THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (PHD)

Segregated Residential and COVID-19 pandemic effects on Healthcare Service utilization dynamics among vulnerable populations in Hungary

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Abbreviations

ABA- Asset-based approach

aOR- adjusted odds ratio

ATC- Anatomical Therapeutic Chemical

CA- Complimentary area

CDC-Center for Disease Control

CEE- Central and Eastern Europe

COPD- Chronic obstructive pulmonary disease

COVID-19- Corona Virus Disease-2019

CRPNR- Cost related prescription non-redemption

CRR- crude redemption ratio

CVD- Cardiovascular disease

EU- European Union

GP- General Practitioner

HCS-Healthcare Service

HCSO- Hungarian Central Statistical Office

HCU- Healthcare Service use/utilization

IHD- ischemic heart disease

iOR-interaction odds ratio

ISSP-International Social Survey Programe

NIHIFM-National Institute of Health Insurance Fund Management

OOP- out-of-pocket payment

OTC- Over-the-counter Therapy

PHC- Primary Health Care

PNR-Prescription nonredemption

RRR-Relative Redemption Ratio

SARS-CoV2- Severe Acute Respiratory Syndrome coronavirus

SHCP-Swiss Hungarian Cooperation Program

SRC- Segregated Roma Colony

WHO- World Health Organization

1. Introduction

1.1 Background of Healthcare services utilization

The history of need and demand for secured health and ill-free life status-seeking practices or healthcare utilization (HCU) had been observed in prehistoric or ancient times (1). However, the occurrence of endemic and epidemic diseases created an opportunity for the establishment of causation and innovations in public health and epidemiology for today's world (2). The concept of health care services (HCS) started from 2600 BC when Imhotep described, diagnosed and managed two hundred diseases. From time to time its concepts have been updated and modernized based on technologies, research and scientific findings. The sources of basic healthcare services at a time included societal beliefs and religious views about disease prevention and health promotion (3). Modern HCS includes delivering curative, preventive and palliative care at primary, secondary and tertiary healthcare institutions for patients (4). The following are basic concepts under the modern HCS (General practitioner (GP) visits, Specialist care, Hospital admission and prescription redemption).

1.2 Basic concepts

General practitioner visits, Specialist care and Hospital admission

The general concept of these terms is more or less related to the continuum of health ill process called 'health-seeking process' (5). GPs or medical doctors are health professionals who treat all common or general medical disorders. They refer critical patients to hospitals and other medical services for further specialist treatment. While the specialists are medical doctors who have advanced training and degrees in a specific branch of medicine (each human organ and system level) (6).

Then again, the history of the hospital and its concepts date back to the first century BC and was started in Greece (7). It is the concept that assigning of a severely ill outpatient person to a hospital as an inpatient for further investigation, appropriate care and treatment of an illness or injury wherein the patient's length of stay is overnight and typically exceeds 24 hours (6).

Prescription redemption

For the first time, prescriptions were written on a clay tablet in Mesopotamia around 2100 BC. The ancient city of Baghdad was known for the establishment of the first drugstores in the 8th century BC (8). Regrettably, patients started to miss the order or prescribed medicines at the time either intentionally and unintentionally (9). Gradually, prescription nonredemption (PNR) has started to become a major public health issue. So, it has been described as the ina-

bility to buy or purchase a new drug accordingly within a specified number of days i.e., an averagely of 30 days after the medication was prescribed. If such a mismatch happens that is considered as PNR (10–13). It has synonyms like primary non-compliance, primary medication nonadherence, not dispensing prescriptions, newly initiated drug nonrefilling (14–17). It also shows the linkage or proportion of the number of prescribed medications per the number of dispensed medications by patients**.** On the other hand, according to a WHO report cost-related PNR (CRPNR) was defined as out-of-pocket (OOP) fees that make difficulties in redeeming the prescriptions at the point of care among the patients (18). The causal factors are usually drug-related, patient-physician communication, sociodemographic and economic, disease-related and health system characteristics (19,20). Subsequently, not a single party is responsible or blamed for PNR (21–24)**.** Earlier studies described the influence of drug costs on achieving or redeeming those medications (25,26,35–41,27–34)**.** Given the financial barriers, the lower redemption of prescriptions among patients leads to poor health illness outcomes. For instance, Kennedy J and colleagues investigated that more than 55% of patients did not redeem the prescribed medications due to the increased cost of drugs (12). CRPNR was also related to the higher sociodemographic disadvantage index (SDI) (42,43). Hence, as the cost of prescribed drugs increases, patients tend to use over-the-counter therapy (OTC), nonordered medicines (44).

Roma population

Roma or Gypsies were moved originally from the northwestern Indian subcontinent to Europe following the Byzantine empire from the 10^{th} to 12^{th} century (45). Later they spread and mixed with indigenous Europeans across Europe (46). Historically despite the democratization, the Romas' socioeconomic and every livelihood become under a big threat (47). In many parts of Europe, they have been considered as minorities and failing to utilize HCS than the general population (48–50). In the Hungarian context, more than half a million Roma (8.8%) of the general population are living in the country (51). Their lesser degree of HCU and poor lifestyle pushed them to underprivileged and making vulnerable to health problems (52). For this reason, enormous findings from Hungary and others uncovered that Roma health is equivalent to global health given that special attention is needed to fill the gaps on ill-health problems. According to these studies and reports usually, they have been known for low HCS seekers, health threats, detested in all HCS perspectives (53–60). They were also mistreated in every regard during the corona virus disease (COVID-19) pandemic in the European Union (EU) including Hungary (48,55).

Segregated settlement or Segregated Roma Colony (SRC)

It has been well studied that the place of residence matters the quality of life, living conditions and lifestyle of the individuals (61–63). The less deprived or undercrowded setting typically favors a healthy lifestyle, better utilization of services, reduced mortality, and morbidity (64–67). According to previous studies in Hungary, the most deprived settlements are clustered in the northern and northeastern parts of the country. In these settlements majority of inhabitants are Roma (68). The indicators of the deprivations were defined as poor quality of housing and overcrowding. This led them to poor lifestyle and health outcomes compared to the Hungarian general population (69–71). Due to the social trends of the last decade, the ethnic composition of segregated colonies changed. The recent colonies are populated mainly but not exclusively by Roma (72).

Corona Virus Disease pandemic

This is a viral disease that originated in Wuhan, China in late 2019 (73) and later covered the whole world declared as a pandemic on 11th May 2020. It is caused by a virus called Severe Acute Respiratory Syndrome coronavirus (SARS-CoV2) (73,74). It has caused a whole encircled crisis throughout the world for all human lives. Economy collapse, lack of job, furlough, unemployment, HCS deterioration and low utilization, excess mortality, lack of public trust in healthcare, and others could be mentioned (75–82)**.** The most widely mentioned factors in several works of literature were susceptible social groups and the mechanisms that helped patients to meet their healthcare demand during the pandemic (19,83–87). But a substantial number of patients ceased HCU during the pandemic in different countries with various gradients (75,78,79,88).

Vulnerability to HCS utilization

The noun "vulnerable" and verb “vulnerare” was originated from the Latin origin ‘vulnus’ (to wound) (89). Its concept has been widely studied and defined as being disadvantaged or deprived socially and which results in social challenges of health disparities (90). It occurs as a gap between an individual or client’s demand and the mechanism to achieve those needs. Being easily liable to this mismatch exposes a section of the population in jeopardy of underprivileged HCU (89–93). Thus, a disease-causing agent, environment, ethnicity, or any characteristics of individuals can be a risk factor and trigger the susceptibility to HCU (90,92,93).

1.3 Factors affecting HCU among social strata

Globally, HCU and social inequalities have usually been emanating from several dimensions of factors (78,79,88,94–97). According to Newman and Andersen's model, these factors were

broadly categorized into three themes (98,99). These were (*1) predisposing factors* are those sociodemographic features of the subject that occur before their health state (age, sex, ethnicity, residence), *enabling factors* to show the means or basic infrastructures and logistics needed to access the services (educational attainment, marital status, economic level, accessibility, availability of medical supplies and drugs), and *need factors* are the utmost and instant reasons for HCU and indicate the perceived health condition of the subject (perceived severity and duration of the diseases). But these factors may facilitate or inhibit the HCU (100–103). For instance, single/divorced or widowed marital status (104–106), lower educational attainment (107,108), chronic nature of diseases (101,109–111) have negatively been affecting the proper HCU.

Prescription redemption and determinants

Piette and colleagues designed five core factors of prescription redemption and CRPNR. These are patient, drug, healthcare, patient-physician, and sociodemographic determinants (19). Sociodemographic and economic characteristics like; age, sex, ethnicity, educational attainment, residence, cost, marital status (112–114), communication with physician (115), fear of medication side effects, access, availability, behavioral factors and natural history of the disease were mentioned. Usually, patients with underlying chronic illnesses skip or underuse the prescribed medications due to the above-mentioned factors. Cooper and colleagues uncovered that 73% of the patients with chronic illness skipped their prescriptions intentionally in the USA (116–123). But the intensity and distribution of factors are not limited to these factors. (25,124–130). Being minority population has a higher PNR than general or indigenous counterparts (44,63,131,132). Marital status is also correlated with the redemption of prescribed medications. In Sweden, PNR of antidepressants was higher among divorced than married couples (133). Being geographically deprived or living in poor settings where access to the healthcare system is associated with low HCU (134–137).

Other recent pooled analyses come with a vast of determinants for prescription nonredemption (138,139). There were several factors from individuals to the healthcare system that had been hampering the magnitude of prescription nonredemption. According to several studies across the globe, there were various factors affecting the proper dispense of their prescribed medications among patients. For instance, having lower income and prolonged duration of medication time in Portugal (140), younger age in the USA (141–144) and Denmark (145), fear of side effects in the USA (22,146), increased cost of medications in the USA (147), being the ethnic minority in the USA (144,148,149) and New Zealand (63,131,150) and vulner-

ability due to disability Iceland (151) had a higher likelihood of not dispensing their prescribed medications. However, unprecedented situations like the COVID-19 effect have not been studied.

Besides, as mentioned above the unprecedented COVID-19 pandemic is currently driving and widening the gaps on HCU. However, gaps have not been explicitly identified among the susceptible social strata.

Ethnicity and HCS utilization

Before and during the COVID-19 pandemic, numerous previously published researchers revealed the relationship between ethnicity and HCU (152–161). For instance, American-Africans and Hispanics encountered a higher magnitude of rehospitalization and hospital admission rate than whites (157,162). In Vietnam, the indigenous (*Tay people*) utilized outpatient care more than Kinh and other ethnic groups (163). Regarding total hospital costs, the Hispanics had more total hospital costs than white Americans (161). Concerning PNR and/or CRPNR and minorities, studies were published from various continents (164–173). In Oceania; New Zealand Maori and Pacific populations have higher odds of CRPNR than indigenous counterparts (63,149,150). Filipinos and indigenous Hawaiians were less likely to adhere to prescribed medications compared to the native Japanese population (174). The majority of the studies from North America showed the relationship between CRPNR and ethnicity (12,141,169,170,175–180). Almost all of these findings uncovered that Black American Africans and non-Hispanics have higher odds of CRPNR. For instance, Non-Hispanic Black has fewer odds of facing CRPNR than Non-Hispanic Whites (176). Similarly diabetic, hypertensive and hyperlipidemic patients of Black Americans showed higher PNR (181). Shin and colleagues discovered that Blacks have lower redemption of prescriptions than whites in the integrated healthcare settings (178). Conclusively, a meta-analysis finding revealed that nonwhites have higher odds of nonredemption around 53% than whites (182). But CRPNR extent has not been well addressed during the pandemic era.

During the COVID-19 pandemic era, ethnicity still has been the potential determinant of HCU (183–185). The hospitalization rate among ethnic minorities was higher than indigenous or native populations in the USA and Europe. Hispanics, Asians and Blacks were on averagely two times more likely to get admitted to the hospital than whites (186). In the European context, including Hungary, the Roma were the main victims of the lockdown from HCU perspectives (48,55). Ethnic minorities particularly blacks, Asians and others were highly victims

of getting emergency and referral medical services than whites due to the COVI-19 pandemic in the United Kingdom (187).

Marital status and HCS utilization

Different studies have their inferences regarding the relationship between marital status and HCU before and after the pandemic lockdown. For instance, before the pandemic lockdown widowed had a higher likelihood of HCU among other subgroups due to mental, physical and emotional health burdens following the loss of their partners (188–190). Similarly, studies from South Korea and the Netherlands revealed that this marital stratum had less avoidance of HCU than married ones during the pandemic lockdown (189,191).

Educational attainment and HCS utilization

Most of the studies including European nations and others revealed that achieving higher academic status is usually had been associated with increased HCU (107,108,192,193). A study from the Netherlands and others uncovered that during a pandemic lockdown, patients with lower academic groups had higher avoidance of healthcare use than others (194,195). However, another big European survey revealed that subjects with higher academic status have lower avoidance of HCS during the pandemic (196). But a finding from South Korea did not show the significant relationship between educational attainment stratum and healthcare use (191). In Taiwan, those who had better educational attainment or know-how about health had a higher likelihood of HCU before the pandemic era (197).

Chronic diseases and HCS utilization

Chronic diseases are those illnesses with longstanding duration and multiple risk factors (198). According to the Center for Disease Control (CDC) classification, they are cardiovascular disease (CVD), cancer, diabetes, chronic respiratory diseases (199). Chronic care patients have a better and more frequent visit of a specialist than elective cases (200,201). During COVID-19, especially chronic bronchitis or chronic obstructive pulmonary disease (COPD) patients were admitted and readmitted to hospital in a huge number than other respiratory illnesses (202,203). Also, diabetic, malignant, and cardiovascular patients were frequently admitted to the hospitals than healthy individuals (204–207). Previously different findings had their conclusion regarding the relationship between chronic diseases and CRPNR. Several chronic patients rely on multiple medications and face financial barriers to redeem prescriptions. For instance, in the USA CRPNR for Atherosclerotic CVD was 12.6% (35), Canada 10.2% for chronic multimorbidity (38) and 1.6-3.1% among developed European nations (39). During the COVID-19 pandemic, about 10.7% of hypertensive patients did

not redeem their prescription due to cost (208). During the pandemic, most respiratory and mental disorder patients were better utilized in healthcare than healthy individuals (209–211).

Healthcare costs and HCS utilization

Healthcare costs include both direct and indirect expenses and resources used related to the management of illness in the healthcare system. Direct cost covers financial payments for the provided service in the specific healthcare institution. Direct cost covers financial payments for the provided service in the specific healthcare institution. Those services might be laboratory diagnostic, nursing care, medical supplies and drugs, food supply during the care period (212). While indirect costs include an economic burden such as lost working time, salary, productivity, home care and chores due to the hospital or any healthcare institution stay (213,214). However, according to findings from Taiwan, UK, Canada and Iran witnessed that as both costs increase, the utilization of such services usually falls among susceptible individuals (212–216).

Behavioral (immediate) factors and HCS utilization

Individuals' current health status, attitude, intention, forgetfulness, knowledge and HCU are interrelated. Jackevicius and Harrison with colleagues stated that patients perceived lack of effectiveness and repeated prescribing of medications usually demotivated the prescription redemption in Canada and USA, respectively (22,217). In Spain, both adults and children sought health care for urgent and severe medical emergencies (218). Similarly, Ray Moynihan and fellow researchers in their systematic review encompassed more than 80 countries revealed this trend had a similar rhythm concerning HCU during the COVID-19 pandemic (219).

1.4 Dynamics of HCU before and during the COVID-19 pandemic

As described in the beginning, HCS services encompass meeting medication demands, GP visits, specialist care, and hospital admission as well. The dynamics of GP visits, specialist care, hospital admission and affording treatment vary from place to place due to the COVID-19 pandemic throughout the world (191,195,219–224). From the global arena, hospital visits were decreased by 63% in China (78), GP visits decreased by 30% in Singapore (77), enormously around nearly three-fourths (73.2%) of patients avoided HCU in South Korea (191). Concerning prescription redemption, before the pandemic globally pooled evidence revealed that 17% of patients did not redeem their prescription accordingly (139). But the magnitude differs from country to country. In New Zealand 9.8%-50% (63,225), Portugal (22.8%) (140), Sweden (2.5%) (226), 9.3% (113), Poland (20.8%) (227), Spain (17.6%) (228), Denmark

(9.3%) (145), Netherlands (51.5%) (229). But during the COVID-19 pandemic, a few studies have shown that CRPNR was found a major health issue after the pandemic. In the USA, about 10.7% of hypertensive patients did not redeem their prescription due to cost (208). For instance, in Singapore, out-of-pocket medical costs were reduced by 23% during the pandemic (77). Also, another study demonstrated that EU members did not modify the regulations regarding out-of-pocket payment for medication during the COVID-19 pandemic (230). However, a pooled analysis from 20 countries with more than 81 studies revealed that substantial declines were seen for aggregate HCU, GP and/or specialist cares, hospital admission rate and therapeutic use. But it suggested the lack of information about HCS inequality among different social strata in those studies (219).

Also, Europe as either EU or each specific country has fallen been under the shadow of the COVID-19 pandemic lockdown effect on HCU. The average avoidance or postponing of the medical service and missing the medications/treatment in the EU were 26% and 12%, respectively (196). From countries perspective, the dynamics in the use of HCS during the pandemic lockdown in the Netherlands, more than 20% of patients did not visit GP or specialist (195), 21% fall in the incidence of hospital admission recorded in Croatia (231), both the GP and specialist care declined by 6% and hospital admission by 39% in Germany (75).

Whereas the magnitude of CRPNR in Central Europe specifically Poland ranges from 16% to 21% before the pandemic. For inhalable 15.3%, antihistamines 20.9%, and aggregate redemption was 20.8%, while general redemption of prescriptions in Hungary ranged from 64.1% to 66.8% (227,232–234). Additionally, CRPNR a little bit varies from general PNR across countries. It was less than 5% in the affluent Western European countries (39). But the CRPNR has not yet been studied during the pandemic lockdown elsewhere.

In Hungary situation, 20% of medical appointments were postponed by doctors and 9% of patients missed visiting their doctors due to the fear of acquiring infection (196). But these respective figures were lowest for Bulgaria (2%) and Slovakia and Spain (4%), respectively. But the deprivation, being male and Roma settlements were a higher risk for increased mortality of the COVID-19 cases than their reference strata (235). Then again, the pandemic lockdown actions also showed a similar trend in excess mortality in the first year of the pandemic in relatively the same pathway with other Eastern and Central European countries (Slovakia, Poland and Romania) (236).

Therefore, it is important to explicitly investigate further the dynamics of HCS services uptakes and susceptible social groups attributed to the COVID-19 pandemic lockdown in Hungary.

1.5 Health Outcomes of low HCS utilization

The consequences of low HCU either preventive or curative have been a global major health issue. When subjects do not tend to use HCS, the prevalence and incidence of the diseases inevitably increase (237–241). From the beginning to the end, this amplifies the severity, poor prognosis, unwanted complications, direct and indirect healthcare costs, hospital admission, disability and even death (242). However, timely healthcare visits and getting appropriate remedies have been crucial to improving the health condition of the individuals, families and community. For instance, those individuals who used to visit their GP and specialists have a higher likelihood of achieving the redemption of the prescribed medication (243,244). Also, another big survey revealed that individuals who had more PHC visits had a lower possibility of hospitalization rate (245).

