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MODELLING THE DETERMINANTS OF INAPPROPRIATE EMERGENCY DEPARTMENT ADMISSION: A HURDLE MODEL ANALYSIS IN AUTONOMOUS PROVINCE OF BOLZANO (ITALY)

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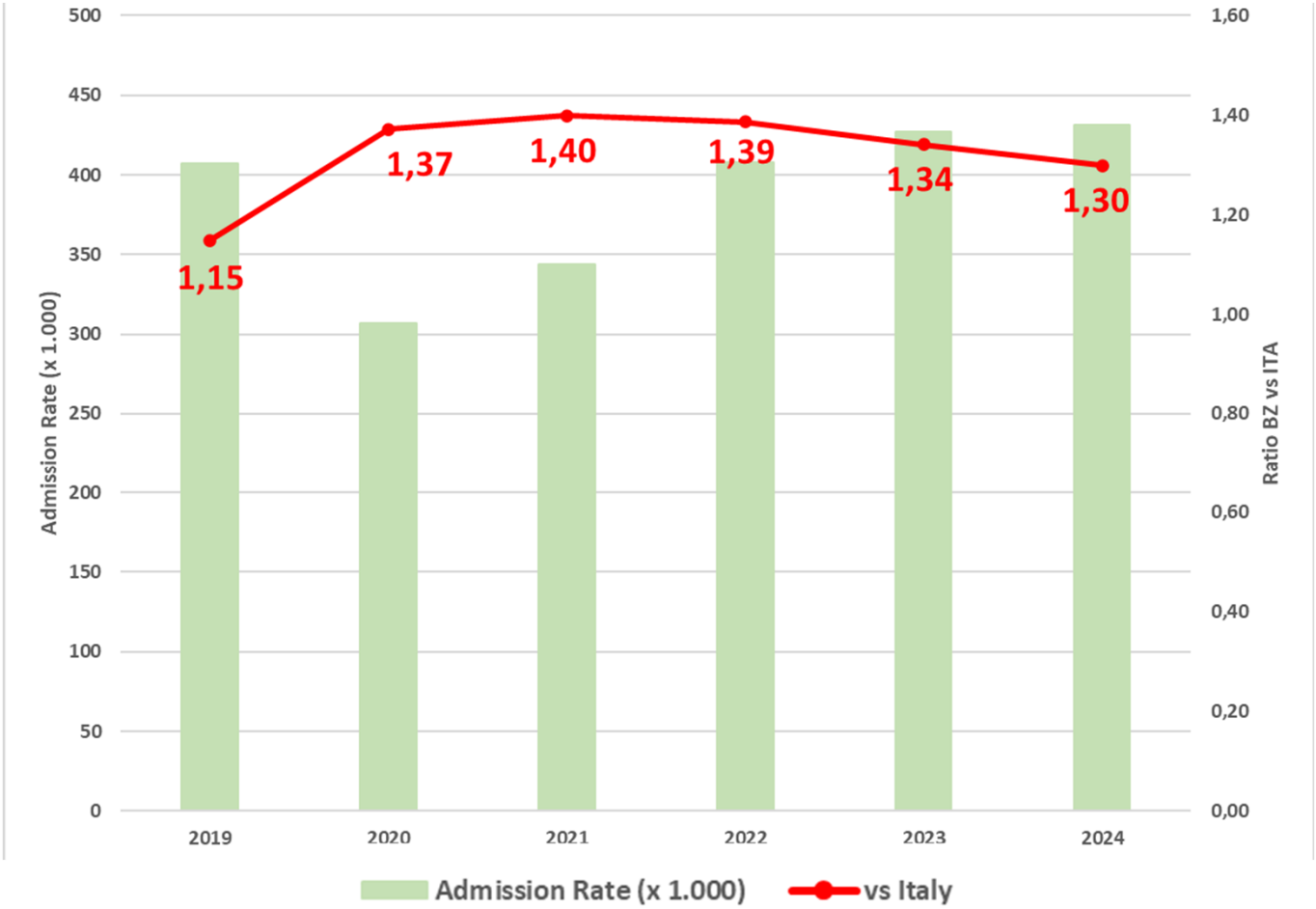
INTRODUCTION

