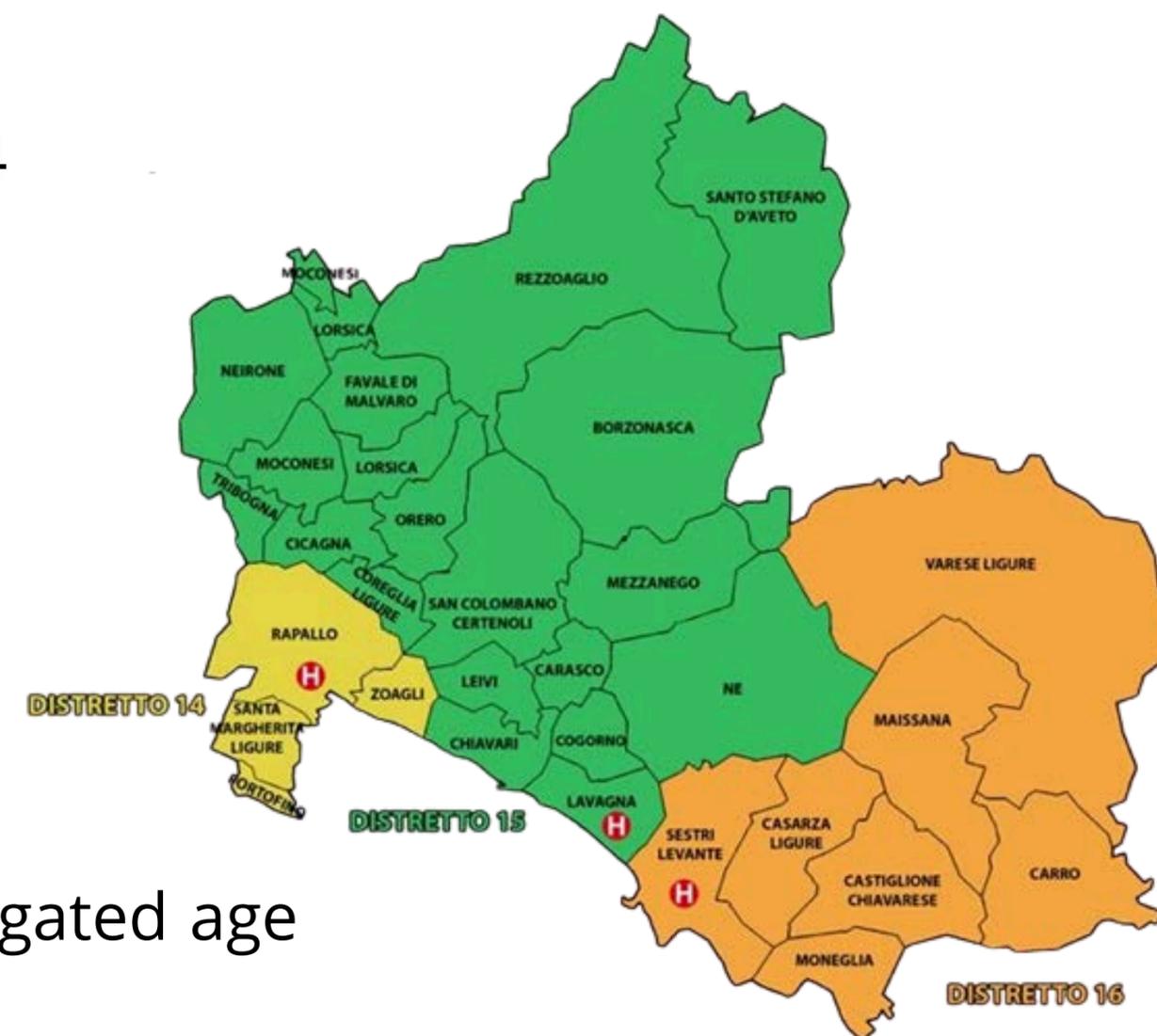Ministero
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Dataset Overview

- **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+)

Inclusion Criteria

- **Focus**: patients with chronic diabetes and heart failure

- **Identification**: guidelines established by the Ministry of Health

- **Exclusion**: non-residents to prevent data inconsistencies due to high tourist influx
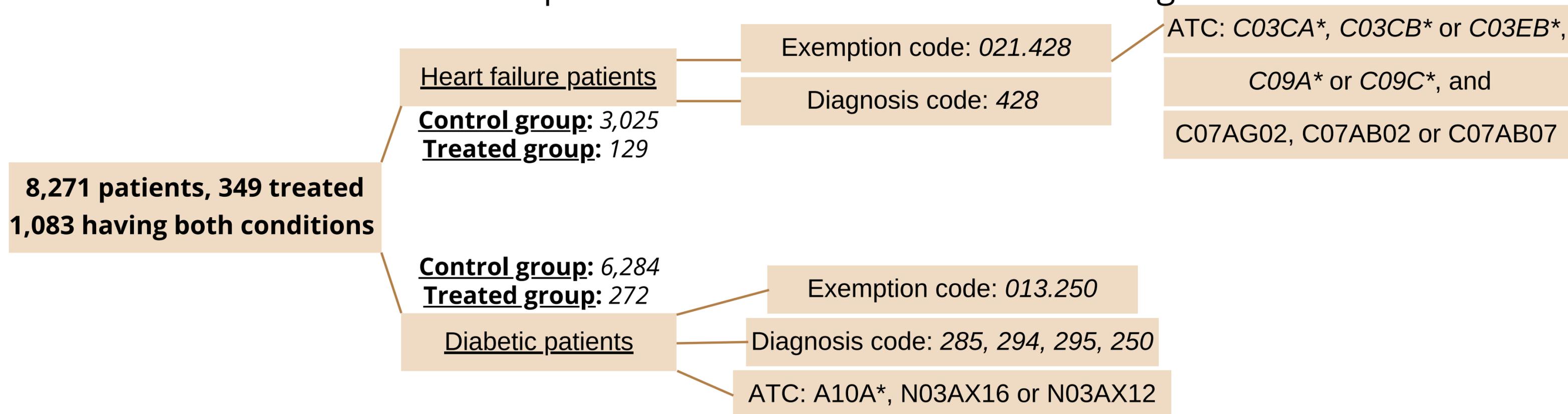
8,271 patients, 349 treated 1,083 having both conditions

Heart failure patients

Control group: *3,025*
Treated group: *129*

Exemption code: *021.428*

Diagnosis code: *428*

ATC: *C03CA*, C03CB* or C03EB*,*

C09A or C09C*, and*

C07AG02, C07AB02 or C07AB07

Diabetic patients

Control group: *6,284*
Treated group: *272*

Exemption code: *013.250*

Diagnosis code: *285, 294, 295, 250*

ATC: A10A*, N03AX16 or N03AX12

Empirical Strategy

- **Panel dataset**: Bi-annual panel to assess the impact of COVID-19 and telemonitoring on patient adherence

- **Outcome variables**: Adherence (%) to ATC *A02BC02*, *A10BA02*, *C03CA01* and *C07AB07* by proportion of days covered

$$PDC = \frac{\text{Number of days covered}}{\text{Number of days in the semester}} \times 100$$
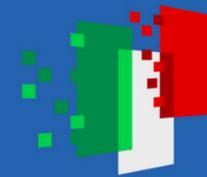
- **Independent variables**
  - **Demographics**: gender, age group, municipality
  - **Health status**: exemptions, comorbidities
  - **Treatment type**: telemonitoring exposure

Econometric Approach

- **Variables**: continuous variable ranging from 0 to 100, representing the percentage of adherence to therapy

- **Challenges**: high frequency of missing data

- **(Temporary) Empirical strategy**: Tobit model with random effects

$$y^*_{it} = \beta_0 + \beta_1 X_{it} + \delta Exposure_{it} + time_t + \alpha_i + u_{it}$$

- **(Future) Empirical strategy:** Difference-in-Differences

Descriptive Statistics

Independent variables insights - demographic characteristics

- **Gender distribution:** 50.52% men vs 49.48% women in the control group; 51.58% men vs 48.42% women in the treated group

- **Age Distribution:** 81.99% individuals over 65 in the control group; 67.05% in the treatment group, with a broader age range

- **Urban vs Rural:** 80.74% from urban areas in the control group vs 79.66% in the treatment group