1.6 Effective interventions for improving prescription nonredemption

According to a few studies across the world, there are different kinds of practical interventions had been taken to improve prescription redemption for chronic diseases (246,247). Most of the interventions used a multifaceted and integrated approach to boost the level of prescription redemptions based on their specific findings.

In Denmark, a trial study was conducted with aim of increasing prescription redemptions among diabetic patients. GPs were provided with electronic feedback on the quality of care provided for patients. At the end of the intervention period, those who were intervened had 32.8% and controls had 12% of redemption of oral hypoglycemics (248). In Hungary, integrated and multi-professional services were delivered for GPs to enhance prescription redemptions at the PHC level. The intervention encouraged patients to dispense their prescriptions significantly than before the intervention period (249). On the other hand, in the USA phone calls were done for patients as a reminder to check their status of dispensing their prescribed medications. All of the interventions had significant effects in enhancing the prescription rate than their counterparts (250,251). For example, Renner and colleagues' study showed that the given intervention was effective with an increased dispensing ratio twice among the intervention group with 15.4% vs 7.5% (252).

Asset-based approach (ABA) model

This approach is a kind of intervention that mostly supports and focuses on strengths and what works among the vulnerable groups or end-users. From a HCU perspective, it enables people to share their insights and views of nearby services, accesses to health resources and their private or shared desires (253). The steps are taken at the individual, community and organizational levels. It allows their active involvement in the planning, delivery and outcomes of the interventions and the invention of community-based solutions (254). Because understanding the vulnerable population's cultural, social and demographic adaptability have a para amount of importance than the usual top-down approaches (255). In a precise explanation, this approach empowers the uptake of the specific healthcare elements among vulnerable sections of the population. This approach showed a substantially positive impact on reducing the gap or inequalities of HCU among the population in Scotland (256), the UK (257), South Korea (258), the USA (253), Japan (259), Finland (258) and Canada (253). But in the Hungary context, before 2012 there was no such approach except Public Health Focused Model Programme for Organizing Primary Care Services Backed by a Virtual Care Service Centre such approach to improve HCU including prescription redemption among subjects in the SRCs and CAs (260).

Digital health interventions (DHI)

This is a recent intervention model launched by WHO to improve HCU among chronic care patients. It uses the social platform, mass media or any electronic devices such as mobile phones to remind the patients not to miss dispensing their prescribed drugs (261) As mentioned above, a few studies were used to apply to improve the prescription redemption among chronic care patients (248,252,262). Also, its cumulative impact was assessed by the pooled analysis making the difference that providing proper DHI has a substantial capacity to bring positive HCU among the vulnerable groups (261).

Swiss Hungarian Cooperation Program effect on prescription redemption

In 2012, Swiss Hungarian Cooperation Program (SHCP) was launched with a theme Public Health Focused Model Programme for Organizing Primary Care Services Backed by a Virtual Care Service Centre such approach to improve HCU including prescription redemption among subjects in Hungary (260). This program mainly focused on reducing preventable deaths and diseases through expanding additional GP clusters (GPC). The four GPCs were providing further new services (health status evaluation, lifestyle counseling on nutrition, health psychology, physiotherapy, preventive services, and community health promotion programs) for the residents with the special focus given to the Roma community. Finally, the

program has been successfully and significantly addressed primary health care services including prescription redemption at the national level (249,263). Even though the intervention program was inclusive of the Roma minority, the prescription redemption in the SRCs and CAs was not yet assessed.

1.7 Study context

According to the previous studies, Hungary has moderate HCU in including prescription redemption due to various determinants (232,249,264). Furthermore, the dynamics of other HCU following the COVID-19 pandemic have not been well investigated except for a few preliminary findings of the immediate effects (235,236). As a result, this will provide the lenses through which the dissertation, as well as its methodological flows, new findings, conclusions and recommendations, can be displayed. Hence, mainly this dissertation focused on the impact of the segregated settlement on prescription redemption and the COVID-19 pandemic on the dynamics of HCU, vulnerable social strata and sociodemographic, and clinical determinants in Hungary. Hence, it is very essential to ensure external validity and intervene in the identified gaps according to the findings across Hungary.

1.8 The rationale of the research

The core reasons behind carrying out this study could be mentioned as follows. According to several reports and study findings, comparatively to the EU, western and a few of Central and Eastern Europeans (CEE), Hungarians bear relatively lower life expectancy, HCU, higher mortality and morbidity rate (57,232,238,241,265–268). Additionally, about 8.8% of the population is Roma (51). As mentioned above, Roma are usually characterized by poor health status and lifestyle. This has been contributing to enormous health problems and increasing their vulnerability (70,269–274). From this perspective, the proper HCU has enormous health implications among the disposed population. These are regular HCS visits including GP and specialist, proper purchasing of prescribed drugs and medical supplies play a crucial role in the wellbeing of nations (237–241,275). It implies that better GP visits, specialist care and prescription redemptions have a decent impact on health; such as reducing mortality, hospital admission rate, severity and disability (17,23,145,146,228,276–278). Despite few studies that have been conducted on primary medication adherence (232,249) in Hungary, none of the studies discovered its magnitude difference among Roma communities and the impact of segregated settlement or Segregated Roma Colony (SRC) on the redemption of prescriptions.

Furthermore, the COVID-19 pandemic deteriorated almost all aspects of life across the globe both at the individual and system level (74,80–82,207,267,279,280). Similarly in Hungary, the pandemic lockdown caused several health crises. Since the pandemic, Hungary ranked among the top ten countries in Europe with more than 39,000 deaths and 1.3 million COVID-19 cases until the end of 2021 (281). Besides the extent, determinants and vulnerable social strata for HCU have not been explicitly studied yet except for limited findings on the immediate effects. For instance, Oroszi B and colleagues' study revealed that being living in the most deprived settings had fewer cases but a higher mortality rate compared to the national figures. Being male, deprived and Roma densely inhabited residentials had a higher mortality incidence (235). So, whether the mortality was due to whether lack or reduction in the HCU attributed to the lockdown or other reasons has not been well defined. Hence, it is essential to uncover and intervene, compare and scrutinize GP visits, specialist care, hospital admission and CRPNR determinants, the susceptible social strata due to the pandemic lockdown in the pre-pandemic and pandemic (after the first wave of the pandemic) periods in Hungary. (**Figure 1**)

2. Objectives

The general objective of this dissertation was to investigate the dynamics and determinants of the HCS uptake in the pre-pandemic and the COVID-19 pandemic periods in Hungary. Having this the specific aims were

1. To assess the crude prescription redemption among Roma living in segregated settlements versus complementary areas.
2. To investigate the age-sex indirect standardized redemption ratio of Roma living in segregated settlements versus complementary areas.
3. To estimate the GP visit, specialist care, hospitalization and CRPNR pre-pandemic and during the COVID-19 pandemic
4. To investigate the effect of the pandemic on GP visit, specialist care, hospitalization and CRPNR controlled for established predictors and
5. To determine susceptible social strata to the GP visit, specialist care, hospitalization and CRPNR elicited by the pandemic lockdown in Hungary.

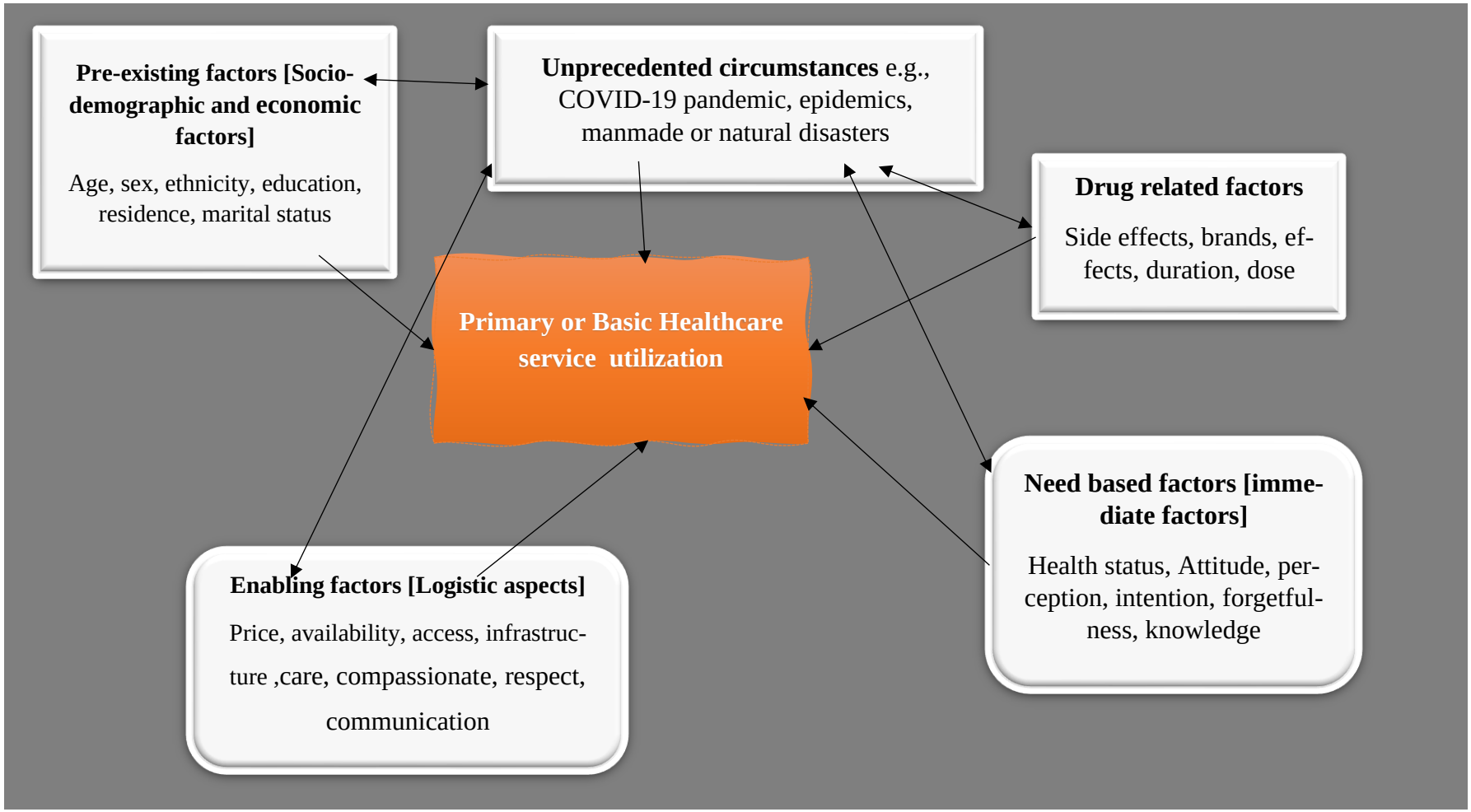

Figure 1 A conceptual framework of Primary Healthcare utilization barriers and enhancers adapted from the various literature review.

3. Methodology

3.1 Study setting and data source

The data were emanated from three different databases. Firstly, the secondary data analysis was applied with data obtained from the 2012 National Institute of Health Insurance Fund Management (NIHIFM) of Hungary for a prescription nonredemption among Segregated Roma Colony (SRC) and Complementary Areas (CAs) http://www.neak.gov.hu/. While 2021 International Social Survey Program (ISSP) (282) and wave 3 European Health Interview Survey (EHIS) (283) databases of Hungary were used for the rest of the objectives (COVID-19 pandemic lockdown versus healthcare use dynamics).

Segregated Roma Colony and Complementary Areas, Prepandemic and Pandemic data

The data were obtained from NIHIFM of Hungary in 2012. It was a part of the "Public Health Focused Model Programme for Organizing Primary Care Services Backed by a Virtual Care Service Centre" program in Hungary (260). The foremost goal of the program was to reorganize preventive service delivery at PHCs by the GP team and to supply improved care without segregating the Roma people (69).

In the SRC, there were about 758 colonies were existed with nearly 134,000 inhabitants. Of these, 94% of colonies are occupied by the Roma population (284). According to previously published studies, the colonies have been living in the underprivileged setting with varying degrees of health seriousness which can be measured by a merged score based on indicators of access to services and the presence of environmental vulnerabilities (53,59,284,285). The proportion of Roma residents were in this colony approximately 20% to 25% of the estimated whole number of Roma population in Hungary (284).

Secondly, we have got the required data from the Hungarian Central Statistical Office (HSCO). Then EHIS 2019 wave 3 database of Hungary has been utilized to investigate socioeconomic, demographic, healthcare, and related factors before the pandemic. Data were collected from September to December 2019. The full description of EHIS was published elsewhere with the aim is to measure European States' health status on a harmonized basis with a high degree of comparability among the member states. It incorporates health status indicators, health determinants, and HCS of EU citizens (283).

Thirdly, 2021 ISSP data of Hungary has been utilized to investigate socioeconomic, demographic, healthcare, related factors after the first wave of the COVID-19 pandemic. Data were collected from March to May 2021. ISSP is an international survey conducted each year on

social sciences to bring various importance to the theme (282,286). In this survey, Health and Health Care module contains health-related questionnaires.

3.2 Population

In the indirect age-sex standardized redemption all age groups (0 to 85 years and above) were included in the study from both SRC and CA settlements.

All residents of Hungary aged 18 years and above were used for pre-pandemic and pandemic data analysis. Both sexes and ethnicities (Roma and non-Roma origins) were incorporated into our study population. The data of prescription redemption for age was categorized as 0-17 (this category majorly included pediatrics) (287,288), 18-24, 25-44, 45-64 and 65 years and above.

3.3 Data collection

The data were collected from three different sources. The specific data collection method is defined in **figure 2** below.

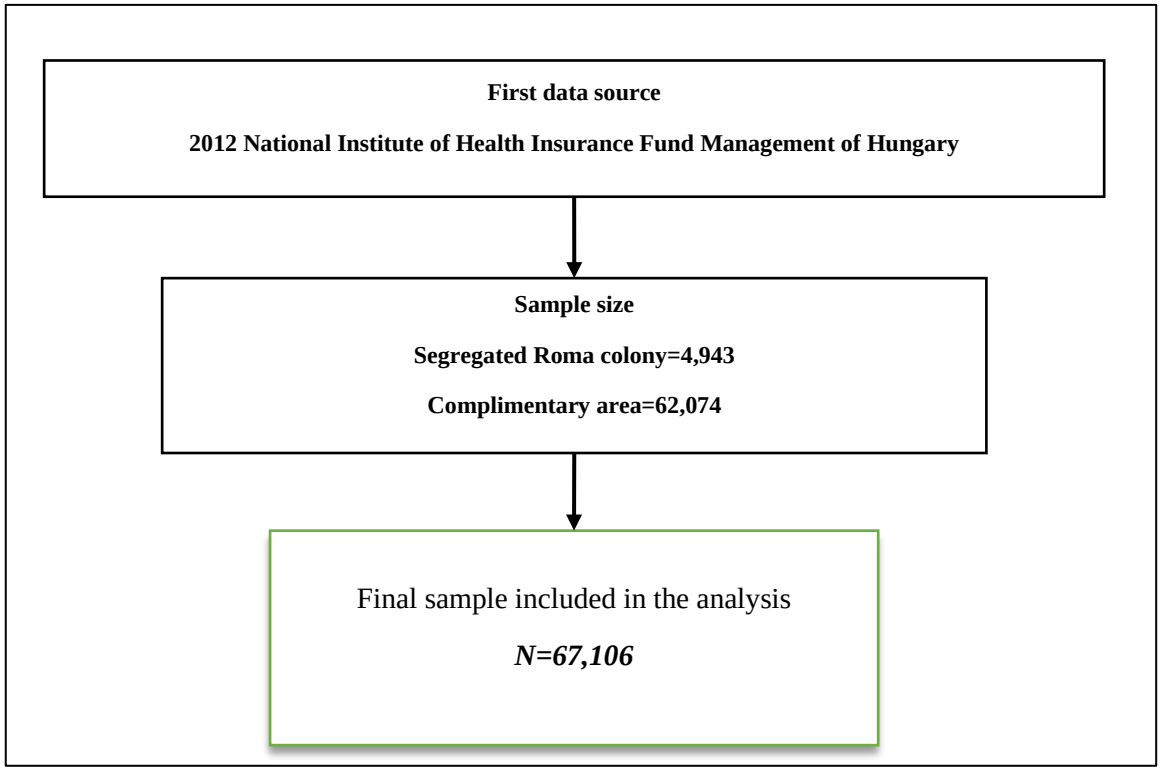

Figure 2 Segregated and complementary areas sample recruitment process for the dissertation on prescription redemption in Hungary

As the EHIS 2019 data contained participants from 15 years and above, 15-17 years subjects were excluded from the analysis. (**Figure 3**)

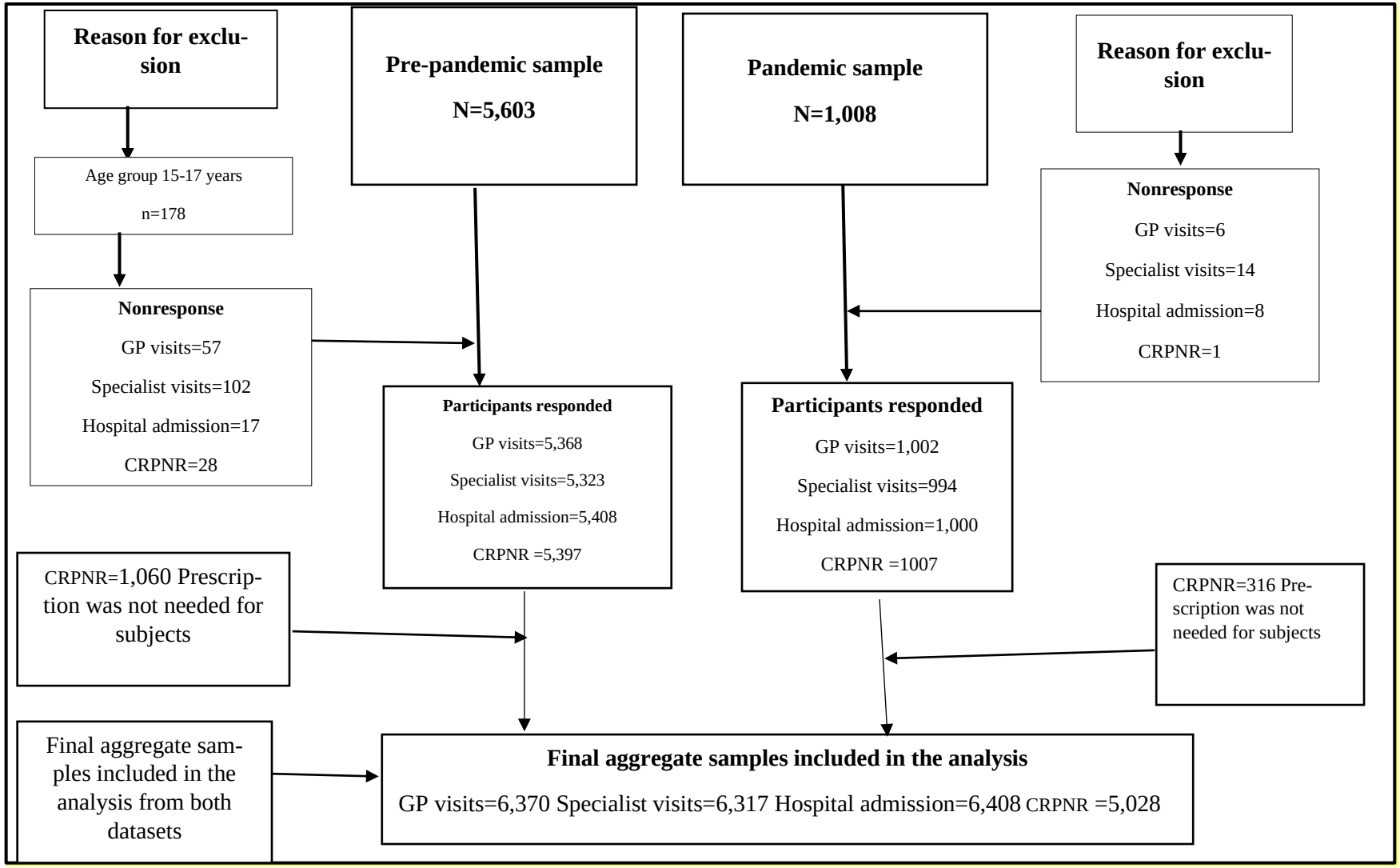

Figure 3 Sample recruitment process for the dissertation on health services utilization in pre-pandemic and pandemic periods in Hungary

3.4 Outcome variable measurement and statistical analysis

Indirect age-sex specific redemption ratio

The normality of indirectly standardized redemption ratios' distribution was checked for both prescription and redemption among SRC and CA. Then, the crude redemption rate (CRR) was calculated for the country, SRCs, and CAs. Prescriptions were calculated by age- and sex-sp ecific numbers of written prescriptions and the national reference redeemed-to-written the ratio for all strata (232,249). To compare the prescription redemption between SRC and CA, age-sex specific indirect standardization was applied to control the confounding effect of age and sex between two strata for each Anatomic Therapeutic Chemical (ATC) classification. ATC was classified and controlled by WHO under Collaborating Centre for Drug Statistics Methodology. Under this classification scheme, the first level of the ATC code was used to show anatomical main groups and its letter (ATC_A to ATC_V) (289).