- ***Overcrowding***
  excessive number of patients waiting to be examined and treated
  vs
  the physical capacity or to the available personnel of the emergency room

- ***ED inappropriate admissions***
  - *conditions that could be managed in primary care settings*
  - *delays in treating seriously ill patients*
  - *increase of the costs due to unnecessary investigations*

- ***Health policy***
  To analyze the geographical variation in ED use (unwarranted variation)
  To reduce ED potentially ***inappropriate admissions***

ED Admission Rates (per 1,000 inhabitants) 2019-2024



Source:
Mes Lab Institute of Management of Sant'Anna School of Advanced Studies (Pisa, Italy), The Italian Regional Performance Evaluation System (IRPES)
Ministry of Health

OBJECTIVES

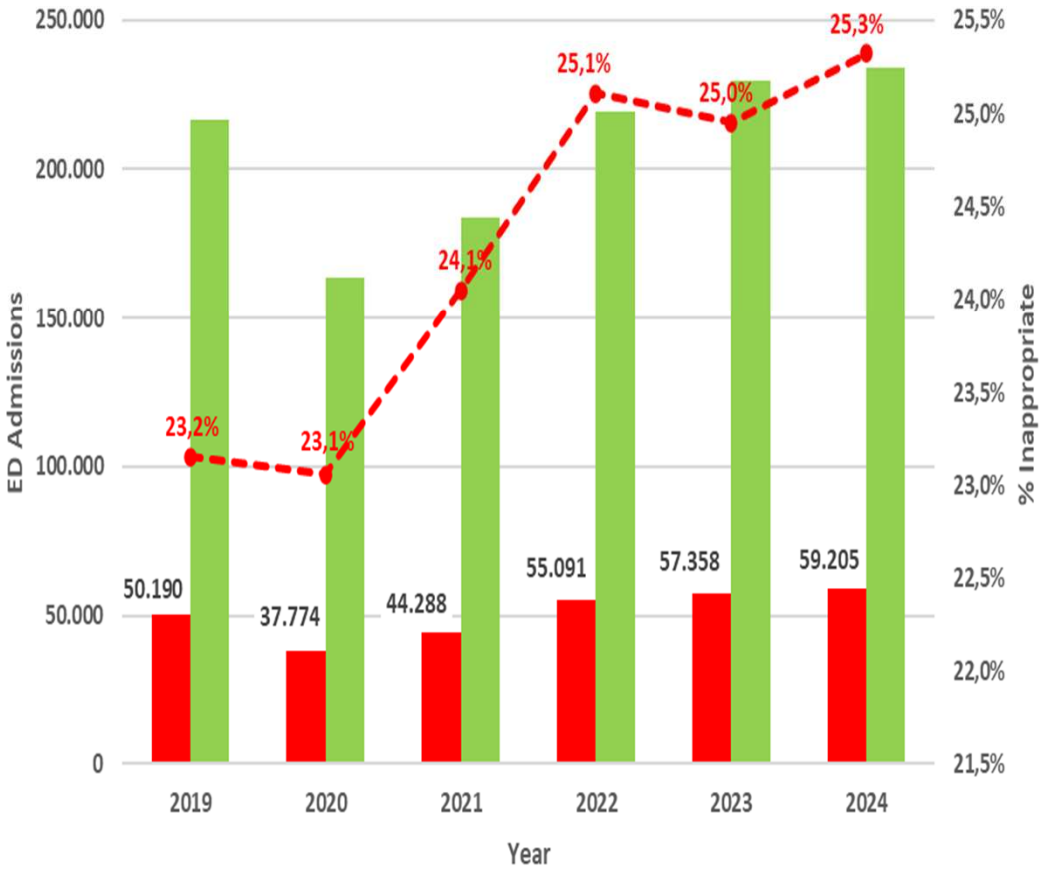
- ✓ To analyse and compare geographic variations in inappropriate ED admissions among the province of Bolzano

