DISSERTATION FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PHD)

Examining the Impact of Roma Ethnicity and Socioeconomic Segregation on Healthcare Access and Expenditure in Hungary

By Feras Kasabji

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Feras Kasabji

SUPERVISOR:

Dr. Sándor János

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List of Abbreviations:

SES: SocioEconomic Status

PHC: Primary Healthcare

GMP: General Medical Practice

GP: General Practitioner

GDP: Gross Domestic Product

EU: European Union

WHO: World Health Organization

OECD: Organization for Economic Co-operation Development countries

NIHIFM: National Institute of Health Insurance Fund Management

srEDU: Standardized Relative Education

srEMP: Standardized Relative Employment

srEXP: Standardized Relative Expenditure

rHD: Relative Housing Density

rRP: Relative Roma Proportion

IQR: interquartile range

CI: Confidence Interval

SA: Segregated Areas

CA: Complementary Areas

CT: Computed Tomography

MRI: Magnetic Resonance Imaging

1 Introduction

Adequate healthcare and equitable healthcare spending remain a pressing concern for policy makers in the European Union (EU) and Hungary, where disparities persist despite efforts to address them. According to the Health Systems in Transition report on Hungary [1], a key problem is the continuing lack of an overarching, evidence-based strategy for mobilizing resources for health, which leaves the health system vulnerable to broader economic policy objectives and makes good governance hard to achieve. Healthcare expenditure in Hungary has been rising steadily in the last decade, where in 2022, the country spent $2840 per capita on healthcare in terms of purchase power parity PPP, compared to the average of $4986 in countries within the Organization for Economic Co-operation Development (OECD),This expenditure equates to a total healthcare spending of 6.7% of the country's Gros Domestic Product (GDP) [2] still below the average of 9.2% for countries within the Organization for Economic Co-operation Development (OECD), where gaps exist especially in funding outpatient services and medication [3]. Some of the main reasons driving healthcare costs include ageing populations, rising levels of chronic disease prevalence, technological advances and most importantly socio economic inequality [4–6]. While new technologies, facilities, and increased spending improve overall health outcomes, they also impose a risk of raising resource allocation inequalities within disadvantaged groups [7–9].This unequal distribution of healthcare resources is a serious cause for concern requiring further research.

Perceived access to quality healthcare is also lower in Hungary where only 44% of the population were satisfied with access to quality healthcare [2] compared to the 67% OECD average. Another persistent pattern for Hungary is particularly high hospital based care use [3,10] revealing a dangerous weakness in healthcare access. This exacerbates the need for emergency

care and underscores the importance of examining the reasons behind unequal access to care, that heavily impacts poor communities [11–13].

This apparent dissimilarity has many contributing factors. However, Socioeconomic status (SES) emerges as a significant determinant of healthcare access and expenditure, individuals with lower education, and employment, living in rural areas or being of a segregated minority face greater barriers to quality healthcare [11,12,14–19]. These factors can potentially be the focus of interventions aimed at diminishing inequalities in healthcare access and spending.

Ethnicity further complicates the landscape of healthcare access and expenditure [20,21], as ethnic minorities are often disproportionately impacted by socioeconomic disadvantages, one such group are the Roma, the largest ethnic minority in Europe (EU) [22] and Hungary [23] where they constitute around 94% segregated inhabitants[24]. Specific data on Roma health status is scarce, however their life expectancy is estimated to be 10 years shorter [25], with higher risk of coronary, chronic, and communicable diseases [26–28]. This is one of the more pressing health equity concern in the EU and Hungary prompting investigations on Roma access or misuse of healthcare services [13,29,30].

However, any Roma centered study often faces two key challenges, the first being whether to include ethnicity as an indicator of social deprivation and a predictor of health status. The literature on this topic is highly inconclusive, some studies advocate for including ethnicity as a main predictor of health due to genetic or cultural reasons [31,32], while others argued ethnicity only impacts health through a social pathway that could get fully mitigated when accounting for SES. Moreover, using ethnicity as a main predictor could increase division and stigmatization. In many cases it seems that SES may be the critical factor that needs addressing in order to implement policies successfully [33–36], ultimately reducing inequality and achieving

better health outcomes for Roma. The second obstacle is the inability to accurately identify Roma in localized demographics [37,38] leading to difficulties in monitoring their health statistics, mainly attributable to ethical and methodological barriers. These limitations are clearly evident in the minimal impact of Roma-specific health policies [39,40] on the widening Roma health gap [41,42]. Confronting these issues is one of the main goals of this thesis, by developing comprehensive analyses using a wide range of data and methodologies to explore the role of Roma ethnicity in healthcare. Furthermore, to bypass the constraints of Roma identification, the thesis employed inclusion criteria similar to those used by some EU countries, such as Hungary. These criteria target segregated areas regardless of ethnicity, where Roma and non-Roma populations live in similar socioeconomic deprivation, in accordance with Hungarian national social inclusion strategies [43]. This approach caters to the sensitive needs of local communities and ultimately help inform more effective polices to reduce health inequality and achieve better outcomes for people within deprived communities.

A key organization for these healthcare polices in Hungary is the National Institute of Health Insurance Fund management (NIHIFM) which organizes the country's official health insurance and health monitoring systems. NIHIFM collects performance indicators evaluating General Medical Practices (GMPs) [44,45] which influence their pay for performance, however a significant amount of data on primary healthcare (PHC) operation are collected but not utilised by the NIHIFM, creating an untapped reservoir of valuable research material.

2 Objectives

2.1 Related to Roma ethnicity and SES effect on healthcare reimbursement.

A. Investigate the relation between GMPs' healthcare reimbursement by the NIHIFM and the proportion of Roma within their patient population.

B. Control for SES indicators of patients and GMP structural characteristics, in order to detail their association with healthcare expenditure, and describe the Roma impact independent from those well-established factors.

C. Gauge the usefulness of GMP level Roma specific indicators in formulating equality-oriented health policies.

2.2 Related to using untapped NIHIFM data to monitor health status, healthcare use and reimbursement of segregated areas.

A. Apply the available yet unutilized NIHIFM data to investigate inequality in healthcare use and reimbursement at the GMP level, between deprived segregated areas where mostly Roma reside, and nearby non-segregated areas.

B. Delineate the variation in inequality indicators across Hungarian GMPs serving both communities.

C. Assist in developing a novel equality focused health monitoring system.

3 Literature review

3.1 Health status of low SES patients in the EU and Hungary

In 2021 the average life expectancy at birth reached 80.3 years in the EU, while in Hungary it was 75.2 years [2], moreover research has indicated that in central European countries, persons with lower SES and especially education have on average 10 year shorter life expectancy [46] compared to those with tertiary education, which is the highest in the region according to studies investigating 27 European countries [47,48].

In Hungary, men at the age of 30 with lower education live on average 11 years shorter than the highly educated, while for women the gap is smaller at 3.1 years [3]. Similar disparities in health were discovered among Roma who often reside in low SES segregated communities as indicated by both local Hungarian [49] and EU based research [25]. It is important to note that within these segregated areas other ethnicities experience similar deprivation ranging from 6 % of total community population according to some studies [24] to 32.2% [50] in others.

3.2 Determinants of SES and health

SES is an intricate and multifaceted concept comprising numerous factors including Income, education, employment and living standards. These factors collectively impact all aspects of an individuals' life and wellbeing and contribute to health disparities among underprivileged patients in multiple pathways as described by studies globally and across the EU [51–53]. However, understanding the relationship between social differences and health inequalities is very complex. The model proposed by Evans et al [54] illustrates how SES is correlated with systematic variations in living conditions and influences the degree of vulnerability to these conditions. This aligns with other conceptual frameworks such as the World Health Organization (WHO) social determinants of health model [55] that illustrates how SES impacts health equity through intermediary determinants like working and living conditions. The theory of fundamental causes by Phelan et al [56] further elaborates that higher SES groups are persistently favored in health disparities regardless of present health risk due to resources such as money, knowledge and power. Additionally, recent European multinational projects such as "Romomatter" [57] touch on the psychosocial context within the Roma community that might adversely influence the SES and health of girls and women in particular, perpetuating a cycle of worsening conditions. .

Collectively these models demonstrate the complexity of this relationship and highlight the need for broad multisectoral polices and interventions to address social and economic determinants of health inequality. The Sustainable Development Goals (SDGs) established by the United Nations in 2012 [58] acknowledge this requirement and provide a comprehensive framework. SDG 3 (Good Health and Well-being) aims to ensure healthy lives and promote well-being for all at all ages, while SDG 4 (Quality Education) and SDG 8 (Decent Work and Economic Growth) emphasize the importance of education and employment as key determinants of health. Additionally, SDG 10 (Reduced Inequalities) specifically targets the reduction of inequality within and among countries. Collectively, these SDGs reinforce the necessity of a holistic approach to mitigating health disparities, aligning with the theoretical models and emphasizing the importance of coordinated efforts across different sectors and levels of governance.

3.3 Key healthcare challenges facing low SES groups in the EU and Hungary

According to a systematic review conducted across Europe [59], segregated Roma communities have poor waste management, high environmental risks and challenging housing conditions. Rigorous comparative studies have also found that deprived persons (both Roma and non-Roma) often engage in health compromising actives such as smoking, alcohol consumption, low physical activity and unhealthy diets [60,61] which are speculated to be attributed to cultural differences between SES groups as well as them having reduced access to healthy environments and lack of availability of certain food items due to poverty and segregation . This is further compounded by low health literacy, limited awareness of personal health and lack of knowledge about the local healthcare system [29,62]. Another aspect that should not be overlooked is the tension between patients and healthcare providers, who according to recent

research [29,62,63] have difficulty communicating with, and deliver culturally appropriate care to deprived patients.

3.4 Importance of primary healthcare

The 1978 Alma-Ata declaration [64] introduced primary healthcare as the key component in achieving equal and acceptable levels of health for all, since then numerous studies [65,66]. have corroborated the major role of primary care and GPs in increasing the overall health and health equity of patients. GPs serve as patients first point of contact when seeking care, and most stay with the same practitioner for a lifetime, which fosters a collaborative relationship that is essential for quality healthcare, as it helps the GP in adapting to a patient's psychological, cultural and socioeconomic needs. However the impact of GP-specific structural indicators is scarcely researched, a Hungarian study in 2019 [45] found that across 12 parameters, patients' health as well as GP performance was associated with GPs' patient list size and location, but did not include other factors such as age of GP.