- **Littoral Hill Prevalence:** 78.05% in the control group vs 76.22% in the treatment group
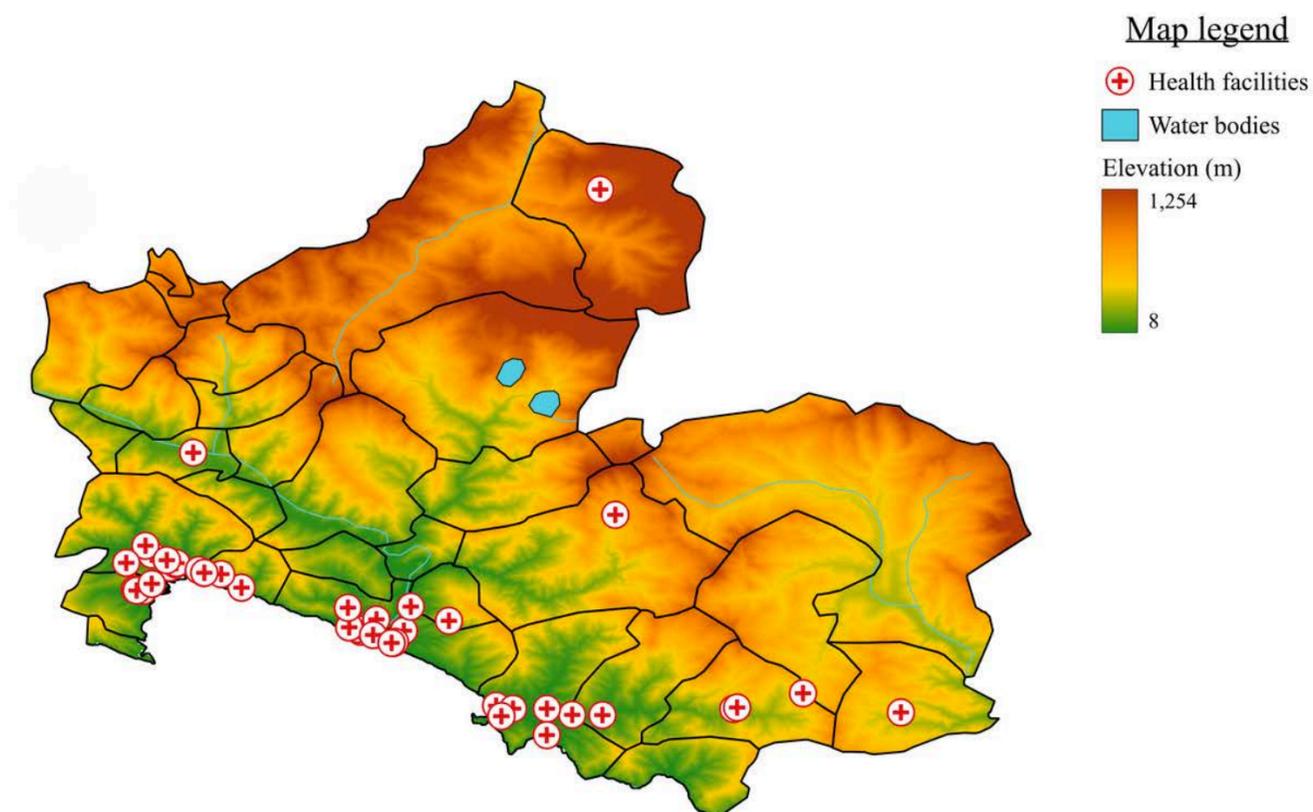
Descriptive Statistics

Independent variables insights - Access Barriers Index

PCA analysis: based on EDs, hospitals, specialized departments, and distance from municipal centroid

Descriptive Statistics

Independent variables insights - health status characteristics

- **Group homogeneity:** treatment and control groups show similar health characteristics

- **Exemptions:** slightly higher in the treatment group (0.41 vs 0.39)

- **Medications:** slightly higher in the treatment group (36.63 vs 34.82)

- **Charlson index:** higher comorbidity in the treatment group (0.94 vs 0.90)

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

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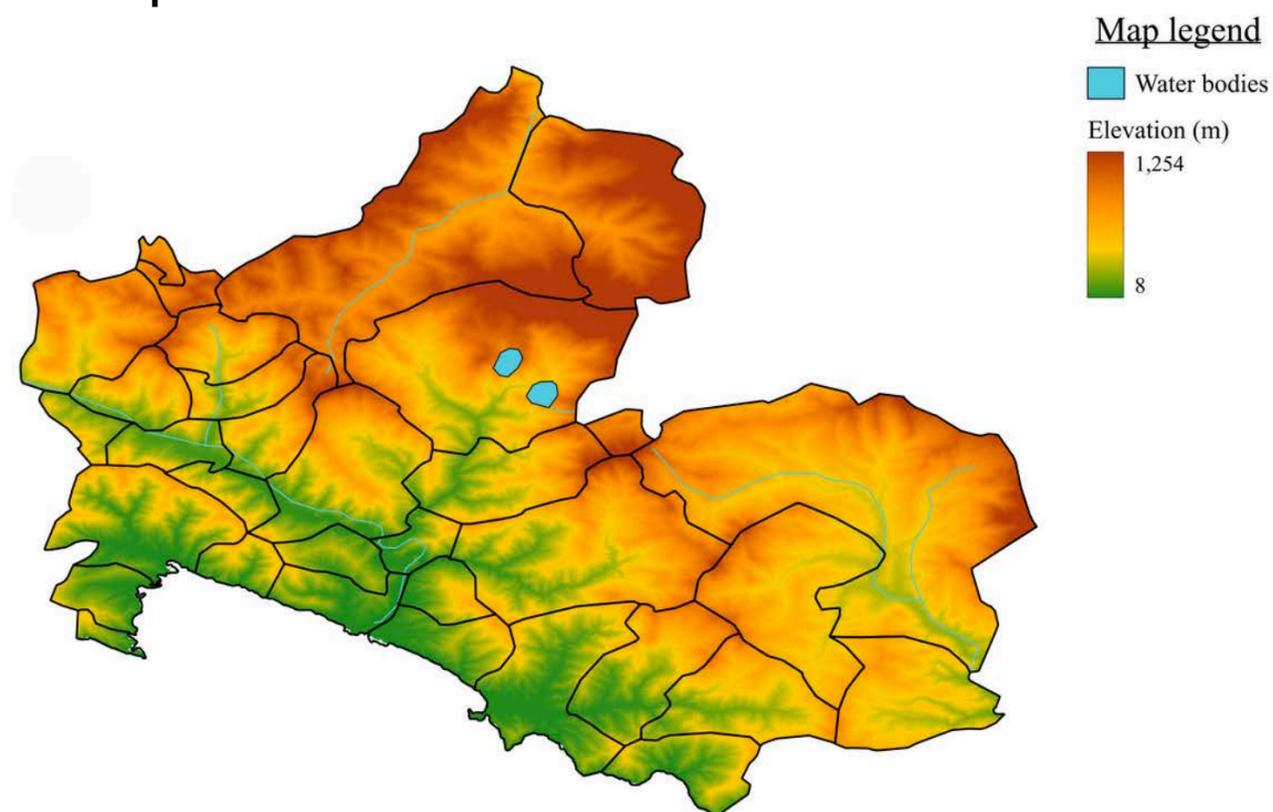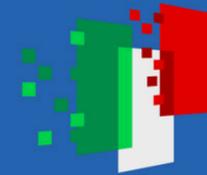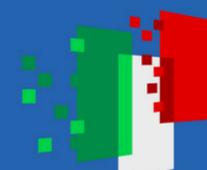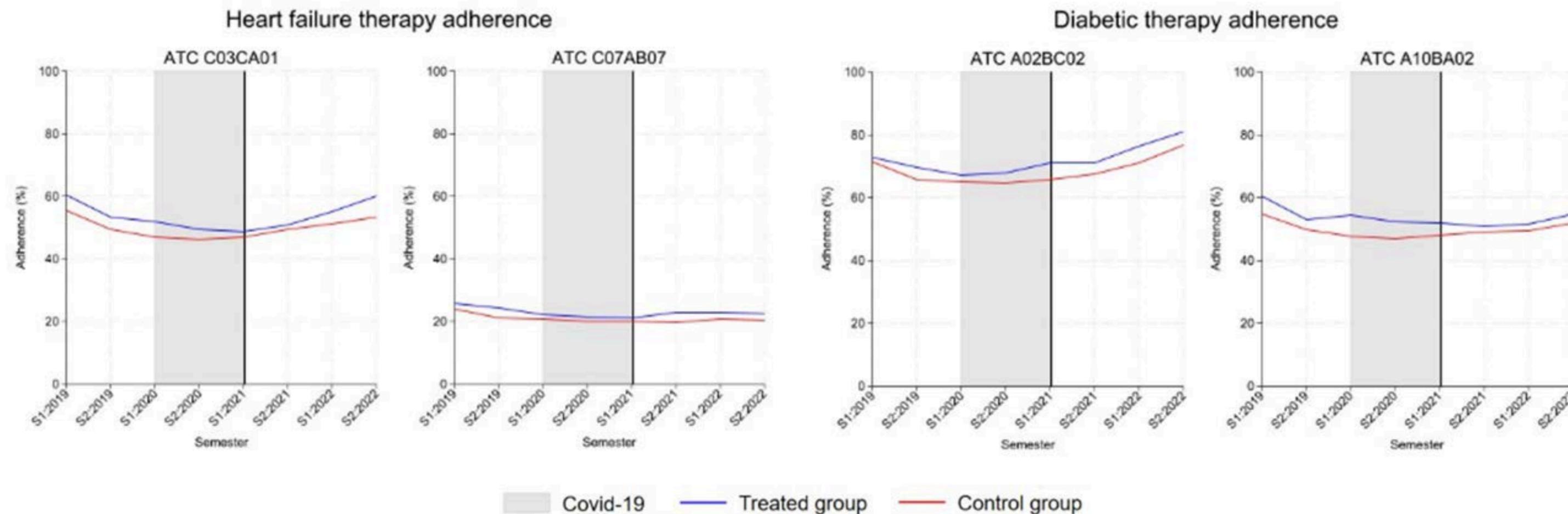
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Descriptive Statistics