- ✓ To identify determinants of these variations

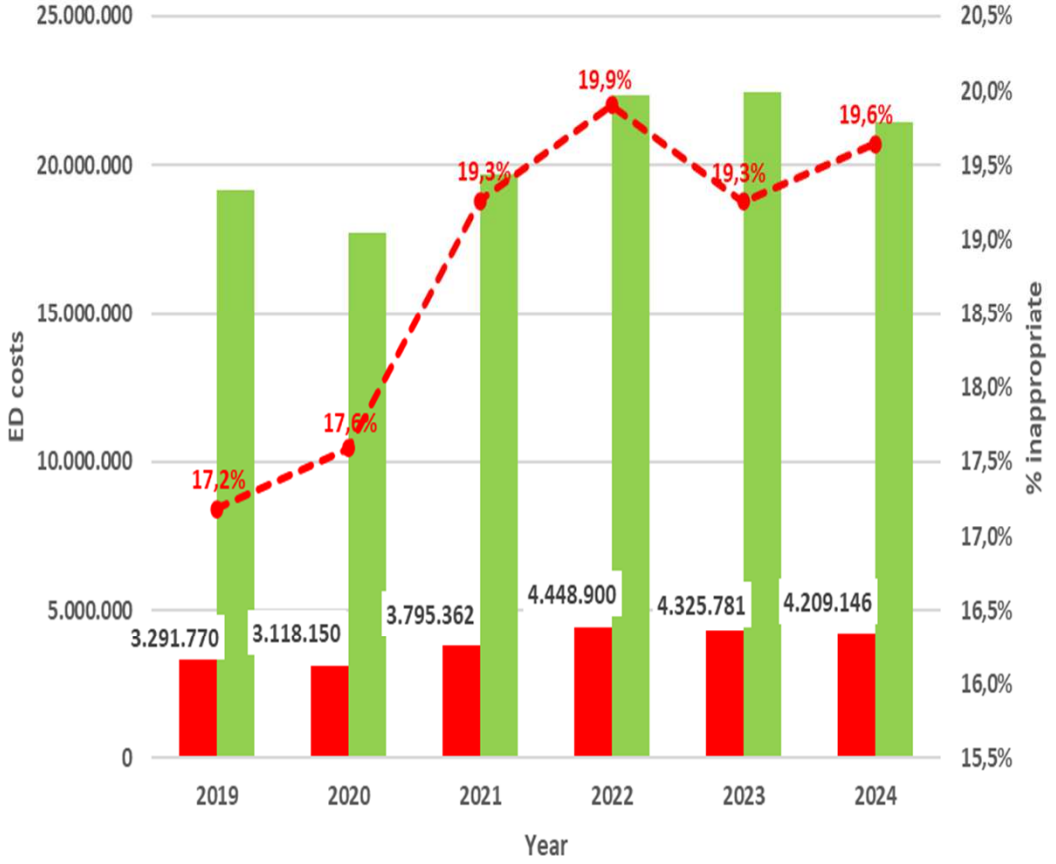
Selection Criteria:

- ✓ ED Admissions (2019-2024) by resident patients
- ✓ Inappropriate admissions are defined as
  - Triage: Level 4 (less urgent)/Level 5 (non urgent)
  - No Diagnosis of Trauma
  - Arrival Time from 8 a.m to 8 p.m. (week-end and Public Holidays excluded)
  - by Private Transport or referred by GP
  - Discharge Home

EDs Inappropriate Admissions (%)

