Three Essays on Health Systems Response to Epidemiologic Crises and Trends

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Ai viaggiatori, alle sorprese della vita, a Riccardo, ai miei genitori.

Quando ti metterai in viaggio per Itaca
devi augurarti che la strada sia lunga,
fertile in avventure e in esperienze […].

Devi augurarti che la strada sia lunga.
Che i mattini d'estate siano tanti
quando nei porti – finalmente e con che gioia –
toccherai terra tu per la prima volta:
negli empori fenici indugia e acquista
madreperle coralli ebano e ambre
tutta merce fina, anche profumi
penetranti d'ogni sorta;
più profumi inebrianti che puoi,
va in molte città egizie
impara una quantità di cose dai dotti.

Sempre devi avere in mente Itaca –
raggiungerla sia il pensiero costante.
Soprattutto, non affrettare il viaggio;
fa che duri a lungo, per anni, e che da vecchio
metta piede sull'isola, tu, ricco
dei tesori accumulati per strada
senza aspettarti ricchezze da Itaca.
Itaca ti ha dato il bel viaggio;
senza di lei, mai ti saresti messo sulla via.
Nulla di più ha da darti.

E se la trovi povera, non per questo Itaca ti avrà deluso.
Fatto ormai savio, con tutta la tua esperienza addosso
già tu avrai capito ciò che Itaca vuole significare.

C. Kavafis

Acknowledgments

I would like to express my heartfelt gratitude to my supervisors for the support and guidance I received during these intense and rewarding years of my Ph.D. program. They guided me while also allowing me the freedom to explore my own path. I am grateful to Professor Marco Meneguzzo for his pragmatic and real-life approach, and to Professor Stefano Calciolari for his rigor and close mentorship. I thank them for these years filled with joy and growth, and I am confident that I am emerging from this experience as a better person in every way. I extend my gratitude to the other members of the doctoral thesis committee, Professor Aleksandra Torbica and Professor Antonietta Mira, for reading my work and providing essential feedback.

I also want to thank everyone who encouraged me to embark on this journey; initially, I only partially believed in it, but now I cannot imagine having done otherwise. I am deeply grateful to those who stood by me throughout: my life partner, Riccardo, and my parents. Finally, I thank everyone I met along the way, and even the obstacles and unexpected events. The surprises, twists, and uphill battles were fundamental pieces of this journey.

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Introduction

In an era marked by dynamic demographic shifts and unprecedented health crises, the intersection of health economics and public health stands as a critical field of inquiry. The 21st century has witnessed a profound transformation in global health landscapes, characterized by the dual challenges of an aging society and the emergence of novel infectious diseases. Among these, the COVID-19 pandemic has emerged as a defining moment, unveiling systemic vulnerabilities within health systems worldwide. As nations grapple with the ramifications of this crisis, the imperative to understand the intricate interplay between economic factors and epidemiological trends has never been more pressing. The demographic transition towards an increasingly aged society poses multifaceted challenges, straining healthcare resources and necessitating innovative approaches to address the complex health needs of older populations. Simultaneously, the COVID-19 pandemic accentuated the profound socioeconomic determinants underpinning health outcomes, shedding light on disparities in healthcare access and intensifying the call for targeted policy interventions.

Funding for my doctoral journey has been generously provided by the Swiss Learning Health System (SLHS), a national platform dedicated to advancing health systems and health services research. The SLHS serves as a nexus for dialogue among diverse stakeholders within the Swiss healthcare system, facilitating the exchange of knowledge and expertise across policy, research, and practice domains. It endeavors to forge evidence-based solutions to address the challenges confronting the healthcare system with the ultimate goal to enhance the resilience of the Swiss healthcare system, promote population health, and optimize the value delivered by healthcare expenditures. Within this framework, my doctoral thesis seeks to explore the mechanisms underpinning resilience in healthcare systems and the dynamic interplay of factors crucial for adaptation in evolving health landscapes.

The opening chapter of my thesis scrutinizes Ticino's hospital system response to the COVID-19 pandemic. Utilizing a qualitative analysis approach, the study is based on semi-structured interviews with key managerial figures from the three COVID-19 centers, conducted as part of a Rapid Response Review (RRR). It assesses the acute sector response at the cantonal level, delving into crisis management strategies aimed at safeguarding essential services and navigating logistical challenges within hospital management.

The entire chapter is accessible as reviewed Rapid Response Review at the official Website of the Swiss Learning Health System (www.slhs.ch):

- Calciolari, S., González, L., Luini, C., & Meneguzzo, M. (2020). Strategic and organizational response of Ticino's public and non-profit mulit-hospital system facing the COVID-19 emergency. *Swiss Learning Health System*. Available at: www.slhs.ch/images/learning-cycles/2020-Rapid_Response_Reviews/PB_HospitalSystem_final.pdf

In addition, an extended version of the first case study (Chapter 1, section 1.3.3.) was published on the academic peer-reviewed journal Mecosan:

- González G., Greco A., Luini C., Calciolari S., Meneguzzo M. (2021) Gestire la crisi COVID-19: il caso dell'Ospedale "La Carità" di Locarno nell'ambito della risposta del sistema ospedaliero ticinese alla pandemia, *Mecosan, (Vol. XXX):* 71-95. (ISSN 1121-6921)

Following the RRR, a Stakeholder Dialogue was held, bringing together a diverse group of key stakeholders. Although the outcomes of the dialogue are not included in this document, the objective was to collaboratively review the recommendations, barriers, and facilitators identified in the RRR. Through a deliberative process, stakeholders aimed to achieve a shared understanding of the issues and determine the best course of action. Stakeholder Dialogues are

a valuable mechanism for evidence-based decision-making and promoting a culture of shared responsibility.

The second chapter delves into a comprehensive analysis of frailty, acknowledging its multifaceted nature and its profound impact on clinical practice, public health, and the sustainability of healthcare systems. This research underscores the importance of considering frailty's physical, social, and psychological dimensions in predicting healthcare utilization among elderly Europeans. Utilizing a quantitative econometric approach, the study draws on the SHARE dataset to conduct its analysis.

The chapter is accessible in the form of reviewed Policy Brief focused on the Swiss healthcare system at the official Website of the Swiss Learning Health System (www.slhs.ch):

- Luini C. & Calciolari S. (2023). Effect of frailty on healthcare utilization: policy analysis and recommendations to the Swiss health system. *Swiss Learning Health System*. Available at: www.slhs.ch/media/nmtfdmbw/policy-brief_effect-of-frailty-on-healthcare-utilization.pdf

In addition, a scholarly version of the chapter was published in the peer-reviewed journal Social Science & Medicine:

- Calciolari, S., & Luini, C. (2023). Effects of frailty bio-psycho-social dimensions on healthcare utilization among elderly in Europe: a cross-country longitudinal analysis. *Social Science & Medicine*, 339. (ISSN 0277-9536)

Following a process like the one described earlier regarding the RRR, the Policy Brief was succeeded by a Stakeholder Dialogue aimed at cultivating a collective understanding of the identified issues and determining the most effective course of action through collaborative

deliberation. The outcomes of the dialogue are not included in this document but can be consulted at the official Website of the Swiss Learning Health System (www.slhs.ch):

- Luini C. & Calciolari S. (2023). Summary of the Stakeholder Dialogue on: Effect of frailty on healthcare utilization: policy analysis and recommendations to the Swiss health system. *Swiss Learning Health System.* Available at: https://www.slhs.ch/media/tc1b0ilm/summary-stakeholder-dialogue_effect-of-frailty-on-healthcare-utilization.pdf

In the third chapter, the focus shifts to Switzerland's alternative health insurance schemes designed to improve care coordination. This investigation specifically scrutinizes the impact of health insurance schemes which employ gatekeeping principles, on healthcare service utilization among the elderly frail population. The overarching aim is to derive policy implications on the adoption of gatekeeping mechanisms for a specific target population of complex patients. This study entails a rigorous quantitative econometric analysis, leveraging data from the Swiss Health Survey.

Notably, a portion of this study has been accepted for publication in the journal Yearbook of Swiss Administrative Sciences and an abstract of the work was accepted for presentation at the European Conference on Health Economics (in July 2024). The complete study is currently slated for submission to a leading health economics journal.

While my doctoral research endeavors into the resilience of healthcare systems and the dynamics influencing health outcomes share a coherent thread, it's important to note that the first chapter stands somewhat apart from the subsequent studies. This distinction arises from the significant influence of the SLHS, particularly in commissioning the RRR during the critical COVID-19 period. This initial investigation underscores how emergent health crises can

reshape research priorities and methodologies, highlighting the pivotal role of timely and targeted research in informing policy and practice.

1. Strategic and organizational response of Ticino's hospital system facing the COVID-19 emergency: three case studies.

1.1. Introduction

1.1.1. Background on emergency

In 2020, the SARS-CoV-2 (hereafter COVID-19) pandemic hit the world. Starting in China, where the first outbreak was identified in the region of Wuhan in December 2019, the pandemic reached Europe with its first three cases detected in France (January 24th, 2020) and its first three Italian cases four days later. On February 25th, Switzerland diagnosed its first case in the canton of Ticino (UFSP, 2020b, 2020a).