As the number of participants is quite different both in size, age distribution and settings made the comparison difficult. Thus, the age-and-sex band was used to calculate the age-sex specific redemption ratios between the strata.

The following formula was used to determine the indirectly standardized redemption ratio (SRR) (290).

$$\text{SRR} = \frac{Observed\ (drugs\ redemeed\ among\ the\ prescribed\ amounts\ by\ healthcare\ provider)}{Expected\ (prescribed\ amounts\ by\ healthcare\ provider\ \times\ Reference)}$$

where the reference is the crude redemption proportion of each age and sex band.

Then the relative redemption ratio (RRR) was calculated as the ratio of indirect age-sex specific redemption ratio among SRC to CA. Similarly, the relative redemption difference (RRD) was computed as the difference between SRR_{SRC} and $SRR_{CA.}$

$$RRD = SRR_{SRC} - SRR_{CA}$$

Attributable risk

Attributable risk (the redemption attributed to the residential area) was calculated as the product of the RD and the expected amount of redemption among SRC. The equation was as follows:

$$Attributable\ number\ of\ redemptions = RRD\ \times\ expected\ amount\ of\ redemption\ among\ SRC$$

GP visits, Specialist care, Hospital admission and CRPNR

All of the dependent variables (GP visit, specialist care, hospitalization and CRPNR) were dichotomous variables for subjects who had at least one episode of them before one year (within 12 months) of the survey. If the patient had a history of GP visits, specialist care, hospital admission and CRPNR in a year was classified as 'yes'=1 and unless 'no'=0. Those who were not willing to answer, remember and medical help was needed according to their yearly perceived health status were excluded from the analysis.

Explanatory variables

The potential explanatory variable in this study was the survey period. Participants recruited for the study were categorized under pre-pandemic and pandemic periods based on this variable. The variable "Educational attainment" had four categories (completed 1 to grade to 8 primary school, the vocational school includes without a high school diploma, high school graduation with diploma and tertiary includes college and university graduates). The variable "region" was classified as the residential place of the subjects as Central-Hungary, Central-Transdanubia, Western-Transdanubia, Southern-Transdanubia, Northern-Hungary, Northern-Great-Plain and Southern-Great-Plain. The variable "Marital status" was classified as married, single, widowed, and divorced. Then "Ethnicity" was categorized based on self-reported information of the subject for which identity or they belong to Roma or non-Roma. In Hungary, Roma comprised 8.9% of the total population (51).

In the analysis section, both descriptive and analytic statistics were done using Statistical Package for Social Sciences (SPSS®) version 21 (291). Before carrying out further analysis, data transformation was done as follows.

First, we had two separate datasets with different amounts of variables and cases (EHIS 2019 wave 3 with 541 variables and 5,603 cases while ISSP 2021 contains 136 variables and 1,008 cases). The difference was originated from the data collection guideline or tools of each program. However, they both were collected from the Hungarian population living in Hungary. This makes the first intersection or common in terms of the population and setting under the study. Then we thoroughly searched for common variables from both datasets like age, sex, marital status, educational attainment, and others that are pertinent to our study. After this stage, we got 19 variables those are existing in both datasets except for the IDs of participants. But still, we have to check for the variable's types, categories, or measurement similarities. Then, we have to rename types of variables and recode for variables with different categories in a way that cannot breach or deviate from the original classification or measurement in both

datasets. After renaming names and recoding values of each variable, other independent or mutually exclusive variables were removed from each dataset (original names were removed from each SPSS variable view). In this way, the data were transformed. After finalizing the selection, renaming and recoding of those common and important variables, we have created a new database by merging two datasets using those 19 variables. Through this process, the completeness of each variable has been confirmed and checked before analysis. All of our outcome variables are dummy variables and the interpretation of the results is made accordingly.

Frequency, proportions, and figures were used to display the descriptive findings. In the analytic statistics, first, we conducted a bivariate analysis for identifying the associated variables besides the interaction effect or interaction odds ratio of pandemic (iOR) lockdown. Then multivariable logistic regression was run with the interaction effect of the pandemic, to identify independently associated with dependent variables (control the confounding effect of sociodemographic and clinical factors). Also, the interaction of the effect of the pandemic on outcome variables among selected vulnerable social groups was assessed with a 95% CI to evaluate the statistical significance. Also, a statistical test for the goodness of fit was checked using Hosmer–Lemeshow test for each outcome variable. The goodness of fit tests had a p-value greater than 0.05, confirming that the data well fits the model (observed event pair expected event rates in subgroups of the population under the model).

Also, the Chi-square (χ^2) test was used to show the relationship between sociodemographic and clinical predictors and each studied outcome variable and for each study period.

3.5 Ethical clearance

The ethical consent for SRC and CA study used a secondary database and did not reveal any participant information (name, identity, or any further data kept anonymously). Therefore, according to the Hungarian regulations, no ethical approval was not required for such a study.

The EHIS wave 3 was endorsed by the European Statistical System Committee per Commission Implementing Regulation (EU) No. 255/2018. The ISSP data were used per the Ethical statement of ISSP https://issp.org/wp-content/uploads/2022/02/ethical_statement_issp.pdf the ethical requirements were approved according to the legal requirement of Hungary https://tarki.hu/sites/default/files/2018-05/adatbiztonsag_20180525.pdf

4. Results

4.1 The magnitude of redemption of prescribed medications

There were about a total of 67,017 residents studied. Among these 4,943 (7.4%) and 62,074 (92.6%) residents were living in SRCc and CAs, respectively. The majority of inhabitants; 1925 (38.94%) were 0 to 17 years in SRC while 64 years and above were 17,905 (28.84%) followed by 45 to 64 years 17,500 (28.19%) in CA. Males dominated in SRC (50.23% vs 48.28%, p=0.008). (**Table 1**)

Table 1 Sociodemographic data of study participants of Segregated Roma Colonies and Complementary Area in Hungary, 2012

Characteristics	**Category**	**SRC (%)**	**CA (%)**	**P-value**
Age category in years	0-17	1,925(38.94)	9,974(16.07)	<0.001
	18-24	716(14.48)	6,046(9.74)	<0.001
	25-44	1,305(26.40)	17,905(28.84)	0.006
	45-64	814(16.48)	17,500(28.19)	<0.001
	65 and above	183(3.70)	10,649(17.16)	<0.001
Sex	Male	2,483(50.23)	29,969(48.28)	0.008
	Female	2,460(49.77)	32,105(51.72)	0.066
Total		4,943(100%)	62,074(100%)	

SRC- Segregated Roma colonies, CA complementary area

The 2012 national crude redemption ratio of Hungary was 66.8%. Females and pediatric age followed by old age groups have redeemed better than their respective counterparts (p<0.001). (**Table 2**)

The majority of redemption was done for ATC-J (anti-infectives for systemic use) followed by ATC P (Antiparasitic products, insecticides, and repellents) with 76.8% and 75.33%, respectively. Conversely, cardiovascular and dermatological classes occupied the least space. (**Table 3**)

Table 2 National Crude Redemption ratios by sociodemographic characteristics in Hungary 2012

Patient characteristics	**Category**	**Written prescriptions**	**Dispensed prescriptions**	**Dispensed percentage**	**p-value***
Age groups (years)	0-17	7,117,169	4,966,700	69.78	<0.001
	18-24	1,471,638	941,073	63.95	
	25-44	8,859,296	5,804,608	65.52	
	45-64	45,160,578	29,125,328	64.49	
	65 and above	63,615,115	43,485,342	68.36	
Sex	Male	50,581,743	33,589,698	66.41	<0.001
	Female	75,642,053	50,733,353	67.07	
Total		126,223,796	84,323,051	66.80	-

**by chi-square test*

Table 3 National Crude Redemption ratios by ATC classifications in Hungary 2012

ATC groups	**Written prescriptions**	**Dispensed prescriptions**	**Dispensed percentage**
A- Alimentary tract and metabolism	20,395,783	14,417,501	70.69
B- Blood and blood forming organs	8,919,109	6,049,914	67.83
C- Cardiovascular system	61,978,491	39,118,918	63.12
D- Dermatologicals	1,519,730	958,432	63.07
G- Genito-urinary system and sex hormones	879,489	625,473	71.12
H- Systemic hormonal preparations*	1,306,624	929,123	71.11
J- Anti-infectives for systemic use	5,786,947	4,444,509	76.80
M-Musculo-skeletal system	7,849,077	5,544,645	70.64
N- Nervous system	7,944,060	5,730,169	72.13
P-Antiparasitic products, insecticides and repellents	62,044	46,736	75.33
R-Respiratory system	7,456,389	5,043,686	67.64
S- Sensory organs	871,650	597,112	68.50
V-various	1,254,403	816,833	65.12
Total	126,223,796	84,323,051	66.80

** excluding sex hormones and insulins*

Crude redemption ratio in segregated Roma colonies and complimentary areas

In 2012, a total of 947,008 prescriptions were written by healthcare providers for patients in the study area. Among these 674,670 were dispensed by patients. This makes the crude prevalence of prescription redemption 71.24% (95% CI, 71.15-71.34%). Comparatively, in SRC 46,107 prescriptions written and dispensed amount was 33,720 making 73.13% (95% CI, 72.79-73.60%) while in CA 900,901 prescriptions written and dispensed amount was 640,950 making 71.15%, (95% CI, 71.06-71.25%) by patients. The amount prescription per person for specific age and sex, majority of prescriptions went for 65 years and above followed by 45 to 64 years in SRC and vice versa for CA. More prescriptions were written for females in both settlements (61.9% in SRC vs 61.58% in non-SRC). There were significant differences seen in the age-specific dispense rate between the settlements. In SRC, both females and males dispensed relatively higher than counterparts in CAs. On the other hand, significant differences were seen in the redemption rate for different ATC classes. Regarding each ATC class, prescription redemption among two settlements, alimentary tract and metabolism (77.6 vs 74.96%), cardiovascular (74.92 vs 67.15%), musculoskeletal (76.53 vs 73.96%), and various types (81.83 vs 75.23%) of prescriptions were highly redeemed among SRC than CA patients. Conversely, anti-infectives for systemic use (57.60 vs 74.67%) and sensory organ system (62.57 vs 71.47%) prescriptions were less redeemed among SRC than CA. (**Table 4**)

Table 4 Crude prescription redemption of medications by age and sex among Segregated Roma Colonies and Complementary Area, Hungary in 2012

Characteristics	Category	Segregated Roma Colonies			Complementary Area			p-value
		Number of Prescriptions	Dispensed	Percentage	Number of Prescriptions	Dispensed	Percentage	
Age category in years	0-17	8,839	5,134	58.08	47,172	32,187	68.23	<0.001
	18-24	1,284	671	52.23	14,130	9,122	64.56	<0.001
	25-44	7,884	5,933	75.26	80,208	57,453	71.63	<0.001
	45-64	19,923	15,874	79.67	350,836	246,581	70.28	<0.001
	65 and above	8,177	6,108	74.69	408,555	295,607	72.36	<0.001
Sex	Male	17,662	12,703	71.9	346,089	245,279	70.8	<0.001
	Female	28,445	21,017	73.88	554,812	395,671	71.3	<0.001
A- Alimentary tract and metabolism		6,581	5,107	77.60	132,702	99,469	74.96	<0.001
B- Blood and blood forming organs		2,493	1,894	75.97	66,839	49,669	74.31	0.064
C- Cardiovascular system		13,356	10,156	74.92	409,505	274,969	67.15	<0.001
D- Dermatologicals		1,029	685	66.57	12,384	8,575	69.24	0.747
G- Genito-urinary system and sex hormones		201	159	79.10	5,846	4,557	77.95	0.698

Table 4 Continued

H- Systemic hormonal preparations, excluding sex hormones and insulins	406	305	75.12	9,651	7,482	77.53	0.257
J- Anti-infectives for systemic use	6,451	3,716	57.60	53,999	40,324	74.67	<0.001
M-Musculo-skeletal system	5,143	3,936	76.53	71,036	52,403	73.96	<0.001
N- Nervous system	3,369	2,612	77.53	64,578	49,299	76.40	0.113
P-Antiparasitic products, insecticides and repellents	32	20	62.50	539	416	77.18	0.057
R-Respiratory system	5,125	3,819	74.52	62,137	45,222	72.78	0.007
S- Sensory organs	505	316	62.57	6,012	4,297	71.47	<0.001
V-various	1,216	995	81.83	5,673	4,268	75.23	<0.001
Total	46,107	33,720	73.15	900,901	640,950	71.14	-

Crude redemption ratio each ATC classification by age and sex among SRC and CA

The crude redemption ratio by age and sex among SRC and CA was calculated from **Tables 5-17**. The Chi-square test was used to evaluate the significant difference in the redemption between the two groups.

Alimentary tract and metabolism group (ATC-A)

The significant differences were seen for the majority of redemption in the CA from 0-17 years old; 70.29% in the vs 50.82% in the SRC (p<0.001). On the contrary, for age group 45-64 years old redeemed significantly higher in the SRC than with 81.62% in the SRC vs 75% in the CA (p=0.001). There is no significant difference for redemption for sex between the two groups. (**Table 5**)

Table 5 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-A (Alimentary tract and metabolism group)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	549	279	50.82	4,238	2,979	70.29	<0.001
	18-24	148	106	76.35	1,385	938	72.56	0.676
	25-44	1,204	936	77.74	11,324	8,292	73.22	0.192
	45-64	3,417	2,789	81.62	53,098	39,825	75.00	0.001
	65-X	1,263	997	78.94	62,657	47,435	75.71	0.328
Sex	Male	2,496	1,944	77.88	48,788	36,512	74.84	0.198
	Female	4,085	3,163	77.43	83,914	62,957	75.03	0.194
Total		6,581	5,107	77.60	132,702	99,469	74.96	0.070

**by chi-square test*

Blood and blood-forming organs (ATC-B)

The significant difference in redemption was only seen for the age category of 45-64 years old with the higher 82.08% in the SRC vs 73.05% in the CA (p=0.006). There is no significant difference for redemption for sex between the two groups. (**Table 6**)

Cardiovascular system group (ATC-C)

The significant differences were seen for redemption in the age category of 25-44 and 45-64 years old with the higher 75.48% vs 65.74%, and 76.53% vs 65.55% in the SRC and CA, respectively, p<0.001. There is a significant difference for redemption among males (73.8% vs 66.42%) and females (75.55% vs 67.59%) given that higher for both sexes in the SRC than CA (p<0.001). Moreover, an aggregate crude redemption ratio was significantly higher in SRC than CA (74.92% vs 67.15; p<0.001). (**Table 7**)

Table 6 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-B group (Blood and blood-forming organs)

Variable	Category	Segregated Roma colonies			Complementary area			p-value *
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	124	60	48.39	740	488	65.95	0.064
	18-24	81	38	46.91	595	343	57.65	0.321
	25-44	456	340	74.56	3,917	2,831	72.27	0.681
	45-64	1,278	1,049	82.08	24,975	18,244	73.05	0.006
	65-X	554	407	73.47	36,612	27,763	75.83	0.630
Sex	Male	954	754	79.04	27,793	20,635	74.25	0. 207
	Female	1,539	1,140	74.07	39,046	29,034	74.36	0.923
Total		2,493	1,894	75.97	66,839	49,669	74.31	0.476

**by chi-square test*

Table 7 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-C group (Cardiovascular system)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	28	21	75.00	150	110	73.33	0.943
	18-24	69	43	62.32	1,001	720	71.93	0.474
	25-44	2,235	1,687	75.48	25,065	16,477	65.74	<0.001
	45-64	7,350	5,625	76.53	170,792	111,962	65.55	<0.001
	65-X	3,874	2,780	71.76	212,497	145,700	68.57	0.069
Sex	Male	4,852	3,581	73.80	155,851	103,520	66.42	<0.001
	Female	8,704	6,575	75.54	253,654	171,449	67.59	<0.001
Total		13,556	10,156	74.92	409,505	274,969	67.15	<0.001

**by chi-square test*

Dermatologicals (ATC-D)

In this ATC classifications, there is no significant redemptions were seen for age, sex and aggregate as well. However, it was relatively higher observed redemption in the CA (69.24%) than SRC in aggregate form. (**Table 8**)

Table 8 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-D group (Dermatologicals)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescrip-tions	Dispensed prescrip-tions	Dispensed percent-age	Written prescrip-tions	Dispensed prescrip-tions	Dispensed percent-age	
Age catego-ry in years	0-17	276	156	56.52	1,975	1,241	62.84	0.320
	18-24	49	33	67.35	716	509	71.09	0.816
	25-44	238	145	60.92	2,221	1,551	69.83	0.216
	45-64	312	239	76.60	4,239	2,987	70.46	0.349
	65-X	154	112	72.73	3,233	2,287	70.74	0.827
Sex	Male	442	261	59.05	4,784	3,260	68.14	0.078
	Female	587	424	72.23	7,600	5,315	69.93	0.625
Total		1,029	685	66.57	12,384	8,575	69.24	0.443

**by chi-square test*

Genito-urinary system and sex hormones excluding contraceptives(ATC-G)

Despite the lack of significant redemptions differences, for age, sex and aggregate band, it was a higher observed redemption in the CA (79.1% vs 77.95%). Also, males redeemed more than females in both settlements. (**Table 9**)

Table 9 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-G group (Genito-urinary system and sex hormones)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescrip-tions	Dispensed prescrip-tions	Dispensed percent-age	Written prescrip-tions	Dispensed prescrip-tions	Dispensed percent-age	
Age catego-ry in years	0-17	5	4	80.00	39	33	84.62	0.937
	18-24	10	5	50.00	120	91	75.83	0.458
	25-44	43	34	79.07	455	380	83.52	0.819
	45-64	77	55	71.43	1,573	1,162	73.87	0.852
	65-X	66	61	92.42	3,659	2,891	79.01	0.381
Sex	Male	96	81	84.38	3,400	2,754	81.00	0.790
	Female	105	78	74.29	2,446	1,803	73.71	0.960
Total		201	159	79.10	5,846	4,557	77.95	0.892