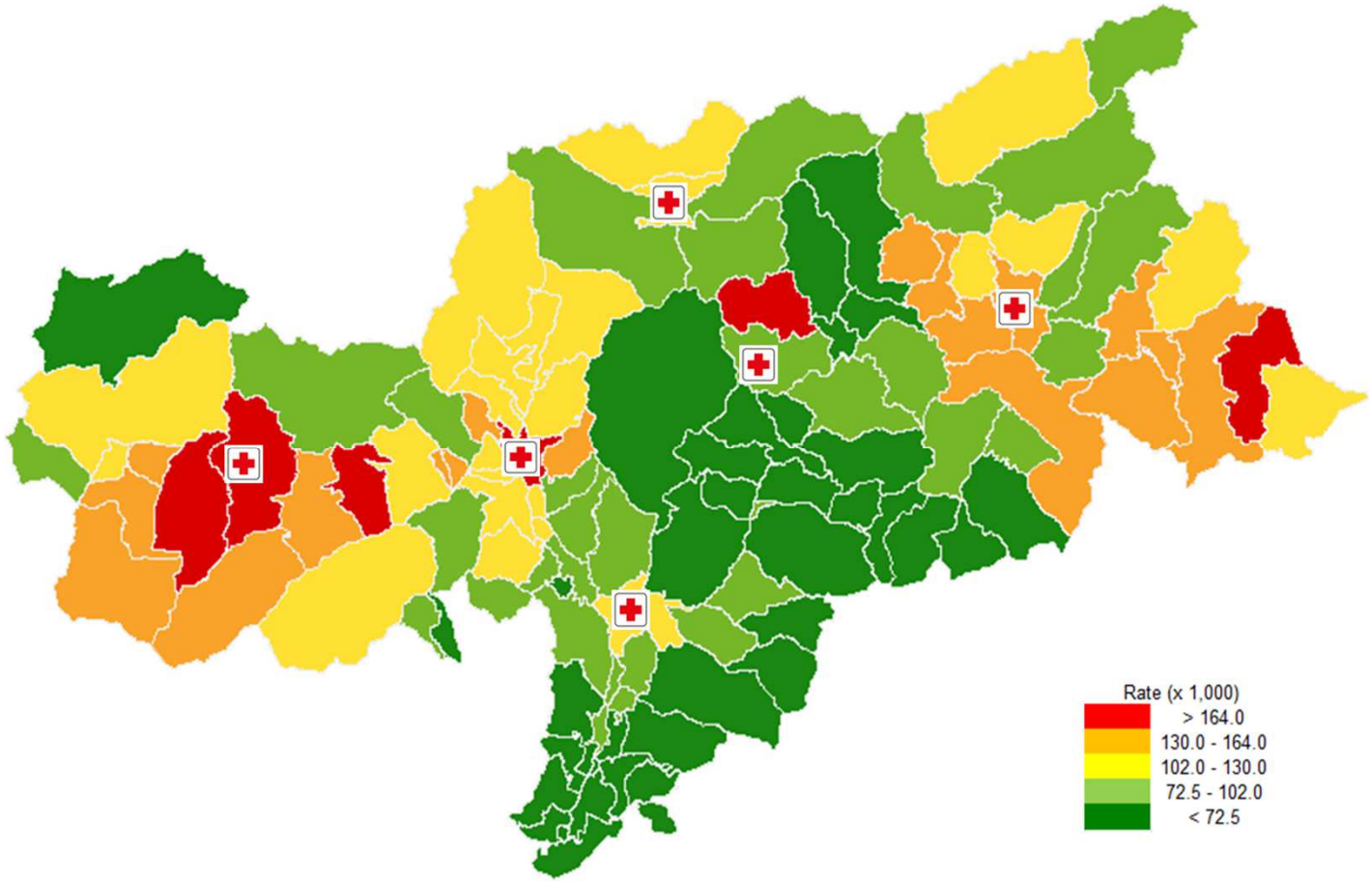


Costs (tariffs) of EDs Inappropriate Visits (%)



INAPPROPRIATE ED ADMISSIONS INAPPROPRIATE (%)

ED Inappropriate Admission Rates (2024) – Municipalities level (n = 116)