From a geographic point of view, Switzerland shares borders with France and Italy, respectively, in the west and in the south. Incidentally, the French speaking regions (in particular, the cantons Geneva and Vaud) and the canton of Ticino were the most affected regions in Switzerland. In particular, two public events may have triggered the observed outbreaks in the bordering Lombardy (Italy) and Ticino (Switzerland): the soccer match Atalanta vs. Valencia taking place in Milan (Italy) on February 19th and the Carnival procession in Bellinzona (Ticino, Switzerland) on February 23rd. At that time, no restrictions had been in place yet.

From the confirmation of the first case the virus rapidly spread across Switzerland. Consequently, on February 28th and March 16th, the Federal Council declared the situation as, respectively, “particular” and “extraordinary” (Confederazione Svizzera, 2016), and issued

more and more restrictive measures aimed at safeguarding public health (see Table 1.1). In Ticino, some federal measures were complemented or even anticipated to tackle the specificities of the local context. In particular, the canton decided to expand the intensive care capacities.

After the peak of cases was reached on March 23rd, the number of hospitalizations and deaths started decreasing, with the number of intensive care cases back to a level compatible with ordinary capacity. On this ground, on April 16th, the Federal Council decided to ease the measures starting from April 27th (UFSP, 2020b).

Table 1.1: Timelines of implementation and ease of COVID-19 related restrictions as of July 6th, 2020

Date of Entry into Force	*Implementation and ease of COVID-19 related restrictions*
28.02.2020	Ban on demonstrations with more than 1000 people
13.03.2020	Ban on public and private demonstrations with more than 100 people. Limitation of 50 people in restaurants and bars, including personnel. Ban on entry to Switzerland for people coming from countries and regions at risk, unless fulfilling specific conditions.
14.03.2020	Clarification: the ban also applies to ski areas
16.03.2020	Ban on classroom teaching
17.03.2020	Ban on public and private demonstrations, including sporting events and corporate activities. Closure of facilities accessible to the public. The imposed ban and closure did not apply to facilities that sell goods and services for daily use.
19.03.2020	Ban on shopping tourism
21.03.2020	Ban on gatherings of more than 5 people. Obligation to keep a distance of more than 2 meters in gatherings of more than 5 people.
25.03.2020	Ban on healthcare facilities, in particular on hospitals, clinics, dental clinics and medical practices, to perform non-urgent tests, treatments and medical interventions.
16.04.2020	Announcement of the Swiss Government of the progressive ease of measures (in two phases).

27.04.2020	<u>Phase 1</u> Green light for the reopening of: • DIY and gardening centers, including nurseries and florists; • commercial operations offering services with physcial contact, such as hairdressers, massage practices, tattoo studios and beauty centers (escort or prostitution services and erotic clubs had to stay closed); • self-service facilities such as solariums, car wash plants or flower fields. Green light for the execution of all outpatient interventions, including non-urgent ones. Withdrawal of the limitation that only the close family circle could attend funeral ceremonies.
11.05.2020	<u>Phase 2</u> Green light for: • classroom teaching in compulsory schooling (elementary and lower secondary schools) • classroom teaching with groups of no more than 5 people in upper secondary, tertiary and in other training centers • exams at educational institutions (excluding elementary and lower secondary schools) Green light for the reopening of shops, markets, travel agencies, museums, libraries, and sport facilities. Green light for sporting activities (max. five people, not involving physical contact), competitive and professional sport in groups of up 5 people or teams. 1st phase of restaurants reopening limited to seated groups of four and parents with their children. 1st easing phase of entry restrictions to Switzerland.
28.05.2020	Easing of ban on religious services
01.06.2020	Green light for the collection of signatures in public spaces
06.06.2020	Gatherings of max. 30 people in public spaces Demonstrations, political demonstrations and assemblies of companies of max. 300 people. Resumption of classroom teaching in secondary schools, professional schools and universities, as well as in other training centers. 2nd phase of restaurants reopening for groups of more than four people, tracing client details whenever the distance is smaller than prescribed.

	Opening of discotheques, dance clubs and night clubs (tracing client details when distance is smaller than prescribed). 2nd phase of openings in the sports sector (max 300 spectators). Opening of swimming pools, wellness centers, botanical gardens and animal parks, cinemas, gig venues, theaters, casinos, ski lifts, leisure facilities for the summer tourism, holiday camps for children and adolescents (up to 300 people), campings and erotic clubs. Easing of rules for people at higher risk.
15.06.2020	2nd easing phase of entry restrictions to Switzerland: opening of borders with Germany, France and Austria.
20.06.2020	Abrogation of the limit of 300 participants on public demonstrations and introduction of new obligation to wear face masks.
22.06.2020	Minimum distance of 1.5 meters between individuals Repeal of: (a) max. number of 30 people in public spaces, (b) obligation of consumption when seated in restaurants, bars, discotheques, etc., (c) obligation for restaurants, bars, discotheques, etc. to close between 00.00 am and 06.00 am, (d) specific rules for the sports sector, (e) rules for people at higher risk. (f) protection measures in construction and manufacturing sites.
06.07.2020	Obligation to wear face masks in public transports. Quarantine for travelers coming from countries or regions at high risk of contagion.

Source: Adapted from UFSP (2020b) and UFSP (2020c).

In the next subsections, we are presenting a description of the the epidemic in Switzerland and in Ticino, based on the Federal Office of Public Health's (FOPH) monitoring from February 25th to May 11th, 2020 (when for the second consecutive day zero positive cases were reported) and a brief description of the hospital system in Ticino and of its key actors.

It is important to note that during the emergency, only severe cases requiring hospitalization, patients considered at high risk as well as healthcare workers or people in close contact with

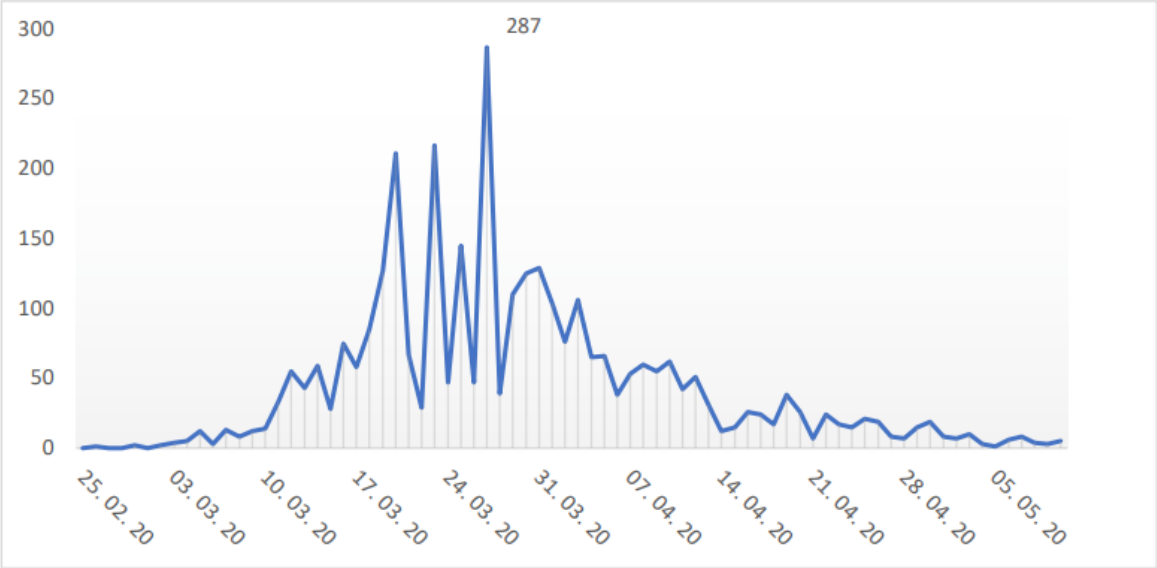
patients at risk were considered eligible for testing. As of mid-April, recommendations on test eligibility included also subjects with mild symptoms. Therefore, such changes must be taken into consideration when interpreting epidemiological data as presented in the next section, especially the number of positive cases (UFSP, 2020b).

1.1.2. Epidemiological outlook

As of May 10th, the FOPH reported 30,305 positive cases in Switzerland and the Principality of Liechtenstein, meaning a prevalence of 353 cases per 100,000 inhabitants, with overall 309,595 tests performed (12% of which turned out positive – however, more than one test can be performed per person) (UFSP, 2020c). The peak in the trend of the COVID-19 contagions was reached on March 23rd with 1,464 positive cases detected in one day. Elderly subjects were significantly more affected than younger people and men accounted for 46% of total cases. However, among the age group of people younger than 60 years women were more often affected than men, while men were more often affected than women in the age group of people being older than 60 years.

In Ticino, as of May 11th, the FOPH reported 3,238 positive cases, meaning a prevalence of 916 cases per 100,000 inhabitants. As shown in Figure 1.1, the peak in the number of positive cases in Ticino was reached on March 27th with 287 cases detected, based on data from the Division of Public Health (Divisione della Salute Pubblica, DSP) of the Department of Health and Society (Dipartimento della Sanità e della Socialità, DSS) of the Canton of Ticino (Dipartimento di Sanità e di Socialità, 2020).