Outcome trends

Descriptive Statistics

Outcome trends, by age

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Outcome trends, by age

Therapy adherence, ATC A02BC02 — Age range 0-65, Age range 65+
Therapy adherence, ATC A10BA02 — Age range 0-65, Age range 65+
Covid-19 · Treated group · Control group
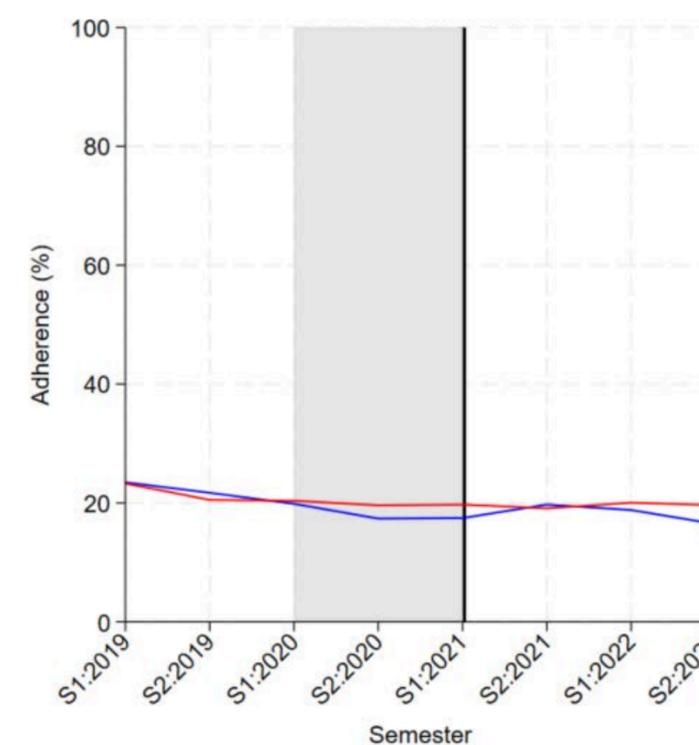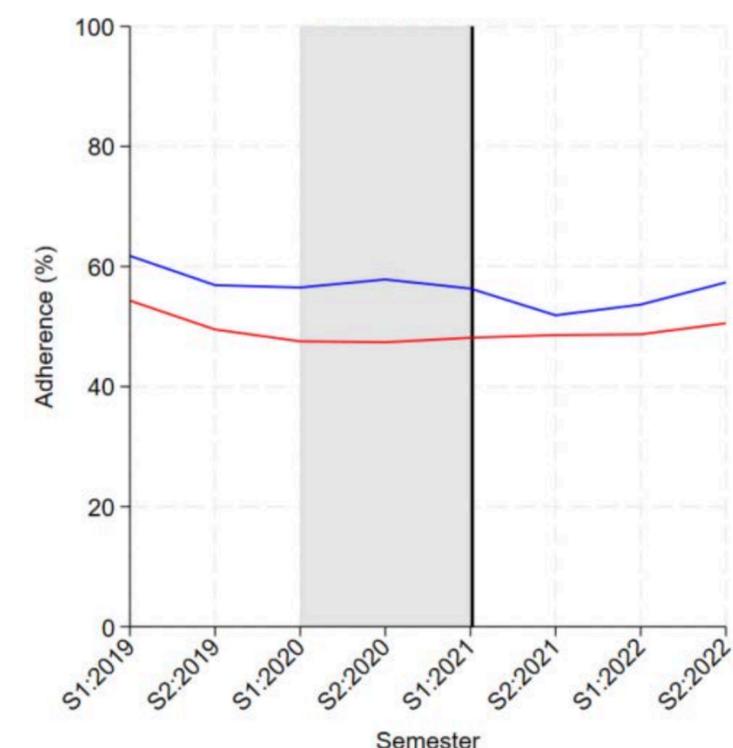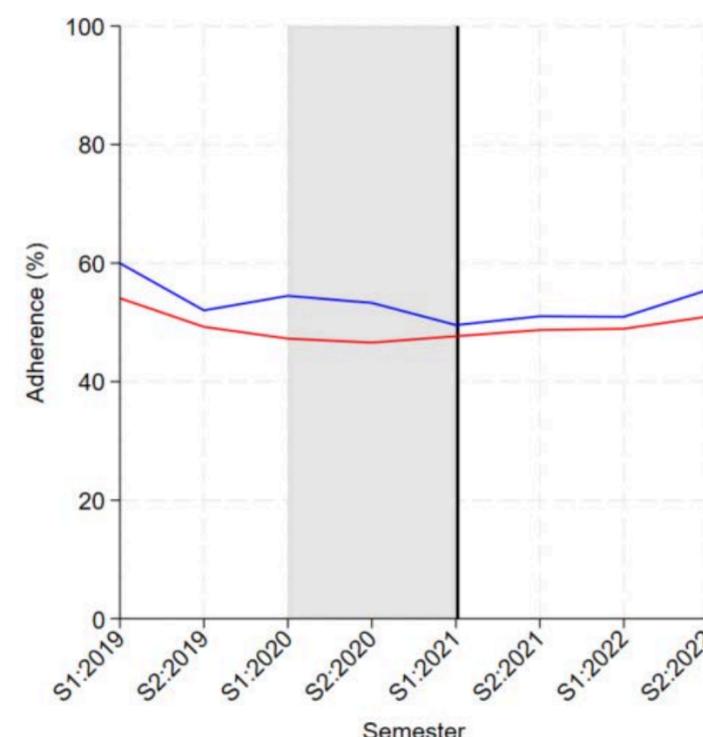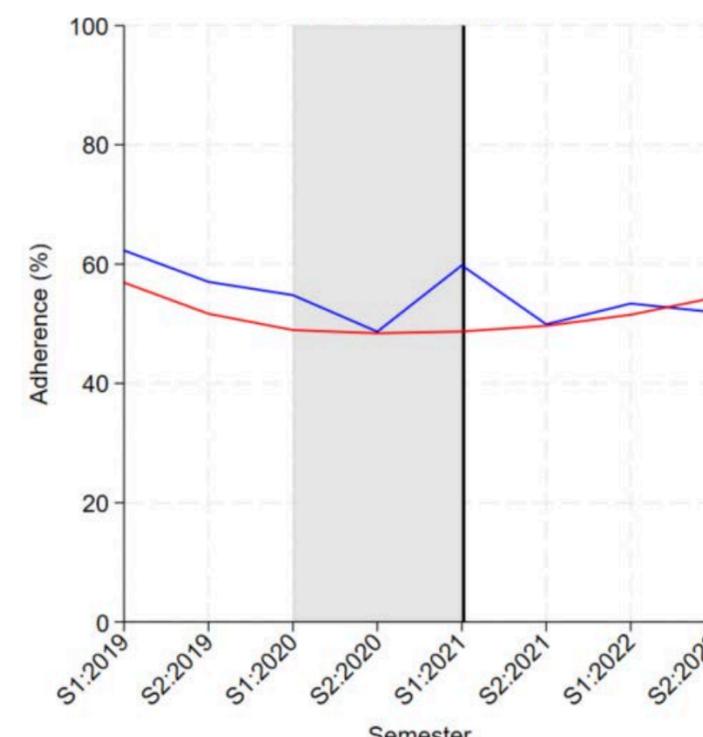
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Descriptive Statistics