3.5 History of addressing primary healthcare inequality

Access to quality PHC is crucial for preventative care, from screening and early diagnosis of health issues to management of chronic conditions. However, a concerning trend known as the inverse care law mentioned in research from 1971 [67], states that availability of good healthcare often decreases as the need for it increases within a population. This led to a race to establish an elaborate institutionalized response. And by 1983, Jarman et al identified that people residing in low SES environments tend to face more challenges, have fewer resources, and quality PHC compared to wealthier areas [68] thus creating the Jarman index to help calculate PHC resource allocation. However the previously discussed SES factors, exponentially complicate developing formulas dedicated to funding GMPs and mitigating health inequality

[69,70], evidenced by the iterations to indexes such as Jarman's, among which are the "Minimum practice income guarantee" formula and then the Carr-hill formula [71]. Evidence have been accumulating that health polices over the past 30 years have not been enough to reduce inequalities in PHC [72], and calling for further reliance on evidence based-approaches, particularly considering the Inverse Care Law and SES. Moreover, a recent systematic review found that there are more than 691 indicators impacting health inequality and PHC [73]. Highlighting the complex interactions between factors affecting health disparities, and the need for continued iterations in health formula processes.

3.6 The Economic burden of health inequality

With the constant increase of health spending across the globe, it is important to note that socioeconomic health inequalities not only impact individuals' lives but also add a significant economic burden on countries, according to an article on health costs in the EU [74], around 33 million cases of ill health and 700,000 deaths per year are lost in the European union due to health inequality between SES groups, as measured by education levels. Treating these cases amounts to 20% of the total health costs . additionally, these health disparities reduce labor productivity, which translates to €980 billion per year or 9.4% of the EU's GDP, similarly a recent analysis in the USA [75] found that the economic burden due to education related health inequalities was $940-$978 billion and $421-$451 was caused by ethnic health inequalities. Furthermore, an Austrian study [76] found that men and women with lower education levels have 66% and 20% higher lifetime health costs compared with those with high education, and closing the healthcare gap between socioeconomic groups could reduce healthcare expenditure by 19% for the whole population.

The mechanisms by which losses in lives resulting from health inequalities translate to economic burden on countries are complex. However, some pathways may involve healthcare costs, social security costs, and reduced labor productivity leading to losses in GDP.

3.7 Rationale of the study

The Hungarian government's current approach to Roma integration focuses on providing resources for education, employment, and housing in segregated communities defined by a government decree [77]. Many programs fall within this framework including the "catch up settlements" [78], "Maltese Charity Service Naszlady Attila Program", and "Telemedicine is not a goal, but a tool" [79]. While these efforts aim to address social and economic disparities, there is a gap in knowledge regarding the impact of these determinants on the health of individuals living within these communities.

Deprivation and low SES have been implicated in influencing healthcare inequality, affecting access and funding of healthcare leading to adverse health outcomes in marginalized communities, making them a particular point of interest in recent scientific research. According to the sustainable development goals in health equity [80], education, income and employment are some of the most impactful social determinants of health. However, despite the growing attention, definitive answers remain elusive on the specific role they play in health outcomes [81–84]. These findings affirm the complex interplay of social factors concerning the health status and healthcare of the population in general and deprived communities in particular.

Furthermore, Hungarian research [85,86] in addition to analysis by the national institute of family and social policy, highlight the presence of non-Roma individuals in segregated communities, suggesting a more complex picture of segregation than solely focusing on Roma populations. The WHO framework on health systems governance [87] provides comprehensive guidelines for

addressing health inequities through strategic policy frameworks, effective oversight, coalition-building, equitable resource allocation, and continuous monitoring and evaluation. This framework is essential for understanding the broader systemic issues that contribute to health disparities faced by low SES groups. The findings of this study can reinforce the current epidemiological evidence and underscore the importance of further exploring determinants of inequality as well as the potential to strengthen health provision pathways, in alignment with the WHO's governance principles.

Correspondingly, the first part of this dissertation was dedicated to describing the state of health inequalities focusing on SES factors and ethnicity, and examining the polices currently in place to address them. By identifying the primary social determinants of health currently contributing the most to health reimbursement inequality, in addition to assessing the intricate role of ethnicity, the study aimed at providing empirical evidence essential to tailor scientifically driven decision making geared towards addressing social vulnerabilities of disadvantaged communities, and weaknesses found within the Hungarian health financing system [1].

However, measuring the health of disadvantaged populations is challenging, especially for monitoring ethnicity-based inequalities. Difficulties arise from various factors, with one major obstacle being the limited, incomplete, or variable collection of ethnicity data in health and social care systems, hindering the assessment of disparities and the conceptualization of appropriate polices [88–91]. This is further complicated by the reluctance of some patient communities such as the Roma to disclose their ethnicity [92,93]. Studies suggested that it could be feasible to bypass these issues using indirect methods to estimate disparities [94,95]. Given these considerations, it is crucial to prioritize research that focuses on investigating specific pathways and methodologies necessary to monitor health-related indicators, ultimately

enhancing the well-being of the Roma and other marginalized populations. Therefore, the second study in this doctoral thesis aimed to address this gap in the literature by examining the possibility of using spatial segregation where mostly deprived communities including Roma reside, to monitor and compare their health status as well as engagement with healthcare services with that of the non-segregated population, by employing readily existing but unutilized data collected by the NIHIFM. The findings can reinforce the current epidemiological evidence and underscore the importance of further exploring determinants of inequality as well as the potential to strengthen health provision pathways.

4 Methods:

4.1 Part I:

4.1.1 Setting

A comprehensive nationwide cross-sectional study encompassed all General Medical Practices (GMPs) in Hungary, totaling 4818, catering to adults aged 18 years and above. Data specific to GMPs' adult health expenditures from 2012 to 2016 and their structural attributes in 2012 were sourced from the National Health Insurance Fund (NHIF). Socioeconomic status indicators were derived from the latest census conducted by the Hungarian Central Statistical Office in 2011.

4.1.2 Socioeconomic Status Indicators

To gauge socioeconomic status, multiple indicators were calculated, the observed count of self-declared Roma individuals in each community or settlement was compared to the expected count, calculated based on the total Roma population in the country (N=315,583), the overall population of Hungary (N=9,937,628), and the population of the specific settlement. This yielded the settlement-specific relative Roma proportion (rRP).

Education levels, quantified by years of school attendance, and employment rates in settlements were standardized by age and sex and aggregated for each settlement. The expected values for settlements were determined using national reference years of school attendance (for individuals aged at least 7 years) and employment ratios (for individuals aged at least 15 years), stratified by demographic characteristics (see supplementary Tables A1-A2). Standardized relative education (srEDU) and standardized relative employment (srEMP) were computed for each settlement.

The housing density index for settlements (rHD) was determined by the number of occupants per one hundred rooms relative to the national average.

The settlement-level socioeconomic status indicators were then transformed into GMP-specific indices, by weighing them according to the number of GMP clients residing in different settlements.

4.1.3 GMP Structural Indicators:

Multiple indicators were established for each GMP, including categories based on the number of insured individuals (≤800, 801–1200, 1201–1600, 1601–2000, >2000), the rural or urban classification of the GMP's location, and the demographic served (adults only or adults and children). Additionally, GMPs were categorized by the age groups of their general practitioners (<65 years old or ≥65 years old) and by geographical location across counties in Hungary.

4.1.4 Health expenditure:

Health reimbursement to Hungarian GMPs is divided into capitation fees and performance-based fees from NHIF. Capitation fees are fixed per number of patients regardless of services rendered, while performance-based fees cover various services like medicine reimbursement,

dental care, and hospitalization and are the cause of per capita health spending variability [1]. Public spending on healthcare in Hungary has been rising steadily from 69.7%, in 2009 [1] to 72.5% in 2021 [96], with private sources primarily contributing through out-of-pocket payments.

The average per capita expenditure per year for GMPs was calculated by aggregating expenditure recorded by the NHIF over a five-year investigation period, excluding per capita financing. Additionally, expected five-year payments were determined for each GMP based on age and sex-specific national reference payments over the same duration (refer to Appendix Table A3). The ratio of observed to expected per capita payments yielded the GMP-specific standardized relative expenditure (srEXP).

Finally To normalize the data, the two-step Box-Cox method [97] was applied to the resulting variables of srEMP, srEDU, srEXP, and srRP. These weighted and normalized GMP-specific socioeconomic status indicators were used in further analyses.

4.1.5 Data Analysis

GMP expenditure distribution was analyzed using means (± standard deviation SD) of standardized expenditure srEXP. The relationships between patients' socioeconomic status, GMP's structural characteristics, and srEXP were assessed through Pearson correlation and one-way ANOVA tests. A mixed two-level multivariable linear regression model was employed to explore the impact of GMP-specific socioeconomic indicators srEMP, srEDU, rHD, srRP and structural indicators, while considering county clustering. The linear regression coefficients (b) were utilized to depict the associations between explanatory variables and outcomes along with their corresponding 95% confidence intervals (95% CI). The model's fit was assessed using the adjusted R2. Additionally, issues like multicollinearity and heteroskedasticity were examined (with relevant figures B1 and B2) in the appendix. Three

models were constructed to explore the correlation between rRP and srEXP: a bivariate linear regression analysis (Model A), a multivariable model incorporating GMP structural characteristics (Model B), and Model B supplemented with socioeconomic status indicators other than rRP (Model C). The standardized linear regression coefficient (β) for Model C was computed to ascertain the relative effect size of each independent variable. Significance was determined at $p<0.05$ in this analysis. The data analysis was conducted using SPSS version 20.

4.2 Part II:

4.2.1 Setting

This research utilized individual health records and assessed aggregated indicators at the level of General Medical Practices (GMPs) in Hungary. A total of 4359 Hungarian GMPs providing care for adults were included in the study. These GMPs were all contracted with the National Institute of Health Insurance Fund Management (NIHIFM), the sole health insurance institute in Hungary. The NIHIFM supplied data from 2020 for secondary analysis concerning healthcare utilization, reimbursement, and health status of adult patients associated with these GMPs.

4.2.2 Study Design

A cross-sectional investigation was conducted on Hungarian GMPs catering to segregated adult populations. Segregated areas (SAs) were identified based on a governmental decree that defines them as clusters within settlements where adults aged 18-59 have predominantly primary-level education at most and lack active income. The NIHIFM classified households as either SAs or non-segregated areas (complementary areas (CAs)), which were mutually exclusive categories. By utilizing addresses, any adult aged 18 or above could be categorized

as residing in an SA or CA. GMPs without patients residing in SAs were excluded from the analysis.

4.2.3 Healthcare Delivery measures:

Various healthcare delivery rates were computed as the number of patients utilizing healthcare services per patient within a GMP over the preceding 12 months. These indicators encompassed: 1) general practitioner visits, 2) outpatient services excluding computed tomography or magnetic resonance imaging (CT/MRI), 3) CT/MRI services, and 4) hospitalizations.

4.2.4 Healthcare Reimbursement measures:

Per capita reimbursement for these services with the addition of medication costs was determined as health insurance expenditure (in Euros) per patient within the general medical practice over the previous 12 months. Since NHIFM finances GMPs on a per capita basis regardless of visit frequency, number of GP visits was not included in reimbursement indicators as it does not impact GMP average per capita funding variability.

4.2.5 Premature Mortality measure:

Premature mortality encompassed all-cause deaths of individuals under 65 years who had not changed their GMP within the past 5 years to exclude those who passed away under the care of a new GMP without prior health management.