Figure 1.1: COVID-19 cases detected in Ticino over time

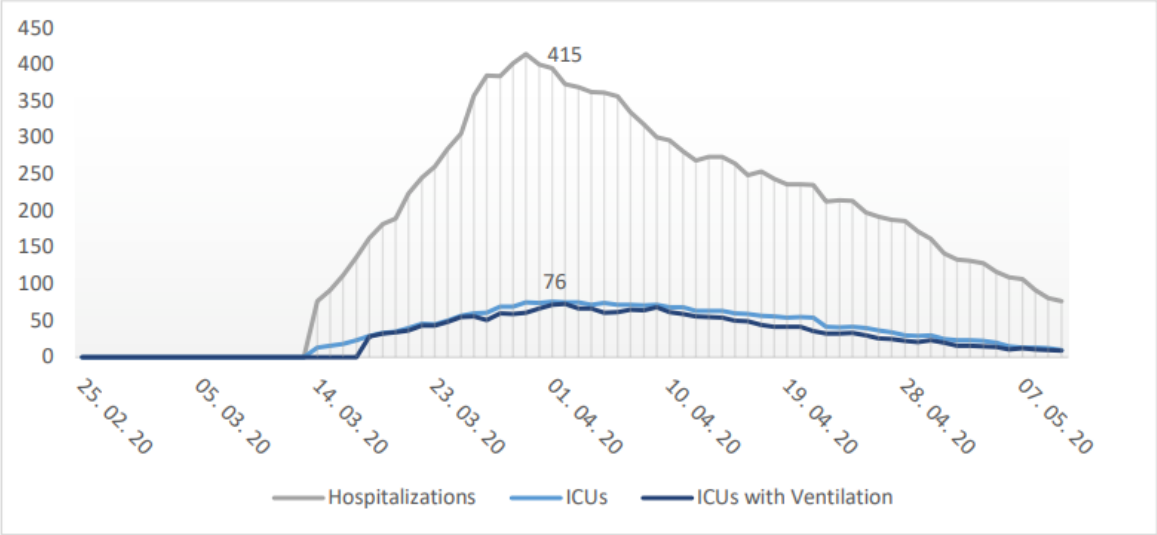


Source: Dipartimento di Sanità e di Socialità, 2020

As emerging from FOPH data (UFSP, 2020c), the peak in the number of COVID-19 hospitalizations in Switzerland was reached on March 27th, with 203 hospitalizations, after which the number started to fall steeper than it has risen. Men represented 60% of the total hospitalized cases and the elderly were significantly more often hospitalized than younger people. Across all age groups, men were consistently more hospitalized than their female counterparts.

Figure 1.2 shows the trend of all-cause hospitalizations and, among them, the cases that accessed ICUs (with or without ventilation), based on data from the DSP of the Canton of Ticino (as of May 10th) (Dipartimento di Sanità e di Socialità, 2020). In Ticino, the peak of hospitalizations was reached on March 30th (415 cases), on the same day the highest number of deaths was recorded. The peak in the number of ICUs and ventilated beds was reached on April 1st (76 beds) and April 2nd (73 beds) respectively.

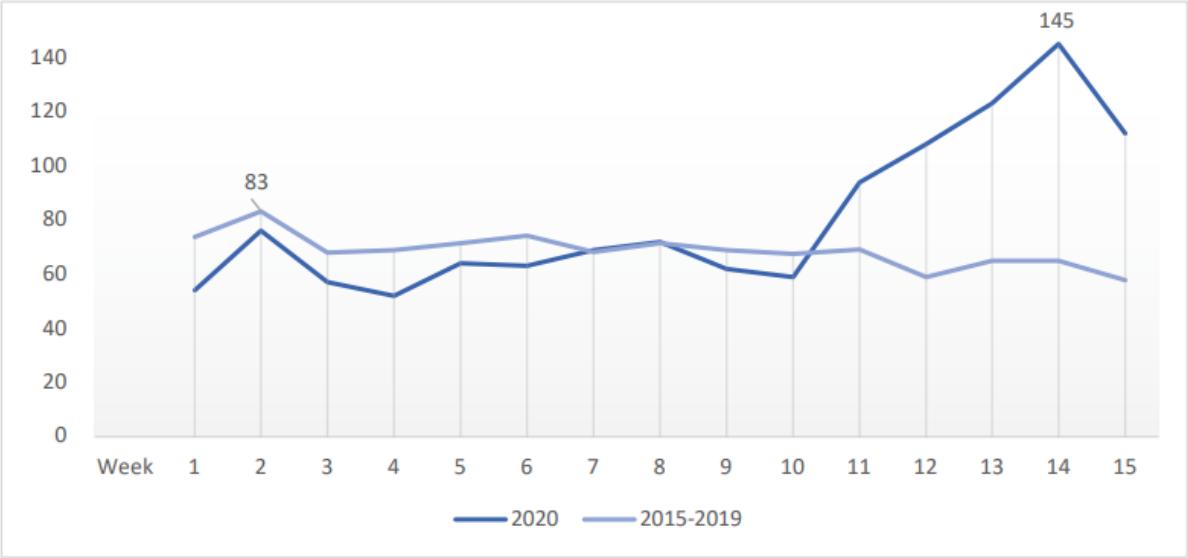
Figure 1.2: All-cause hospitalizations, among which cases accessing intensive care in Ticino over time.



Source: Dipartimento di Sanità e di Socialità, 2020 - *ICUs=Intensive care unit cases*

In Switzerland, the first death associated with COVID-19 was recorded on March 5th and, as of May 10th, the cumulated number of deceases equaled 1,538 (FOPH data, as of May 11th) (UFSP, 2020c). Figure 1.3 allows appraising the magnitude of COVID-19 mortality in Ticino by comparing all-cause mortality during the first 15 weeks of 2020 with the average mortality observed during the same period in the previous five years. The figure is based on data from the Federal Statistical Office (FSO) as of April 22nd. In Switzerland, and even more in the Canton of Ticino, there was an unusual increase in the number of all-cause deaths from week 11 onwards, reaching a peak in week 14 (March 30th – April 5th) and then starting to decline.

Figure 1.3: All-cause deaths in Ticino: 2020 vs. average 2015-2019

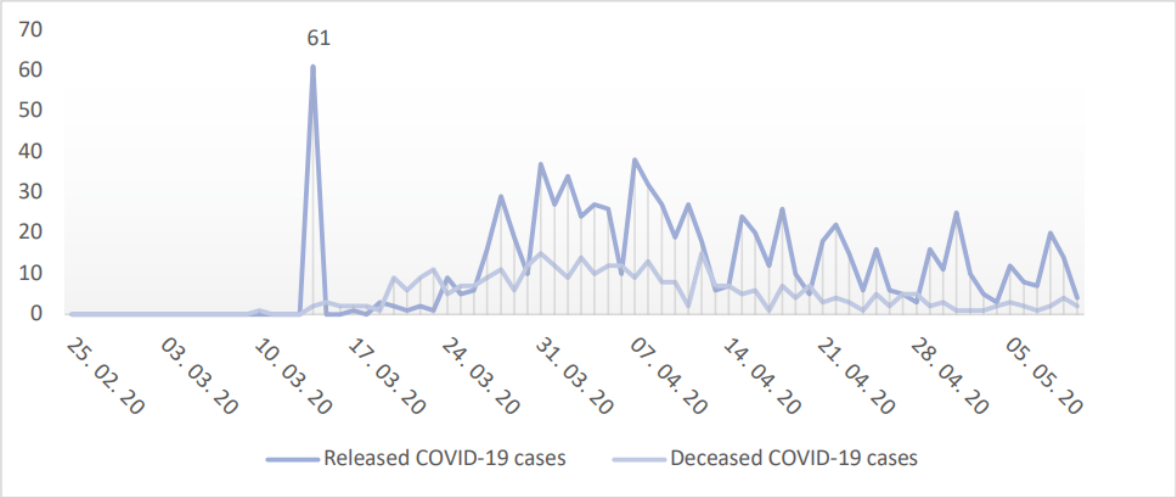


Source: Federal Office of Statistics

As far as the trend of the COVID-19 deceases in Switzerland is concerned, the peak was reached with 58 deaths on March 30th (5-6 days after the peak of positive cases). After this date, the figures started their fall albeit at a slower rate than their rise (FOPH data, as of May 11th) (UFSP, 2020c). According to the FOPH data on age- and sex-specific COVID-19 mortality rates in Switzerland (the number of cases per 100,000 inhabitants), overall men represented 58% of total deaths and the death rate was consistently higher for men than for women across all age groups.

Figure 1.4 shows the current released and deceased COVID-19 cases in Canton Ticino, as of May 10th, based on the data of the DSS.