Outcome trends, by area

Descriptive Statistics

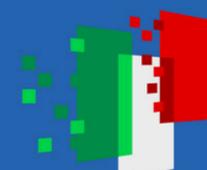## Outcome trends, by area

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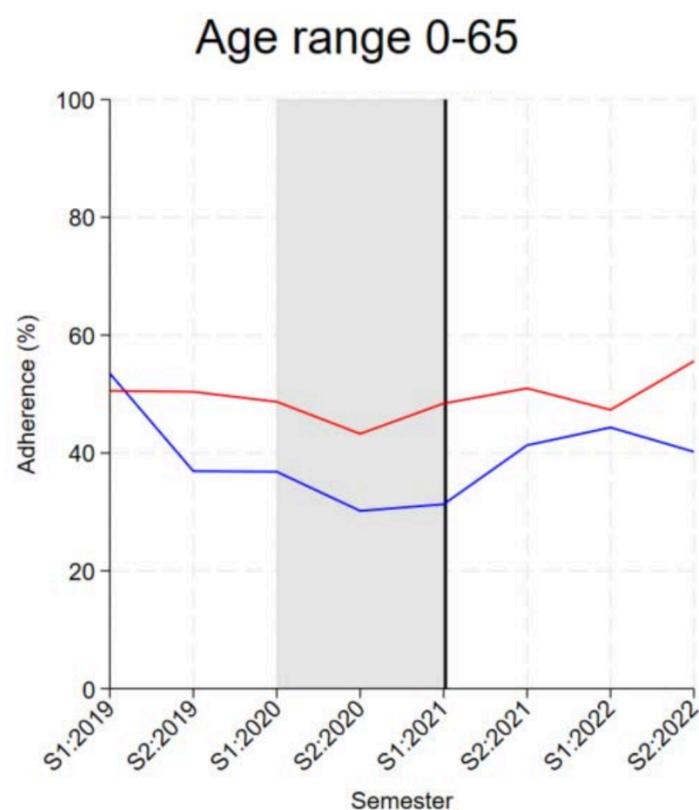
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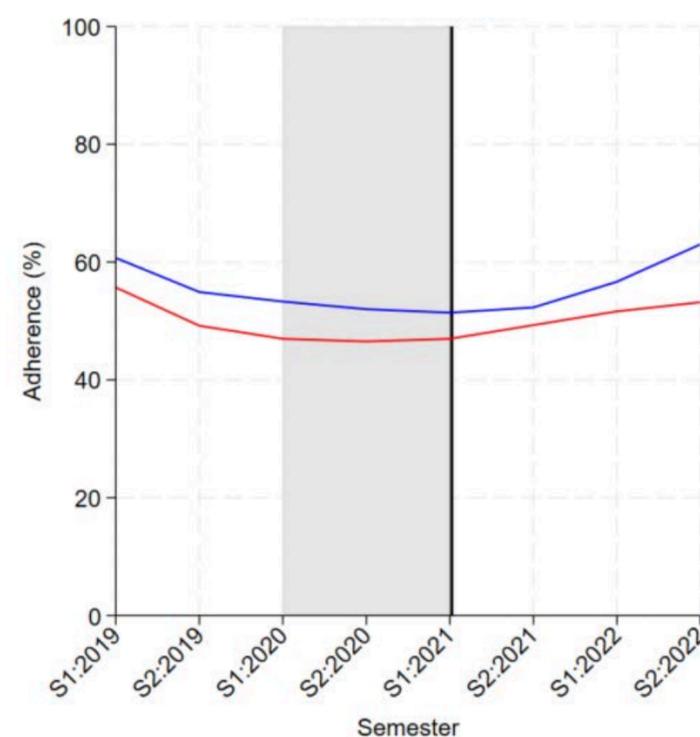DI RIPRESA E RESILIENZA

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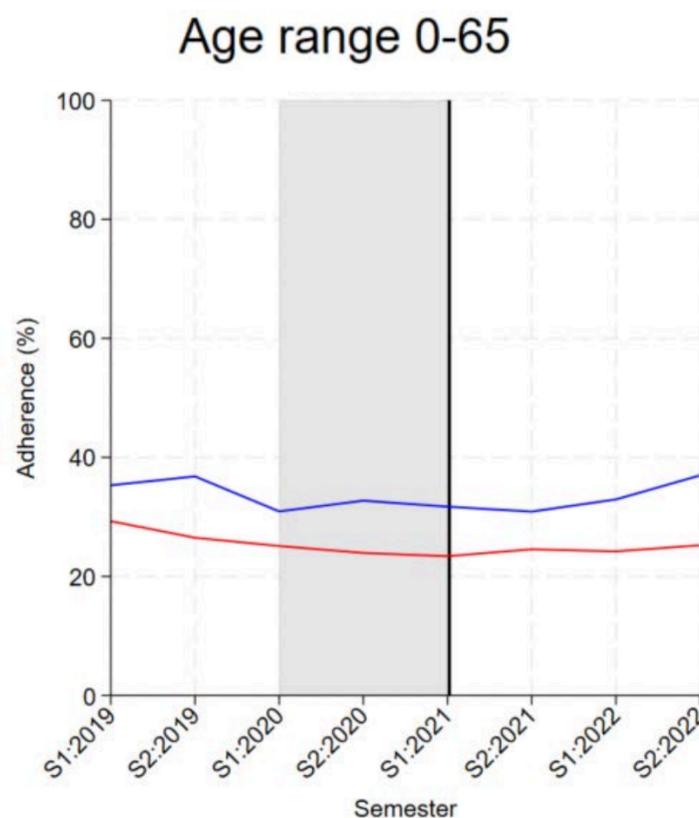
Descriptive Statistics