**by chi-square test*

Systemic hormonal preparations excluding sex hormones and insulins (ATC-H)

The huge observed redemption variation was seen for the 18-24 years age category higher for CA (83.6% vs 42.86%). However, there was no significant difference due to the low observed number of patients in the SRC. As a whole, the observed redemption was higher in the CA than SRC (77.53% vs 7512%) for age categories, sexes and aggregate as well. (**Table 10**)

*Table 10 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-H group (Systemic hormonal preparations**)*

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescrip-tions	Dispensed prescrip-tions	Dispensed percent-age	Written prescrip-tions	Dispensed prescrip-tions	Dispensed percent-age	
Age catego-ry in years	0-17	11	9	81.82	149	115	77.18	0.900
	18-24	7	3	42.86	189	158	83.60	0.330
	25-44	105	76	72.38	1,458	1,135	77.85	0.640
	45-64	221	163	73.76	4,364	3,348	76.72	0.710
	65-X	62	54	87.10	3,491	2,726	78.09	0.561
Sex	Male	96	70	72.92	1,860	1,428	76.77	0.749
	Female	310	235	75.81	7,791	6,054	77.71	0.779
Total		406	305	75.12	9,651	7,482	77.53	0.684

**by chi-square test ** excluding sex hormones and insulins*

Anti-infectives for systemic use (ATC-J)

The significant differences were seen for redemption in the age category of 0-17 and 18-24 years old with the higher 65.98% vs 50.29% in the CA and 60.17% vs 37.14% in the SRC, respectively ($p<0.001$). There is a significant difference for redemption among males (72.82% vs 55.65%) and females (76.01% vs 59.11%) given that higher for both sexes in the CA than SRC ($p<0.001$). Also, an aggregate crude redemption ratio was significantly higher in CA than SRC (74.68% vs 57.6%; $p<0.001$). (**Table 11**)

Musculoskeletal system (ATC-M)

The significant difference in redemption was only seen for the age category of 45-64 years old with the higher 81.99% in the SRC vs 73.41% in the CA ($p<0.001$). Also, there was a significant difference in redemption for females with the higher 78.48% in the SRC vs 74% in the CA ($p=0.031$) between the two groups. (**Table 12**)

Table 11 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-J group (Anti-infectives for systemic use)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	4,186	2,105	50.29	20,819	13,736	65.98	<0.001
	18-24	490	182	37.14	5,195	3,126	60.17	<0.001
	25-44	731	531	72.64	10,005	7,883	78.79	0.168
	45-64	851	730	85.78	11,760	10,134	86.17	0.930
	65-X	193	168	87.05	6,220	5,445	87.54	0.958
Sex	Male	2,807	1,562	55.65	22,574	16,439	72.82	<0.001
	Female	3,644	2,154	59.11	31,425	23,885	76.01	<0.001
Total		6,451	3,716	57.60	53,999	40,324	74.68	<0.001

**by chi-square test*

Table 12 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-M group (Musculoskeletal system)

Variable	Category	Segregated Roma colonies			Complementary area			p-value *
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	491	297	60.49	2,773	1,819	65.60	0.308
	18-24	136	74	54.41	1,089	666	61.16	0.444
	25-44	1,228	914	74.43	9,571	6,867	71.75	0.430
	45-64	2,532	2,076	81.99	31,593	23,191	73.41	<0.001
	65-X	756	575	76.06	26,010	19,860	76.36	0.945
Sex	Male	1,853	1,354	73.07	28,110	20,638	73.42	0.898
	Female	3,290	2,582	78.48	42,926	31,765	74.00	0.031
Total		5,143	3,936	76.53	71,036	52,403	73.77	0.094

**by chi-square test*

Nervous system (ATC-N)

In this ATC group, there is no significant redemptions were seen for age, sex, and aggregate as well. However, it was a higher observed redemption in the SRC (77.53%) than CA (76.34%) (p=0.563). On the other hand, for 45-64 years age categories there was a marginal significance with a higher redemption among SRC than CA (p=0.060). (**Table 13**)

Table 13 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-N group (Nervous system)

Variable	Category	Segregated Roma colonies			Complementary area			p-value *
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	284	224	78.87	929	762	82.02	0.701
	18-24	103	69	66.99	638	459	71.94	0.670
	25-44	869	665	76.52	6,911	5,653	81.80	0.222
	45-64	1,588	1,275	80.29	23,352	17,427	74.63	0.060
	65-X	525	379	72.19	32,748	24,998	76.33	0.411
Sex	Male	1,161	921	79.33	20,796	16,346	78.60	0.839
	Female	2,208	1,691	76.59	43,782	32,953	75.27	0.600
Total		3,369	2,612	77.53	64,578	49,299	76.34	0.563

**by chi-square test*

Antiparasitic products, insecticides, and repellents (ATC-P)

Although there were no significant redemptions were seen for age, sex, and aggregate as well, it had a higher observed redemption in the (CA 77.18%) than SRC (62.50%) (p=0.470). (**Table 14**)

Table 14 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-P group (Antiparasitic products, insecticides and repellents)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	4	3	75.00	24	23	95.83	0.764
	18-24	8	5	62.50	28	17	60.71	0.964
	25-44	7	5	71.43	151	105	69.54	0.964
	45-64	10	5	50.00	245	202	82.45	0.364
	65-X	3	2	66.67	91	69	75.82	0.889
Sex	Male	16	10	62.50	179	119	66.48	0.883
	Female	16	10	62.50	360	297	82.50	0.498
Total		32	20	62.50	539	416	77.18	0.470

**by chi-square test*

Respiratory system (ATC-R)

In this ATC classification, there were significant redemptions seen for 0-17 years old with the majority in the CA 67.95% vs 60.66% (p=0.001). On the other hand, for 25-44 and 45-64 years old with the majority in the SRC 79.21% vs 68.86% (p=0.021), and 81.83% vs 72.99% (p=0.001) than CA, respectively. There were no significant redemptions were seen for sexes and aggregate population between two groups. (**Table 15**)

Table 15 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-R group (Respiratory system)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	1,505	913	60.66	9,886	6,718	67.95	0.011
	18-24	165	107	64.85	2,822	1,857	65.80	0.909
	25-44	683	541	79.21	8,106	5,582	68.86	0.020
	45-64	2,135	1,747	81.83	22,677	16,551	72.99	0.001
	65-X	637	511	80.22	18,646	14,514	77.84	0.618
Sex	Male	2,073	1,513	72.99	26,910	19,835	73.71	0.779
	Female	3,052	2,306	75.56	35,227	25,387	72.07	0.100
Total		5,125	3,819	74.52	62,137	45,222	72.78	0.289

**by chi-square test*

Sensory organs (ATC-S)

There were significant redemptions seen for 0-17 years old with the majority in the CA 66.49% vs 47.32% (p=0.001). Remarkably, the redemption was less than 50% in this ATC classification among Roma. There were no significant redemptions were seen for sexes and aggregate population between two groups. (**Table 16**)

Various (ATC-V)

Under this classification, none of age, sex band and aggregate did not show significant differences for redemptions. But the total redemption is higher in the SRC (81.83%) than in CA (75.23%). (**Table 17**)

Table 16 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and complementary area for ATC-S group (Sensory organs)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescriptions	Dispensed prescriptions	Dispensed percentage	Written prescriptions	Dispensed prescriptions	Dispensed percentage	
Age category in years	0-17	205	97	47.32	1,125	748	66.49	0.001
	18-24	18	6	33.33	276	179	64.86	0.160
	25-44	82	59	71.95	878	622	70.84	0.931
	45-64	121	96	79.34	1,773	1,271	71.69	0.473
	65-X	79	58	73.42	1,960	1,477	75.36	0.882
Sex	Male	204	129	63.24	2,248	1,634	72.69	0.234
	Female	301	187	62.13	3,764	2,663	70.75	0.178
Total		505	316	62.57	6,012	4,297	71.47	0.074

**by chi-square test*

Table 17 Crude prescription redemption ratio by sociodemographic characteristics for segregated Roma colonies and Non-segregated Roma settlements for ATC-V group (Various)

Variable	Category	Segregated Roma colonies			Complementary area			p-value*
		Written prescrip-tions	Dispensed prescrip-tions	Dispensed percent-age	Written prescrip-tions	Dispensed prescrip-tions	Dis-pensed percent-age	
Age category in years	0-17	1,171	966	82.49	4,325	3,415	78.96	0.373
	18-24	0	0	-	76	59	77.63	NA
	25-44	3	0	0	146	75	51.37	0.216
	45-64	31	25	80.65	395	277	70.13	0.617
	65-X	11	4	36.36	731	442	60.47	0.381
Sex	Male	612	523	85.46	2,796	2,159	77.22	0.125
	Female	604	472	78.15	2,877	2,109	73.31	0.346
Total		1,216	995	81.83	5,673	4,268	75.23	0.076

**by chi-square test, NA- Not applicable*

Indirect age-sex standardized redemption ratio

Regarding the relative risk of redemptions, alimentary tract and metabolism RR=1.035 [95% CI 1.006-1.062], cardiovascular RRR=1.115 [95% CI, 1.097-1.135], musculoskeletal RRR=1.037 [95% CI, 1.003-1.067] and various types RRR=1.088 [95% CI, 1.006-1.139] of prescriptions were highly redeemed among SRC than CA. Conversely, anti-infectives for systemic use RRR=0.771 [95% CI, 0.766-0.816] and sensory organ system RRR=0.875 [95% CI, 0.791-0.987] prescriptions were less likely re-deemed among SRC than CA. The risk of redemption among SRC was higher than CA after adjusting differences for age and sex. About 3.6% of Roma living in SRC were more likely to dispense the prescribed medications than CA, RRR=1.028[1.018-1.038] vs RRR=0.998[0.992-1.005]. (**Table 18**)

Table 18 Standardized redemption (dispensed/expected) ratio of medications among Segregated Roma colonies and Complementary areas in Hungary 2012

ATC classification	Segregated Roma colonies		Complementary area		RRR (95%, CI)	Attributable number of redemptions	Attributable percentage of redemptions
	Dispensed/Expected	SRR [95% CI]	Dispensed/ Expected	SRR [95% CI]			
A- Alimentary tract and metabolism	5,107/4,941.12	1.034[1.006-1.062]	99,469/99,634.87	0.998[0.992-1.005]	1.035(1.010-1.060)	173	3.5
B- Blood and blood forming organs	1,894/1,854.07	1.021[0.976-1.069]	49,669/49,708.93	0.999[0.990-1.008]	1.022(0.983-1.063)	43	-2.2
C- Cardiovascular system	10,156/9,136.16	1.111[1.090-1.133]	274,969/275,988.84	0.996[0.993-1.001]	1.115(1.097-1.135)	1051	11.5
D- Dermatologicals	685/710.4	0.964[0.895-1.039]	8,575/8,549.6	1.003[0.982-1.024]	0.961(0.904-1.022)	-28	-3.9
G- Genito-urinary system and sex hormones	159/156.76	1.014[0.868-1.185]	4,557/4,559.22	0.999[0.971-1.029]	1.015(0.884-1.165)	2	-1.5
H- Systemic hormonal preparations, excluding sex hormones and insulins	305/314.36	0.970[0.867-1.085]	7,482/7,472.64	1.001[0.978-1.024]	0.969(0.879-1.068)	-10	-3.1
J- Anti-infectives for systemic use	3,716/4,699.78	0.791[0.766-0.816]	40,324/39,340.2	1.025[1.015-1.035]	0.771(0.753-0.791)	-1100	-22.9
M-Musculo-skeletal system	3,936/3,803.56	1.035[1.003-1.067]	52,403/52,535.44	0.997[0.989-1.006]	1.037(1.010-1.067)	141	3.7
N- Nervous system	2,612/2,573.89	1.015[0.977-1.055]	49,299/49,337.11	0.999[0.99-1.008]	1.016(0.982-1.051)	41	-1.6
P-Antiparasitic products, insecticides and repellents	20/24.43	0.818 [0.528-1.268]	416/411.56	1.011[0.918-1.112]	0.809(0.573-1.145)	-5	-19.0
R-Respiratory system	3,819/3,736.66	1.022[0.99-1.055]	45,222/45,304.34	0.998[0.989-1.007]	1.024(0.996-1.052)	90	-2.4
S- Sensory organs	316/357.46	0.884[0.791-0.987]	4,297/4,255.54	1.009[0.979-1.04]	0.875(0.802-0.955)	-45	-12.5
V-various	995/928.99	1.071[1.006-1.139]	4,268/4,334.01	0.984[0.955-1.014]	1.087(1.028-1.150)	80	8.8
Total	33,720/32,847.67	1.034[1.006-1.062]	640,950/641,822.33	0.998[0.992-1.005]	1.028(1.018-1.038)	920	2.8

SRR: standardized redemption ratio = observed/expected number of redemptions RRR: relative redemption = SRRsegregated Roma colonies / SRRcomplementary area Attributable number of redemptions = (SRRsegregated Roma colonies-SRRcomplementary area) × expected number of redemptions in SRC

4.2 Sociodemographic and economic characteristics during pre-pandemic and COVID-19 pandemic periods in Hungary

Under all outcome variables, the frequency of females, middle-and early old-aged adults (35-64 years old), married, central Hungary residents and non-Roma patients dominated in both pre-pandemic and pandemic periods. But the number of Roma who participated during the pre-pandemic was three times higher than the pandemic. The leading chronic diseases were hypertension and diabetes in both periods. (**Table 19**)

Table 19 sociodemographic and Clinical characteristics of participants during pre-pandemic and pandemic periods in Hungary

Characteristics	**Category**	**GP visit**				**Specialist care**				**Hospital admission**				**CRPNR**			
		Pre-pandemic	Pandemic	P#	Total	Pre-pandemic	Pandemic	P#	Total	Pre-pandemic	Pandemic	P#	Total	Pre-pandemic	Pandemic	P#	Total
Age categories in years	18-34 years	1080 (20.1)	162 (16.2)	**<0.001**	1242 (19.5)	1059 (19.9)	158 (15.9)	**<0.001**	1217 (19.3)	1094 (20.2)	161 (16.1)	<0.001	1255 (19.6)	744 (17.2)	88 (12.7)	**<0.001**	832 (16.5)
	35-64 years	2670 (49.7)	623 (62.2)		3293 (51.7)	2652 (49.8)	620 (62.4)		3272 (51.8)	2690 (49.7)	622 (62.2)		3312 (51.7)	2094 (48.3)	394 (57)		2488 (49.5)
	65+ years	1618 (30.1)	217 (21.7)		1835 (28.8)	1612 (30.3)	216 (21.7)		1828 (28.9)	1624 (30)	217 (21.7)		1841 (28.7)	1499 (34.6)	209 (30.2)		1708 (34)
Sex	Female	2916 (54.3)	593 (59.2)	**0.005**	3509 (55.1)	2902 (54.5)	587 (59.1)	**0.008**	3489 (55.2)	2935 (54.3)	591 (59.1)	0.005	3526 (55)	2451 (56.5)	420 (60.8)	0.035	2871 (57.1)
	Male	2452 (45.7)	409 (40.8)		2861 (44.9)	2421 (45.5)	407 (40.9)		2828 (44.8)	2473 (45.7)	409 (40.9)		2882 (45)	1886 (43.5)	271 (39.2)		2157 (42.9)
COPD	Absent	5143 (95.8)	967 (96.5)	0.305	6110 (95.9)	5099 (95.8)	959 (96.5)	0.316	6058 (95.9)	5183 (95.8)	965 (96.5)	0.331	6148 (95.9)	4123 (95.1)	659 (95.4)	0.731	4782 (95.1)
	Present	225 (4.2)	35 (3.5)		260 (4.1)	224 (4.2)	35 (3.5)		259 (4.1)	225 (4.2)	35 (3.5)		260 (4.1)	214 (4.9)	32 (4.6)		246 (4.9)
IHD	Absent	5037 (93.8)	935 (93.3)	0.532	5972 (93.8)	4992 (93.8)	927 (93.3)	0.534	5919 (93.7)	5077 (93.9)	933 (93.3)	0.486	6010 (93.8)	4010 (92.5)	628 (90.9)	0.150	4638 (92.2)
	Present	331 (6.2)	67 (6.7)		398 (6.2)	331 (6.2)	67 (6.7)		398 (6.3)	331 (6.1)	67 (6.7)		398 (6.2)	327 (7.5)	63 (9.1)		390 (7.8)
Hypertension	Absent	3443 (64.1)	691 (69)	**0.003**	4134 (64.9)	3403 (63.9)	685 (68.9)	0.003	4088 (64.7)	3481 (64.4)	689 (68.9)	0.006	4170 (65.1)	2479 (57.2)	387 (56)	0.569	2866 (57)
	Present	1925 (35.9)	311 (31)		2236 (35.1)	1920 (36.1)	309 (31.1)		2229 (35.3)	1927 (35.6)	311 (31.1)		2238 (34.9)	1858 (42.8)	304 (44)		2162 (43)
Diabetes	Absent	4826 (89.9)	847 (84.5)	**<0.001**	5673 (89.1)	4782 (89.8)	840 (84.5)	**<0.001**	5622 (89)	4867 (90)	845 (84.5)	**<0.001**	5712 (89.1)	3811 (87.9)	539 (78)	**<0.001**	4350 (86.5)
	Present	542 (10.1)	155 (15.5)		697 (10.9)	541 (10.2)	154 (15.5)		695 (11)	541 (10)	155 (15.5)		696 (10.9)	526 (12.1)	152 (22)		678 (13.5)