Figure 1.4: Released and deceased COVID-19 cases in Ticino over time

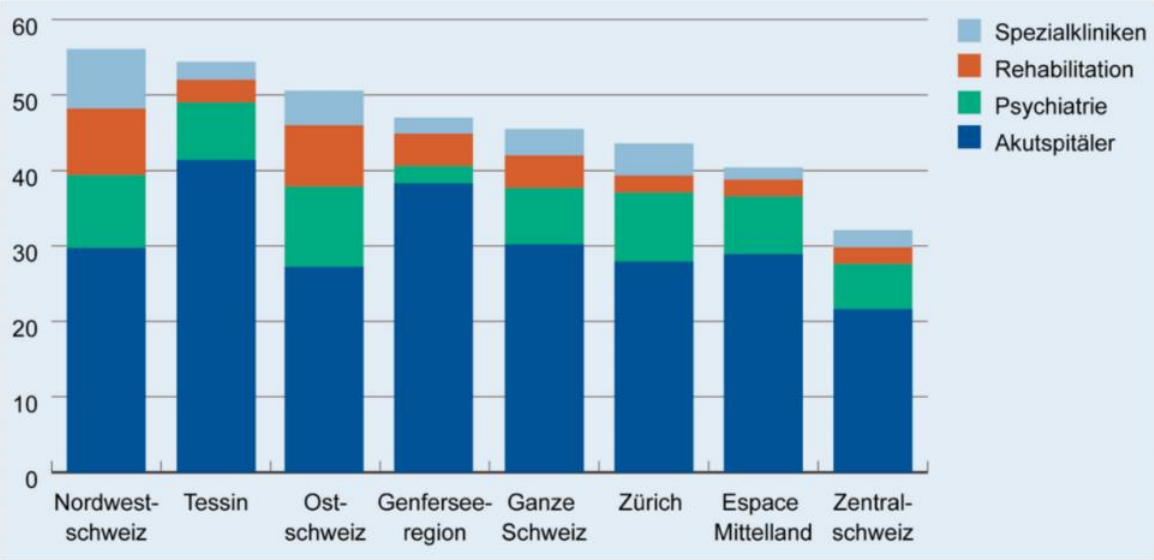


Source: Dipartimento di Sanità e di Socialità, 2020

1.1.3. Overview of the hospital system in Ticino

As shown in Figure 1.5, based on data from the Federal Statistical Office (FSO), Ticino is the second region in Switzerland with the highest number of hospital beds, with 54.4 beds per 10,000 inhabitants – following North-West Switzerland (with 56 beds per 10,000 inhabitants), while it scores first in terms of acute-care beds density (41.4), followed by the Lac Leman Region (38.3). The Canton of Ticino, moreover, scores second in terms of the average number of inhabitants served by an emergency service (59,000), compared with the Swiss average equal to 70,500 inhabitants (Hospital +, 2020).

Figure 1.5: Number of hospital beds by Region of Switzerland (per 10,000 inhabitants)



Source: Hospital + (2020) *"H+ Spital- und Klinik-Monitor", based on Federal Statistics Office 2015 data*

Another peculiarity of the delivery system of health services in Ticino is the fact that about 42% of beds are managed by private organizations (USTAT, 2017), while the Swiss average is slightly below 20% (OECD, 2006), which creates a relevant difference between the public and private sectors in Ticino. More specifically, there is one public multi-site hospital in Ticino: the Ente Ospedaliero Cantonale (EOC), consisting of some acute and rehabilitation structures. In addition, there are several private clinics providing acute or rehabilitation services. An updated list of the structures involved in the Cantonal planning is reported below and graphically illustrated in the map below (Figure 1.6):

- Ente Ospedaliero Cantonale (EOC), with the following hospital sites:
    - Ospedale Regionale di Bellinzona e Valli "San Giovanni", in Bellinzona
    - Ospedale Regionale di Locarno "La Carità", in Locarno
    - Ospedale Regionale di Bellinzona e Valli, in Faido
    - Ospedale Regionale di Bellinzona e Valli, in Acquarossa
    - Ospedale Regionale di Lugano "Civico", in Lugano

    - Ospedale Regionale di Lugano “Italiano”, in Lugano
    - Ospedale Regionale di Mendrisio “Beata Vergine”, in Mendrisio
    - Clinica di Riabilitazione EOC, in Novaggio and Faido
- Cardiocentro Ticino, in Lugano
- Clinica Luganese Moncucco, in Lugano
- Clinica Sant’Anna “Salus Medica”, in Sorengo
- Clinica Santa Chiara, in Locarno
- Ars Medica Clinic, in Gravesano
- Clinica Fondazione Giorgio Varini, in Orselina
- Ospedale Malcantonese, in Castelrotto
- Clinica Hildebrand “Centro di riabilitazione Brissago”, in Locarno

An important note regards the Cardiocentro Ticino, which has been an autonomous private non-profit organization specialized in cardiology since its establishment in Lugano in 1995. However, it has worked in strict collaboration with the EOC since the beginning. The buildings of the EOC hospital site “Civico” and Cardiocentro Ticino are adjacent and usually share the same entrance. In 2019, the EOC and the specialized center signed an agreement to define a common governance while ensuring clinical, management, and financial autonomy to Cardiocentro Ticino.

Figure 1.6: Map of Ticino Hospitals and Clinics

1.1.4. Scope and objective of the review

This rapid review aims to conduct an in-depth analysis of the response organized by the three providers of the cantonal hospital system that acted on the front line of the pandemic in the Canton of Ticino. More specifically, the study firstly addresses the rationale and the challenges of setting up a specific acute sector response at the cantonal level, involving several actors (public and private). Secondly, it analyzes the managerial response of the hospital management that has been confronted with different logistical challenges, highlighting similarities and differences emerging from the interviews.

1.2. Methods

This case study concerns an exceptional event, with a global magnitude never experienced by modern health systems before. In mid-April 2020, a first search of the literature focused on how health systems that had experienced epidemic outbreaks before had prepared hospitals to respond to those outbreaks or what hospitals that had faced epidemic outbreaks had learnt (using “outbreak”, “hospital”, “emergency”, “response”, “preparedness” as main search terms in academic databases such as PubMed, CINAHL, ScienceDirect). Overall, the search showed few results that would be relevant to the current pandemic, except for a few in-press contributions that were often characterized by either a clinical focus and/or sub-organizational perspectives (e.g., emergency service, pediatric department). Based on the little available literature and selected media news, it was decided to conduct semi-structured interviews with key informants of the hospital system in the Canton of Ticino. Key informants were recruited via a network of professional contacts that had been established over the past 20 years through an

executive education program in the healthcare sector at the University of Lugano, Ticino, Switzerland.[1]

Three case studies were developed based on the in-depth analysis of the interviews conducted with the management of three hospitals in Ticino: (1) Ospedale Regionale di Locarno; (2) Cardiocentro Ticino; (3) Clinica Luganese Moncucco. The interviews were conducted either face-to-face or virtually and occurred between May 15th and May 28th, 2020. In the first two organizations at least two researchers conducted inperson interviews with the General Director, the Medical Director, the Head of the Nursing Service, the responsible of the Psychological Service, and the Head of the Technical and Logistical Service. On average, the researchers dedicated about six hours of interviews (including the site visit) to each case at the first two organizations. The Clinica Luganese Moncucco allowed for a 75-minute virtual interview with the General Director, and later provided comments and additional information based on the case study draft received and specific questions aimed to foster comparability with the other two cases. All the interviews were type-recorded and transcribed within 72 hours after the interviews had been conducted. The three organizations received the predefined questions in advance – organized by topics – to prepare for the interviews. However, the researchers solicited further information during the interview, if deemed necessary.

During the period March-April 2020 the authors of the review constantly monitored the main local news media (main news outlets being: Corriere del Ticino, Regione, Ticinonline, Il Caffè) and the official websites of the Department of Health and Society (DSS) of the Canton of Ticino and the Federal Office of Public Health (FOPH). This allowed the researchers to reduce the

[1] Specifically, we refer to the Master of Advanced Studied "Net-MEGS" (www.net-megs.usi.ch)

information asymmetry with their interviewees and be able to ask for confirmation regarding unclear aspects of contradictory information.

1.3. Results

1.3.1. Ticino hospital system reconfiguration during the emergency

The hospital managers initially relied on the responsibility of the Federal Office of Public Health (FOPH) and the Cantonal Public Health Office ("Ufficio del Medico Cantonale") to provide guidelines on how to manage the threat of an epidemic and to detect cases. However, the situation changed with the first diagnosed case in Italy that had been transmitted within the country.

At the beginning of the emergency in Ticino (mid-February), the canton decided to dedicate the Italian hospital in Lugano, which is the smallest site of EOC to care for infected patients, using the EOC hospital "La Carità" (the EOC site in Locarno – hereafter ODL) as a buffer capacity structure. The Italian hospital is usually equipped with three intensive care beds, and the plan was to double its capacity to face the emergency. Meanwhile, the canton decided to maintain the Cardiocentro Ticino (CCT) as COVID-free center. This was intended as a strategy to preserve the only center for cardiopathic patients in Ticino, especially considering the risk of not being able to transfer any patient to Zurich (in fact, there were rumors about closing the Gotthard road tunnel, connecting Ticino with the German-speaking part of Switzerland, to tackle the epidemic). In this respect, rigorous rules about the usage of personal protection equipment to use were applied to all the people entering the CCT.

From February 20th till the beginning of March, the hospitals of Ticino autonomously started communicating to foster a coordinated response. Therefore, in this period, the response

basically followed a bottom-up approach, with the FOPH and the Cantonal Public Health Office hardly able to foresee the needed changes and consequently issuing clear decisions or guidelines. At the beginning of March, also based on the dramatic developments of the epidemic in Lombardy, the ODL was established as COVID center for the canton, with the Italian hospital in Lugano becoming a backup structure. All the necessary technology and personnel were moved from the EOC sites of Bellinzona and Mendrisio to the ODL, and all the ODL's non-COVID patients were transferred to the other EOC sites.

After two weeks, also the private hospital "Clinica Luganese Moncucco" (CLM) in Lugano became a COVID center, serving the "Sottoceneri" region[2], the Southern region of the canton, to deal with the risk of the ODL's capacity saturation. A week later, the CCT became a mixed structure (the only one in the canton) with two isolated patient pathways – COVID vs. non-COVID – and some of its intensive care professionals were temporarily transferred to ODL.