4.2.6 Data Analysis

Standardized performance metrics were calculated using the national average as a benchmark. Indicators for SAs and CAs were indirectly standardized by age groups (18–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69, 70–74, 75–79, and 80 and above), sex, and

eligibility for exemption certificates which are issued by local municipalities to patients with disadvantaged socioeconomic status and chronic illnesses for free access to medications and medical devices upon GP recommendation. Standardized risk ratios for SAs (SRsa) and CAs (SRca) were obtained by dividing GMP-level observed values by the benchmark expected values for each indicator and GMP. These data were aggregated to generate country-level standardized measures for SAs and CAs.

The relative performance in SAs was characterized by the risk ratio (RR), calculated as the SRsa/SRca ratio nationally for each GMP, along with the corresponding 95% confidence intervals (95% CIs). Additional impact measures such as excess cases in SAs, percentage of risk attributable to segregation in SA populations (attributable risk), and percentage of risk attributable to segregation in the entire country's population (population attributable risk) were computed using nationally and locally adjusted standardized ratios.

5 Results

5.1 Part I:

5.1.1 Descriptive statistics:

The total adult population within the examined GMPs amounted to 7,506,059 individuals. The total expenditure reached 873,797,515,655 Hungarian Forints (HUF) annually, translating to a national average per-capita expenditure of 116,412 HUF per year. Notably, per-capita expenses exhibited significant variation across different demographic strata as detailed in Supplementary Table A3. The average yearly GMP-specific per-capita expenditures followed a normal distribution pattern, as illustrated in Figure 1. Specifically, the mean (± standard deviation) of the GMP-specific standardized expenditure (srEXP) was calculated at 1 ± 0.15.

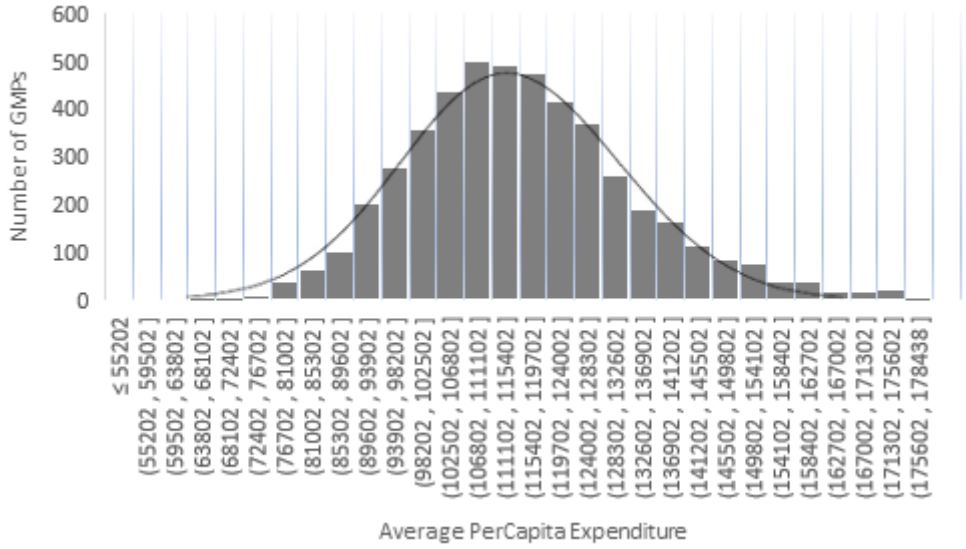

Figure 1. Distribution of average per-capita expenditure among the Hungarian GMPs studied.

The GMP-specific srEDU, srEMP, rHD, and rRP exhibited medians (Interquartile Ranges: IQR) of 0.91 (0.1), 0.92 (0.22), 1.01 (0.20), and 0.37 (0.75) respectively, as outlined in Table 1. Pearson's correlation analysis revealed that rRP displayed negative correlations with both srEDU ($r = -0.55$; $p < 0.001$) and srEMP ($r = -0.71$; $p < 0.001$), indicating that Roma populations tended to have lower levels of education and employment. Furthermore, srEDU and srEMP demonstrated a strong positive correlation with each other ($r = 0.80$; $p < 0.001$), suggesting a link between higher education levels and increased employment rates. Notably, rHD showed no significant correlation with any of the other socioeconomic indicators examined in the analysis.

Table 1. Crude socioeconomic status indicators for the whole population and the distribution of their relative proportions among general medical practices in Hungary.

Variable	Crude indicator for the whole country	Median (IQR)
Roma proportion	3.10% (315583/9,937,628)	0.54 (2.30)
Employment ratio	46.44% (3942723/8,489,969*)	0.92 (0.22)
Housing density	1.08 (10771119**/9,937,628)	1.01 (0.20)
Years of education	10.38 (96217389/9264462***)	0.91 (0.1)

*Population over 14 years old, ** Number of rooms for a person, *** Population over 7 years.

The data indicates that out of the total GMPs examined, 274 had vacant General Practitioner (GP) positions. GMPs where GPs were aged over 65 accounted for 26.70% of the total. A majority of the GMPs were situated in urban areas, comprising 66.40% of the sample. Furthermore, 69.30% of the GMPs exclusively catered to adult patients. List sizes for most GMPs fell within the ranges of 1201-1600 (31.90%) and 1601-2000 (29.70%). In contrast, 19.20%, 4.00%, and 14.20% of GMPs provided healthcare services to more than 2000, less than 800, or 801–1200 insured patients respectively, as detailed in Table 2.

Table 2. Per-capita expenditures (in Hungarian forint) of the National Health Insurance Fund by general medical practice (GMP) structural characteristics during the period 2012-2016 in Hungary.

GMP characteristics	Categories	Number of GMPs (%)	Average per capita expenditure (±SD)	P value*
GP (age and vacancy)	Vacant GMPs	273 (5.70%)	113976 (±20715)	0.023
	GPs younger than 65	3532 (73.30%)	116759 (±20943)	
	GPs older than 65	1289 (26.70%)	116988 (±19394)	
Type of settlement	Urban	3198 (66.40%)	118042 (±19091)	<0.001
	Rural	1620(33.60%)	114408 (±22951)	
GMP type	For adults only	3337 (69.30%)	117982 (±19043)	<0.001
	For adults and children	1481 (30.70%)	114203 (±23360)	
GMP size (number of patients)	≤800	193 (4.00%)	117986 (±23687)	<0.001
	801-1200	725 (15.20%)	119346 (±22918)	
	1201-1600	1540 (31.90%)	118382 (±21039)	
	1601-2000	1434 (29.70%)	116347 (±19585)	
	2000<	926 (19.20%)	112735 (±17671)	
County	Budapest	865 (18.00%)	117989 (±18068)	<0.001
	Baranya	209 (4.30%)	135521 (±20263)	
	Bács-Kiskun	256 (5.30%)	116025 (±17696)	
	Békés	187(3.90%)	122870 (±21309)	
	Borsod-Abaúj-Zemplén	372 (7.70%)	114362 (±20751)	
	Csongrád	204 (4.20%)	121642 (±17366)	
	Fejér	194 (4.00%)	111226 (±19894)	
	Győr-Moson-Sopron	203 (4.20%)	103027 (±15623)	
	Hajdú-Bihar	244 (5.10%)	124405 (±19657)	
	Heves	161 (3.30%)	124883 (±21479)	
	Komárom-Esztergom	144 (3.30%)	110720 (±16981)	
	Nógrád	109 (2.30%)	113147 (±17877)	
	Pest	481 (10.00%)	110442 (±20442)	
	Somogy	172(3.60%)	120730 (±20856)	
	Szabolcs-Szatmár-Bereg	266 (5.50%)	112080 (±15928)	
	Jász-Nagykun-Szolnok	194 (4.00%)	118343 (±19830)	
	Tolna	119 (2.50%)	121861 (±17970)	
	Vas	133 (2.80%)	117535 (±33926)	
	Veszprém	164 (3.40%)	109797 (±16885)	
	Zala	141 (2.90%)	116221 (±19183)	
Total	---	4818 (100.00%)	116820(±20539)	---

*By one-way ANOVA

5.1.2 Regression analysis

The two-level bivariate mixed linear regression model A revealed a significant positive association between the relative Roma proportion (rRP) and standardized expenditure (srEXP) with a coefficient of (b= 0.011, 95%CI: 0.008; 0.013). This association persisted in model B, which adjusted for GMP structural characteristics, showing a coefficient of (b= 0.005, 95%CI: 0.002; 0.007). However, upon incorporating additional socioeconomic status indicators in model C, the impact of rRP on srEXP became nonsignificant with a coefficient of (b= 0.002, 95%CI: -0.001; 0.005), indicating that the Roma population proportion did not significantly affect expenditures.

In model C (adjusted R2=0.147), standardized education (srEDU) exhibited a positive correlation with expenditures, with a coefficient of (b= 0.199, 95%CI: 0.128; 0.271), suggesting higher education levels were linked to increased spending. Conversely, standardized employment (srEMP) showed a negative association with srEXP, with a coefficient of (b=-0.282, 95%CI: -0.359; -0.204), indicating that higher employment rates were associated with lower expenditures. No significant relationship was observed between relative housing density (rHD) and srEXP.

Notably, srEXP was significantly reduced in smaller GMPs serving less than 800 clients (b = -0.043, 95%CI: -0.066; -0.020) and those catering to 800-1199 clients (b = -0.018, 95%CI: -0.031; -0.004). Additionally, the presence of permanent GPs aged over 65 years had a negative impact on spending (b = -0.026, 95%CI: -0.036; -0.016). GMPs exclusively providing services to adults exhibited a significant positive correlation with srEXP (b = 0.016, 95%CI: 0.001; 0.032) compared to those serving both adults and children. Geographical location was also identified as a significant factor influencing expenditures as detailed in Table 3.

Table 3. Association between the proportion of Roma among GMP patients, and standardized average per-capita expenditures estimated with linear regression models controlling for SES of patients and the structural characteristics of GMPs.