	2024
RATE	109.7
MIN	32.5
MAX	208.5
(High/Low)	6.4
SCV	> 10 (very high)

METHODS (1)

Regression model

- ✓ *Outcome*
  - *EDs Inappropriate Admissions (non-negative integer)*

- ✓ *Explanatory variables:*
- ✓ *Individual level*
  - *Age (years)*
  - *Gender (1 = F; 0 = M)*
  - *High Migration Pressure Countries (1 = yes; 0 = no)*
  - *Chronic conditions (n)*
  - *Registration with GP (1 = yes; 0 = no)*
  - *Frequent User (1 = yes; 0 = no)*
  - *Travel distance to the hospital (minutes)*

- ✓ *Municipality level*
  - *EDs Inappropriate Admissions: Length of Stay (LOS) (median)*
  - *Chronic patients (%)*
  - *Over65 patients (%)*

METHODS (2)

- ***Regression model***

  - ✓ *Given the existence of excess zeros in the distribution of inappropriate admissions, we tested the following three different models (Deb, Norton, Annu. Rev. Public Health, 2018):*
    - *Zero Inflated Poisson Model (ZIP)*
    - *Zero Inflated Binomial Model (ZIBN)*
    - *Hurdle count data Model (HM)*

  - ✓ *We also tested for fixed effects (FE) vs random effects (RE)*

  - ✓ *Model performance was compared using the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC)*

RESULTS (1)

VARIABLES	NO ED INAPPROPRIATE ADMISSIONS	ED INAPPROPRIATE ADMISSIONS	p
Admissions (n, %)	90,623 (67.8)	42,949 (32.2)	
Age (years) Mean (sd)	45.7 (26.9)	45.5 (24.7)	0.271[a]
Females (n, %)	43,365 (47.9)	22,497 (52.4)	< 0.001[b]
HMPC (n, %)	7,326 (8.7)	5,589 (12.6)	< 0.001[b]
Chronic conditions Mean (sd)	0.93 (1.6)	0.89 (1.5)	< 0.001[a]
GP (n, %)	89,033 (98.2)	42,017 (97.8)	< 0.001[b]
Frequent User (n, %)	2,621 (2.9)	5,444 (12.7)	< 0.001[b]

Note:
[a] t-test (continuous variables)
[b] Chi-square test (binary variables)

RESULTS (2)

Regression model (estimates)

Hurdle count data Model (HM)
+
Random Effects (RE)
→ municipalities (n=116)
is the best specification

HURDLE MODEL + RANDOM EFFECT
(j = municipality)