Table 19 continued

Cancer	Absent	5253 (97.9)	980 (97.8)	0.915	6233 (97.8)	5210 (97.9)	972 (97.8)	0.856	6182 (97.9)	5293 (97.9)	978 (97.8)	0.883	6271 (97.9)	4228 (97.5)	672 (97.3)	0.714	4900 (97.5)
	Present	115 (2.1)	22 (2.2)		137 (2.2)	113 (2.1)	22 (2.2)		135 (2.1)	115 (2.1)	22 (2.2)		137 (2.1)	109 (2.5)	19 (2.7)		128 (2.5)
Region	Central-Hungary	1533 (28.6)	304 (30.3)	0.334	1837 (28.8)	1523 (28.6)	304 (30.6)	0.289	1827 (28.9)	1549 (28.6)	304 (30.4)	**<0.001**	1853 (28.9)	1242 (28.6)	202 (29.2)	**<0.001**	1444 (28.7)
	Central-Transdanubia	593 (11)	110 (11)		703 (11)	590 (11.1)	110 (11.1)		700 (11.1)	595 (11)	110 (11)		705 (11)	465 (10.7)	89 (12.9)		554 (11)
	Northern-Great-Plain	836 (15.6)	148 (14.8)		984 (15.4)	829 (15.6)	146 (14.7)		975 (15.4)	840 (15.5)	148 (14.8)		988 (15.4)	667 (15.4)	102 (14.8)		769 (15.3)
	Northern-Hungary	673 (12.5)	120 (12)		793 (12.4)	663 (12.5)	115 (11.6)		778 (12.3)	678 (12.5)	119 (11.9)		797 (12.4)	562 (13)	76 (11)		638 (12.7)
	Southern-Great-Plain	660 (12.3)	133 (13.3)		793 (12.4)	657 (12.3)	133 (13.4)		790 (12.5)	666 (12.3)	132 (13.2)		798 (12.5)	545 (12.6)	97 (14)		642 (12.8)
	Southern-Transdanubia	508 (9.5)	86 (8.6)		594 (9.3)	502 (9.4)	86 (8.7)		588 (9.3)	513 (9.5)	86 (8.6)		599 (9.3)	413 (9.5)	53 (7.7)		466 (9.3)
	Western-Transdanubia	565 (10.5)	101 (10.1)		666 (10.5)	559 (10.5)	100 (10.1)		659 (10.4)	567 (10.5)	101 (10.1)		668 (10.4)	443 (10.2)	72 (10.4)		515 (10.2)
Educa-tional attainment	Primary	1024 (19.1)	165 (16.5)	**<0.001**	1189 (18.7)	1021 (19.2)	163 (16.4)	**<0.001**	1184 (18.7)	1026 (19)	165 (16.5)	**<0.001**	1191 (18.6)	871 (20.1)	140 (20.3)	0.001	1011 (20.1)
	Vocational	1291 (24)	309 (30.8)		1600 (25.1)	1282 (24.1)	308 (31)		1590 (25.2)	1296 (24)	309 (30.9)		1605 (25)	1043 (24)	215 (31.1)		1258 (25)
	High School	1817 (33.8)	398 (39.7)		2215 (34.8)	1795 (33.7)	394 (39.6)		2189 (34.7)	1839 (34)	396 (39.6)		2235 (34.9)	1448 (33.4)	252 (36.5)		1700 (33.8)
	Tertiary	1236 (23)	130 (13)		1366 (21.4)	1225 (23)	129 (13)		1354 (21.4)	1247 (23.1)	130 (13)		1377 (21.5)	975 (22.5)	84 (12.2)		1059 (21.1)
Marital status	Married	3110 (57.9)	535 (53.4)	0.077	3645 (57.2)	3084 (57.9)	534 (53.7)	**<0.001**	3618 (57.3)	3128 (57.8)	535 (53.5)	**<0.001**	3663 (57.2)	2545 (58.7)	366 (53)	**<0.001**	2911 (57.9)
	Single	1026 (19.1)	187 (18.7)		1213 (19)	1016 (19.1)	183 (18.4)		1199 (19)	1040 (19.2)	186 (18.6)		1226 (19.1)	709 (16.3)	100 (14.5)		809 (16.1)
	Divorced	425 (7.9)	149 (14.9)		574 (9)	423 (7.9)	147 (14.8)		570 (9)	428 (7.9)	148 (14.8)		576 (9)	354 (8.2)	104 (15.1)		458 (9.1)
	Widowed	684 (12.7)	126 (12.6)		810 (12.7)	683 (12.8)	125 (12.6)		808 (12.8)	685 (12.7)	126 (12.6)		811 (12.7)	632 (14.6)	119 (17.2)		751 (14.9)
Ethnicity	non-Roma	5251 (97.8)	937 (93.5)	**<0.001**	6188 (97.1)	5209 (97.9)	930 (93.6)	**<0.001**	6139 (97.2)	5291 (97.8)	935 (93.5)	**<0.001**	6226 (97.2)	4244 (97.9)	647 (93.6)	**<0.001**	4891 (97.3)
	Roma	104 (1.9)	65 (6.5)		169 (2.7)	102 (1.9)	64 (6.4)		166 (2.6)	104 (1.9)	65 (6.5)		169 (2.6)	87 (2)	44 (6.4)		131 (2.6)
Total		5368 (100)	1002 (100)		6370 (100)	5323 (100)	994 (100)		6317 (100)	5408 (100)	1000 (100)		6408 (100)	4337 (100)	691 (100)		5028 (100)

The extent of HCU in the pre-pandemic and the COVID-19 pandemic periods

There were significant reductions in all of the outcome variables except for CRPNR between the two periods. There were 4251 and 561 episodes of GP visits, corresponding to a prevalence of 79.2% (95% CI 78.1-80.3) and 56% (95% CI 52.9-59.1), 3426 and 378 episodes of specialist care, corresponding to a prevalence of 64.4% (95% CI 63.1%-65.7%) and 38.0% (95% CI 35.0%-41.0%), and 728 and 68 episodes of hospital admission, corresponding to a prevalence of 13.5% (95% CI 12.6%-14.4%) and 6.8% (95% CI 5.2%-8.4%), and 245 and 36 episodes of CRPNR, corresponding to a prevalence of 5.6% (95% CI 4.9%-6.3%) and 5.2% (95% CI 3.5%-6.9%) in the pre-pandemic and pandemic periods, respectively. The GP visits, specialist care and hospital admission were accompanied by a significant reduction between two periods for studied predictors. (**Figure 4**)

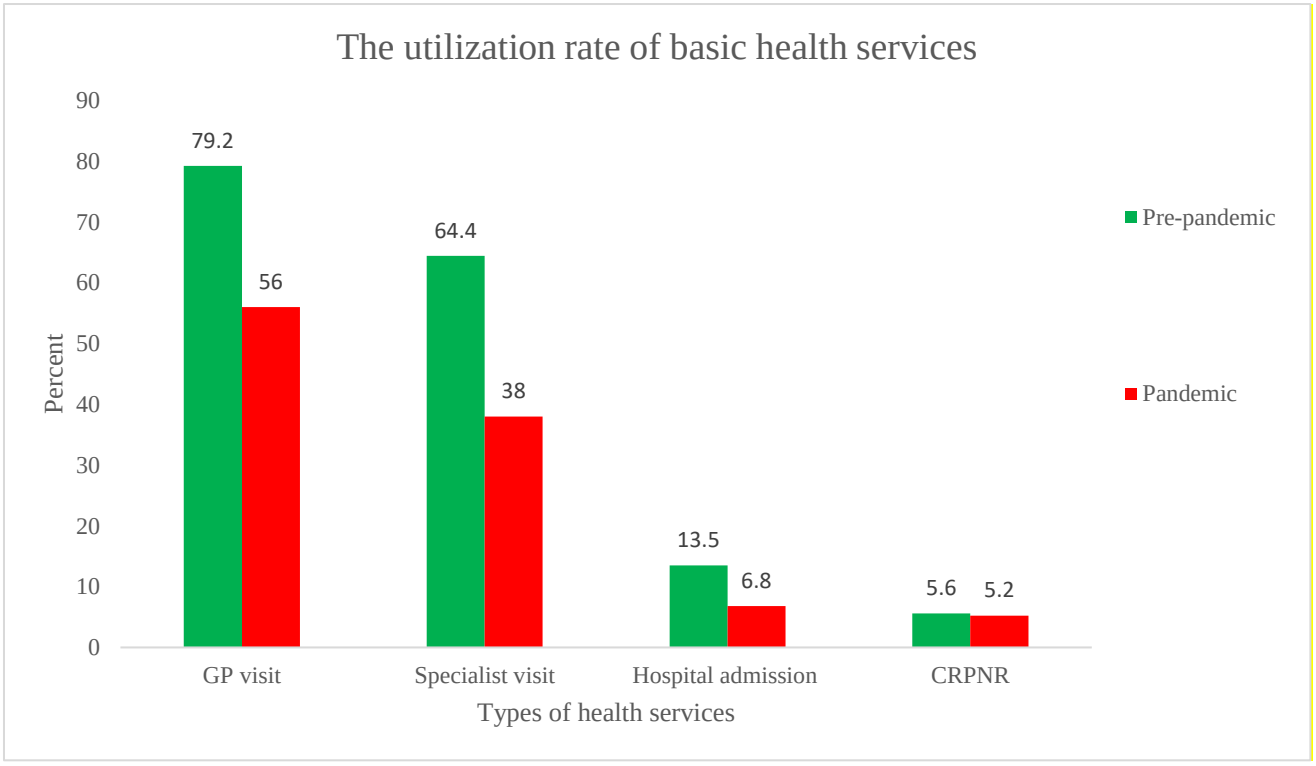

Figure 4 The change in dynamics of primary healthcare uptake in pre-pandemic and pandemic periods in Hungary

The distribution of outcome variables under predictors in both periods

For each outcome variable, the descriptive measurement for all of the above sociodemographic and clinical variables was computed for both periods. The uptake of studied outcome variables was significantly higher for old age, females, having chronic diseases, central-Transdanubia, Central Hungary inhabitants and non-Roma patients in both periods. But the GP and specialist care were more frequent among widows during the pandemic period and the reverse was true for CRPNR for this subgroup. (**Table 20**)

Table 20 The frequency of outcome variables under each explanatory characteristics pre-pandemic and pandemic periods in Hungary

Characteristics	Category	GP visit		Specialist care		Hospital admission		CRPNR	
		Pre-Pandemic	Pandemic	Pre-Pandemic	Pandemic	Pre-Pandemic	Pandemic	Pre-Pandemic	Pandemic
Age category in years	18-34 years	766 (70.9)	54 (33.3)	585 (55.2)	35 (22.2)	84 (7.7)	10 (6.2)	49 (6.6)	3 (3.4)
	35-64 years	2010(75.3)	326 (52.3)	1664 (62.7)	208 (33.5)	296 (11)	24 (3.9)	105 (5)	15 (3.8)
	65+ years	1475 (91.2)	181 (83.4)	1177 (73)	135 (62.5)	348 (21.4)	34 (15.7)	91 (6.1)	18 (8.6)
Sex	Female	2415 (82.8)	342 (57.7)	2001 (69)	232 (39.5)	424 (14.4)	41 (6.9)	142 (5.8)	24 (5.7)
	Male	1836 (74.9)	219 (53.5)	1425 (58.9)	146 (35.9)	304 (12.3)	27 (6.6)	103 (5.5)	12 (4.4)
COPD	Absent	4039(78.5)	533 (55.1)	3228 (63.3)	355 (37)	662 (12.8)	60 (6.2)	220 (5.3)	32 (4.9)
	Present	212 (94.2)	28 (80)	198 (88.4)	23 (65.7)	66 (29.3)	8 (22.9)	25 (11.7)	4 (12.5)
IHD	Absent	3935(78.1)	502 (53.7)	3131 (62.7)	329 (35.5)	602 (11.9)	53 (5.7)	209 (5.2)	26 (4.1)
	Present	316 (95.5)	59 (88.1)	295 (89.1)	49 (73.1)	126 (38.1)	15 (22.4)	36 (11)	10 (15.9)
Hypertension	Absent	2455(71.3)	285 (41.2)	1966 (57.8)	191 (27.9)	340 (9.8)	29 (4.2)	131 (5.3)	14 (3.6)
	Present	1796 (93.3)	276 (88.7)	1460 (76)	187 (60.5)	388 (20.1)	39 (12.5)	114 (6.1)	22 (7.2)
Diabetes	Absent	3736 (77.4)	421 (49.7)	2965 (62)	271 (32.3)	600 (12.3)	37 (4.4)	196 (5.1)	15 (2.8)
	Present	515 (95)	140 (90.3)	461 (85.2)	107 (69.5)	128 (23.7)	31 (20)	49 (9.3)	21 (13.8)
Cancer	Absent	4143 (78.9)	544 (55.5)	3319 (63.7)	363 (37.3)	677 (12.8)	58 (5.9)	239 (5.7)	32 (4.8)
	Present	108 (93.9)	17 (77.3)	107 (94.7)	15 (68.2)	51 (44.3)	10 (45.5)	6 (5.5)	4 (21.1)
Region	Central-Hungary	1206 (78.7)	150 (49.3)	1075 (70.6)	98 (32.2)	196 (12.7)	13 (4.3)	67 (5.4)	10 (5)
	Central-Transdanubia	482 (81.3)	87 (79.1)	374 (63.4)	64 (58.2)	85 (14.3)	12 (10.9)	21 (4.5)	1 (1.1)
	Northern-Great-Plain	667 (79.8)	84 (56.8)	519 (62.6)	65 (44.5)	115 (13.7)	7 (4.7)	52 (7.8)	13 (12.7)
	Northern-Hungary	532 (79)	64 (53.3)	420 (63.3)	31 (27)	99 (14.6)	13 (10.9)	43 (7.7)	2 (2.6)
	Southern-Great-Plain	522 (79.1)	58 (43.6)	397 (60.4)	37 (27.8)	99 (14.9)	8 (6.1)	36 (6.6)	2 (2.1)
	Southern-Transdanubia	397 (78.1)	50 (58.1)	300 (59.8)	34 (39.5)	69 (13.5)	8 (9.3)	19 (4.6)	4 (7.5)
	Western-Transdanubia	445 (78.8)	68 (67.3)	341 (61)	49 (49)	65 (11.5)	7 (6.9)	7 (1.6)	4 (5.6)
Educational attainment	Primary	827 (80.8)	121 (73.3)	614 (60.1)	84 (51.5)	199 (19.4)	22 (13.3)	83 (9.5)	23 (16.4)
	Vocational	1026 (79.5)	176 (57)	790 (61.6)	115 (37.3)	182 (14)	24 (7.8)	49 (4.7)	8 (3.7)

Table 20 continued

	High school	1456 (80.1)	200 (50.3)	1177 (65.6)	145 (36.8)	207 (11.3)	17 (4.3)	81 (5.6)	5 (2)
	Tertiary	942 (76.2)	64 (49.2)	845 (69)	34 (26.4)	140 (11.2)	5 (3.8)	32 (3.3)	(0)
Marital status	Married	2472 (79.5)	295 (55.1)	2054 (66.6)	203 (38)	404 (12.9)	31 (5.8)	126 (5)	10 (2.7)
	Single	727 (70.9)	72 (38.5)	533 (52.5)	42 (23)	87 (8.4)	9 (4.8)	44 (6.2)	4 (4)
	Divorced	345 (81.2)	76 (51)	293 (69.3)	49 (33.3)	71 (16.6)	9 (6.1)	25 (7.1)	9 (8.7)
	Widowed	621 (90.8)	116 (92.1)	475 (69.5)	82 (65.6)	150 (21.9)	19 (15.1)	44 (7)	13 (10.9)
	Married missed	86 (69.9)	2 (40)	71 (60.7)	2 (40)	16 (12.6)	(0)	6 (6.2)	(0)
Ethnicity	non-Roma	4167 (79.4)	529 (56.5)	3372 (64.7)	354 (38.1)	705 (13.3)	62 (6.6)	230 (5.4)	28 (4.3)
	Roma	76 (73.1)	32 (49.2)	47 (46.1)	24 (37.5)	20 (19.2)	6 (9.2)	14 (16.1)	8 (18.2)
	Roma missed	8 (61.5)	0 (0)	7 (58.3)	NC	3 (23.1)	NC	1 (16.7)	NC
Total		4251 (79.2)	561 (56)	3426 (64.4)	378 (38)	728 (13.5)	68 (6.8)	245 (5.6)	36 (5.2)

Factors associated with health care utilization among vulnerable social strata

The higher level of educational attainment had more frequent utilization of specialist care, while with less for hospital admission and CRPNR. Roma people accessed GP and specialist care more frequently, and they had more often CRPNR than non-Roma counterparts. The occurrence of each outcome was more frequent among widowed, and less frequent (except for CRPNR) among single. Residence places of the subjects manifested the inequality for all outcome variables for different subgroups. The probability of CRPNR was significantly elevated among divorced and widowed.

Moreover, the uneven effect of the pandemic lockdown on health care use among most of the social strata was observed. During the pandemic lockdown, the utilization of GP and specialist was significantly higher among primary level educational attainment compared to highly educated patients. While the CRPNR was significantly lower for highly educated persons than primary educated counterparts. The pandemic lockdown modified the use of GP and specialist care use among widowed patients in the same direction [increased utilization]. On the other hand, this stratum showed an increased odds of facing the CRPNR during the pandemic period. Among the Roma, the less reduction in specialist care use [only 9.6%] was recorded compared to the non-Roma population (26.6%) attributed to the pandemic lockdown. (**Table 21**)

Table 21 Dynamics and determinants of the health services utilization among vulnerable social groups before and during the COVID-19 pandemic in Hungary

	Characteristics	Category	Pre-pandemic prevalence*	Pandemic prevalence*	95% CI**
GP visit in a year	Educational attainment	Primary	827 (80.8)	121 (73.3)	reference
		Vocational	1026 (79.5)	176 (57.0)	**0.768 (0.641-0.920)**
		High school	1456 (80.1)	200 (50.3)	**0.753 (0.635-0.893)**
		Tertiary	942 (76.2)	64 (49.2)	**0.710 (0.590-0.855)**
	Marital status	Married	2472 (79.5)	295 (55.1)	reference
		Single	727 (70.9)	72 (38.5)	**0.612 (0.532-0.705)**
		Divorced	345 (81.2)	76 (51.0)	0.873 (0.715-1.066)
		Widowed	621 (90.8)	116 (92.1)	**3.204 (2.489-4.122)**
		Missed	86 (69.9)	2 (40.0)	NC
	Ethnicity	non-Roma	4167 (79.4)	529 (56.5)	reference
		Roma	76 (73.1)	32 (49.2)	**0.563 (0.409-0.774)**
		Missed	8 (61.5)	0 (0.0)	NC
Specialist care in a year	Educational attainment	Primary	614 (60.1)	84 (51.5)	reference
		Vocational	790 (61.6)	115 (37.3)	0.920 (0.790-1.071)
		High school	1177 (65.6)	145 (36.8)	1.062 (0.919-1.226)
		Tertiary	845 (69.0)	34 (26.4)	**1.288 (1.097-1.513)**
	Marital status	Married	2054 (66.6)	203 (38.0)	reference
		Single	533 (52.5)	42 (23.0)	**0.556 (0.487-0.634)**
		Divorced	293 (69.3)	49 (33.3)	0.905 (0.755-1.084)
		Widowed	475 (69.5)	82 (65.6)	**1.338 (1.136-1.576)**
		Missed	71 (60.7)	2 (40.0)	NC
	Ethnicity	non-Roma	3372 (64.7)	354 (38.1)	reference
		Roma	47 (46.1)	24 (37.5)	**0.484 (0.354-0.661)**
		Missed	7 (58.3)	0 (0.0)	NC
Hospital admission in a year	Educational attainment	Primary	199 (19.4)	22 (13.3)	reference
		Vocational	182 (14)	24 (7.8)	**0.646 (0.526-0.795)**
		High school	207 (11.3)	17 (4.3)	**0.489 (0.400-0.598)**
		Tertiary	140 (11.2)	5 (3.8)	**0.517 (0.412-0.647)**
	Marital status	Married	404 (12.9)	31 (5.8)	reference
		Single	87 (8.4)	9 (4.8)	**0.630 (0.500-0.794)**
		Divorced	71 (16.6)	9 (6.1)	1.197 (0.926-1.547)
		Widowed	150 (21.9)	19 (15.1)	**1.953 (1.604-2.378)**
		Missed	16 (12.6)	0 (0.0)	NC
	Ethnicity	non-Roma	705 (13.3)	62 (6.6)	reference
		Roma	20 (19.2)	6 (9.2)	1.294 (0.846-1.979)
		Missed	3 (23.1)	0 (0.0)	NC
CRPNR in a year	Educational attainment	Primary	83 (9.5)	23 (16.4)	reference
		Vocational	49 (4.7)	8 (3.7)	**0.405 (0.290-0.565)**
		High school	81 (5.6)	5 (2.0)	**0.455 (0.338-0.612)**
		Tertiary	32 (3.3)	(0.0)	**0.266 (0.177-0.399)**
	Marital status	Married	126 (5.0)	10 (2.7)	reference
		Single	44 (6.2)	4 (4.0)	1.287 (0.917-1.806)
		Divorced	25 (7.1)	9 (8.7)	**1.636 (1.108-2.415)**
		Widowed	44 (7.0)	13 (10.9)	**1.676 (1.217-2.308)**
		Missed	6 (6.2)	0 (0.0)	NC
	Ethnicity	non-Roma	230 (5.4)	28 (4.3)	reference
		Roma	14 (16.1)	8 (18.2)	**3.624 (2.254-5.828)**
		Missed	1 (16.7)	0 (0.0)	NC

** -Number of cases (and proportion as %) of a positive outcome ** -odds ratios with 95% confidence intervals from logistic regression models, NC-not computable*

Sociodemographic and clinical factors associated with HCS utilization

Bivariate logistic analysis was computed to observe the relationship between pertinent social strata and outcome variables. At least one subgroup of the sociodemographic and clinical characteristics is associated with studied outcome variables. Aging, being female and having a chronic disease were highly related to GP visits, specialist access and hospitalization rate. However, age and sex did not show the same pattern for CRPNR except for chronic diseases. Particularly COPD, IHD and diabetes patients had more frequent episodes of CRPNR. Furthermore, for each predictor and the studied characteristics association varied by age, sex, residence and chronic illness status. (**Table 22a-d**)

Table 22a Sociodemographic and clinical stratum-specific GP visit frequency in a year observed in pre-pandemic and pandemic periods in Hungary.