Outcome trends, by Charlson index

Descriptive Statistics

Outcome trends, by Charlson index

Regression Results

Tobit model - general results

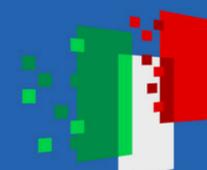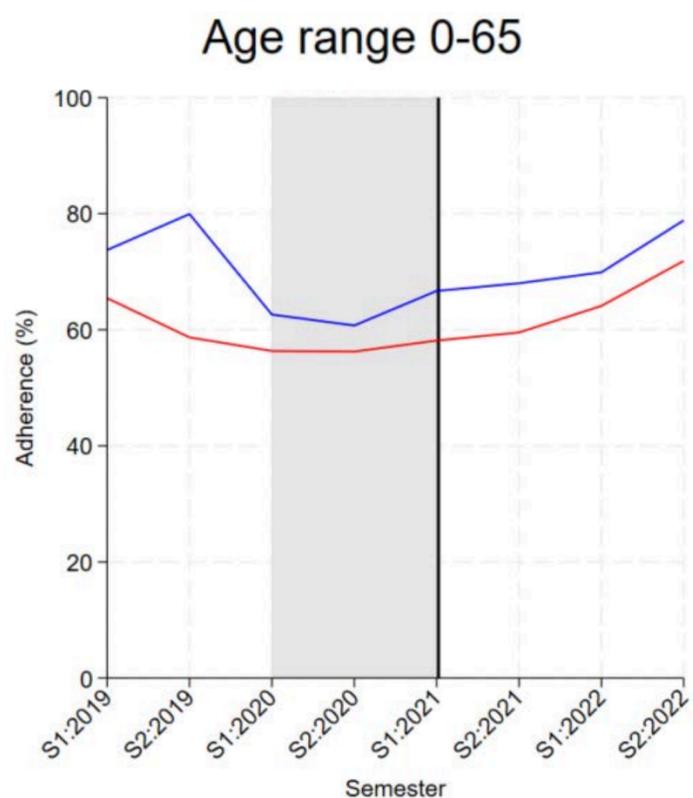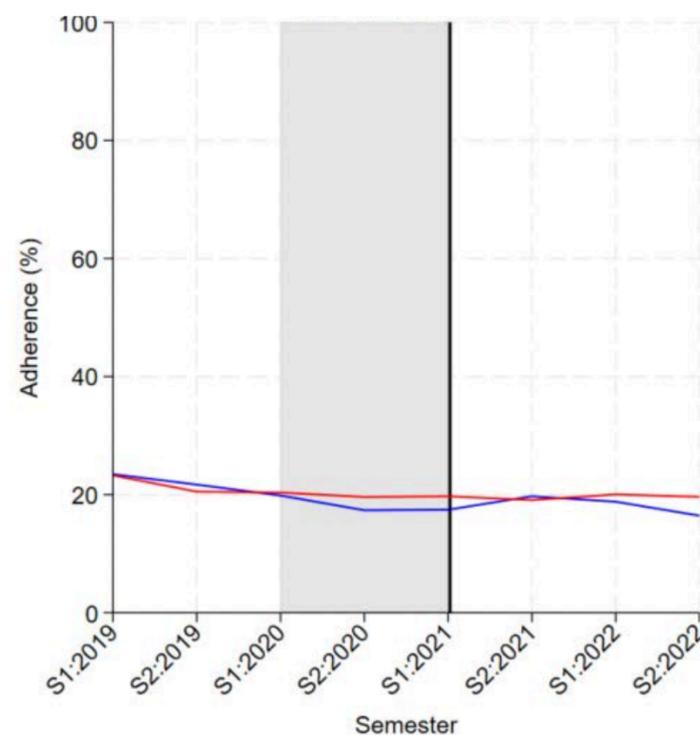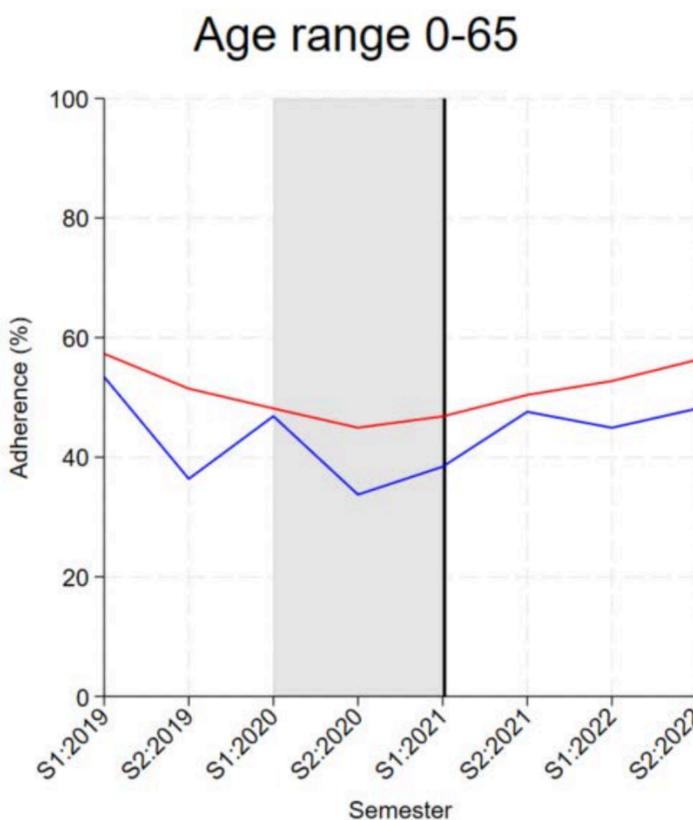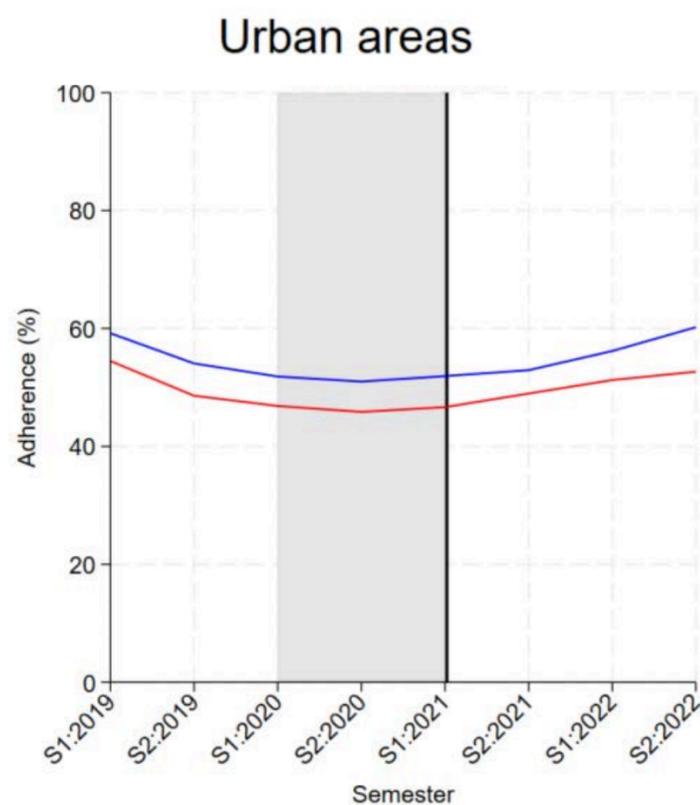| Variables	Adherence to ATC A02BC02	Adherence to ATC A10BA02	Adherence to ATC C03CA01	Adherence to ATC C07AB07
Male	-0.748	0.464	1.612*	0.668
	(0.929)	(1.077)	(0.947)	(0.674)
Age group:				
46-65	22.94***	0.951	13.68	-0.0864
	(4.592)	(4.374)	(10.64)	(4.903)
65+	29.56***	1.609	18.08*	-4.914
	(4.431)	(4.211)	(10.48)	(4.808)
Charlson index	0.236	-0.530	1.175***	-0.512**
	(0.270)	(0.332)	(0.271)	(0.201)
Barrier index	0.0200	0.305	0.0867	-0.0450
	(0.200)	(0.234)	(0.192)	(0.137)
Semester:				
S2:2019	-4.228***	-4.151***	-5.281***	-2.675***
	(0.752)	(0.724)	(0.843)	(0.465)
S1:2020	-4.662***	-5.993***	-6.523***	-2.906***
	(0.756)	(0.734)	(0.851)	(0.467)
S2:2020	-4.705***	-7.144***	-6.851***	-3.651***
	(0.758)	(0.740)	(0.868)	(0.468)
S1:2021	-2.304***	-5.785***	-5.183***	-3.634***
	(0.762)	(0.750)	(0.874)	(0.472)
S2:2021	-0.566	-5.429***	-2.431***	-3.770***
	(0.768)	(0.762)	(0.889)	(0.474)
S1:2022	3.474***	-4.539***	-0.312	-3.174***
	(0.782)	(0.782)	(0.915)	(0.480)
S2:2022	7.757***	-3.573***	0.801	-3.530***
	(0.811)	(0.825)	(0.972)	(0.494)
Observations	17,071	11,437	12,117	8,701
Number of patients	4,490	2,420	3,500	2,246

Regression Results

Tobit model - by areas

Urban areas

Variables	Adherence to ATC A02BC02	Adherence to ATC A10BA02	Adherence to ATC C03CA01	Adherence to ATC C07AB07
Male	-1.277	0.678	1.330	0.670
	(1.033)	(1.205)	(1.056)	(0.759)
Age group:				
46-65	24.25***	4.226	13.36	7.651
	(5.342)	(4.936)	(11.88)	(5.883)
65+	29.83***	5.270	15.16	3.641
	(5.161)	(4.752)	(11.69)	(5.770)
Charlson index	0.0811	-0.591	1.088***	-0.370
	(0.294)	(0.364)	(0.298)	(0.229)
Barrier index	0.0527	0.0133	-0.146	0.385
	(0.398)	(0.444)	(0.400)	(0.284)
Semester:				
S2:2019	-4.495***	-4.325***	-5.182***	-3.070***
	(0.837)	(0.823)	(0.956)	(0.520)
S1:2020	-5.212***	-5.935***	-6.446***	-2.939***
	(0.842)	(0.834)	(0.967)	(0.523)
S2:2020	-5.597***	-7.023***	-6.954***	-3.971***
	(0.844)	(0.841)	(0.985)	(0.524)
S1:2021	-2.633***	-5.663***	-5.179***	-3.859***
	(0.847)	(0.854)	(0.993)	(0.529)
S2:2021	-1.105	-5.096***	-2.645***	-3.973***
	(0.857)	(0.868)	(1.012)	(0.531)
S1:2022	3.027***	-4.524***	-0.242	-3.347***
	(0.873)	(0.890)	(1.039)	(0.539)
S2:2022	7.263***	-3.712***	0.553	-3.700***
	(0.906)	(0.938)	(1.104)	(0.555)
Observations	13,862	9,017	9,416	7,002
Number of patients	3,640	1,936	2,764	1,800