- *Binary*

$$logit\left[P\left(Y_{ij} > 0\right) = x_{ij}\gamma + b_j\right]$$

- *Count*

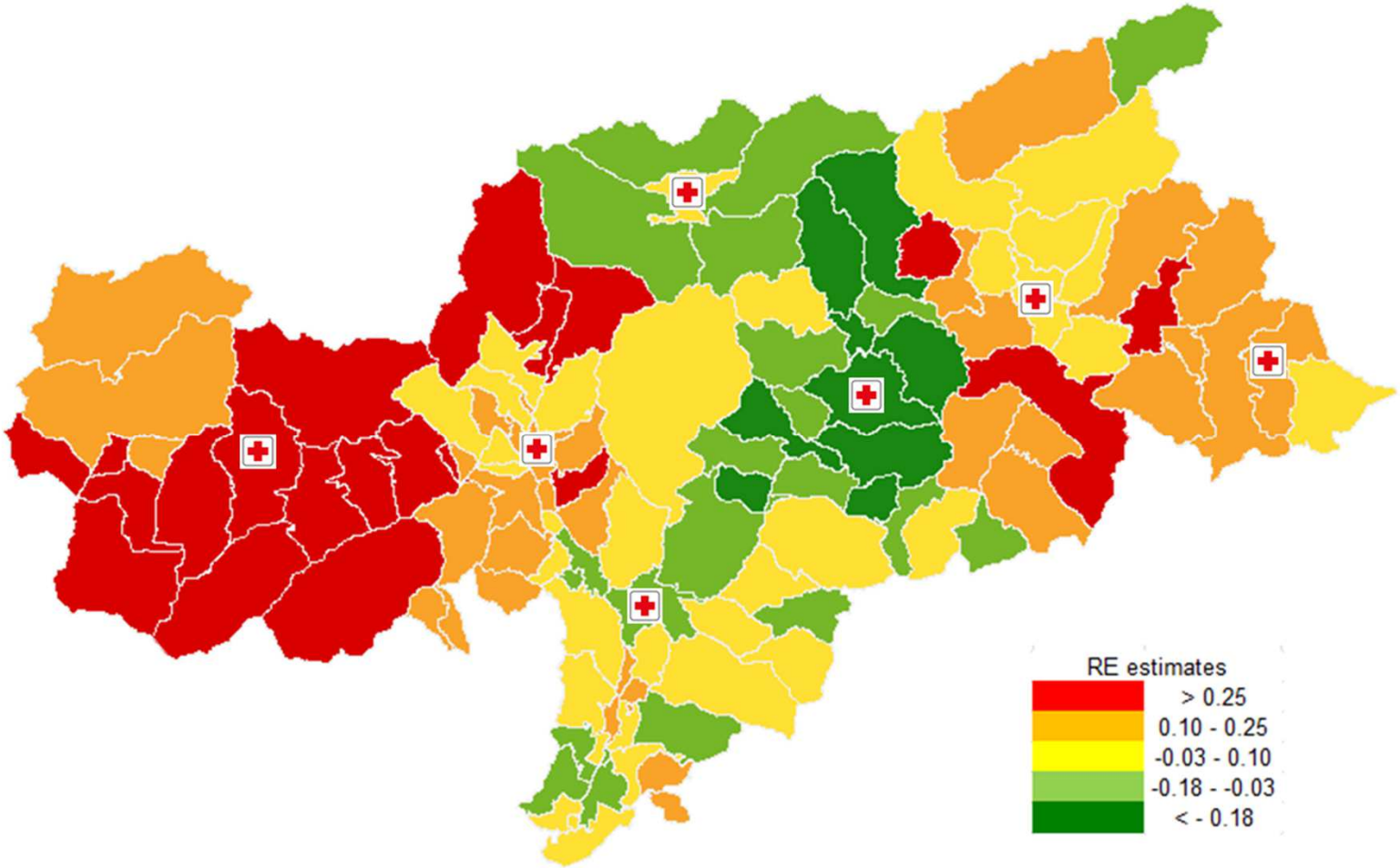
$$\log(\lambda_{ij}) = x_{ij}\beta + u_j$$

RESULTS (3)

		Coefficients	
VARIABLES	CATEGORY	BINARY	NON ZERO
Age	-	0.00129*	0.00059
Sex	F	0.18210*	0.06852*
Frequent User	Yes	1.57967*	1.97246*
GP	Yes	-0.15246*	-0.38468*
HPMC	Yes	0.45012*	0.19110*
Chronic conditions	-	-0.05833*	0.02264*
Distance from ED (minutes)	-	-0.00694*	-0.00141
LOS (median)	-	0.00090	0.00063
Chronic %	-	0.02047	0.01677
Over 65 %	-	0.10885	0.00204

* statistical significance at the 5% level

RESULTS (4)



CONCLUSIONS

- Higher ED volume and overcrowding increase the risk of inappropriate admissions
- Inappropriate ED admission rates have risen over time
- Variation persists across the 116 municipalities, even after adjusting for patient case mix
- Geography — including proximity to the ED — and the organization of health resources may explain these differences
- Limited GP or specialist access, long waiting times, short ED stays, and low or no copayment can make the ED attractive for non-urgent cases
- Reducing inappropriate admissions requires coordinated action by policy makers, healthcare professionals, and patients

For any questions

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