Characteristics	**Category**	**Pre-pandemic prevalence***	**Pandemic prevalence***	**OR (95%CI)****
Age groups	18-34 years	766 (70.9)	54 (33.3)	reference
	35-64 years	2010 (75.3)	326 (52.3)	**1.256 (1.093-1.444)**
	65+ years	1475 (91.2)	181 (83.4)	**4.761 (3.922-5.779)**
Sex	Female	2415 (82.8)	342 (57.7)	reference
	Male	1836 (74.9)	219 (53.5)	**0.695 (0.620-0.78)**
COPD	No	4039 (78.5)	533 (55.1)	reference
	Yes	212 (94.2)	28 (80.0)	**4.037 (2.549-6.393)**
IHD	No	3935 (78.1)	502 (53.7)	reference
	Yes	316 (95.5)	59 (88.1)	**5.641 (3.688-8.628)**
Hypertension	No	2455 (71.3)	285 (41.2)	reference
	Yes	1796 (93.3)	276 (88.7)	**6.428 (5.414-7.631)**
Diabetes	No	3736 (77.4)	421 (49.7)	reference
	Yes	515 (95.0)	140 (90.3)	**5.687 (4.140-7.812)**
Cancer	No	4143 (78.9)	544 (55.5)	reference
	Yes	108 (93.9)	17 (77.3)	**3.436 (1.895-6.230)**
Region	Central-Hungary	1206 (78.7)	150 (49.3)	reference
	Central-Transdanubia	482 (81.3)	87 (79.1)	**1.506 (1.215-1.868)**
	Northern-Great-Plain	667 (79.8)	84 (56.8)	1.143 (0.955-1.369)
	Northern-Hungary	532 (79.0)	64 (53.3)	1.073 (0.886-1.300)
	Southern-Great-Plain	522 (79.1)	58 (43.6)	0.966 (0.800-1.166)
	Southern-Transdanubia	397 (78.1)	50 (58.1)	1.079 (0.871-1.335)
	Western-Transdanubia	445 (78.8)	68 (67.3)	1.189 (0.966-1.465)
Educational attainment	Primary	827 (80.8)	121 (73.3)	reference
	Vocational	1026 (79.5)	176 (57.0)	**0.768 (0.641-0.920)**
	High school	1456 (80.1)	200 (50.3)	**0.753 (0.635-0.893)**
	Tertiary	942 (76.2)	64 (49.2)	**0.710 (0.590-0.855)**
Marital status	Married	2472 (79.5)	295 (55.1)	reference
	Single	727 (70.9)	72 (38.5)	**0.612 (0.532-0.705)**
	Divorced	345 (81.2)	76 (51.0)	0.873 (0.715-1.066)
	Widowed	621 (90.8)	116 (92.1)	**3.204 (2.489-4.122)**
	Married missed	86 (69.9)	2 (40.0)	NC
Ethnicity	non-Roma	4167 (79.4)	529 (56.5)	reference
	Roma	76 (73.1)	32 (49.2)	**0.563 (0.409-0.774)**
	Roma missed	8 (61.5)	0 (0.0)	NC

** Number of cases (and proportion as %) of positive outcomes*
*** odds ratios with 95% confidence intervals from logistic regression models*
NC- not computable

Table 22b Sociodemographic and clinical stratum-specific specialist visit frequency in a year observed in pre-pandemic and pandemic periods

Characteristics	Category	Pre-pandemic prevalence*	Pandemic prevalence*	OR (95%CI)**
Age groups	18-34 years	585 (55.2)	35 (22.2)	reference
	35-64 years	1664 (62.7)	208 (33.5)	**1.288 (1.128-1.469)**
	65+ years	1177 (73.0)	135 (62.5)	**2.448 (2.104-2.849)**
Sex	Female	2001 (69.0)	232 (39.5)	reference
	Male	1425 (58.9)	146 (35.9)	**0.703 (0.635-0.778)**
COPD	No	3228 (63.3)	355 (37.0)	reference
	Yes	198 (88.4)	23 (65.7)	**4.017 (2.837-5.689)**
IHD	No	3131 (62.7)	329 (35.5)	reference
	Yes	295 (89.1)	49 (73.1)	**4.527 (3.383-6.060)**
Hypertension	No	1966 (57.8)	191 (27.9)	reference
	Yes	1460 (76.0)	187 (60.5)	**2.533 (2.263-2.836)**
Diabetes	No	2965 (62.0)	271 (32.3)	reference
	Yes	461 (85.2)	107 (69.5)	**3.298 (2.701-4.026)**
Cancer	No	3319 (63.7)	363 (37.3)	reference
	Yes	107 (94.7)	15 (68.2)	**6.372 (3.589-11.313)**
Region	Central-Hungary	1075 (70.6)	98 (32.2)	reference
	Central-Transdanubia	374 (63.4)	64 (58.2)	0.932 (0.778-1.116)
	Northern-Great-Plain	519 (62.6)	65 (44.5)	**0.833 (0.710-0.977)**
	Northern-Hungary	420 (63.3)	31 (27.0)	**0.769 (0.648-0.913)**
	Southern-Great-Plain	397 (60.4)	37 (27.8)	**0.680 (0.574-0.805)**
	Southern-Transdanubia	300 (59.8)	34 (39.5)	**0.733 (0.607-0.886)**
	Western-Transdanubia	341 (61.0)	49 (49.0)	**0.808 (0.674-0.970)**
Educational attainment	Primary	614 (60.1)	84 (51.5)	reference
	Vocational	790 (61.6)	115 (37.3)	0.920 (0.790-1.071)
	High school	1177 (65.6)	145 (36.8)	1.062 (0.919-1.226)
	Tertiary	845 (69.0)	34 (26.4)	**1.288 (1.097-1.513)**
Marital status	Married	2054 (66.6)	203 (38.0)	reference
	Single	533 (52.5)	42 (23.0)	**0.556 (0.487-0.634)**
	Divorced	293 (69.3)	49 (33.3)	0.905 (0.755-1.084)
	Widowed	475 (69.5)	82 (65.6)	**1.338 (1.136-1.576)**
	Married missed	71 (60.7)	2 (40.0)	NC
Ethnicity	non-Roma	3372 (64.7)	354 (38.1)	reference
	Roma	47 (46.1)	24 (37.5)	**0.484 (0.354-0.661)**
	Roma missed	7 (58.3)	0 (0.0)	NC

** Number of cases (and proportion as %) of positive outcomes*
*** odds ratios with 95% confidence intervals from logistic regression models*
NC- not computable

Table 22c Sociodemographic and clinical stratum-specific hospital admission frequency in a year observed in pre-pandemic and pandemic periods

Characteristics	Category	Pre-pandemic prevalence*	Pandemic prevalence*	OR (95%CI)**
Age groups	18-34 years	84 (7.7)	10 (6.2)	reference
	35-64 years	296 (11.0)	24 (3.9)	**1.321 (1.039-1.679)**
	65+ years	348 (21.4)	34 (15.7)	**3.234 (2.548-4.105)**
Sex	Female	424 (14.4)	41 (6.9)	reference
	Male	304 (12.3)	27 (6.6)	**0.854 (0.735-0.993)**
COPD	No	662 (12.8)	60 (6.2)	reference
	Yes	66 (29.3)	8 (22.9)	**2.990 (2.259-3.957)**
IHD	No	602 (11.9)	53 (5.7)	reference
	Yes	126 (38.1)	15 (22.4)	**4.485 (3.597-5.594)**
Hypertension	No	340 (9.8)	29 (4.2)	reference
	Yes	388 (20.1)	39 (12.5)	**2.429 (2.090-2.822)**
Diabetes	No	600 (12.3)	37 (4.4)	reference
	Yes	128 (23.7)	31 (20.0)	**2.359 (1.941-2.867)**
Cancer	No	677 (12.8)	58 (5.9)	reference

Table 22c Continued

	Yes	51 (44.3)	10 (45.5)	**6.045 (4.279-8.541)**
Region	Central-Hungary	196 (12.7)	13 (4.3)	reference
	Central-Transdanubia	85 (14.3)	12 (10.9)	1.255 (0.969-1.625)
	Northern-Great-Plain	115 (13.7)	7 (4.7)	1.108 (0.873-1.406)
	Northern-Hungary	99 (14.6)	13 (10.9)	**1.286 (1.005-1.645)**
	Southern-Great-Plain	99 (14.9)	8 (6.1)	1.218 (0.949-1.563)
	Southern-Transdanubia	69 (13.5)	8 (9.3)	1.160 (0.878-1.534)
	Western-Transdanubia	65 (11.5)	7 (6.9)	0.950 (0.715-1.262)
Educational attainment	Primary	199 (19.4)	22 (13.3)	reference
	Vocational	182 (14)	24 (7.8)	**0.646 (0.526-0.795)**
	High school	207 (11.3)	17 (4.3)	**0.489 (0.400-0.598)**
	Tertiary	140 (11.2)	5 (3.8)	**0.517 (0.412-0.647)**
Marital status	Married	404 (12.9)	31 (5.8)	reference
	Single	87 (8.4)	9 (4.8)	**0.630 (0.500-0.794)**
	Divorced	71 (16.6)	9 (6.1)	1.197 (0.926-1.547)
	Widowed	150 (21.9)	19 (15.1)	**1.953 (1.604-2.378)**
	Married missed	16 (12.6)	0 (0.0)	NC
Ethnicity	non-Roma	705 (13.3)	62 (6.6)	reference
	Roma	20 (19.2)	6 (9.2)	1.294 (0.846-1.979)
	Roma missed	3 (23.1)	0 (0.0)	NC

** Number of cases (and proportion as %) of positive outcomes*
*** odds ratios with 95% confidence intervals from logistic regression models*
NC- not computable

Table 22d Sociodemographic and clinical stratum-specific CRPNR frequency in a year observed in pre-pandemic and pandemic periods

Characteristics	**Category**	**Pre-pandemic prevalence***	**Pandemic prevalence***	**OR (95%CI)****
Age groups	18-34 years	49 (6.6)	3 (3.4)	reference
	35-64 years	105 (5.0)	15 (3.8)	0.760 (0.544-1.063)
	65+ years	91 (6.1)	18 (8.6)	1.023 (0.727-1.438)
Sex	Female	142 (5.8)	24 (5.7)	reference
	Male	103 (5.5)	12 (4.4)	0.918 (0.719-1.172)
COPD	No	220 (5.3)	32 (4.9)	reference
	Yes	25 (11.7)	4 (12.5)	**2.402 (1.598-3.612)**
IHD	No	209 (5.2)	26 (4.1)	reference
	Yes	36 (11.0)	10 (15.9)	**2.505 (1.793-3.501)**
Hypertension	No	131 (5.3)	14 (3.6)	reference
	Yes	114 (6.1)	22 (7.2)	1.260 (0.99-1.603)
Diabetes	No	196 (5.1)	15 (2.8)	reference
	Yes	49 (9.3)	21 (13.8)	**2.258 (1.701-2.998)**
Cancer	No	239 (5.7)	32 (4.8)	reference
	Yes	6 (5.5)	4 (21.1)	1.448 (0.750-2.792)
Region	Central-Hungary	67 (5.4)	10 (5.0)	reference
	Central-Transdanubia	21 (4.5)	1 (1.1)	0.734 (0.452-1.192)
	Northern-Great-Plain	52 (7.8)	13 (12.7)	**1.639 (1.164-2.309)**
	Northern-Hungary	43 (7.7)	2 (2.6)	1.347 (0.921-1.97)
	Southern-Great-Plain	36 (6.6)	2 (2.1)	1.117 (0.749-1.667)
	Southern-Transdanubia	19 (4.6)	4 (7.5)	0.922 (0.572-1.486)
	Western-Transdanubia	7 (1.6)	4 (5.6)	**0.387 (0.204-0.735)**
Educational attainment	Primary	83 (9.5)	23 (16.4)	reference
	Vocational	49 (4.7)	8 (3.7)	**0.405 (0.290-0.565)**
	High school	81 (5.6)	5 (2.0)	**0.455 (0.338-0.612)**
	Tertiary	32 (3.3)	(0.0)	**0.266 (0.177-0.399)**
Marital status	Married	126 (5.0)	10 (2.7)	reference
	Single	44 (6.2)	4 (4.0)	1.287 (0.917-1.806)
	Divorced	25 (7.1)	9 (8.7)	**1.636 (1.108-2.415)**
	Widowed	44 (7.0)	13 (10.9)	**1.676 (1.217-2.308)**

Table 22d Continued

	Married missed	6 (6.2)	0 (0.0)	NC
Ethinicity	non-Roma	230 (5.4)	28 (4.3)	reference
	Roma	14 (16.1)	8 (18.2)	**3.624 (2.254-5.828)**
	Roma missed	1 (16.7)	0 (0.0)	NC

** Number of cases (and proportion as %) of positive outcomes*
*** odds ratios with 95% confidence intervals from logistic regression models*
NC- not computable

Determinants of healthcare utilization and subgroup-specific role of COVID-19 pandemic

After controlling for the potential confounders and social strata, with time to the pandemic the remarkable exhaustive reductions were observed for the probability of specialist care and hospital admission during the pandemic period. But the decline in GP visit frequency was less strong and proved to be borderline significant in the multivariable model. Also, the CRPNR did not show a significant change during the pandemic period.

The association between the studied outcome variables and age, sex, residential place, and prevalence of chronic disease described by bivariate analyses have been confirmed by multi-variable analysis with varying degrees of association. The remarkable social stratum for HCU was Roma for CRPNR. The CRPNR was more frequent among Roma (aOR=2.018, 95% CI: 1.061-3.838). But the association was insignificant with GP visits, specialist care, and hospital admission for this ethnicity. However, marital status did not show a significant relationship with the three studied outcomes (GP visit, hospital admission and CRPNR). But it showed significant association with the specialist care, which was less likely among single (aOR=0.753, 95%CI: 0.636-0.891) and widowed (aOR=0.740, 95%CI: 0.597-0.918) compared to the married group. The role of achieving a higher educational attainment as a determinant of more frequent use of GP and specialist care after controlling the sociodemographic and clinical status of survey participants. Conversely, the subgroup had fewer odds of hospital admission and CRPNR was confirmed by the final model.

Under the pandemic interaction model, a multivariable model proved that uneven distribution of pandemic effect by social status. The decline in hospital admission attributed to the pandemic was evenly distributed for all of the social strata [educational attainment, ethnicity and marital] subgroups. The pandemic effect was appeared to be significantly lower among mid-level educated for GP (iORhigh school/primary=0.434, 95%CI: 0.243-0.776) and specialist care (iORhigh school/primary=0.598, 95%CI: 0.364-0.985, iORtertiary/primary=0.331, 95%CI: 0.179-0.611). Also, this subgroup had a less likelihood of CRPNR than primary educational attainment subjects (iORhigh school/primary=0.236, 95%CI: 0.075-0.743).

Regarding the marital stratum, the pandemic significantly provoked the likelihood of both GP visits (iOR=2.284, 95% CI: 1.043-4.998) and specialist care (iOR=1.915, 95% CI: 1.157-3.168) wth among widowed compared to married subgroup. The specific pandemic effect on HCU among the Roma was not confirmed in the multivariable approach. Thus, the pandemic has no sole effect on the ethnicity in terms of Roma and non-Roma counterparts. (**Table 23**)

Table 23 Determinants of the outcome variable pre-pandemic and pandemic by multivariable logistic regression model controlled for the interaction between periods and the studied sociodemographic characteristics in Hungary.