Rural areas

Variables	Adherence to ATC A02BC02	Adherence to ATC A10BA02	Adherence to ATC C03CA01	Adherence to ATC C07AB07
Male	1.410	-0.514	2.712	0.422
	(2.120)	(2.426)	(2.111)	(1.449)
Age group:				
46-65	20.12**	-9.951	19.55	-18.23**
	(8.929)	(9.446)	(23.44)	(8.606)
65+	31.66***	-10.85	32.52	-25.41***
	(8.603)	(9.113)	(23.21)	(8.442)
Charlson index	1.175*	-0.159	1.654***	-0.941**
	(0.674)	(0.809)	(0.641)	(0.414)
Barrier index	-1.095**	0.0585	-0.918**	-0.325
	(0.444)	(0.525)	(0.433)	(0.285)
Semester:				
S2:2019	-2.700	-3.484**	-5.584***	-0.987
	(1.710)	(1.518)	(1.783)	(1.035)
S1:2020	-1.875	-6.189***	-6.685***	-2.810***
	(1.716)	(1.545)	(1.792)	(1.032)
S2:2020	-0.448	-7.570***	-6.412***	-2.326**
	(1.724)	(1.553)	(1.830)	(1.038)
S1:2021	-0.518	-6.172***	-5.121***	-2.725***
	(1.736)	(1.571)	(1.841)	(1.042)
S2:2021	2.104	-6.599***	-1.669	-2.924***
	(1.731)	(1.587)	(1.866)	(1.046)
S1:2022	5.780***	-4.539***	-0.483	-2.452**
	(1.761)	(1.637)	(1.932)	(1.055)
S2:2022	10.23***	-3.111*	1.620	-2.818***
	(1.816)	(1.729)	(2.045)	(1.080)
Observations	3,209	2,420	2,701	1,699
Number of patients	850	484	736	446

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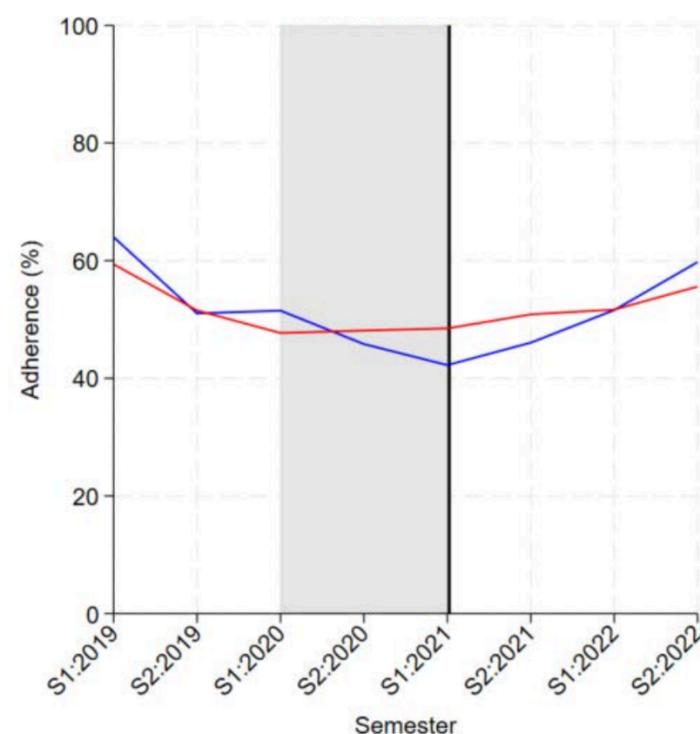DI RIPRESA E RESILIENZA