Variables*	Category	Model A		Model B		Model C	
		b (95%CI)**	P value	b (95%CI)**	P value	b (95%CI)**	P value
Roma proportion		0.011 [0.008;0.013]	<0.001	0.005 [0.002;0.007]	0.001	0.002 [-0.001;0.005]	0.250
SES	Employment	Not controlled				-0.282 [-0.359;-0.204]	<0.001
	Housing density					-0.034 [-0.082;0.014]	0.160
	Education					0.199 [0.128;0.271]	<0.001
Type of settlement	Rural			-0.007 [-0.022;0.007]	0.329	-0.011 [-0.026;0.004]	0.140
	Urban			1 [reference]		1 [reference]	
GP position	GP permanent, ≥65 years old			-0.026 [-0.036;-0.016]	<0.001	-0.026 [-0.036;-0.016]	<0.001
	GP vacancy			0.010 [-0.010;0.030]	0.330	0.008 [-0.012;0.028]	0.410
	GP permanent, <65 years old			1 [reference]		1 [reference]	
GMP type	GMP for adults only			0.016 [0.001;0.031]	0.038	0.016 [0.001;0.032]	0.040
	GMP for children and adults			1 [reference]		1 [reference]	
List size	≤800			-0.038 [-0.061;-0.015]	<0.001	-0.043 [-0.066;-0.020]	<0.001
	801-1200			-0.012 [-0.025;0.001]	0.074	-0.018 [-0.031;-0.004]	0.010
	1201-1600			-0.003 [-0.013;0.007]	0.576	-0.005 [-0.015;0.005]	0.350
	1601-2000			1 [reference]		1 [reference]	
	2000<			0.003 [-0.009;0.015]	0.592	0.005 [-0.007;0.017]	0.420
County	Baranya			0.136 [0.114;0.159]	<0.001	0.120 [0.094;0.145]	<0.001
	Bács-Kiskun			-0.030 [-0.051;-0.010]	<0.001	-0.035 [-0.059;-0.011]	<0.001
	Békés			-0.002 [-0.024;0.021]	0.883	-0.017 [-0.044;0.010]	0.210
	Borsod-Abaúj-Zemplén			-0.021 [-0.040;-0.002]	0.027	-0.041 [-0.064;-0.018]	<0.001
	Budapest			1 [reference]		1 [reference]	
	Csongrád			0.012 [-0.01;0.034]	0.271	0.002 [-0.023;0.027]	0.880
	Fejér			-0.047 [-0.069;-0.024]	<0.001	-0.045 [-0.070;-0.019]	<0.001
	Győr-Moson-Sopron			-0.129 [-0.152;-0.107]	<0.001	-0.106 [-0.131;-0.082]	<0.001
	Hajdú-Bihar			0.080 [0.060;0.101]	<0.001	0.058 [0.032;0.084]	<0.001
	Heves			0.037 [0.012;0.062]	<0.001	0.028 [0.002;0.055]	0.040
	Jász-Nagykun-Szolnok			-0.016 [-0.039;0.006]	0.158	-0.021 [-0.047;0.004]	0.100
	Komárom-Esztergom			-0.056 [-0.081;-0.030]	<0.001	-0.028 [-0.056;0]	0.050
	Nógrád			-0.079 [-0.108;-0.050]	<0.001	-0.096 [-0.127;-0.065]	<0.001

	Pest			-0.043 [-0.06;-0.026]	<0.001	-0.046 [-0.065;-0.026]	<0.001
	Somogy			0.002 [-0.022;0.026]	0.848	-0.013 [-0.040;0.014]	0.350
	Szabolcs-Szatmár-Bereg			0.010 [-0.011;0.031]	0.359	-0.010 [-0.036;0.016]	0.460
	Tolna			0.016 [-0.012;0.044]	0.255	0.011 [-0.019;0.041]	0.490
	Vas			-0.022 [-0.048;0.005]	0.110	0.009 [-0.019;0.037]	0.530
	Veszprém			-0.089 [-0.113;-0.065]	<0.001	-0.082 [-0.108;-0.055]	<0.001
	Zala			-0.047 [-0.072;-0.021]	<0.001	-0.032 [-0.059;-0.005]	0.020

*Normalized Roma proportion and SES indicators were used, ** Linear regression Coefficient (B) and 95% confidence interval (95%CI)

Based on the standardized linear regression coefficients, standardized employment (srEMP) exhibited the most substantial negative impact on spending with a coefficient of $\beta = -0.219$. This was followed by being situated in Győr-Moson-Sopron County ($\beta = -0.140$) and Veszprém County ($\beta = -0.097$), both contributing negatively to expenditures. Conversely, the most significant positive effect on spending was observed in Baranya County ($\beta = 0.159$), followed by standardized education (srEDU) with a coefficient of $\beta = 0.13$. The lack of significant impact from the Roma population proportion was reflected in a minimal standardized linear regression coefficient of $\beta = -0.023$.

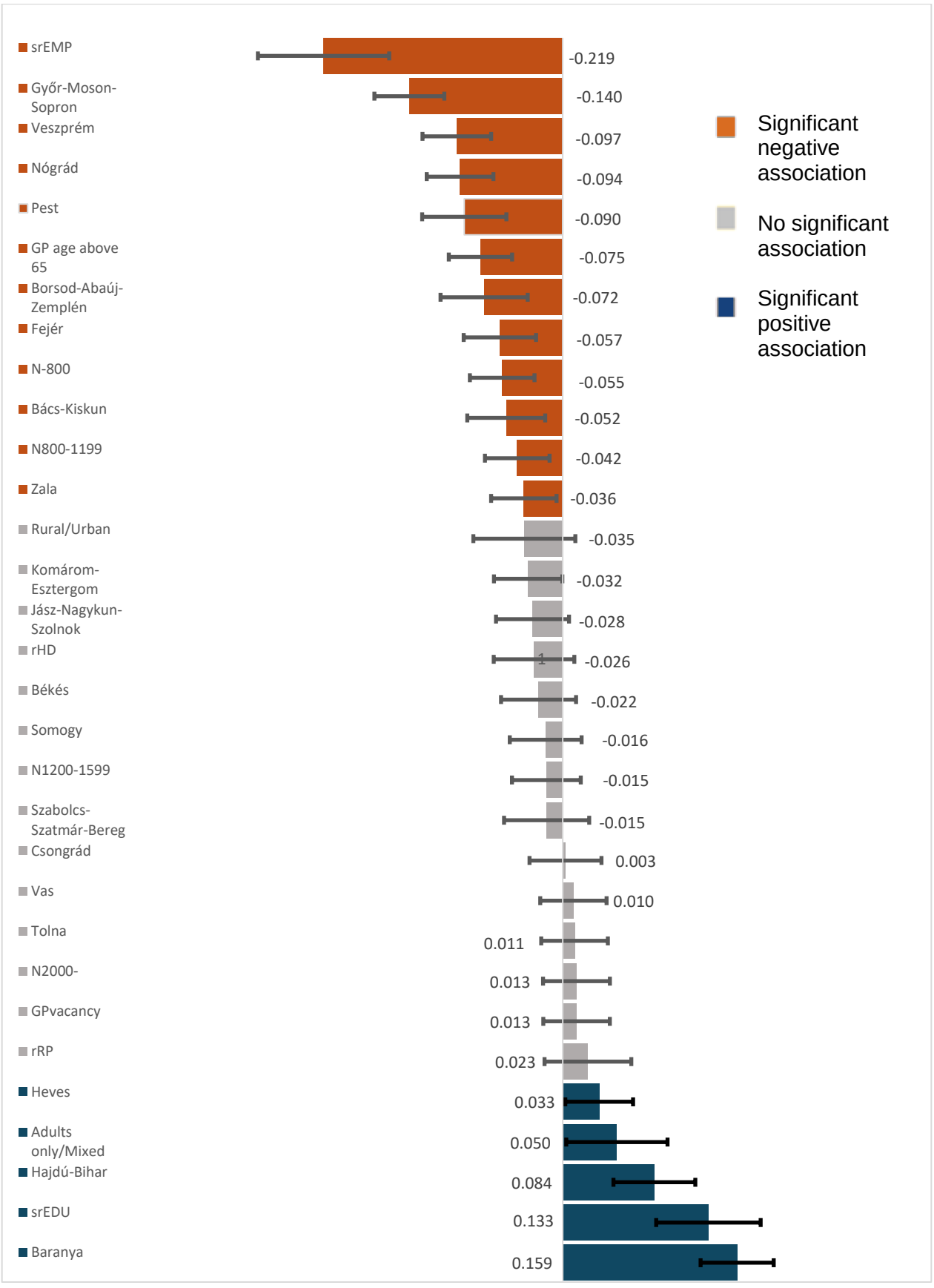

Figure 2. Strength of the association between Roma, socioeconomic factors, and GMP-specific structural indicators with average per-capita GMP-specific expenditures based on the standardized linear regression coefficients.

5.2 Part II:

5.2.1 Descriptive statistics

The studied population encompassed 7,385,641 adults, comprising 3,456,560 men and 3,929,081 women. Within the 2,071 identified SAs, there were 283,876 adults (139,507 men; 144,369 women). A notable demographic contrast was evident between the SAs and CAs populations as depicted in Figure 3.

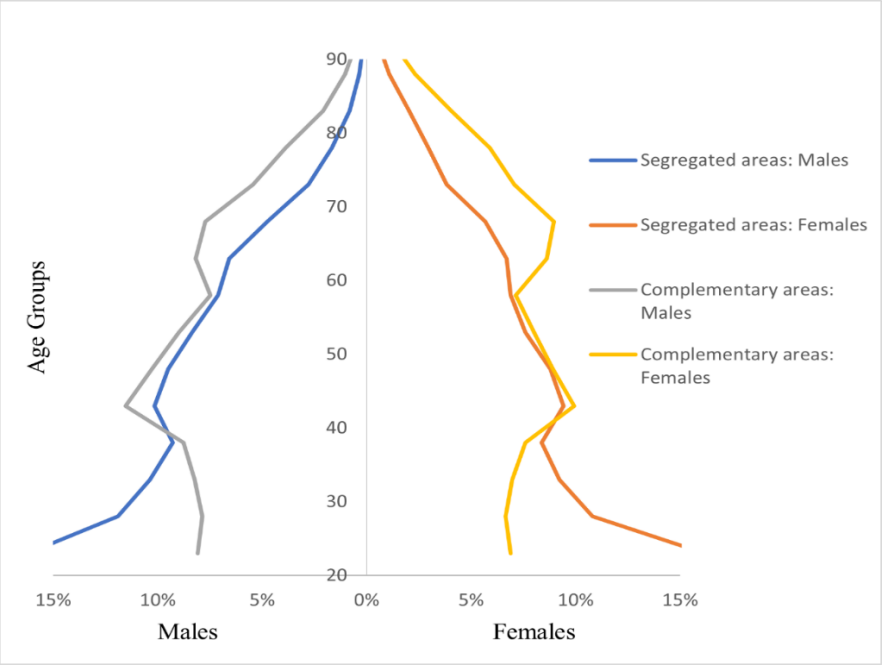

Figure 3. Demographic structure of the segregated and complementary populations.

The average age was significantly lower for individuals residing in SAs (total: 43.3 years; men: 42.2 years; women: 44.4 years) compared to those in CAs (total: 50.4 years; men: 48.5 years; women: 52.1 years). The elderly dependency ratio (the proportion of individuals aged 65 or above among those aged 15 and above) was markedly lower in SAs (15.4%) than in CAs (33.7%).

The distribution of segregated patients within a General Medical Practice (GMP) exhibited substantial variability across standardized healthcare delivery, healthcare reimbursement, and

premature mortality indicators as illustrated in Figures 4, 5, and 6. Imaging examinations displayed the highest level of heterogeneity in both delivery and reimbursement indicators concerning relative GMP performance. Outpatient service utilization demonstrated the greatest variability among the indicators analyzed.