Explanatory variables	Category	GP visit in a year	Specialist care in a year	Hospital admission in a year	CRPNR in a year
Age groups in year	18-34	Reference			
	35-64	0.954 [0.802-1.134]	0.964 [0.819-1.136]	0.969 [0.730-1.285]	0.789 [0.521-1.195]
	65+	**1.700 [1.318-2.193]**	1.112 [0.898-1.376]	**1.500 [1.089-2.068]**	0.749 [0.457-1.227]
Sex	Female	**0.651 [0.570-0.744]**	**0.662 [0.589-0.744]**	0.891 [0.751-1.058]	0.978 [0.744-1.285]
	Male	Reference			
COPD	Absent				
	Present	**2.703 [1.630-4.483]**	2.959 [2.04-4.292]	**1.979 [1.454-2.693]**	**2.104 [1.365-3.244]**
IHD	Absent				
	Present	**1.892 [1.204-2.973]**	**3.016 [2.211-4.115]**	**2.755 [2.153-3.525]**	**1.790 [1.226-2.614]**
Hypertension	Absent				
	Present	**4.039 [3.333-4.895]**	**1.830 [1.595-2.101]**	**1.366 [1.135-1.643]**	0.888 [0.658-1.198]
Diabetes	Absent				
	Present	**2.841 [2.017-4.002]**	**2.546 [2.038-3.182]**	**1.566 [1.256-1.952]**	**2.104 [1.528-2.899]**
Cancer	Absent				
	Present	1.746 [0.932-3.271]	**4.688 [2.591-8.483]**	**4.686 [3.24-6.776]**	1.317 [0.662-2.619]
Region	Central Hungary	Reference			
	Central Transdanubia	**1.547 [1.218-1.964]**	0.986 [0.809-1.202]	1.034 [0.766-1.395]	0.631 [0.384-1.036]
	Northern Great Plain	1.177 [0.961-1.441]	0.865 [0.725-1.033]	1.280 [0.910-1.801]	1.301 [0.906-1.87]
	Northern Hungary	1.046 [0.839-1.304]	**0.754 [0.622-0.914]**	1.060 [0.765-1.470]	1.012 [0.676-1.515]
	Southern Great Plain	1.017 [0.821-1.26]	**0.735 [0.609-0.887]**	1.227 [0.878-1.714]	0.921 [0.600-1.413]
	Southern Transdanubia	1.105 [0.868-1.406]	**0.752 [0.611-0.927]**	1.356 [0.970-1.894]	0.711 [0.430-1.176]
	Western Transdanubia	1.250 [0.993-1.575]	0.860 [0.704-1.05]	1.178 [0.823-1.686]	**0.352 [0.184-0.673]**
Educational attainment	Primary	Reference			
	Vocational	**1.273 [1.008-1.606]**	**1.226 [1.014-1.481]**	0.852 [0.666-1.089]	**0.546 [0.369-0.810]**
	High School	**1.488 [1.194-1.854]**	**1.580 [1.319-1.893]**	**0.733 [0.578-0.929]**	**0.622 [0.436-0.888]**
	Tertiary	**1.258 [0.996-1.59]**	**1.797 [1.473-2.193]**	0.766 [0.587-0.999]	**0.346 [0.218-0.549]**
Marital status	Married	Reference			
	Single	0.990 [0.821-1.192]	**0.753 [0.636-0.891]**	0.863 [0.652-1.143]	1.217 [0.805-1.838]

Table 23 Continued

	Divorced	0.918 [0.697-1.210]	0.962 [0.763-1.214]	1.210 [0.905-1.618]	1.499 [0.947-2.373]
	Widowed	1.113 [0.814-1.522]	**0.740 [0.597-0.918]**	1.030 [0.800-1.325]	1.091 [0.718-1.657]
Ethnicity	non-Roma	Reference			
	Roma	1.054 [0.647-1.718]	0.687 [0.444-1.063]	1.598 [0.924-2.763]	**2.018 [1.061-3.838]**
Year	Pre-pandemic	Reference			
	Pandemic	0.595 [0.342-1.035]	**0.459 [0.287-0.733]**	**0.480 [0.236-0.975]**	0.939 [0.371-2.376]
Educational attainment by pandemic	Primary	0.586 [0.325-1.057]	0.707 [0.426-1.172]	1.022 [0.485-2.154]	0.474 [0.173-1.301]
	Vocational				
	High school	**0.434 [0.243-0.776]**	**0.598 [0.364-0.985]**	0.728 [0.328-1.614]	**0.236 [0.075-0.743]**
	Tertiary	0.536 [0.277-1.035]	**0.331 [0.179-0.611]**	0.763 [0.253-2.302]	NC
Marital status by pandemic	Married	Reference			
	Single	0.743 [0.497-1.11]	0.836 [0.543-1.289]	1.284 [0.556-2.962]	1.092 [0.300-3.968]
	Divorced	0.831 [0.51-1.353]	0.850 [0.529-1.367]	0.822 [0.352-1.918]	2.784 [0.930-8.331]
	Widowed	**2.284 [1.043-4.998]**	**1.915 [1.157-3.168]**	1.073 [0.52-2.215]	2.009 [0.716-5.642]
Ethnicity by pandemic	non-Roma	Reference			
	Roma	0.480 [0.207-1.112]	1.130 [0.511-2.497]	0.533 [0.168-1.687]	0.827 [0.251-2.725]

Bolded=Odds ratio, 95% Confidence Interval for Outcome variables

5. Discussion

Comparison of the main findings with the international context

Prevalence of Redemption of prescriptions among Roma people living in CAs and SRCs

This study assessed the crude redemption ratio (CRR) of national, SRC, and complementary areas. The CRR was 66.80%, 73.13%, and 71.15% for national, SRC, and complementary areas, respectively. Then age-sex standardized redemption ratio was calculated for SRC and complementary areas using WHO guidelines for classification of prescriptions (289).

The magnitude of crude PNR in this study for both SRC (26.86%), CA (28.85%) and national (33.2%) was higher than other EU members. Portugal (22.8%) (140), Sweden (2.5%) (226), Poland (20.8%) (227), Spain (17.6%) (228), Denmark (9.3%) (145), USA (11.5%), and Argentina (4-12%) (292), (293). But lower than other studies from the USA (39.3%) (294), Netherlands (51.5%) (229), and New Zealand 50% (63). The reason for the increment might be the fact that CEE countries have lower socioeconomic status compared to western parts (271,295,296).

Minority and settlement effect on prescription redemption.

Our current finding is a breakthrough that the Roma community living in the SRC both crude and age-sex specific standardized redemptions were higher than CAs. More than 73% and 71% of prescriptions were redeemed in the SRC and the CA, respectively, $p<0.001$. Other findings from Hungary and international settings have dissimilar conclusions for minorities and deprivations versus HCS uptake. For instance, studies from Hungary and Slovakia concerning health and segregated Roma revealed that age-sex specific HCU and all-cause of premature mortality rate were higher in SRC than in CA (53,58,285). Our finding also negates other findings from New Zealand that Māori and the USA black elderly minorities had a lower likelihood of achieving the prescribed medications (44,63). Similarly, other studies from Israel, New Zealand and Sweden uncovered that being socioeconomically disadvantaged and deprived has a higher likelihood of nonredemption of prescriptions (42,149,297). Also, Kapur and Basu revealed that being a rural inhabitant predisposes patients not to redeem medications accordingly (30). In Israel even though patients have universal health insurance coverage, those with low socioeconomic status have a high nonredemption rate (297). In Canada Ontario senior or indigenous population has higher indirectly need-standardized specific dispense of prescription than counterparts (298). Yet again, in the USA the relative rate of prescription redemption among type 2 diabetic patients was significantly low in Latino patients than whites with RR=1.23 [95% CI, 1.19-1.27] to 1.30 [95% CI, 1.23-1.39] (294).

Age and sex correlation with prescription redemption

Females redeemed more prescriptions than males in all settings. The national, SRC, and CAs with 67.07 vs 66.41%, 73.88 vs 71.90%, and 71.3% vs 70.8%, respectively. From 0-17, 45-64, and 64 years and above relatively redeemed 69.78%, 79.67%, and 72.36% for the national, SRC, and complementary areas, respectively. Younger age categories have a lower extent of redemption than middle-aged and elderly-aged classes in all settings. Convincingly, the younger age has a lesser ratio of redemption in both settlements (SRC and CAs). This has similar discoveries from other findings conducted by several researchers across the globe (299–305). The plausible reason for this might be a lack of awareness among youths on the benefits of filling the prescribed medications for better health. In addition, socioeconomic reliance on family or any proxy ones might expose early young patients not to fully adhere to the prescribed medications and supplies.

Regarding gender versus prescription redemption, most studies claimed that women fill better than men (113,306–309). In the UK, females redeemed much more than males (113). Also, a

finding from South Korea uncovered women were better at filling the prescribed medications than men (310). Conversely, in Denmark females have high nonredemption rate than males (145). This inconsistency might be related to the epidemiological trend of ill-health related issues variation across the nations.

Empowering and promoting the health of Roma living in the SRCs

Empowering through provision and delivery of basic health care facilities and promoting health is one of the preventive care strategies to ensure the better utilization of HCS (311–314). This reflection or strategy better works from a prescription redemption point of view among Roma living in the SRCs. If these conditions meet and implemented, they could achieve better HCS package use beyond the prescription redemption at the individual, family and community level as well.

Magnitude of HCS before and COVID-19 pandemic lockdown

GP and specialist visits

There were significant reductions were seen for GP visits, and specialist care by 23.2%, 26.4%, respectively, due to the pandemic lockdown effect. But the CRPNR did not result in significant change. These findings were in line with the others from Europe and elsewhere. For instance, in EU member states, Taiwan, Asian countries and the USA significant decreases in GP and visits, specialists were recorded during the pandemic compared to the pre-pandemic period (75,77,315,78,79,88,109,159,194,196,220). The Hungarian figures of GP and specialist visits are in between among EU and others parts of the globe. These could be taken as a positive response from subjects to the pandemic lockdown regulations that only serious medical illnesses were allowed to attend healthcare institutions and this was supported by other findings (219,223)

Hospital admission

Similarly, the hospital admission rate was declined by 6.7%. But it was quite lower than Germany [39%] (75), and Croatia [21%] (231) while relatively equal with Finland [7%] (316) in Europe and others like Ethiopia [28%] (205), and China [33%] (78). This might be due to the lockdown regulation which promotes only severe medical cases and COVID-19 complicated cases in Hungary. Additionally, the reduction could be due to people's fear to visit the hospitals, imposed restrictions by the government, hospital capacity to accommodate patients and priority given for COVID-19 and intensive care unit (ICU) patients. However, there was no significant pandemic impact was seen for the hospital admission for social strata.

CRPNR

Our study revealed the CRPNR was 5.6% and 5.2% (only 0.4% observed difference) pre-pandemic and pandemic, respectively. However, other studies from the USA (317), and Australia (318) showed a 27.1% and 36% reduction in the overall redemption of the prescriptions, respectively, before and during the pandemic. However, the sole and collaborative effect of the pandemic alongside other predictor characteristics particularly on CRPNR have not been evaluated. The lack of significant difference between the two periods might be due to the availability of home delivery of pharmaceuticals in most EU countries (230).

The interaction role of COVID-19 pandemic along with social strata on HCS uptake

The COVID-19 pandemic lockdown significantly changed/interacted or modified the dynamics of HCU for GP visits, special care and CRPNR among the susceptible social strata.

Pandemic impact, Educational attainment and HCS uptake

Our finding also revealed that subjects with primary educational attainment had a higher hospitalization frequency. This trend was not changed during the pandemic lockdown. The probable reason could be their poor health status. Conversely, an increased frequency of specialist care among highly educated subjects during the prepandemic period might not indicate their poor health condition and needs. Possibly, this imbalance is might be due to variation in the educational attainment difference that existed before the pandemic. Again, inability and intention to use the available health services (193). Then again, this might be due to the higher magnitude of cosmetic or life-prolonging, and/or other elective services in the medical intervention pattern among better more educated stratum. This gap has significantly been declined during the pandemic period. It suggests that the elective interventions were mainly postponed in the time.

These Hungarian findings are not agreeing with the other study from the large survey of the EU and Netherlands (195,196) that established an indirect relationship between educational attainment and HCU [lower educated subjects had higher odds of avoiding HCU] during the pandemic But they were in line with other findings from another big survey in European countries during the pandemic lockdown (222). Moreover, this dissertation revealed the inverse association between CRPNR and the educational attainment that was attributed to the pandemic period. As the result, the difference has been increased among the less educated subgroups. This is the finding that resulted in widened HCU gap due to the pandemic.

Pandemic impact, Roma Ethnicity and HCS uptake

The Roma ethnicity did not show a significant relationship with GP visits and the frequency has been resisted for the pandemic period. But, the specialist care use was found to be less frequent while the hospital admission was more frequent than non-Roma counterparts with a marginal significance. This suggests that Roma had a poor health condition and lesser advanced HCU compared to the non-Roma population. In both periods the Roma were more frequently faced CRPNR compared to their counterparts. This suggests that they have a higher underprivileged situation or settings in the country. But the pandemic lockdown has no significant role in modifying the CRPNR among the subgroup.

In Hungary (53) and other countries, less use of advanced HCS and an increased hospitalization rate among the Roma has widely been investigated (53,54,319–323). Similarly, the relationship between ethnicity/race and CRPNR was widely mentioned in the previous studies from the USA and New Zealand in the prepandemic period. Due to bearable sociodemographic and clinical inequalities, black Americans and Hispanics in the USA (12,141,169,170,175–180), Maori and Pacific populations in New Zealand (63,149,150), and Filipinos and indigenous Hawaiians in Japan (174) were significantly exposed to CRPNR. Despite the pandemic did not bring a significant influence on the CRPNR among Roma, other studies from the USA, UK and other countries established that ethnic minorities were more affected by the pandemic than native people (55,183–185,187,324,325). In addition, more other factors have been contributed to CRPNR before the pandemic (18,56,330,123,130,140,309,326–329). Thus, according to the earlier findings and inferences on the ethnicity or racial minorities during the COVID-19 pandemic (235,324), an appropriate follow-up and support are needed to curb the vulnerability to HCU in terms of CRPNR among the Roma (55,331,332). Nonetheless, our investigation could not demonstrate the pandemic impact on ethnic inequalities in Hungary.

Pandemic impact, Marital status and HCS uptake

Our study discovered that the frequency of GP and specialist visits were highest among widowed stratum. These figures kept resistant compared to the married counterparts attributed to the pandemic. According to the previous findings from European states, Netherlands, Japan, India and USA, this suggests that the lack of close or proxy care given by the partner could increase their susceptibility for physical, social and mental health. This usually pushes them for increased utilization of HCSs (188–190,333–335).

After controlling for other potential sociodemographic and clinical factors, the widowed showed less likelihood of getting advanced care from specialists. This indicated that their healthcare demands were not addressed during the pandemic accordingly.

Among widowed stratum, there was no significant general reduction for GP and specialist cares during the pandemic. The GP visit was an exceptional increase from 90.8% to 92.1% while other marital subgroups showed significant declines. Despite there has been a reduction in specialist care [only 3.9% among widowed] and other subgroups showed remarkable declines for more than 28% and above. Thus, pandemic effect modification/interaction analysis revealed that widows were found to play a protective role against the GP and specialist care restriction. That signals the special healthcare needs of widowed were better addressed during the pandemic resulting in the narrowing of the marital status inequality. This was an outstanding and updated finding that the pandemic lockdown modified the effect in the same direction among the widowed subgroups.

Nonetheless, there was no marital status inequality in terms of hospital admission and CRPNR and were not changed during the pandemic in Hungary as well.

Age and HCS uptake

This study revealed that the uptake of GP visits, specialist care, hospital admission and CRPNR were significantly higher among older patients in both periods. It has a similar inference with previous findings that aging has been a risk factor for poor health due to weakened immunity (191,194,224,336).

Sex and HCS uptake

In our study, males had less likelihood of vising GP and specialists after controlling for other variables in both periods in Hungary. This is in line with other studies suggesting that women or females had a higher prevalence of morbidity and lower self-reported general health status. These push them to visit healthcare professionals more than males (94,191,337–339). Still, females had a higher frequency of hospital admission and CRPNR in both periods. This deviates from EU and Netherlands findings that males were more likely to use HCS than females during the pandemic (195,196). Our finding disproved the previous discoveries and debates that females had more familial burden which resulted in less utilization and more adherence to the first wave of pandemic lockdown regulations in Hungary and elsewhere (340,341).

Chronic diseases versus HCS uptake

In our study, those who had chronic diseases were highly utilized the services in both periods. Mainly COPD, diabetes and IHD patients were significantly increased during the pandemic lockdown for hospital admission and CRPNR than others. Similarly, the lockdown put a significant role on specialist visits and hospital admission frequency among cancer patients. This finding has a similar trend with findings from Italy and other countries that the pre-existing immunosuppression and related pathophysiology of these chronic diseases highly exposed patients for further PHC visits and high admission rates in the hospitals (202,206,207,342)

Residence versus HCS uptake

The residential place of the subjects was found to be the determinant of each HCU under the subgroups. Despite the decline in GP and specialist visits during the pandemic, patients from Transdanubia (Central And Western) regions had better uses of these services during the pandemic. On the other hand, Northern Hungary and Northern Great plain had a higher negative difference in GP and specialist visits during the pandemic. Similarly, the decline in the hospital admission rate was quite narrow for Central-Transdanubia and Northern Hungary during the lockdown compared to Central Hungary. This suggests that to variation in the affluence, health status and deprivation of the regions (238,241).

Asset-based approach (Targeted Support, monitoring, and care for vulnerable groups)

As the pandemic caused a lot of health crises across the globe, its decisive influence and severity worsened among some strata of society. Hungary is also under the domain of this crisis in terms of the uptake of basic HCSs. Thus, integrated and targeted support [professional, community, family and others] for the inadequate reaction, could have been mitigated by the targeted intervention (and should be mitigated in the next phase of the epidemic). Alternatively, it is very vital to further assess the protective role of widowed over PHC service uptake influence by the pandemics.

The role of segregated settlement on HCS utilization and vulnerability

Our study firmly confirmed that the SRC had a significant effect on the redemption of prescriptions after adjusting for age and sex among the Roma. The changes attributed were mainly due to the alimentary tract [ATC-A] and cardiovascular [ATC-C] drug classes. This suggests that the magnitude of these illnesses is more prevalent among Roma.

The role of COVID-19 pandemic on HCS utilization and vulnerability

This study explicitly demonstrated that the preexisting social inequalities among a few susceptible social strata resulted in a decline in the uptake of the HCS during the COVID-19

pandemic lockdown. Thus, it shows the dynamics (decreasing specific HCU) were adequate reactions among the social strata. From this regard, the pandemic exceptionally affected patients with lower academic status increasing the odds of the CRPNR. According to previously published findings, several factors determine CRPNR. To list a few of these, age, educational attainment, ethnicity, marital status, sex, and residence were mentioned (18,56,330,123,130,140,309,326–329). Patients with primary educational attainment and Roma origin had a higher likelihood of the CRPNR during the lockdown. Furthermore, widows had a higher likelihood of using GP and advanced specialist care during the pandemic. This emanated from the severity of health status and priority given for those medical cases during the lockdown pushed them to utilize more than the prepandemic period.

Practical implications

Firstly, the excess prescription redemption among SRCs was a breakthrough finding among the vulnerable, unethically and usually blamed Roma population (61,343). This reflected the improvement in the uptake of basic health services among the Roma population. It revealed that if the culturally adapted interventions are targeted, Roma can better utilize other pillars of HCS. Thus, our study revealed that keeping their preference or analyzing the situation on the ground would better promote their uptakes.

Secondly, the COVID-19 pandemic spectacularly caused a negative magnitude on the HCU among different social strata in Hungary. Except for a hospital admission rate, other HCU were unevenly affected across social strata during the pandemic lockdown. Most of the declined HCSs during the pandemic lockdown were emanated from the preexisting (before the pandemic) social inequality and inequity among the substrata. For this reason, the declines could be considered as adequate reactions from the subjects. During the pandemic, less uptake of the GP and specialist care among the highly educated subgroup suggested that severe medical conditions are less prevalent as the pandemic restrictions allow only those patients with serious medical scenarios (51,219,344,345). This assumption has also been supported by our descriptive findings that this subgroup had a lower frequency of hospital admission during both periods compared to others. While increased GP and advanced care uptake among the widowed subgroup indicated their severe health status in either period (188,189,346,347). On the contrary, the pandemic caused inequality and negatively influenced the CRPNR among less-educated patients. This is a profound COVID-19 pandemic social gap that declined HCU among the educational attainment. This could be mitigated by the state to enable affordability of prescription among the stratum in the next epidemic waves.

On the other hand, Roma vs non-Roma subgroup had a higher magnitude of hospital admission in both periods [19.2 vs 13.3% and 9.2 vs 6.6 % pre-pandemic and pandemic], respectively. That meant they had poor or severe medical conditions during the pandemic. It is also important to note that the Roma had a higher CRPNR than the non-Roma population regardless of the pandemic [with a slight increase in the frequency during the pandemic and problem was almost quadruple among Roma in both periods]. Reasonably, a higher COVID-19 related mortality among the densely populated Roma residences during the lockdown could be due to less redemption (235). This signals that the affordability of drugs and medical supplies is a matter of Roma and it needs prompt attention to overcome the identified problem among the Roma. In general, ABA intervention models can better reduce social inequalities among a vulnerable population in terms of HCU in Hungary.

Strengths and limitations of the study

Firstly, the data from NHIFM includes all data about the prescriptions vs redemption of the country. Thus, the possibility of selection bias is very low. The imbalance of SRCs and CA sample size was compensated by the indirect standardization which was resulted in a good inference.

Regarding the COVID-19 pandemic effect study, a huge database was created from two datasets with a large sample size for both periods. The same structure, flow and questionnaires were included from two separate datasets. Particularly, the pre-pandemic dataset has a quite big sample which increases the statistical power of making the inference for the population under the study. Also, the effect of prescribed medication price has been included in the second study despite the population and study period differ.