During the emergency (until April 27th) all non-urgent ambulatory and surgical activities were stopped, and external visitors were not allowed in the hospital, with exceptions for end-of-life patients and maternity cases.

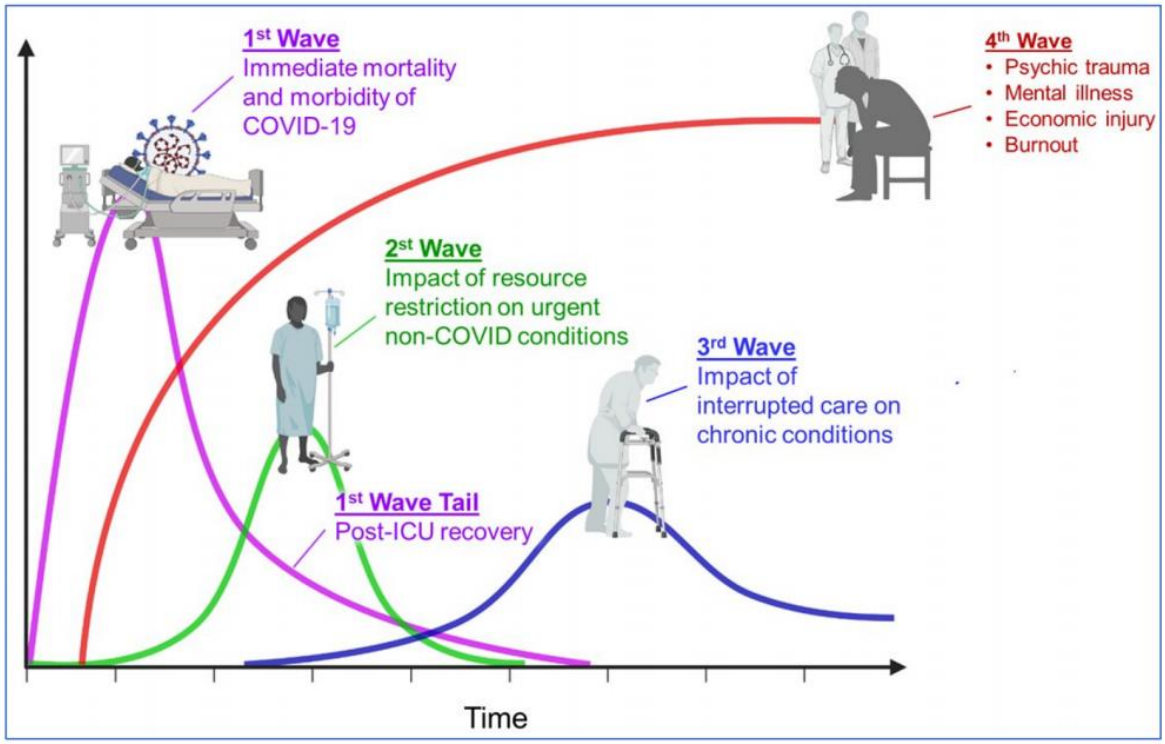
The logic behind the COVID-center's creation strategy relies on three main pragmatic points: (a) chances of intra-hospital outbreaks, which was not so far-off considering the news from the nearby Lombardy, Italy and which would have limited the structures of the cantonal system involved; (b) the concentration of technologies and personnel allows to take advantage of relevant economies of scale and learning; (c) the necessity of ensuring safe care to non-infected – or non-COVID – patients. The downside of such a strategy consisted of transferring

[2] The "Sottoceneri" is the region of Canton Ticino including the districts of Lugano, Mendrisio, and Chiasso.

professionals and patients to different hospital sites, which had to be in line with the professional needs and the epidemiologic compartmentalization.

The selected strategy aimed to cope with four "waves": an interpretative model of the pandemic is shown in Figure 1.7. The first wave consists of the morbidity and mortality of COVID-19, while the other three waves are aftershocks: (i) the resource restrictions on non-COVID urgent acute conditions (2nd wave); (ii) the impact of interrupted care of non-COVID chronic conditions (3rd wave); (iii) psychic trauma, mental illness, burnout, and more (4th wave). The reconfiguration of the hospital system was mainly intended to deal with the first and second wave, while the other two waves were to be addressed also with initiatives at the micro level.

Figure 1.7: Health footprint of the pandemic (four waves)



Source: Victor Tseng's Twitter post (on March 30th, 2020)

The COVID-19 patient care management was organized around 5+1 levels of care: (1) intensive care; (2) acute care; (3) "less-acute" care, including patients coming from the emergency service, those coming from the previous levels or those needing palliative care; (4) post-acute care – though the distinction between the third and fourth level is often not precise; (5) neurologic or pulmonary rehabilitation for those patients who are still in need of it; (6) recovery, for patients who still need to recover because they are fragile or are lacking a social network. The last level was mentioned by the media but could not be confirmed during the interviews. Transitions from one level to the other are not always sequential.

The major capacity building effort concerned the expansion of intensive care beds (level 1) and dedicating beds for COVID-19 cases requiring acute care (level 2). As the pandemic progressed, further levels of care were activated, involving both public and private structures. Table 1.2 summarizes the capacity dedicated to COVID-19 patients, with the first two levels reporting the values during the peak of the crisis.

The reorganization of the hospital system, with COVID-19 acute care beds concentrated in three centers, required a careful triage of all the citizens showing health needs during the emergency. On March 25th, four checkpoints opened (in Mendrisio, Agno, Lugano and in Giubiasco) and on April 6th, two additional centers opened (in Locarno and in the Tre Valli). Citizens could access checkpoints only via telephonic referral of the family doctor, the doctor on duty (Medico di picchetto), the Ticino General Practitioners Association's (Ordine dei Medici del Canton Ticino) hotline, any hospital's emergency service, the Alarm Station 144[3] (Centrale d'Allarme 144), or the first aid station (Guardia Medica).

[3] The Ticino Soccorso 144 is the alarm station of the Canton Ticino and the districs of Mesolcina and Calanca. It is active 365 days per year 24/7 for all health emergency situations.

Table 1.2: Capacity allocated during the emergency peak, by level of care

Structure	Level 1 (intensive care)	Level 2 (acute care)	Level 3 (less acute care)	Level 4 (post-acute care)	Level 5 (rehabilitation)
EOC-ODL (Covid center)	45+25*	180	*n.a.*		
EOC-CCT	6	10			
Clinic of Moncucco	30	200			
EOC-Italian hospital			80		
Clinic Santa Chiara			58		
EOC-Faido			70		
Clinic Malcantonese				(26)	
Clinic Ars Medica				(60)	
EOC-Novaggio					26
Clinic Hildebrand					32+9**

* Intermediate care beds, composing the so called "weaning unit" (see case study "La Carità" for details).
In brackets, reserve beds (not used during the emergency); In italic, private providers (anyone but EOC).
** Beds dedicated to tracheotomized patients requiring special clinical supervision.

The description of the temporary reconfiguration of the hospital system sheds light on the important role played by the collaboration between public and private providers for the effective response to the emergency. This emphasizes the relevant role of the private sector in the cantonal health system in Ticino. The collaboration initially involved the CLM in Lugano, a private hospital, as a buffer structure to prevent the saturation of ODL's beds capacity, especially to cope with the need of intensive care beds. Later also the CCT was activated to deal with cardiopathic patients, who represent a group of cases requiring the specialist care of the only cardiologic center in Ticino.

At the beginning of April, a project of home monitoring for COVID-19 patients was launched, allowing a real-time remote control of patients positively diagnosed but not hospitalized. The

project involves CCT, Fondazione Ticino Cuore, Ticino Soccorso 144, Clinica Luganese, Ordine dei Medici del Canton Ticino.

Table 1.3 provides a summary of the main changes regarding hospitals implemented in Ticino during the emergency.

Table 1.3: Timeline of measures implemented and loosened in Ticino hospitals

Date	Measures Implemented or Loosened in Ticino
1 March	• The ODL opens its activity to COVID-patients
6 March	• DDPS decree requiring hospitals to report on a daily basis the number of intensive-care beds
16 March	• The CLM opens its activity to COVID-patients
23 March	• The CCT opens its activity to COVID-patients
25 March	• Federal Council approves and extends the reorganization of Ticino's hospitals network • Opening of four checkpoints
30 March	• Hospitals reorganization enters into force
1 April	• Launch of project of home-monitoring
6 April	• Opening of two more checkpoints
15 April	• Clinica Luganese di Moncucco reopens its normal ER and inpatient activity (internal medicine, geriatric, oncology and immuno-reumatology)
20 April	• Clinica Luganese di Mocucco reopens its urgent orthopedic and surgery activity
27 April	• Beginning of Phase 2: Hospitals reopen elective surgery and outpatient activity, excluding Ospedale Italiano di Lugano and Ospedale La Carità di Locarno
4 May	• Cardiocentro closes COVID-19 department, leaving only five COVID-19 beds

1.3.2. Three cases of hospital response in Ticino

The COVID-19 pandemic forced hospitals to face the many new challenges associated with a lack of pre-existing scientific evidence and experience. Therefore, it is important to build preparedness by analyzing the actual responses of organizations, with the goal of defining strategies enabling to respond effectively to current and future crises, while maintaining essential services (Peiffer-Smadja et al., 2020). In this respect the Ticino's hospital system decided to undergo a considerable reorganization aimed to contain the dramatic effect of an eventual hospital outbreak, while protecting care capacity for non-infected patients. At the institutional and organizational level, several aspects deserve attention to understand the dynamics and overall effectiveness of the response:

- *The logistic requires relevant and prompt decisions.* Dedicating clinical spaces for COVID-19 patients plays a paramount role to reduce exposure risks among already vulnerable patient groups and helps allay fears about seeking needed services during the crisis. However, any space reorganization or improvement needs to be supplemented with clear communication to guide people through safe access to services, as well as appropriate screening, triage, and infection prevention and control strategies to reduce the chance of diffusing the pathogen (Krubiner C. et al., 2020).
- *The impact of the pandemic on the mental well-being of the healthcare workforce is a major concern.* Physicians, nurses, paramedics, and other healthcare workers could develop high rates of anxiety, depression, acute stress and, eventually, post-traumatic stress as a result of their experiences being at the front lines of the pandemic (Mock J., 2020; WHO, 2020).
- *The barriers imposed for safety reasons resulted in dramatic restrictions introduced for patients' relatives, with limitations (e.g. the use of personal protective equipment) or*

prohibitions of visits. This caused a surreal atmosphere, especially for palliative care and end-of-life situations, in which the presence of a family member next to the patients is paramount (Mercadante et al., 2020). Therefore, ensuring special support to patients and families is a relevant area of adaptation in time of a pandemic. In particular, hospital staff made impressive efforts to help families spend time together using technology (Anand P. & Sharpless J., 2020).