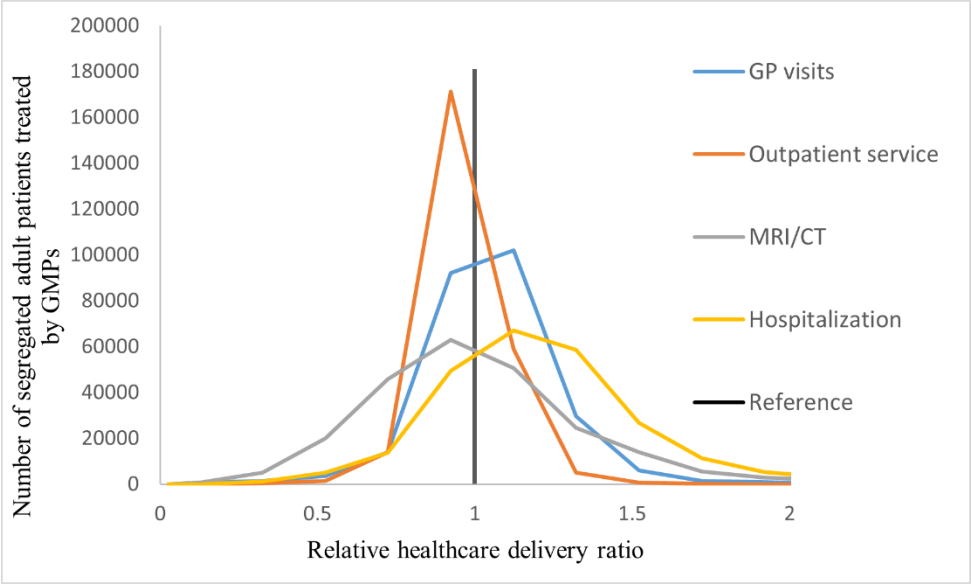

Figure 4. Distribution of segregated adults according to the relative healthcare delivery ratio among Hungarian GMPs.

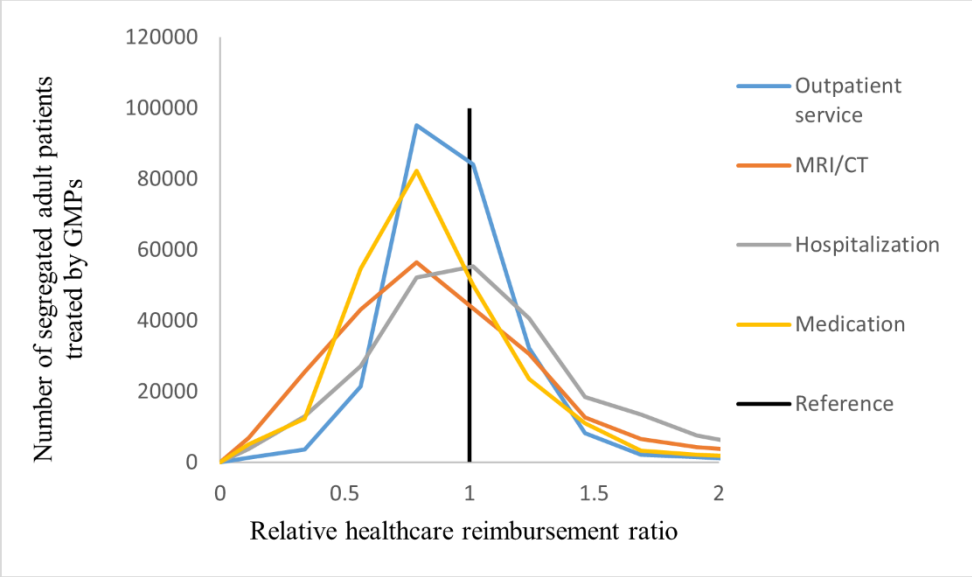

Figure 5. Distribution of segregated adults according to the relative healthcare reimbursement ratio among Hungarian GMPs.

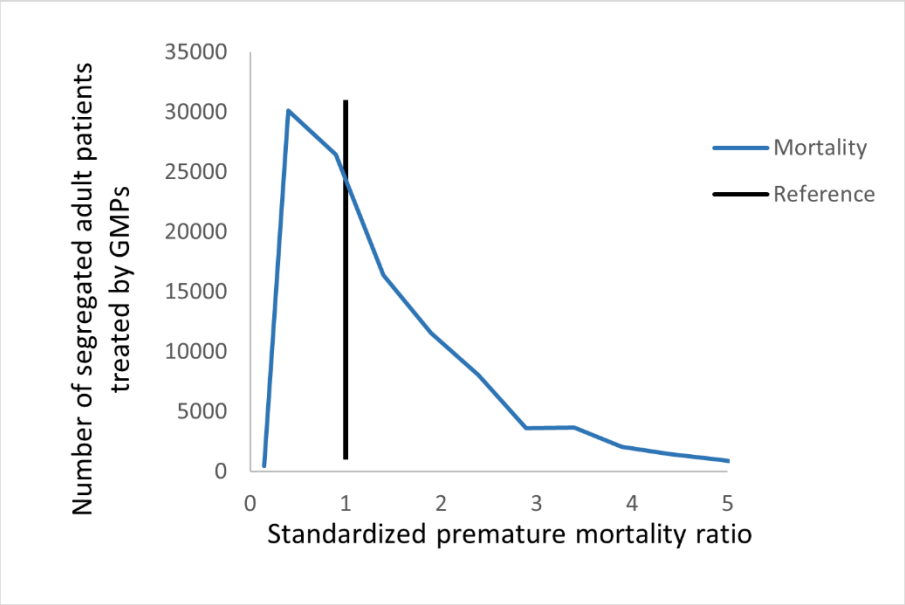

Figure 6. Distribution of segregated adults according to the relative premature mortality ratio among Hungarian GMPs.

5.2.2 Healthcare delivery statistics:

The standardized relative indicators aggregated for the entire country as shown in Table 4, revealed that segregated groups exhibited a significantly higher rate of healthcare service utilization compared to their complementary counterparts (RR=1.222, 95%CI: 1.220;1.223). Specifically, higher rates of GP visits per person per year (RR=1.251, 95%CI: 1.249;1.253) and hospital admissions per year (RR=1.250, 95%CI: 1.237;1.264) in comparison to complementary patients. Conversely, segregated patients experienced a reduced number of treatments per year in outpatient service centers (RR=0.948, 95%CI: 0.943;0.953) and imaging examinations (RR=0.935, 95%CI: 0.920;0.950) relative to their counterparts.

Table 4. Relative healthcare delivery, reimbursement, and all-cause premature mortality among Hungarian adults provided by general medical practices situated in a segregated or complementary area.

Indicators	**Total**	**Segregated Areas**		**Complementary Areas**		**Relative Risk in segregated Areas [95%CI]**
	N	N	Standardized Ratio [95%CI]*	N	Standardized Ratio [95%CI]*	

Healthcare delivery (episodes)						
GP visits	47,754,032	1,993,344	1.238 [1.237;1.240]	45,760,688	0.990 [0.989;0.990]	1.251 [1.249;1.253]
Use of outpatient services without CT/MRI	4,522,976	150,414	0.951 [0.946;0.956]	4,372,562	1.003 [1.002;1.004]	0.948 [0.943;0.953]
Use of CT/MRI	493,566	15,078	0.940 [0.925;0.955]	478,488	1.005 [1.002;1.008]	0.935 [0.920;0.950]
Use of hospital service	836,818	35,527	1.241 [1.228;1.254]	801,291	0.992 [0.990;0.994]	1.250 [1.237;1.264]
Total	53,607,392	2,194,363	1.211 [1.209;1.212]	51,413,029	0.991 [0.990;0.991]	1.222 [1.220;1.223]
Healthcare reimbursement (Euro per capita)						
Outpatient services without CT/MRI	42.67	35.31	0.885 [0.856;0.915]	42.94	1.008 [1.002;1.014]	0.878 [0.848;0.908]
CT/MRI	8.57	6.34	0.823 [0.760;0.890]	8.65	1.009 [0.996;1.022]	0.815 [0.752;0.883]
Hospital service	124.63	117.36	1.062 [1.043;1.082]	124.91	0.999 [0.996;1.003]	1.063 [1.043;1.083]
Medication	147.18	130.01	0.871 [0.856;0.887]	147.82	1.003 [0.999;1.006]	0.869 [0.854;0.884]
Total	323.05	289.02	0.940 [0.929;0.952]	324.33	1.002 [1.000;1.004]	0.938 [0.927;0.950]
Health outcomes						
All-cause premature mortality	23453	1208	1.087 [1.027;1.150]	22245	0.996 [0.983;1.009]	1.092 [1.030;1.157]

* Age, sex, and eligibility for exemption certificate standardized

In terms of attributable risk illustrated in Table 5, residing in a Segregated Area was associated with an 18.1% (95%CI: 18.0;18.2) increase in healthcare service utilization when compared to Complementary Areas., with a population-attributable risk of 0.742%. The excess GP consultations visits were estimated at 400,024 (95%CI: 397,811;402,234) per year, while SA patients' hospitalizations were 7,116 (95%CI: 6,819;7,410) more frequent per year, representing a 20% increase compared to those residing in Complementary Areas. On the other hand, SA patients had lower engagement with specialized services including outpatient care and CT/MRI examinations with 8,241 (95%CI: 9,045;7,441) and 1,046 (95%CI: 7,911;306) fewer instances of care respectively.

Table 5. Impact of segregation among adults living in segregated areas (number of excess cases and attributable risk) and in the whole adult population of Hungary (population attributable risk).

Indicators	Number of excess cases [95%CI]	Attributable risk [95%CI]	Population attributable risk
Healthcare delivery (episodes)			
GP visits	400,024 [397,811;402,234]	20.1% [20.0%;20.2%]	0.838%
Use of outpatient services	-8,241 [-9,045;-7,441]	-5.5% [-6.0%;-4.9%]	-0.182%
Use of CT/MRI	-1,046 [-1,306;-791]	-6.9% [-8.7%;-5.2%]	-0.212%
Use of hospital service	7,116 [6,819;7,410]	20.0% [19.2%;20.9%]	0.850%
Total	397,921 [395,543;400,297]	18.1% [18.0%;18.2%]	0.742%
Healthcare reimbursement (Euro per capita)			
Outpatient services	-4.927[-4.954;-4.901]	-14.0% [-17.8%;-10.2%]	-0.418%
CT/MRI	-1.437[-1.449;-1.425]	-22.7% [-32.8%;-13.3%]	-0.607%
Hospital service	6.968[6.928;7.008]	5.9% [4.2%;7.7%]	0.203%
Medications	-19.619[-19.670;-19.568]	-15.1% [-17.1%;-13.1%]	-0.483%
Total	-18.994[-19.064;-18.923]	-6.6% [-7.8%;-5.3%]	-0.213%
Health outcomes			
Premature mortality	101,544 [37,355;162,213]	8.4% [3.1%;13.4]	0.433%

5.2.3 Healthcare reimbursement statistics:

Significant disparities in healthcare reimbursement were observed based on the residence of patients in SAs or CAs (Table 4). Total health services reimbursement for a General Medical Practice was significantly lower for SA patients (RR=0.938, 95%CI: 0.927;0.950). Specifically, GMPs received lower reimbursement per year for outpatient services provided to SA patients (RR=0.878, 95%CI: 0.848;0.908), MRI/CT examinations (RR=0.815, 95%CI: 0.752;0.883), and medications (RR=0.869, 95%CI: 0.854;0.884). While receiving higher rates of reimbursements for hospital services provided for segregated groups (RR=1.063, 95%CI: 1.043;1.083). Overall, caring for segregated patients led to a reduction in healthcare reimbursement by 6.6% (95%CI: 7.8;5)

compared to complementary groups as displayed in Table 5. This reduction was primarily stemmed from the lower outpatient, MRI/CT imaging, and medication related National Health Insurance Fund Management funding. Care for SA patients was correlated with a spending decrease of -14% (95%CI: -17.8;-10.2%), -22.7% (95%CI: -32.8;-13.3), and -15.1% (95%CI: -17.1;-13.1) respectively, compared to CA patients.