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Regression Results

Tobit model - usage of telemedicine
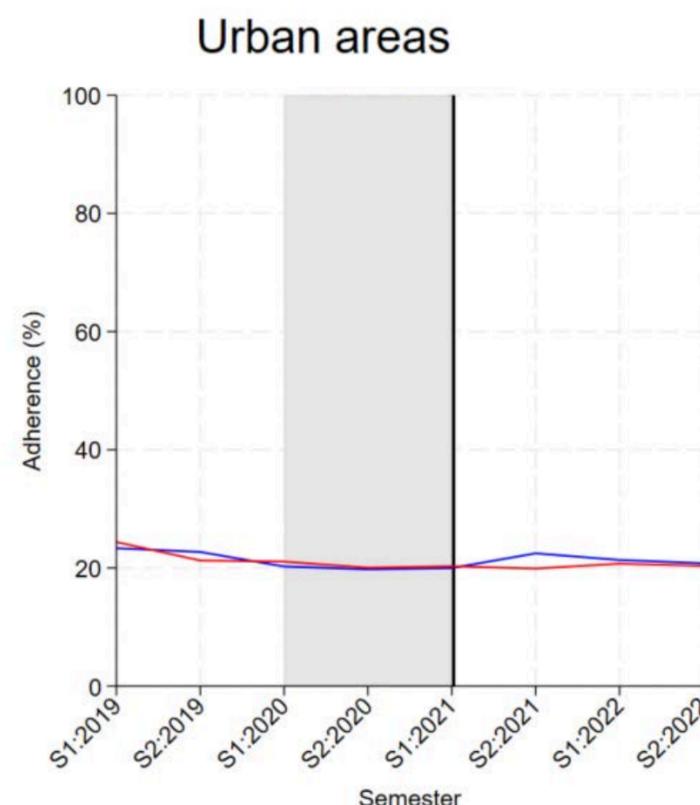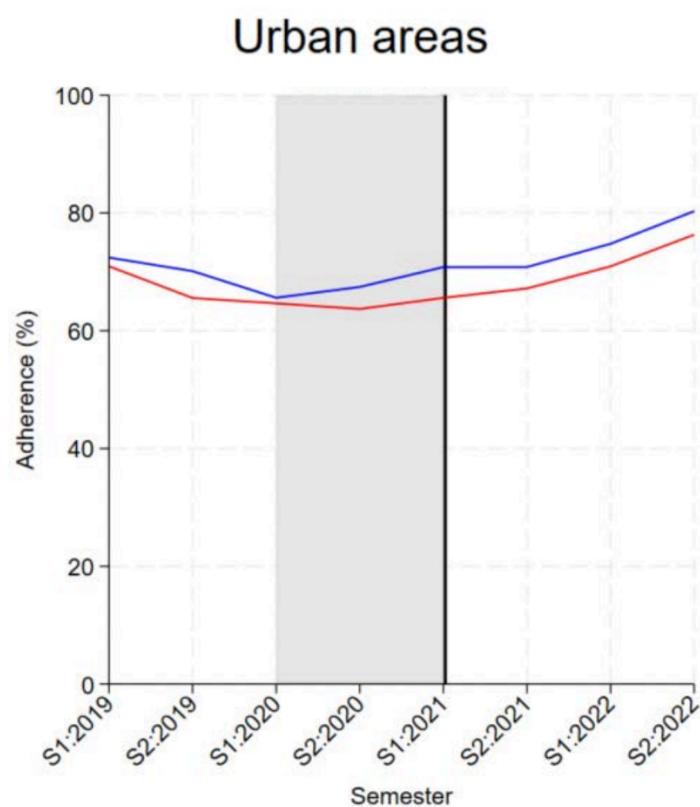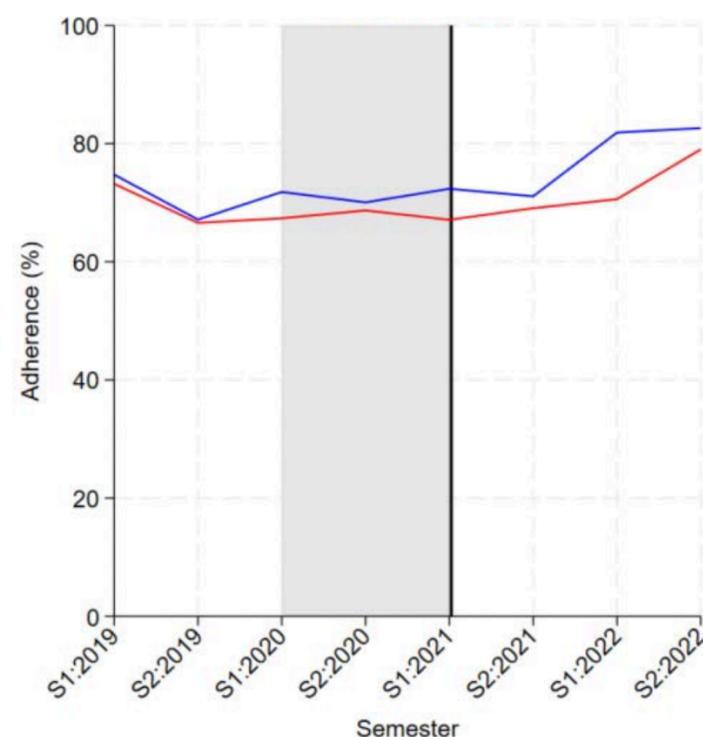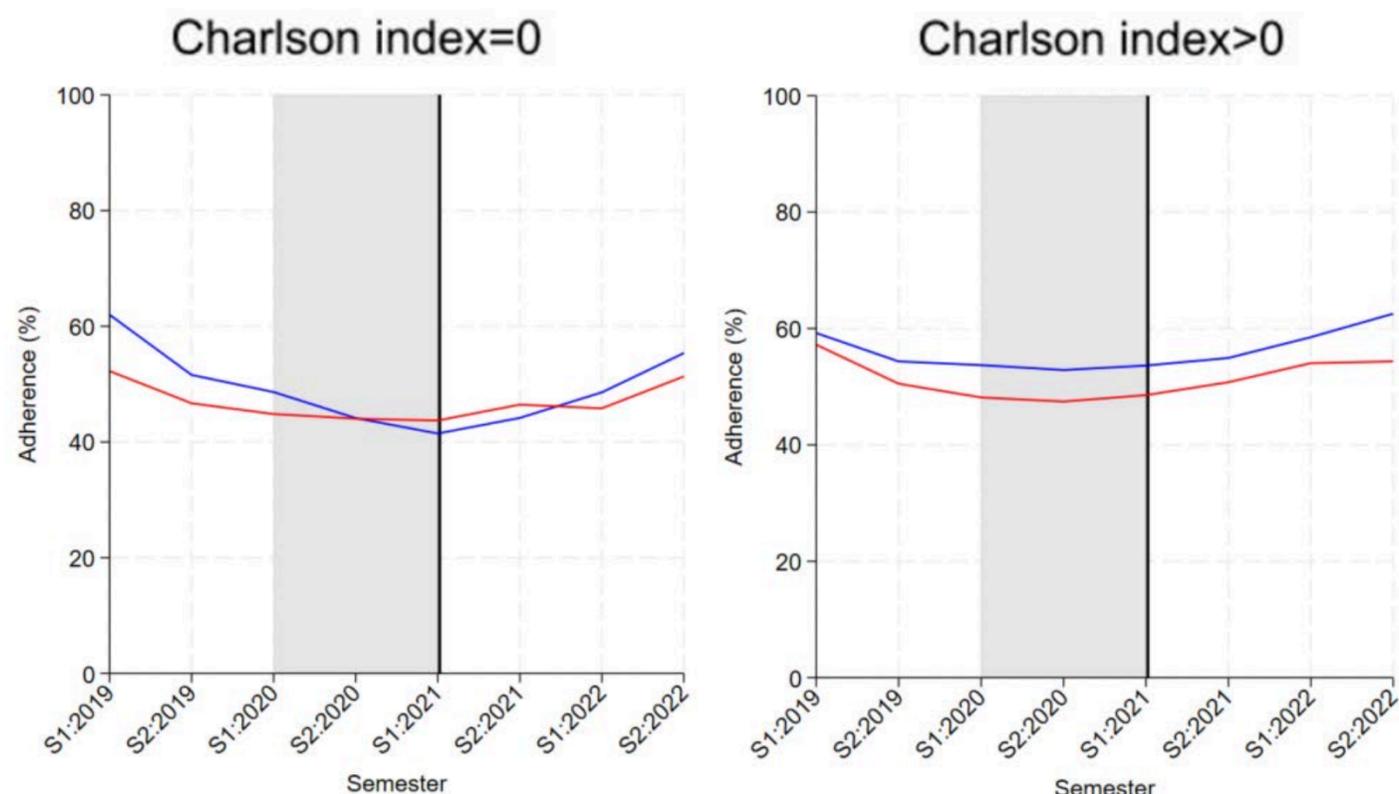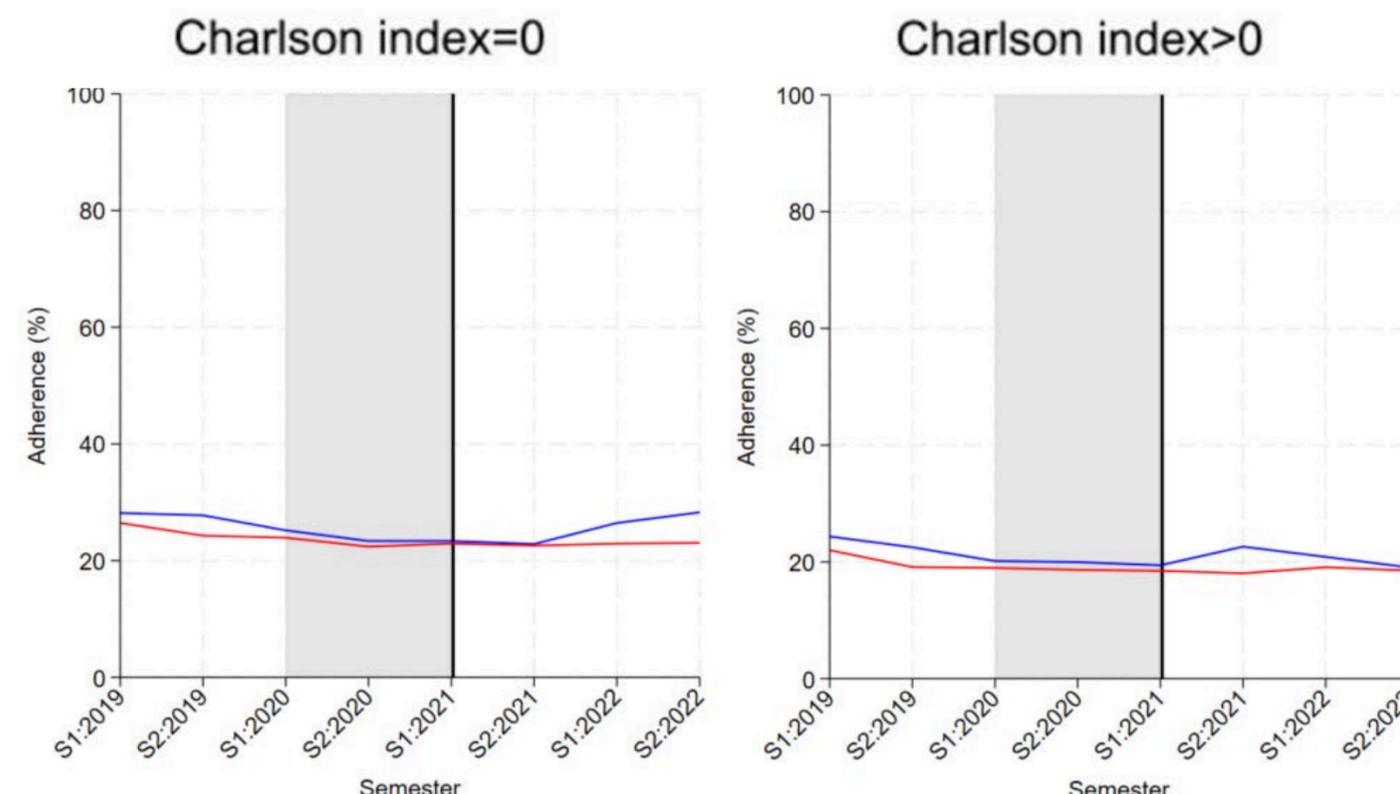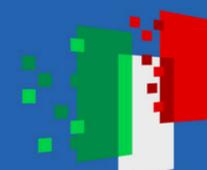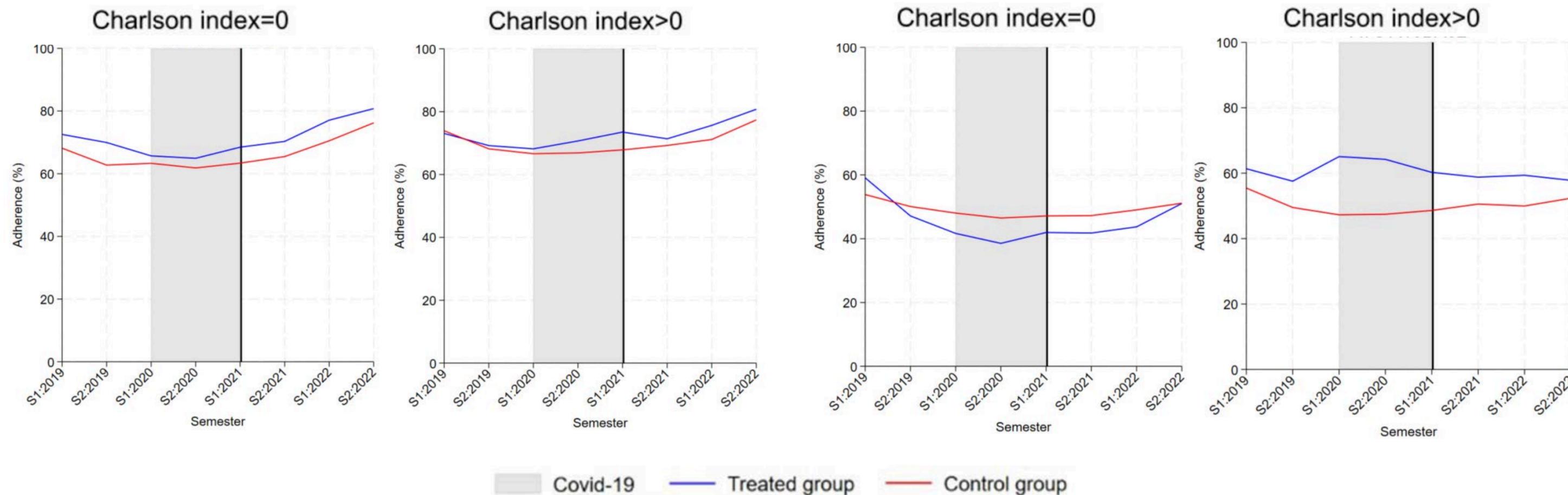
Variables	Adherence to ATC A02BC02	Adherence to ATC A10BA02	Adherence to ATC C03CA01	Adherence to ATC C07AB07
Male	-0.750	0.468	1.607*	0.668
	(0.929)	(1.077)	(0.947)	(0.674)
Age group:				
46-65	23.05***	1.004	13.82	-0.0636
	(4.593)	(4.375)	(10.64)	(4.903)
65+	29.67***	1.674	18.23*	-4.874
	(4.432)	(4.212)	(10.48)	(4.808)
Charlson index	0.234	-0.534	1.176***	-0.513**
	(0.270)	(0.332)	(0.271)	(0.201)
Barrier index	0.0197	0.305	0.0863	-0.0459
	(0.200)	(0.234)	(0.192)	(0.137)
Semester:				
S2:2019	-4.228***	-4.151***	-5.280***	-2.676***
	(0.752)	(0.724)	(0.843)	(0.465)
S1:2020	-4.663***	-5.992***	-6.523***	-2.906***
	(0.756)	(0.734)	(0.851)	(0.467)
S2:2020	-4.706***	-7.142***	-6.852***	-3.651***
	(0.758)	(0.740)	(0.868)	(0.468)
S1:2021	-2.306***	-5.785***	-5.186***	-3.635***
	(0.762)	(0.750)	(0.874)	(0.472)
S2:2021	-0.582	-5.443***	-2.444***	-3.780***
	(0.768)	(0.762)	(0.890)	(0.474)
S1:2022	3.419***	-4.577***	-0.354	-3.206***
	(0.784)	(0.785)	(0.917)	(0.482)
S2:2022	7.632***	-3.646***	0.678	-3.610***
	(0.821)	(0.833)	(0.989)	(0.501)
Exposure	1.784	1.399	1.505	1.119
	(1.876)	(2.226)	(2.251)	(1.153)
Observations	17,071	11,437	12,117	8,701
Number of patients	4,490	2,420	3,500	2,246