- *The effectiveness and rapidity of response (sometimes two aspects not easy to disentangle in the analyzed circumstances) might depend on social capital and trust, which play an important role in fostering collective and coordinated responses*. This is likely true at several levels (state, inter-organizational, community) (Knack, 2002; Wu et al., 2020) and might represent a contagious source of motivation for all the actors involved with different roles.
- Linked to the previous point, the *response capacity and the results are also grounded in the model of governance and inter-institutional cooperation*, such as public-private partnerships (Cepiku D. et al., 2020).

In the following three sub-sections, we present the case studies resulting from in-depth analyses of relevant experiences of hospitals on the front line of the pandemic. The narrative is mainly structured around the key aspect previously outlined.

1.3.3. Case study 1: Hospital "La Carità" of Locarno

Logistical and organizational changes

The ODL operated as COVID center from the beginning of March until mid-April 2020. In this period the hospital closed all non-COVID activities – including the Emergency Service[4]– except for few services, performed in a dedicated external structure, targeting non-COVID patients who could not postpone their treatments (e.g., ambulatory activities for patients in need of "life-saving" weekly infusions). Once the Canton of Ticino appointed the ODL as a cantonal COVID center, the hospital gradually transferred its non-COVID patients to the EOC hospital site of Bellinzona and converted all its specialist settings into internal medicine units, doubling the initial number of ward beds up to 200 (level 2: acute care), and created four additional ICUs (level 1: intensive care). Thus, increasing the number of ventilated beds by almost 1000%. These changes aimed at facing the expected surge in the number of people hospitalized due to the pandemic, foreseeing many cases with severe developments of the disease and a high mortality of patients admitted to the intensive care. The palliative care service also expanded its beds, which were placed in a dedicated area of the hospital, close to lounges set up for the meetings between the treating physicians and the relatives of those patients in very critical conditions.

This logistic reconfiguration required more space than the sum of all the existing wards. Therefore, additional space was created by moving the emergency service outside the hospital building, placing it in a new pavilion and leaving only one operating theatre active to cope with urgent surgeries potentially needed by hospitalized patients.

[4] Although a separate non-COVID service was arranged to care for emergency patients coming autonomously and avoid double transfers.

The ODL gynecologists moved to the Santa Chiara clinic, a local private hospital in Locarno, while other professionals were transferred to the EOC site of Bellinzona. The transfer of professionals and patients were the two main challenges associated with the creation of a cantonal COVID center. The hospital cafeteria was one of the first spaces prohibited to visitors, and seats were arranged to respect the safety distance between the personnel when eating.

The transformation of the hospital "La Carità" into a COVID center was a complex task. In the initial phase, in fact, differentiated COVID/non-COVID pathways had to change several times (e.g., in the Emergency Service) according to the rapidly changing number of COVID and non-COVID patients in the hospital.

Inventiveness and originality played a paramount role in creating new logistic solutions, due to the limited time and alternatives available. Often there were no operating alternatives, and it was often a process of "learning by doing", standards usually strictly respected had to be relaxed. An example is the creation of an external tent for the Emergency Service, whose infrastructure was continuously upgraded and improved. Another example concerned the newly set-up intensive care unit, not always equipped with isolated floors and other standard technical support devices.

Managerial approaches

The emergency situation was continuously generating practical problems and calling for constant coordination. Therefore, the management replaced the ordinary weekly meetings with three daily "open meetings" (at 8.15am, 11.45am and 4.45pm). The "open" qualification meant that: (a) the whole personnel was invited in order to have all the skills and knowledge available in a single place; (b) consecutive roundtables allowed anyone to ask or suggest anything considered relevant, with a shared rule of open-minded listening without judgement.

On average 70-100 people used to participate in each meeting. The meetings aimed at raising awareness about existing issues, foster creativity, and match any problem with an appropriate shared solution. It was inspired by the model of adhocracy (or flatarchy), meaning that each meeting involved a large number of people following few shared communication rules and disregarding hierarchic roles. The "flatness" allowed employees of any hyerarchical level to suggest new ideas also creating ad-hoc teams (e.g., the "pronation" teams further described). Minutes of the discussions were always taken during the meetings, and the decisions were quickly shared via email. A peculiar aspect emphasizing the importance of communication consisted of the adoption of a more direct and efficient communication style. For instance, when an employee called a colleague by phone, she/he did not start the conversation with greetings or excuses for interrupting in order to save precious seconds and get straight to the point.

In addition to the internal communication, the ODL established daily meetings with the Clinica Luganese Moncucco (CLM) and with the EOC Crisis Cell ("Cellula di Crisi"). The meetings with the CLM became routine more quickly than the meetings with the EOC Crisis Cell, because of an initial struggle regarding the managerial style in the EOC. The EOC expected that the ODL executed top-down decisions, for the sake of efficiency and timeliness, while ODL expected a participatory approach to decisions (based on a direct exchange of information and experiences to exploit the inherent flexibility of a multi-site hospital). In this respect, the ODL's management reported that they were missing a close link with key actors of the Ticino's health system during the first two weeks of the emergency. This aspect, in particular, was perceived as a barrier to share a sense of urgency to take decisions and act at a pace coherent with the illness' speed, as experienced daily. Therefore, ODL's management decided to meet in person with the EOC Crisis Cell, the CLM in Lugano, the EOC site in Bellinzona, and so forth. These

initial meetings were opportunities to share personal experiences and perceptions, including the aforementioned sense of urgency often interpreted as panic by external stakeholders (e.g., public authorities or hospitals in other cantons). This initial situation of misalignment also had implications regarding the definition of a common ethical framework to cope with a scenario of capacity shortage (as explained in more detail further down below).

Equipment and new operating solutions

The EOC centrally managed the procurement of medical equipment (e.g., personal protective equipment), and the transfer of technologies and personnel. In particular, the EOC Direction managed the coordination with the Confederation, the army and the Civil Protection. In this respect, the ODL's management reported satisfaction in terms of both quantity and timing. However, when the Swiss oxygen suppliers and wholesalers of oxygen ran out of inventory, as a result of the high demand, the ODL had to sort out solutions in collaborations with other hospitals, which supplied the ODL with their own inventories. When even those inventories turned out to be insufficient, the ODL's technical service staff visited non-COVID hospitals to personally ask for further rationing of the stocks already in use in their wards and transfer all the oxygen not strictly necessary to the ODL.

A relevant innovative solution coming out from the aforementioned daily "open meetings" was the setting up of 25 beds equipped with home fans where patients discharged from intensive care (level 1) could more quickly recover and be moved to the acute care ward (level 2). Such patients had to undergo a tracheotomy, but their recovery time was reduced from four to two-three weeks, with consequent positive impact on the intensive care beds turnover. The innovation – called "weaning unit" by the personnel – resulted from the opportunity of sharing knowledge and skills practiced by some professionals abroad.

Human resources management

When the ODL became a COVID center, the operating model became 24h/24h 7/7, with shifts extended to 12 hours each and no differentiation in terms of patient-professional ratio for either nights or weekends.

The personnel expanded from about 900 to 1,400 full time equivalents (FTEs), with about 150 professionals transferred from other EOC hospital sites and all part-time employees and collaborators temporarily employed full-time to provide the necessary support in the ODL. However, a critical threat was presented by the fact that a relevant proportion of the personnel consisted of foreign professionals residing in Italy (cross-border workers, locally called "frontalieri"). Motivating those people to remain in Ticino during the crisis – temporarily leaving their families in Italy – was a necessary condition for any sustainable response to the pandemic.

Therefore, the ODL offered them to pay for their accommodation, an additional contract compensating for their stay during their free time (including holidays), and a monthly allowance. Conditioned on the fact that Italy did not call up its residents to support its overwhelmed health system. Many of those employees accepted and the organization expressed gratitude for their generous availability. The ODL also provided its whole staff with several supporting initiatives, as further explained in detail.

The middle management reported that all the aforementioned drastic changes did not cause resistance among the personnel. On the contrary, employees often showed willingness to go beyond the requests because of an emerging strong call for cooperation to achieve a "common goal". This was common also among workers coming from different hospitals and settings who never worked together or in the ODL.