5.2.4 All-cause premature mortality statistics:

Age- and sex-standardized premature mortality among the Segregated Area population was significantly higher than that in the Complementary Area population (RR=1.092, 95%CI: 1.030;1.157) (Table 4). The estimated excess cases of premature mortality in the SA population were approximately 101,544 (95%CI: 37,355;162,213) compared with CAs, of which 8.406% (95%CI: 3.092;13.428) can be attributed to the segregated status of living in SAs. Furthermore, the population-level attributable risk, representing the percentage of premature deaths in the country related to segregation, was estimated at approximately 0.433% .

6 Discussion

6.1 Main findings and implications

This thesis extensively investigated the underlying factors influencing healthcare access and expenditure disparities within Hungarian GMPs, as well as the implications for health outcomes in segregated, and deprived populations. Two comprehensive cross-sectional studies were conducted using NIHIFM data, each shedding light on different aspects of the issue. The first study examined the variability in per-capita expenditure among GMPs, revealing significant associations with geographic location, GP structural indicators, and socioeconomic status. Notably, socioeconomic factors emerged as primary determinants of healthcare spending disparities, negating the influence of Roma ethnicity. Underscoring the critical role of education level and employment status in shaping health expenditure patterns, aligning with broader SDGs that advocate for addressing socio-economic barriers to enhance healthcare access.

While the second study investigated healthcare utilization and spending patterns for patients within segregated areas compared to patients in non-segregated areas across Hungarian GMPs, revealing a potential weakness in healthcare delivery pathways, highlighting the delicate interaction between socioeconomic status and healthcare disparities.

6.1.1 Part I

Wide variability in the 5 year average per-capita expenditure among Hungarian GMPs was found in our results, further corroborating the variability of other GMP performance indicators detected in other Hungary based research [45,98]. Although our linear regression model controlled for GMP structural indicators, patients' demographic composition and socioeconomic status, it explained 14.7% of detected variability, emphasizing the extremely complex nature of healthcare inequalities.

According to our basic regression models, Roma relative proportion or rRP was significantly associated with age and sex standardized health expenditure, however this association diminished into non-significant when controlling for socioeconomic indicators with a well-known and thoroughly researched effect on health and health expenditure such as level of education and employment status [99–102]. Specifically, Roma ethnicity demonstrated a negligible role in predicting health expenditure when compared to socioeconomic status indicated by education and employment. This result corresponds with other studies in Hungary that investigated the correlation between ethnicity , health and socio economic factors [34,35] where it was found that SES is a stronger determiner of health of people living in Roma settlements and has higher impact on the prevalence of unhealthy habits such as smoking. Moreover, the quality of primary care represented by GP structural indicators in our comprehensive model, demonstrated a significant association on healthcare expenditure contrary to the observed Roma effect. While no studies were specifically conducted on the different relations between GP structural indicators and Roma on healthcare, GP indicators were proven to have a significant relationship with health provision and quality in international [103,104] and Hungarian studies [44,105,106] where GP's gender, list size, and vacancy had a profound connection with various aspects of healthcare including medication adherence.

In regards to SES, our investigation further revealed a positive correlation between a patient's educational attainment and health insurance spending, the avenues of this association are complex and interlaced [107]. However, this finding might be an indication that healthy behaviours and high health literacy among educated individuals enable them to be more attentive to their health, recognize sickness and symptoms more easily, as well as having better social, interpersonal relationships, and better connections to their healthcare providers, all of which could lead to higher healthcare utilization and specifically preventive care which increases healthcare costs [108].

Corroborated by this comprehensive empirical study on the influence of education and health covering OECD countries [82]. In contrast, our multivariable regression analysis displayed a significant reduction in healthcare expenditure associated with increased employment, seemingly caused by the bidirectional effect of health on the labor market, where ill health often leads to unemployment which in turn can exacerbate existing conditions and negatively affect stress levels and social support [109–111]. Resulting in an increase in healthcare utilization and costs particularly attributable to GP visits and mental healthcare [112,113]. However, while unemployment and low job insecurity clearly impact wellbeing, the effect on healthcare utilization is inconsistent, sometimes even within the same country as evidenced by these two German studies [114,115] that reported opposing results on the association between unemployment and hospital admissions. The observed pattern regarding the inverse impact of education and employment on health spending, suggests that employed individuals may face time constraints hindering their healthcare access, while those with higher education prioritize preventive care, leading to greater spending. Notably in our correlation analysis, Roma were negatively correlated with both SES factors as is in most of Europe [116,117]. Meaning in our study in the case of Roma, the opposite influences of employment and education on reimbursement counterbalance each other.

As for GPs' structural indicators, Smaller GP list sizes correlated with a reduction in per capita health reimbursement, the variation in per capita health reimbursement is not due to increased number of patients but instead could be attributable to the fact that patients with complex needs have the freedom to change their GP, shifting to a GPs that offers more intensive care making them eligible for higher reimbursement. Furthermore, according to our results GP age higher than 65 was associated with a decrease in spending, evidence on the direct effect of physician age on health spending is scarce however some studies suggest that older GPs have more experience, while also

having outdated scientific knowledge, and are less likely to adhere to standard preventive treatment and diagnosis [118,119] lowering overall spending on these services however this is still debated. Conversely more specialized GPs serving adult only patients in our model, were positively associated with spending which is in good concordance with published articles [120,121] as more specialized care is often more expensive [122].

Lastly, health expenditure significantly varied according to geographical location, this impact could be caused by county level disparity in available healthcare services, social conditions, and environmental circumstances with conclusive evidence from diverse sources around the world [123–126] further research is needed to elaborate on the details for this observed associations in Hungarian counties.

Considering the implications, this ecological investigation suggests that in Hungary, the proportion of self-declared Roma within GMPs' patients has no association with the amount of funding he receives from the NIHIFM when controlling for education and employment, two strong socioeconomic determinants of health. It underlines the uncertainties in polices targeting ethnicity regardless of SES. The urgency of the matter the inefficacy of former interventions, as evident in the statistically critical health and wellbeing of Roma populations across the EU, the mechanisms translating Roma ethnicity into health loss are complex with many interrelated parts. Our study suggests adopting systems similar to deprivation indices such as the Scottish index of multiple deprivation (SIMD) and Indices of deprivation 2007 (ID 2007) used in National Health Service in the United Kingdom [127–129] where instead of ethnicity, SES factors such as education and employment are incorporated as measures of deprivation in geographically defined populations. Accordingly, the Hungarian health reimbursement system employs area level deprivation by type of settlement, a practice that could be improved by integrating SES factors into the financing policy.

6.1.2 Part II

Expanding on the previous investigation, this study utilized geographical segregation where mostly undereducated and -employed populations live, as a measure of both deprivation and a tool for health monitoring. It uncovered wide variation and significant dissimilarity between segregated areas (SAs) and their complementary counterparts (CAs), in both healthcare utilization and reimbursement, as well as premature mortality across the studied Hungarian GMPs. Highlighting potential factors contributing to the apparent health gap between the two groups.

A distinct healthcare utilization pattern was observed among adults residing in SAs, where individuals tend to access healthcare services more frequently compared to those in CAs. However, the reimbursement for their care expenses is significantly lower, stipulating disparities in the quality of care provided. Marginalized groups receiving lower quality care is firmly established in global research [130–132] leading to higher cardiovascular and maternal mortality rates and increasing health inequalities.

Concerning primary care, crude indicators in our study show that segregated patients frequented their GPs significantly more, other studies in the EU found similar results among deprived patients with chronic diseases [133] and minorities with low health literacy [134]. It can be hypothesized that this can attributed to their poorer health status [135,136] combined with low "consultation efficacy" [137] which is typically lower among low SES patients, necessitating more frequent GP visits than their high SES counterparts to achieve comparable goals. Conversely, specialized services such as outpatient care and imaging diagnosis were notably underutilized by segregated groups, this trend has been noted in other research [138,139] where it was observed that compared with high SES communities, low SES was associated with lower access to specialized care. This in our study also correlated with significantly reduced GMP reimbursement for these services for segregated

patients, revealing an alarming practice further aggravating the poor health and health services needs of these groups. Since these services are essential for diagnosing, reversing, or halting the progression of chronic diseases, underutilization may escalate undiagnosed conditions until hospitalization is needed for more severe prognoses. A possible direct manifestation of these shortcomings was the observed higher hospitalization rates among SA patients in our study, paralleled by higher reimbursement rates for their GMPs. This finding aligns with previous research from the EU, US and Australia which consistently reported increased hospital admission among deprived patients [140–143]. Additionally, adults living in segregation demonstrated predictably poorer health status, and health outcomes as evidenced by their significantly elevated premature mortality rate compared with adults residing in CAs as illustrated in our results and corroborated by research [144–147] showing a clear link between social inequality and higher mortality rates, referable not only to their aforementioned healthcare use pattern, but also to their unhealthy lifestyles, worse environment and low overall SES status [148].

Based on the presented results, the country-level aggregated relative risk measures demonstrated a significant association between segregation and serious healthcare inequalities, notably these issues appear to stem from a local setting as evidenced by the varying inequality of investigated indicators at the GMP level. While some GMP exhibited a substantial gap in services rendered, others showed no such disparity (Supplementary table A4). This investigation implies that a monitoring system could distinguish between GMPs with and without local bias and could monitor temporal trends in country-level healthcare inequality Currently, in Hungary at least, there is no such monitoring system informing stakeholders on local nor country level data that also bypasses ethnicity related challenges – therefore there is a pressing need for an SA-specific monitoring system. Our results not only showcase the feasibility of a segregation-oriented health monitoring system, but also

proposes suitable indicators for this purpose. After adjusting for, and adding indicators that reflect the intricacies of the observed disparities in mortality as well as healthcare use and expenditure, this monitoring system could support the National Social Inclusion Strategy of the Hungarian government [43], and considering the overrepresentation of Roma in SAs, it could contribute to programs aimed at improving the health status of the Roma population.