Regression Results

Tobit model - by areas

Urban areas

Variables	Adherence to ATC A02BC02	Adherence to ATC A10BA02	Adherence to ATC C03CA01	Adherence to ATC C07AB07
Male	-1.278	0.684	1.320	0.670
	(1.033)	(1.205)	(1.056)	(0.759)
Age group:				
46-65	24.36***	4.321	13.66	7.655
	(5.345)	(4.938)	(11.89)	(5.884)
65+	29.95***	5.369	15.47	3.646
	(5.164)	(4.755)	(11.69)	(5.771)
Charlson index	0.0800	-0.596	1.090***	-0.371
	(0.294)	(0.364)	(0.298)	(0.229)
Barrier index	0.0531	0.0165	-0.147	0.385
	(0.398)	(0.444)	(0.399)	(0.284)
Semester:				
S2:2019	-4.496***	-4.325***	-5.181***	-3.070***
	(0.837)	(0.823)	(0.956)	(0.520)
S1:2020	-5.213***	-5.934***	-6.446***	-2.939***
	(0.842)	(0.834)	(0.967)	(0.523)
S2:2020	-5.598***	-7.021***	-6.957***	-3.971***
	(0.844)	(0.841)	(0.985)	(0.524)
S1:2021	-2.635***	-5.663***	-5.186***	-3.859***
	(0.847)	(0.854)	(0.993)	(0.529)
S2:2021	-1.117	-5.111***	-2.668***	-3.974***
	(0.857)	(0.868)	(1.012)	(0.531)
S1:2022	2.987***	-4.568***	-0.307	-3.349***
	(0.875)	(0.893)	(1.041)	(0.540)
S2:2022	7.172***	-3.787***	0.366	-3.705***
	(0.918)	(0.947)	(1.122)	(0.562)
Exposure	1.304	1.479	2.432	0.0822
	(2.123)	(2.529)	(2.644)	(1.391)
Observations	13,862	9,017	9,416	7,002
Number of patients	3,640	1,936	2,764	1,800

Rural areas

Variables	Adherence to ATC A02BC02	Adherence to ATC A10BA02	Adherence to ATC C03CA01	Adherence to ATC C07AB07
Male	1.394	-0.517	2.711	0.443
	(2.120)	(2.426)	(2.111)	(1.450)
Age group:				
46-65	20.05**	-10.04	19.56	-18.37**
	(8.928)	(9.451)	(23.44)	(8.608)
65+	31.59***	-10.90	32.54	-25.49***
	(8.603)	(9.115)	(23.21)	(8.444)
Charlson index	1.170*	-0.159	1.655***	-0.942**
	(0.674)	(0.809)	(0.641)	(0.414)
Barrier index	-1.096**	0.0582	-0.918**	-0.324
	(0.444)	(0.525)	(0.433)	(0.285)
Semester:				
S2:2019	-2.697	-3.483**	-5.586***	-0.978
	(1.710)	(1.518)	(1.783)	(1.034)
S1:2020	-1.873	-6.189***	-6.687***	-2.801***
	(1.715)	(1.545)	(1.792)	(1.030)
S2:2020	-0.448	-7.565***	-6.413***	-2.314**
	(1.724)	(1.553)	(1.830)	(1.037)
S1:2021	-0.509	-6.171***	-5.121***	-2.715***
	(1.736)	(1.571)	(1.841)	(1.041)
S2:2021	2.082	-6.612***	-1.661	-2.922***
	(1.731)	(1.587)	(1.866)	(1.044)
S1:2022	5.660***	-4.564***	-0.442	-2.609**
	(1.765)	(1.639)	(1.937)	(1.057)
S2:2022	9.969***	-3.189*	1.743	-3.216***
	(1.837)	(1.750)	(2.087)	(1.100)
Exposure	3.690	1.377	-1.264	3.731*
	(3.968)	(4.703)	(4.274)	(2.035)
Observations	3,209	2,420	2,701	1,699
Number of patients	850	484	736	446

Conclusions and Limitations

Results (*ongoing*)

- **Impact of COVID-19**: negative effect on treatment adherence

- **Rural disparities**: limited access to medical facilities

- **Telemedicine**: initially effective only for some drugs and population

Limitations

- **Short implementation period**

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

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

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

Thank you!

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