The personnel working in the logistics, supported the nurses as much as possible when deaths occurred and rooms had to be sanitized. This was usually a nursing staff's task, but the exceptional workload generated by the crisis led people to do their best to "let the nurses do the nurses". This meant expanded work shifts for the cleaning service too, but it was commonly interpreted as an opportunity to make a difference toward a common goal. When the hospital restarted admitting non-COVID patients, the expanded shifts were also useful to support the radiology department for the sanitization process of the only CT scan equipment that had to be used for both COVID and non-COVID patients.

The top management decided not to employ soldiers in the direct patient management. However, 5-6 soldiers have been employed to support auxiliary services: the logistic unit in the hotel management (supporting the management of accommodations for all the collaborators coming from other hospitals and for the employees of the ODL who stopped commuting during the emergency), the laundry department, the waste management, and also the kitchen and the cafeteria.

Supporting initiatives for the personnel

The ODL's management cared about providing its personnel with both psychological support and well-being services to alleviate their stress and establish an empathic relationship of mutual support. These two initiatives were considered complimentary, though they showed a different level of participation from the personnel.

When the ODL started to transform into a COVID-center, the General Director, together with the Medical Director and the Head of the nursing service, discussed with the psychologist of the geriatric area the need to provide psychological support to the whole staff, not only to physicians and nurses but also to administrative, housekeeping and technical staff. The

psychologist agreed with the idea and made himself available to hold meetings on request. The management sent a short message via email to raise staff's awareness about the unpredictable emotional impact that the situation could have on them, with an invitation to contact the psychologist in case of need.

During the following two weeks, there were few requests. Therefore, the psychologist, together with the Head of the nursing service, introduced himself to the staff of those wards where he was not well-know and informed all the teams about the availability of a psychological support service. The psychologist realized that the personnel, while recognizing the importance of such support, was eager to go home and rest once finished with their professional duties because of the cumulated stress. After those two weeks, the General Director decided that it was necessary to propose more practical activities concerning self-care and personal well-being. This led to the implementation of the SoStare project, integrating well-being and psychologic support as described in the box below.

The SoStare project

The SoStare project was an idea based on the literature and information from China and Italy, and it relied on the belief that, during an emergency situation, even more important than receiving a psychological support, is the opportunity for employees to get back to normality and foster awareness of their body and pleasant sensations. Therefore, the management of the ODL decided to provide employees with activities concerning self-care and personal well-being on top of the psychological support. In a week, almost twenty new collaborators (including psychologists, osteopaths, hairdressers, a massage therapist, and a chromotherapist) joined the SoStare project, followed by staff from the traditional Chinese medicine. Professionals were selected based on their skills and willingness to serve, providing them with a temporary contract so that services were free for the staff of the ODL. To benefit from these services, people had to call and book. Every Friday the SoStare schedule for the following week was published. The demand was extremely large, and

services were highly appreciated by both the staff who already worked in the ODL and the staff coming from the other EOC hospital sites.

The east wing of the first floor of the hospital was dedicated to the SoStare services, that were provided in four workstations: two for massages, osteopathy, etc., one for hairdressing, and one for psychological support. In addition, one room was filled with deck chairs where collaborators could come to rest. There was also an atrium with colored sofas, one plant, a coffee machine, and one computer. The kitchen regularly provided drinks, snacks, and lots of sweets, chocolates, and biscuits (received as gifts from people and shops outside the hospital). In this space the staff regularly came to relax during breaks, and it represented an opportunity to meet, chat, and have a "little island" of normality in the midst of the crisis. In the meantime, several requests for psychological support arrived also thanks to the psychologists' rounds around the different wards. The housekeeping team, then followed by other professional teams, was the first to benefit from this service. The main aim of the group meetings was to allow the participants to reflect and take full consciousness of the experience of the emergency. There were also occasional requests from particularly frightened or worried patients and meetings with patients' relatives, although the palliative care staff was mainly responsible for them.

Once a week a one-hour video conference was held among all the psychologists to coordinate their activities, and meetings were also organized between the ODL's psychologists and the other SoStare's project collaborators (hairdressers, massage therapist, etc.). These meetings aimed at dealing with the fact that they were not used to work in a context of suffering. During the first days of the emergency, all the people who had a managerial role within the ODL (team leaders, coordinators, middle managers, etc.) were quite fatigued not only because of the situation but also because of the load of responsibility for their teams. In general, the problems most frequently identified were burnout, anxiety, insomnia, nightmares, fear of getting sick and not being able to perform professional duties. Later, as the pace of work decreased and physical fatigue fell upon the people, many of them felt sadness, fear, and anger.

Most of the requests for psychological support came from nurses, domestic staff, and nursing assistants. The administrative staff also asked for support, as they were under stress since they were the ones who had to timely formalize contracts, look for housing, etc. in a very short time. Medical students and training nurses also received support. The professional figures who made the least use of the service were the physicians. Once the critical period was over, a psychologist stayed in the hospital for a few more weeks to listen to the requests for support and help to elaborate the psychological problems still present in some people (anxiety, insomnia, etc.).

Overall, the SoStare project lasted seven weeks and reached 120-150 average weekly activities. Whatever service was offered, it was likely taken. The only service that did not always go overbooked was the psychological support. One of the few criticisms that the psychologists received concerned that people would have liked psychologists to be in the ward since the beginning of the crisis, instead of having to look for their support.

Palliative care and family support

Among the professionals transferred to the ODL from other EOC hospital sites was the medical nursing team from the EOC Palliative Care Clinic. The palliative care service was an important element for appropriately managing end-of-life cases, working closely with the team of intensive care and internal medicine specialists to provide the best psychosocial and spiritual support to patients and their relatives. Two physicians and two nurses specialized in palliative care, three chaplains and two spiritual assistants were involved in providing palliative care to COVID patients. There were meetings between physicians and patients' relatives, organized in dedicated lounges, aimed to foster human touch when explaining the situation, thus "accompanying" patients' families toward the foreseen end-of-life. During the meetings, physicians were always supported by the staff of the palliative care service. In addition,

everyday patients' families were informed by phone about the patients' health status or, eventually, her/his decease.

Another task of the palliative care team consisted of timely organizing the meetings with family members for patients whose health conditions worsened after their hospitalization (in compliance with the visitors' strict personal protection measures) and required intensive care. In such cases, before the patients' admission to the intensive care (where relatives could not access), their relatives were allowed to greet them. Similar meetings were organized when, for various reasons, admitting patients to intensive care was considered a therapeutic obstinacy, thus allowing the families to come for a last farewell. In these circumstances, chaplains and spiritual assistants played a very important role in providing comfort and listening to the patients and their relatives. For any meeting, the family members were guided to the patient's room with a spiritual assistant or a chaplain and a palliative care nurse (no more than two visitors at a time) and always assisted to wear the protective equipment before entering the ward.

Visits were not allowed in the "weaning unit", except for end-of-life situations. Nevertheless, there was constant attention to create a familiar environment by surrounding patients' bed with different personal belongings (e.g., photos, letters, postcards). In addition, the palliative care team facilitated video calls between the patient and the family whenever possible.

In the lack of specific guidelines to deal with the emergency situation, the palliative care team, together with the internal medicine specialists, created an assessment tool called '3D-TiCoS'. This tool aimed at identifying fragile patients with different comorbidities who would receive conservative, palliative or end-of-life care. It supported physicians' decisions to take in charge patients who were not candidates for intensive care.

Ethical aspects

Initially, the ODL's management perceived a different level of awareness about the extent of the emergency, both within its own personnel and compared with external subjects. The Medical Director reported such discrepancy in the perception of emergency when contacting his colleagues working in other cantons, especially at the beginning of the emergency.

This worried the management also in relation to the eventual necessity of adapting the care standard in case of a shortage of the hospital's intensive care capacity. They needed reference criteria from a higher-level authority to cope with a possible shortage of capacities. As for other matters, the adopted strategy consisted of intensifying contacts with external stakeholders, including in the private healthcare sector in Ticino, as well as with the healthcare sector in Italy (where the awareness regarding the potential ethical problems due to the emergency situation was higher due to the worse epidemiologic situation), and with scientific societies in Switzerland in order to push the topic at the national decision-making level.

The networking activities were followed by a national decision from the Swiss Academy of Medical Sciences regarding common ethical guidelines to cope with the necessity of adapting the standard according to the level of pressure over medical capacity, and the eventual necessity of rationing healthcare services. However, the ODL's management did not report the occurrence of any intensive care rationing during the crisis.

Social capital: trust and community engagement

The local population as a whole and the voluntary associations in particular, showed willingness to help. However, especially considering the average age of the volunteers, they

could not access the hospital for safety reasons. In fact, the canton issued a regulation forbidding non-professional subjects to work or volunteer within the hospitals.

Nevertheless, several interviewees mentioned that the local community represented a source of material and emotional support during the health emergency. Evidence of such support were the daily donations (such as food and other sorts of presents) received by the ODL during that period. Moreover, a point that has been stressed as being very relevant in managing of the emergency was the role that informal social networks played. Without personal connections and contacts some urgent and practical tasks would have unlikely been carried out. One simple example concerns the additional personal lockers that had to be found for the workers transferred to ODL from other hospitals, in order to provide all of them with the necessary space to store their belongings. Since all shops were closed and it was hard to find short-time solutions, the ODL's logistic service managed to find 60 lockers from the Sport Center of Locarno and the padlocks of the lockers from a hardware store in the surroundings, via personal contacts.