7 Strengths and limitations

7.1 Part I

One of the key strengths of this study is its comprehensive coverage of the entire population of Hungary, leveraging compulsory census data participation, and the inclusion of all GMPs in the country effectively controlling for any potential selection bias. This nationwide design led to satisfactory statistical power, further increased by aggregating expenditures through the period of 5 years. This makes the observed results of the influence of rRP fairly convincing. However, the cross-sectional nature of the investigation could restrict interpretations of this association. Nonetheless, these issues are mitigated by the stability of the used explanatory variables such as SES and GMP structural factors which remain consistent over time. Clients' health needs represented by health status and disease profile are missing from our analysis. Further investigations are required to control for these factors. Moreover, our ecological design utilizes group-level data on GMPs and Roma, necessitating caution when interpreting the results, as they highlight the effect of the proportion of Roma within a GMP and the average per capita health expenditure, rather than directly addressing factors influencing individual Roma utilization of healthcare services. Measurement bias was negligible in the study due to the standardized protocols for data collection and processing employed by the NIHIFM and the Hungarian Central Statistical Office. On the other hand, Roma were identified by self-declaration during the 2011 census which resulted in notable underreporting [149,150]. Our results should therefore be interpreted for self-declared Roma and not for the whole population of the Hungarian Roma within a GMP's list.

7.2 Part II

The quality of the data used in this investigation was guaranteed by the standardized protocols of data collection implemented by the NIHIFM [151]. Additionally, it is mandatory for each GMP to

contract with the NIHIFM, which facilitates access to comprehensive reimbursement and health data covering all Hungarian adults living in SAs or CAs. Effectively eliminating any selection bias. However, the data encompassed health information from the year 2020, and was heavily impacted by the COVID-19 pandemic. The first case detected in Hungary was in 04/03/2020 [152], followed by epidemiological measures that impacted healthcare operations [153]. Consequently, it can be said that our results reflect heath care inequality during the epidemic, which holds true to some extent, especially since Covid19 vaccination coverage was lower in SAs, which can contribute to some of the observed differences [154], however it is also mitigated by the fact that SA and CA patients share the same environment, access to care and GP who is ultimately the gatekeeper of treatment. Moreover, due to the ecological nature of the study, caution is necessary when assuming living and health conditions of Roma and non-Roma inhabitants of SAs. Lastly, the results of this investigation do not clarify the mechanisms behind the identified disparities but calls for more detailed pathway analyses that could help conceptualizing interventions aimed at reducing health inequalities.

8 Conclusions

Overall, this thesis highlights the substantial challenges in achieving equality by revealing the extent of disparity in healthcare access, treatment and insurance expenditure within the Hungarian healthcare system. Particularly, concerning the impact of ethnicity and socioeconomic deprivation on primary healthcare expenditure, in addition to their influence on healthcare utilization patterns. The initial analysis showed wide disparities in per-capita healthcare spending across Hungarian GMPs, with education and employment having the strongest impact on the observed variation, increasing it and decreasing it respectively, making them favorable targets for interventions. Moreover, after controlling for these socioeconomic indicators, the significant association of self-reported Roma ethnicity with health spending disappeared, suggesting the inefficiency of ethnicity-specific funding polices. Further research and data collection are warranted to comprehensively analyze the full impact of non-declared Hungarian Roma Moreover, the second analysis in the thesis demonstrated that residence within a deprived area was a strong risk factor impairing healthcare services, as evidenced by their increased mortality rates, and the dissimilarity in healthcare utilization and reimbursement in comparison with their counterparts in non-segregated areas. This varying degree of healthcare provision among Hungarian GMPs is worrying, where some provided adequate care to all patients, others showed varying levels of inequality. To address these disparities, it seems crucial to integrate a multifaceted approach based on the WHO's health systems governance principles, especially those related to ensuring fair distribution of healthcare resources and access to services across different populations, ensuring accountability and inclusivity. This approach aligns with the WHO's commitment to achieving Universal Health Coverage and the Sustainable Development Goals, particularly those related to health equity (SDG 3) and reduced inequalities (SDG 10). Integrating comparative and community-focused approaches

could substantially enrich future research. Such methodologies would allow a deeper understanding of the multifactorial influences on health disparities. More research is recommended to investigate the contrasts in healthcare provision and the local factors involved in the quality of care provided to underprivileged patients. Future studies could benefit from exploring these dimensions, potentially leading to more nuanced and effective health policy interventions. The thesis suggests that interventions regarding health equality should take the local GMP environment into serious consideration, emphasizing the importance of tailoring strategies to the specific needs and circumstances of each community.

9 New findings

9.1 Study 1: Self-declared Roma ethnicity and health insurance reimbursement: a nationwide cross-sectional investigation at the general medical practice level in Hungary

- ***High variation in performance based GMP per-capita reimbursement was uncovered.***

  The 5-year average GMP-specific expenditure srEXP mean (±SD) was 1±0.15.

- ***The relation between self-declared Roma ethnicity and GMP expenditure disappeared after controlling for education and employment.***

  Higher education was significantly associated with more spending ($P < 0.001$, srEDU: $b = 0.199$, 95%CI: 0.128; - 0.271), whereas employment reduced spending ($P<0.001$, srEMP: $b=-0.282$, 95%CI: -0.359; -0.204), Roma proportion had no significant influence on expenditure ($P= 0.250$, rRP: $b=0.002$, 95%CI: -0.001; 0.005).

- ***The reimbursement received by GMPs showed a close link with the location of Hungarian counties.***

According to the linear regression standardized coefficients, Győr-Moson-Sopron County demonstrated the highest reduction in primary health insurance spending (β=-0.140), while Baranya County had the greatest increase (β=0.159).

- ***Employment and education emerged as the most influential factors associated with healthcare expenditure.***

  Employment was related with greatly reduced expenditure srEMP (β=-0.219), contrasting with the elevating association of education (β=0.13).

9.2 Study 2: Cross-sectional comparison of health care delivery and reimbursement between segregated and nonsegregated communities in Hungary

- ***Overall healthcare service utilization was higher among segregated patients, despite reduced access to specialized care.***

  According to the country level standardized relative indicators, patients living in segregated areas exhibited limited use of specialized services such as outpatient services and imaging, (RR=0.948, 95%CI: 0.943;0.953) and (RR=0.935, 95%CI: 0.920;0.950) respectively. However, the total use of healthcare services was higher compared to patients in non-segregated areas (RR=1.222, 95%CI: 1.220;1.223), mainly attributed to excessive GP visits (RR=1.251, 95%CI: 1.249;1.253) and hospitalization rates (RR= 1.250, 95%CI: 1.237;1.264).

- ***Total health service reimbursements were significantly lower for patients living in segregation.***

  Aggregated relative indicators showed that living in segregated areas posed a risk factor for lower total health insurance reimbursement (RR=0.938, 95%CI: 0.927;0.950), even with

the increased spending on hospital care for segregated groups (RR=1.063, 95%CI: 1.043;1.083). This contrast was largely due to the significantly lower reimbursement rates in comparison to their counterparts for outpatient service (RR=0.878, 95%CI: 0.848;0.908), MRI/CT imaging (RR=0.815, 95%CI: 0.752;0.883), and medications (RR=0.869, 95%CI: 0.854;0.884).

10 Summary

The thesis delves into the disparities within the Hungarian healthcare system, in respect to health provision, funding, and outcomes. It explores the socioeconomical, geographical, and structural determinants linked to GMP insurance reimbursement with a focus on Roma ethnicity as a potential driving factor of observed variations. Studying these elements not only sheds light on the complex connection between ethnicity, SES, and healthcare but also offers insights crucial for designing targeted interventions aimed at reducing healthcare inequalities. Additionally, this thesis investigates the differences in healthcare utilization trends between segregated and non-segregated communities, providing findings valuable in improving overall health outcomes for marginalized populations.

The thesis was based on two cross-sectional studies based on data collected by the NIHIFM, first of which employed a comprehensive regression analysis covering 4818 Hungarian GMPs providing care to adults and investigated the association between Roma ethnicity and GMP 5-year average per-capita insurance reimbursement, controlling for SES indicators including education, employment, and housing density, as well as GP structural factors such as GP age, location, and type. Self-declared Roma ethnicity demonstrated a non-significant association (P=0.250) with insurance spending after introducing education and employment as confounding factors, both exhibiting a significant relation (P<0.001). Furthermore, among the studied variables, these SES

factors had the biggest impact on change in GMP reimbursement according to the standardized linear regression coefficients, with srEMP (β=-0.219) and srEDU (β=0.13) for employment and education respectively. The second research included in the thesis involved a secondary analysis using 2020 data provided by the NIHIFM on healthcare utilization, reimbursement, and premature mortality. It implemented person-level health records to compare GMP-level-aggregated indicators for 4359 Hungarian GMPs serving segregated and complementary areas. Distinct trends in engagement with healthcare services were observed for SA and CA patients. According to the aggregated relative ratios, patients in SAs had higher total healthcare utilization rates compared with their non-segregated counterparts (RR=1.222, 95%CI: 1.220;1.223), with emphasis on GP visits and hospitalizations (RR=1.251, 95%CI: 1.249;1.253 and RR= 1.250, 95%CI: 1.237;1.264, respectively), despite having reduced access to outpatient specialized services (RR=0.948, 95%CI: 0.943;0.953) and imaging examinations (RR=0.935, 95%CI: 0.920;0.950). In contrast, this higher utilization was accompanied by significantly lower total insurance reimbursement on patients residing in SA (RR=0.938, 95%CI: 0.927;0.950), due to the reduced outpatient (RR=0.878, 95%CI: 0.848;0.908), imaging (RR=0.815, 95%CI: 0.752;0.883), and medication (RR=0.869, 95%CI: 0.854;0.884) insurance spending for these populations. Hospitalization reimbursement, on the other hand, showed higher spending on segregated groups (RR=1.063, 95%CI: 1.043;1.083).

Our first analysis reveals substantial variation in GMP per-capita insurance reimbursement, associated with SES and GP specific indicators. Notably, Roma ethnicity had no relation when controlling these for these factors. The lack of association with self-declared Roma underscores the importance of SES targeted polices in addressing health inequalities, irrespective of ethnicity. Moreover, the second study provides a valuable comparison of healthcare use, reimbursement and mortality trends between deprived segregated patients and their counterparts. Highlighting

important gaps in healthcare provision and funding within the Hungarian healthcare system, suggesting areas for targeted interventions to enhance equality and the well-being of disadvantaged communities. Addressing these challenges requires general and local evaluation and intervention including restructuring of institutions, infrastructure, staffing, and legal frameworks.

Keywords

Comparative analysis, Cross-Sectional, Roma, Hungarian population, Segregation, Socioeconomic status, Ethnicity, Inequality, Health, Healthcare Financing, General Medical Practice, Healthcare Access, Health policy.