Nonetheless, our study has some limitations. In the PNR in SRCs and CAs study, although we had recruited a large sample, this does not show the national Roma number. Thus, it was not a comparative study interpretation for the total Roma versus non-Roma population in Hungary. On one hand, 6% of people living in SRC are non-Roma (348). Then again, 75% of the Roma are living in the CA in Hungary (349). Therefore, this analysis could underestimate the actual Roma-to-non-Roma variations.

The price of the drugs and medical supplies has been one of the important predictors for achieving redemption. But it has not been investigated in our initial study.

Hungary is one of the better countries in Europe in terms of HCS availability. Besides, it was discovered that GP visiting by Roma people living in SRC was better than the general popula-

tion (53). It indicates unlikely that limited access to primary healthcare could in some way affect the habit of prescriptions redemption.

Under the pre-pandemic and pandemic investigation, due to the time interval between the data collection period, the recall bias is likely. On the other hand, social desirability bias can affect the statistical results. Also, CRPNR has a hugely limited number of the similar topic during the pandemics and further comparison was difficult. Thus, it needs further explicit investigation.

In addition, the variables used in the dissertation for characterization of HCU dynamics and socioeconomic inequalities due to the pandemic effect covered by the basic surveys (EHIS2019 and ISSP2021) only investigated the social subgroups we could evaluate. But it has been quite understandable that more sociodemographic, clinical, economical and other relevant characteristics of participants would be required to make sensible and deep inferences about the target population.

The sample size differs for two periods. A multivariable logistic regression model was used to control such a bias, but it could not compensate for the selection bias caused by different representations of the Hungarian adult society in the two surveys.

6. Conclusion and Recommendations

This dissertation uncovered that the prescription redemption was better in SRCs than CAs after adjusting for age and sex. The chronic illness medications were highly prescribed and significantly redeemed among SRCs than CAs. There was about 3% excess redemption among SRC than CAs.

Next, the COVID-19 pandemic dramatically reduced access to GP visits, specialist care and the hospital admission rate but did not affect CRPNR in Hungary. The changes were unevenly distributed across the social strata. The reductions confessed the better compliance with the pandemic lockdown regulations among the social strata except for inadequate reactions in a few strata for some specific outcomes. The GP and specialist care were had an adequate reaction among the widowed subgroups that were related to the services, attributable to the pandemic lockdown. Whereas specialist care had an adequate reaction for all sociodemographic influenced by the pandemic. Also, a higher academic status was associated with less utilization of specialist services due to the pandemic lockdown. Thus, these reduced uptakes of these services due to the priority given for the severe medical conditions during the lockdown. But

the pandemic lockdown effect on CRPNR among the less educational attainment suggests that integrated support targeting these social strata has high importance in mitigating the harmful consequence of lockdown. Widowed patients proved to be protective to the pandemic lockdown in the respect of GP and specialist care. Although the increased uptake of these services was inspiring, the reasons for these protective factors need further and deep investigations. Wholly, this investigation demonstrated that integrated support for patients with the most susceptible groups has to be focused on during the pandemic-related restrictions or lockdown. In general, ABA can better empower the uptake of HCU that could result in reducing the inequalities and social exclusion among vulnerable societal sections in Hungary.

7. New findings

First study (Study I)

The impact of the segregated colony on prescription redemption

The core finding of this dissertation under the general and specific objectives came with eight important new elements.

i. Roma pediatrics has higher prescription of anti-infectives (ATC_J) than CAs

The majorly of anti-infective (ATC-J) medications were highly prescribed (64.9%) for pediatrics groups within Roma than non-Roma (38.55%) inhabitants. This shows still communicable diseases or susceptibility to acquiring ill-health situations were prevalent among the Roma community. But the redemption for this specific age class was significantly lower for SRC than CAs, (50.29% vs 65.98%). Similarly, the aggregate redemption of this group was significantly lower in SRC (57.6% vs 74.68%) than in the complimentary area.

ii. The cumulative impact of the colony on prescription redemption was seen in excess among Roma living in SRCs

Alimentary tract and metabolism, cardiovascular, musculoskeletal, anti-infective, and sensory organs ATC classes with excess redemption of 3.7%, 11.5%, -22.9%, and -12.5%, respectively.

Overall, 2.8% of excess redemption was seen among SRC than CA that was attributed to the settlement. This might be related to the previous study that the Swiss Hungarian Cooperation Program (SHCP) has been effective in improving the redemption of ATC_A and ATC_C prescriptions by 19.9% and 42.6% (249).

Second study (Study II)

The COVID-19 pandemic lockdown and dynamics of HCS utilization in Hungary

iii. There were massive changes in basic HCS utilization due to the pandemic

Except for CRPNR, the remaining basic HCS were significantly reduced due to the pandemic lockdown in Hungary. The uptake of GP, Specialist service and hospital admission were reduced by 22.2%, 26.4% and 6.7%, respectively. However, the CRPNR did not result in significant change despite there was a 0.4% decrease due to the pandemic lockdown. These changes suggest prepandemic social inequalities and inequities resulted in the difference during the pandemic lockdown except for a few strata and outcomes.

iv. Gender role showed the dominance of females HCU in Hungary

Regardless of the pandemic lockdown, females were found to be more frequent users of all of the studied HCS including the segregated settlements than males.

v. The uptake of HCS for chronic illnesses was moderately reduced during the pandemic period

Almost all kinds of chronic patients had lower utilization of basic HCS during the pandemic lockdown. Thus, it is very crucial to trace chronic patients to reduce the severity, further complications and mortality during the pandemic lockdown period.

vi. Roma had significantly a higher CRPNR than the non-Roma population

Although Roma had better redemption in SRC in the previous study (264), in both periods they had a higher likelihood of CRPNR than non-Roma people. It suggested that the pandemic was not the sole cause for the increased CRPNR among the Roma. Thus, Roma needs special attention on achieving the prescribed drugs and medical supplies from financial barriers perspectives regardless of the pandemic.

The Pandemic Interaction effect /modifying HCS utilization among the social strata

vii. The pandemic lockdown significantly modified the effect of educational attainment on GP visits, specialist care and CRPNR

Subjects with a higher academic level showed a significant decline in the use of GP during the pandemic lockdown. Conversely, the less educated subjects faced a significant increase in CRPNR during the pandemic lockdown. While this is a unique social stratum in that the pan-

demic caused a remarkable inequality in utilizing HCS from CRPNR perspectives in Hungary.

viii. The pandemic lockdown significantly modified the GP and specialist care among marital categories.

Being widowed had a significant role in the GP visits attributed to the pandemic lockdown restrictions. Even though there was a decline in specialist care during the pandemic lockdown, such a reduction was significantly lower than other marital subgroups. This suggested that the responses seemed to be adequate as this marital stratum had serious health issues, needs and demands.

8. Summary

Background: Prescription redemption or primary medication compliance is defined as the proper purchasing of prescribed medications and medical supplies. It does not include over counter drugs or informal dispensed prescriptions. Attaining a better redemption of prescription has the power to alleviate the pain, severity, and speed up the prognosis of the diseases among the patients. But patients usually tend to miss or skip or omit to dispense the prescribed drugs and medical supplies either intentionally or unintentionally. Moreover, sociodemographic vulnerability worsen the problem. Subsequently, it is very crucial to scrutinize the reason behind the nonredemption of prescribed medications among SRCs versus CAs.

On the other hand, a continuum of HCU is a basic approach to ensure the wellbeing of nations. They include both preventive and curative services provided by HCS units. They have a chain-like feature starting from visiting frontline professionals; general practitioners (GP), specialist levels, getting proper curative services for health ill conditions. The better utilization of HCS had an extra benefit on reducing severity, incidence, prevalence, complications and quickening the prognosis of the illness. Thus, better GP or specialist care has a lower possibility of facing medical emergencies and admission to hospitals**.** Besides this, redeeming the prescribed medications and medical supplies has equal importance in relieving the further negative consequences of diseases among the patients. However, there is a paucity of explicit understanding regarding the variation due to the segregated areas of residence, ethnicity, and other sociodemographic and clinical predictors on uptake of the continuum of health care services. Furthermore, the COVID-19 pandemic caused an imbalance in the HCU dynamics and created vulnerable social strata throughout the globe. But this dynamics of HCU has not been investigated yet in Hungary or elsewhere.

Objectives: The general objective of this study was to investigate the effect of segregated settlement and COVID-19 pandemic on the dynamics of basic HCU among the vulnerable population in Hungary. Accordingly, our specific objectives were *(1)* to investigate the crude prescription redemption among Roma living in segregated settlements versus complementary areas, *(2)* to investigate the indirect age-sex standardized redemption ratio of Roma living in segregated settlements versus complementary areas, *(3)* to estimate the GP visit, specialist care, hospitalization and CRPNR pre-pandemic and during the COVID-19 pandemic *(4)* to investigate the effect of the pandemic on GP visit, specialist care, hospitalization and CRPNR controlled for established predictors and *(5)* to determine subgroups susceptible to the GP visit, specialist care, hospitalization and CRPNR provoked by the pandemic in Hungary.

Methods: Data were obtained from NIHIFM-2012, EHIS-2019 and ISSP-2021 for SRCs vs CAs, pre-pandemic and pandemic periods, respectively. All age groups [for SRCs vs CAs], and 18 years and above [for pre-pandemic and pandemic periods] were included in the study. The indirect adjusted age-sex standardized redemption ratios [SRR] were calculated for SRCs vs CAs.

Whereas descriptive and analytic computations were done for pre-pandemic and pandemic data. Tables, figures, and proportions were displayed for sociodemographic and clinical characteristics for each outcome variable. Under the analytic section, multivariable logistic regression along with 95% CI was calculated to control the confounding factors in the pre-pandemic and pandemic data analysis. The COVID-19 lockdown was found to be the effect modifier or interaction variable on outcome variables of HCU for some sociodemographic strata that were more susceptible to the pandemic lockdown/restrictions.

Results: The crude redemption ratio of national, SRC and CAs were 84,323,051/126,223,796 (66. 8%), 46,107/33,720 (73.13%) and 901,901/640,950 (71.15%), respectively. SRC has the highest CRR than both CAs and national figures. Females dispensed more than males in both settlements. From 45-64 and 65 years and above redeemed more than other age strata in SRCs and CAs, respectively. The age-sex standardized redemption ratio was 1.028 [1.018-1.038] SRCs to CAs. The impact of the settlement showed an excess of 2.8% or extra 920 redemptions per year among SRCs compared to the CAs.

The COVID-19 pandemic lockdown caused drastic reductions in the HCU compared to the pre-pandemic period; GP visit (79.2% vs 56%, $p<0.001$), specialist care (64.4% vs 38%, $p<0.001$), hospital admission (13.5% vs 6.8%, $p<0.001$) but not for CRPNR (5.6 vs 5.2%,

p=0.662). The pandemic lockdown modified the effect on GP and specialist care among widowed strata. It significantly shifted the uptake of GP visits from 90.8% to 92.1% aOR=2.284 (1.043-4.998). While positively from provoked the effect of widowed on the specialist care from unadjustedOR=1.338 (1.136-1.576) to aOR=1.915 (1.157-3.168) after controlling for pertinent sociodemographic and clinical factors. Conversely, the effect of educational attainment [highly educated levels] were negatively dragged by the pandemic lockdown on GP visits and specialist care from unadjustedOR=0.710 (0.590-0.855) to aOR=0.434 (0.243-0.776), and aOR=1.288 (1.097-1.513) to aOR= 0.331 (0.179-0.611), respectively. The important social inequities observed in this study was that the subjects with lower academic levels had higher CRPNR than others due to the pandemic lockdown.

Practical implications: The main practical interpretation of better-prescribed medication redemption means quickening the prognosis of the disease and maintaining the well-being of the subjects. Compared to the earlier research about the Roma and their poor health status, lifestyle and HCU, our current findings disproved that Roma were poor healthcare utilizers from a prescription redemption viewpoint. This has been supported by both CRR of 73.13% which was greater than national (66.8%) and CAs (71.15%) and age-sex adjusted SRR with an excess of 2.8% redemption among Roma. If culturally adapted preventive models are applicable, other pillars of HCU and lifestyle could be improved based on our current findings.

Meantime, the continuum of HCU was significantly affected by the pandemic lockdown. The uneven influence of the pandemic was seen for GP visits and specialist care among marital while CRPNR among educational attainment strata were provoked in positive and negative directions, respectively. These are prominent findings are that the widowed stratum effect on GP and specialist visits were significantly modified as a protective role. This seemed an adequate reaction as the disadvantaged groups in the prepandemic era got more opportunities to utilize HCS during the pandemic. In addition, serious health crises among the widowed subgroup may increase GP and specialists during the lockdown. Then again, the higher educational attainment stratum effect on the specialist care was shifted from protective to exposing role. But the CRPNR was significantly reduced among less-educated patients attributed to the pandemic lockdown needs further mitigations in the next epidemic waves.

Conclusion and recommendations: Nearly a three-fourth of Roma living in the SRCs redeemed their prescriptions accordingly. They had a significant portion of excess redemption than CAs for in a year. It shows that Roma contradicted the previous findings which prejudiced and marked them for poor health and lifestyle.

The pandemic dramatically dragged down the continuum of HCS care in Hungary. Several sociodemographic and clinical factors played an exposing and protective role subject to the interaction of the pandemic lockdown. Some social strata were mainly victims or susceptible to the pandemic lockdown. Lower educational attainment was found to be improved for GP and specialist care attributed to the pandemic lockdown. This indicated that the preexisting sociality inequality was manifested during the pandemic lockdown restrictions. Remarkably, the widowed stratum played a protective role for GP and specialist care attributed to the pandemic. These effects seem to be adequate reactions since the pandemic regulations allow only serious medical conditions. But the lower CRPNR among the less-educated subgroup was an inadequate reaction. A Roma had a higher likelihood of CRPNR than a non-Roma population regardless of the lockdown.

Thus, our finds suggested that culturally adapted approaches mainly ABA and in-depth interview studies are important for investigating the HCS uptake of the Roma population in SRCs. The basic reason for applying the ABA for Roma in the SRCs it enables well exploring and understanding of their needs, demands, gaps and opportunities through their active involvement from beginning to the end of the intervention program in the future. This could enhance and empower them more than the usual or standard public health intervention model or top-down approach. So at the end of the day, a better prescription redemption and other HCU push them for an improved healthy lifestyle and health status.

Also, the continuum of HCU needs close monitoring mainly for susceptible social strata under each studied outcome component. Inadequate reactions among the predisposed social strata (less educated subgroup) should be mitigated in the next phase of the epidemic. We also recommend further studies on the new insights which played a protective role in the utilization of GP and specialist care among the widowed subgroup in Hungary.

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10. Keywords

Prescription non-redemption, Roma people, cardiovascular drugs, alimentary tract drugs, anti-infective agents, CRPNR, COVID-19 pandemic, hospital admission, GP visit, healthcare service, Hungary, interaction effect, specialist care

11. Acknowledgment

First and foremost, I am enormously thankful to my supervisor, Professor Dr. Janos Sandor for his priceless and invaluable unceasing help, support, advice, motivation and patience during my PhD study. His level of deep knowledge, outstanding technical ability, seniority, tolerance and abundant experience has stimulated me in all my ways and times of research and daily life. It is not easy to achieve my ambition of having PhD study without his wonderful help, charming and often welcoming approach both in my good and bad moments. I have no more words to express my heartfelt gratitude that better explains his role in my journey which is very vital for my present and future career as well.

I also would like to thank Professor Adany Roza and Prof Margit Balasz for their kindness and help during my PhD study. It is their kind help and support that has made my study and life easy in the school to have a pleasing time.

Still, I have a great honor and kindly valued Koos Zoltanne, Reka Kovacs and Zsuzsa Toth for their technical help and unreluctantly pleasant support.

I kindly thank Tempus Public Foundation for offering me all the required provisions under the Stipendium Hungaricum Scholarship scheme.

Here again, I am so grateful for my beloved and juvenile wife Seblewengel Getachew, our sons Eyoab and Benayas for their taking the risk, paying sacrifice, moral support, big patience and love during my PhD study. You are a reference of a strong and brilliant lady for a dude that broke the stereotype further study is impossible after having a marriage at an early age for a man. This PhD is completely impossible without your willingness and commitment to letting me do and God Bless you!

Last, but not least I would like to thank my childhood and youthful academic founders, Mr. Abebe Kema, Awoke Belay Mrs. Genet Mekuria, who has empowered and enlightened me and others [Dr. Tadewos Menta, Mr. Muluken, Tekle, Tadele, Adal, Solomon, Kongo, Demeke, Degu, Taybela, Desalegn] not mentioned here made me a man of today. Meanwhile Mr. Haile Balango and Ephrem Aysa you have taken my risk and made an extraordinary bridge once in my life that connected my vision and ambition. I would like to say Thank you!

My mother Asamenech Mekonin, you have been making me energetic and productive in my life and I am proud of you my beloved mother. I love you, siblings too. And I dedicate this PhD to my beloved father Begashaw Bekele who has nurtured me in love and compassion till

now. I always wonder and admire you for life!! You are a genuine father to your children, we love you always and I praise God for you in our lives!!

I am also highly grateful to the staff and co-workers of Mizan Tepi University, College of Health Sciences. I greatly appreciate your kind moral support from the beginning to today of my study.

12. Funding

The study was carried out in the framework of the “Public Health-Focused Model Program for Organizing Primary Care Services Backed by a Virtual Care Service Center” (SH/8/1). The Model Program is funded by the Swiss Government via the Swiss Contribution Program (SH/8/1) in agreement with the government of Hungary. Additional sources of funding were from the GINOP-2.3.2-15-2016-00005 project, which was cofinanced by the European Union and the European Regional Development Fund.

Also, the “ Routine monitoring for the health status and health care use in the Hungarian segregated colonies” program (BM/6327-3/2021, FEIF/951/2021-ITM), supported by the Deputy State Secretary for Social Inclusion of the Hungarian Government. Furthermore, the Stipendium Hungaricum Scholarship Program (grant SHE-15324-002/2018 to Bayu Begashaw Bekele) supported his PhD study. Funders have no role in the design, collection, analysis, interpretations, and publication processes.

This study was funded by the Stipendium Hungaricum Scholarship scheme under Tempus Public Foundation with reference number SHE-15324-002/2018 to Bayu Begashaw Bekele.

13. Publication List

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Registry number: DEENK/88/2022.PL
Subject: PhD Publication List

Candidate: Bayu Begashaw Bekele
Doctoral School: Doctoral School of Health Sciences

List of publications related to the dissertation

1. **Bekele, B. B.**, Alhaffar, M. H. D. B. A., Wasnik, R. N., Sándor, J.: The Effect of the COVID-19 Pandemic on the Social Inequalities of Health Care Use in Hungary: a Nationally Representative Cross-Sectional Study.
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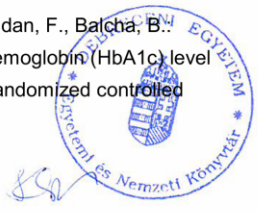

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Develop. Country Studies 6 (2), 116-122, 2016.

Total IF of journals (all publications): 23,657
Total IF of journals (publications related to the dissertation): 9,2

The Candidate's publication data submitted to the iDEa Tudóstér have been validated by DEENK on the basis of the Journal Citation Report (Impact Factor) database.

18 February, 2022