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14 Appendices

14.1 Appendix A: supplementary tables

Table A1. Average number of years of school attendance by demographic strata in Hungary according to the Census 2011.

Age Groups (years)	Male	Female	Total
7-9	3.11	3.22	3.16
10-14	4.28	4.35	4.32
15-19	8.49	8.67	8.58
20-24	11.23	11.76	11.49
25-29	11.88	12.70	12.28
30-34	11.91	12.61	12.26
35-39	11.64	12.21	11.92
40-44	11.54	11.92	11.73
45-49	11.52	11.76	11.64
50-54	11.39	11.42	11.40
55-59	11.38	11.11	11.24
60-64	11.48	10.89	11.15
65-69	11.15	10.29	10.65
70-74	9.91	9.05	9.38
75-79	9.55	8.03	8.56
80-84	9.52	7.38	8.06
85+	8.87	6.49	7.12

Table A2. Ratio of employed persons by demographic strata in Hungary according to the Census 2011.

Age Groups (years)	Male	Female	Total
15–19	0.037	0.028	0.033
20–24	0.446	0.368	0.408
25–29	0.761	0.622	0.693
30–34	0.831	0.618	0.726
35–39	0.831	0.685	0.759
40–44	0.801	0.755	0.778
45–49	0.765	0.759	0.762
50–54	0.708	0.711	0.710
55–59	0.593	0.497	0.542
60-64	0.202	0.134	0.165
65–69	0.106	0.058	0.079
70–74	0.052	0.021	0.033
75–	0.019	0.005	0.009

Table A3. Age and sex specific per capita expenditures of National Health Insurance Fund a year for the period of 2012-2016 in Hungary.

Age Groups	Male Total Expenditure HUF	Male per Capita Expenditure HUF	Female Total Expenditure HUF	Female per Capita Expenditure HUF	Total per Capita Expenditure HUF
18-19	13,802,129,944	38,687	15,262,497,639	43,318	82,005
20-24	46,233,527,489	33,610	53,480,755,298	39,849	73,459
25-29	56,248,085,797	37,933	71,970,992,283	50,066	87,998
30-34	68,736,993,366	42,631	98,340,967,184	62,219	104,850
35-39	95,613,551,112	47,226	128,142,553,553	64,648	111,874
40-44	106,497,833,863	56,811	128,242,903,562	69,709	126,520
45-49	121,073,168,492	74,308	142,740,067,185	87,625	161,933
50-54	152,403,595,028	107,827	176,453,588,360	118,870	226,697
55-59	239,428,912,861	151,105	271,133,263,317	151,758	302,863
60-64	284,085,397,572	186,222	317,557,488,304	170,778	357,000
65-69	258,576,269,028	224,086	302,392,902,747	195,976	420,062
70-74	219,548,490,630	255,224	284,098,186,716	215,612	470,836
75-79	153,512,705,698	272,618	242,152,795,130	229,268	501,885
80-84	94,968,635,311	265,382	172,995,558,262	222,408	487,789
85+	50,879,694,624	228,742	129,364,363,228	208,610	437,352
Total	1,961,608,990,815	2,022,412	2,534,328,882,768	1,930,714	3,953,123

Table A4. Number of GMPs, size of the adult population, and excess number of episodes of healthcare delivery and mortality among segregated patients compared to complementary patients.

Indicators	GMPs with lower RR in SA than in CA			GMPs with non-different RR in SA and CA			GMPs with higher RR in SA than in CA		
	Number of GMPs*	Adult population in segregated areas	Excess of episodes among segregated adults	Number of GMPs*	Adult population in segregated areas	Excess of episodes among segregated adults	Number of GMPs*	Adult population in segregated areas	Excess of episodes among segregated adults
Healthcare delivery (episodes)									
GP visits	1110	55137	-71482.50	2078	86538	1587.06	1164	110626	165999.22
Use of outpatient services without CT/MRI	27	10026	-1078.09	4262	240184	-4328	8	2021	305.47
Use of CT/MRI	16	5111	-169.62	2297	227518	85.47	167	6855	523.55
Use of hospital service	1	65	-8.31	2757	205279	3143.88	325	40851	2931.05
All-cause premature mortality									
All-cause premature mortality	5	2759	-73.78	558	103334	137.39	125	3616	158.83

*Margins of error: GP visits (109), Outpatient service (107), CT/ MRI (62), hospital service (77), mortality (17).

14.2 Appendix B: regression analysis assumptions and supplementary figures

Considering the intricate nature of the variables involved in our linear regression model, we thoroughly tested all assumptions relating to linear regression. There were no indications of multicollinearity problems in the estimation of coefficients, as revealed by the multicollinearity diagnosis conducted in SPSS, using the most common cut-off point of 10, no variables exhibited a variance inflation factor (VIF) exceeding that value. Additionally, according to the SPSS plot analysis of residuals, depicted in figure A1, our data demonstrated homoscedasticity showing a constant variance in residuals across all levels of the independent variables, resulting in the homoscedasticity of our model.

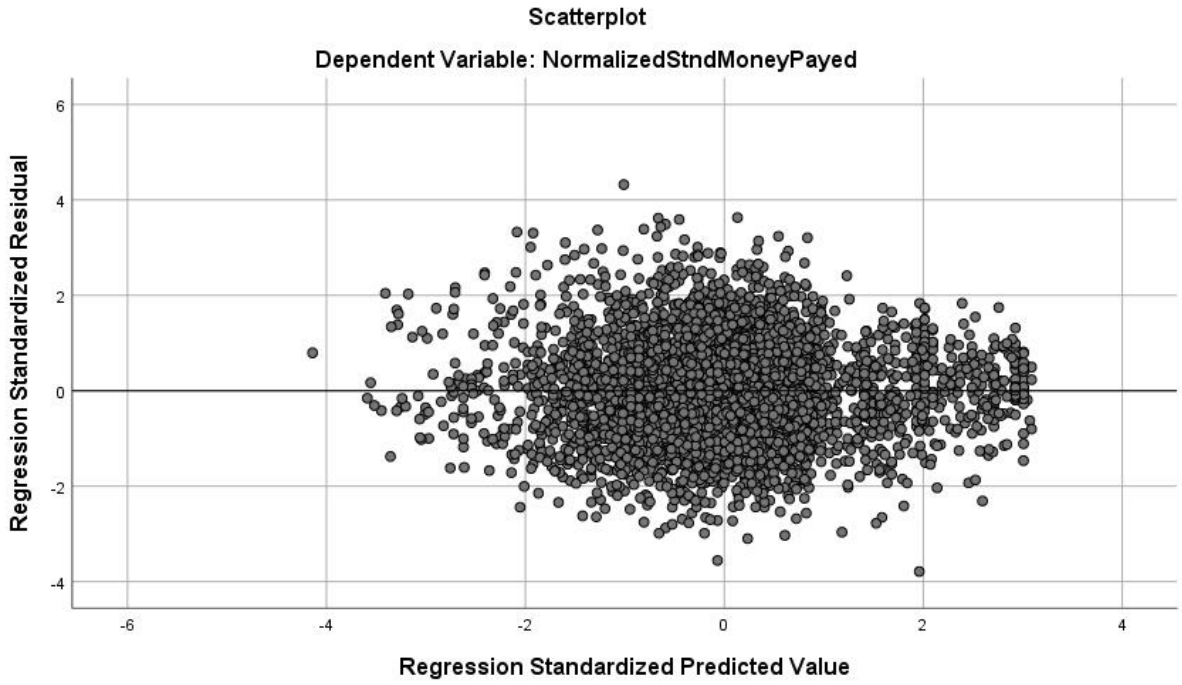

Figure B1. Scatterplot analysis of standardized regression residuals to standardized predicted values.

However, our tests revealed that the residuals do not meet the assumption of normal distribution according to Kolmogorov-Smirnov as indicated by the significant P value <0.05. Despite this deviation from normality, the shape of the distribution largely follows the characteristics of normal distribution, as depicted in Figure A2. This contradictory result can be attributed to the large sample size of our sample where even minor departures from normality can cause a

statistically significant result, suggesting that the assumption of normality was not grossly violated and the analysis results can still be interpreted.

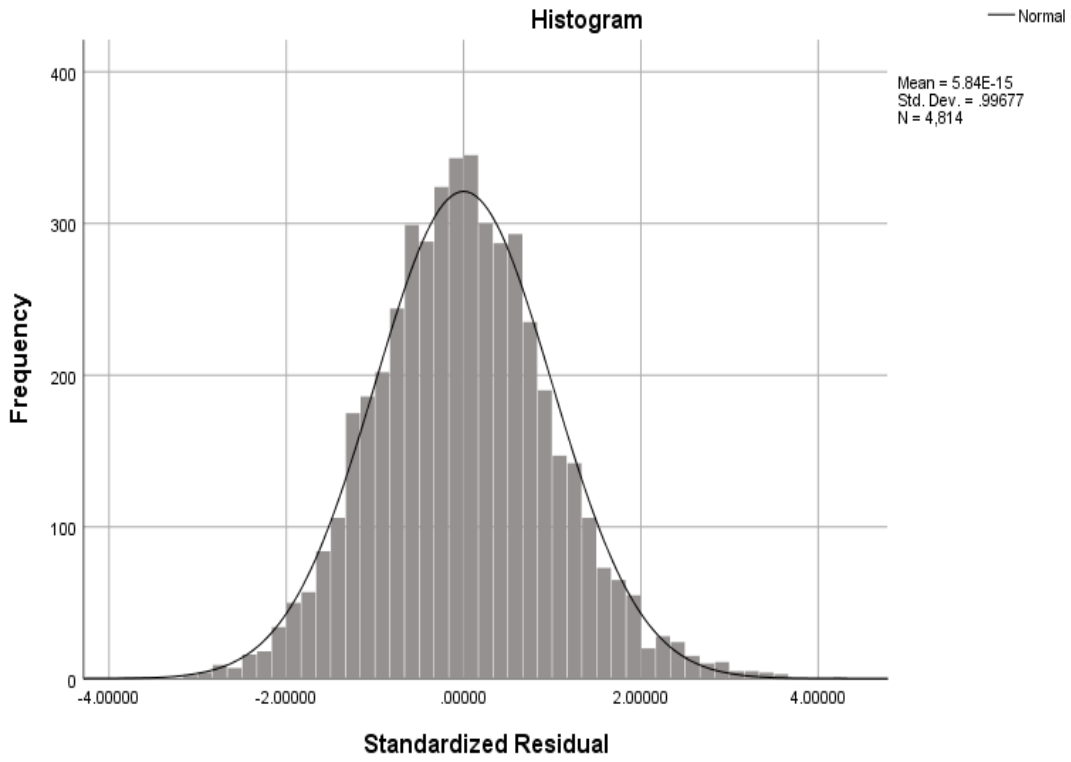

Figure B2. Distribution of regression analysis standardized residuals.

Fulfilment of these three prerequisites indicates that the assumptions underlying the regression analysis were met, ensuring the reliability of the results.

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