Discussion

The case of the ODL emphasizes some relevant aspects worth of further discussion.

First, the institutionalization of public-private collaborations was an effective mean to face the emergency[5]. In the reconfiguration of the cantonal hospital system during the emergency, the leading providers (such as the ODL) initially relied on the informal relations of their top managers and on a peer-to-peer intense professional exchange of information with other

[5] See pages 14-15 for a list of private and public hospitals in Ticino.

hospitals. Later, the reconfiguration was institutionalized by the canton to formalize roles and stabilize mutual expectations.

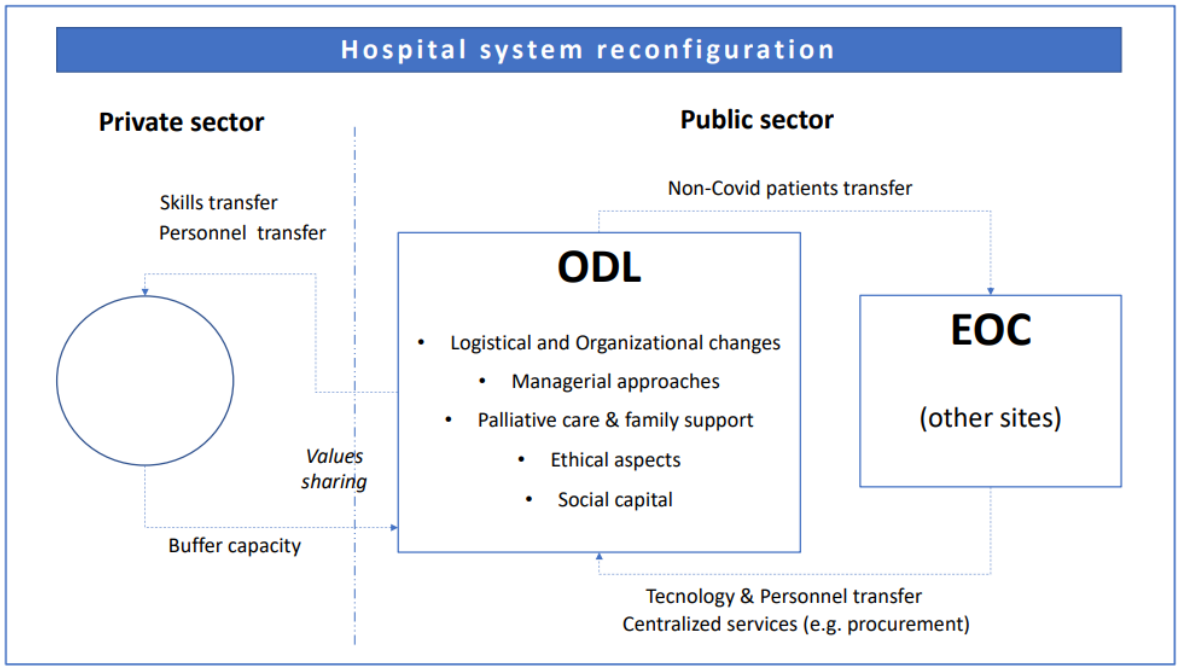
Second, the experience of the ODL highlights the potential of operating in a context of intra- and inter-organizational cooperation, as summarized in Figure 1.8. As far as the intra-organizational relationships are concerned, the compartmentalization of COVID patients in the ODL, which required a coordinated transfer of patients across the different EOC hospital sites and a concentration of all the medical technologies and professionals, resulted in an efficient management of the intensive care (level 1) and acute care (level 2) beds dedicated to COVID patients. As far as the inter-organizational relationships are concerned, the sharing of knowledge and practices between the OLD and the other public and private hospitals fostered the appropriate care of patients across the structures designated to treat COVID cases. In addition, the sharing of values of the ODL's top management with other structures, such as other EOC sites as well as other private structures, in particular the Cardiocentro Ticino and the Clinica Luganese di Moncucco was the premise to set common ethical principles to stimulate an official statement from higher-level authorities to cope with the potential need to adapt the standards of care in case of shortage of capacities. Finally, at the EOC level, the centralization of certain services might have played a strategic role to effectively cope with, for instance, the procurement challenges that occurred during the emergency.

In addition, the effectiveness of the logistical and organizational response of the ODL was complemented by bottom-up internal communication flows, as well as by a certain level of inventiveness and originality, both resulting from the more direct and efficient communication style adopted on a daily basis. Further, the relevant increase of human resources in the ODL and their strong commitment played a crucial role in the achievement of the overall organizational

response. Such commitment was likely fostered by the significant effort of the ODL's management to care for its personnel (e.g., the SoStare project) during the emergency.

Finallly, the local community played an important role as a source of material and emotional support during the health emergency.

Figure 1.8: ODL's role and relationships in the hospital system of Ticino



In general, the adaptation process to the emergency has been defined (or described) as being "fluid" in different interviews, as priorities and objectives were requiring continuous adjustment over time, following a "learning by doing approach". In this respect, the managerial approaches adopted, the preexisting assets of personal relationships among key actors, and the diffuse feeling of a shared responsibility toward a common goal played an important role.

The fact that there were no deaths among hospital professionals during the emergency and that the infection rate among the hospitals' personnel was aligned with the Swiss average (5-

6%) may be considered an indicator of the effective implementation of good personal protection practices during the emergency.

1.3.4. Case study 2: Cardiocentro Ticino

Logistical and organizational changes

A few weeks after the outbreak of the pandemic, the initial decision of not involving the Cardiocentro Ticino (CCT) in managing COVID cases changed because of the need to care for infected cardiopathic patients. From the beginning of the emergency, those patients had been treated either by the ODL or the CLM. The CCT did not operate as a *pure* COVID center, as it maintained its ordinary services for non-COVID patients, though completely separated from the services dedicated to infected patients. In fact, the CCT's building consists of two floors and the infrastructure is designed and equipped to activate the ventilation and constant monitoring of patients in any room. On March 18th, after a careful evaluation, the CCT decided to dedicate the second floor to COVID patients and isolated that space from the rest of the hospital, to minimize the risk of contamination. This has been possible by rearranging offices, dedicating one elevator to the personnel caring for COVID patients, and in general reorganizing the hospital processes and flows by isolating COVID patients and personnel from their non-COVID counterpart.

As a matter of fact, it would have been more convenient to manage the COVID-related activities on the first floor, where ordinary hospital activities take place and the ICUs are available. However, this would have prevented a strict isolation of COVID patient flows, leading to potential issues of contamination. The Technical Service was able to create pressure differentiations between rooms, corridors and the nursing stations. Yellow and red zones were defined, the red ones being the patient's room where no one could enter unless properly

equipped with masks, gowns' covers and other personal protection means, while the yellow zones being the corridor, where the nurses would get dressed and undress to get in/out of the red zone. The greatest risk laid in the exit, especially because the space of the clinic did not allow the creation of appropriate "middle-spaces" between the red zone and the rest of the space. However, as recommended by EONOSO (Infection Prevention and Personnel Medicine Service), all the procedures were implemented in the most rigorous way coherent with the characteristics of the clinic (bypassing rules only if strictly necessary). Despite the lack of "middlespaces", the CCT was able to implement a rooms-depressurization system– for which effectiveness was validated throught a technical test using smokes.

An additional change was implemented to foster isolation. In normal conditions, the CCT and hospital "Civico" (ORL) are adjacent and connected by means of a corridor, thus sharing the main entrance. During the outbreak, as the ORL was a non-COVID hospital, the CCT decided to use a different entrance and created a tent dedicated to the triage of its personnel, to avoid overcrowding and the consequent risk of contaminations.

Finally, specific changing rooms along with specific offices were set up for the COVID personnel, and the spaces formerly used as waiting rooms were transformed into storage areas. In particular, the staff of Technical Service, who used to work in a single office (with four people), was split in two separate offices (with two people each), as an additional protective measure aimed to ensure that one couple would stay healthy should someone of the other group fall sick. Before opening the COVID ward, a meeting was organized with a delegation of the ODL' Crisis Cell, who made a site visit to share information for the safety and protection of collaborators and patients that was based on their experience. For instance, when the Technical Service of the CCT met its counterpart from the ODL, the ODL suggested the CCT to install cameras and baby-control systems as a means of supervising the COVID patient from outside

the room. Considering the high risk in entering the rooms, such solutions proved to be very cost-effective because it enabled both a visual and an audio supervision of the patients, as well as an active communication with the patient when necessary.

The staff of the CCT completed all the logistical changes in a few days, with the COVID ward ready by March 23rd: six intensive care beds (ventilated) in three rooms, six beds for intermediate care in another three rooms, and two further rooms for suspected COVID patients waiting for the results of the diagnostic test. The new logistical configuration, with two ICUs (COVID vs. non-COVID) lasted till the beginning of May without ever reaching a saturation of the capacity. Therefore, during this period, a few non-cardiopathic patients in serious conditions were transferred to the CCT from the ORL, instead of transferring them to a COVID center.

In contrast to what was reported by the ODL, which stressed the importance of creativity in enabling a timely response to the crisis, the CCT instead emphasized a strong focus on the importance of logic, followed by technical knowledge and the pursuit of clearly defined objectives.

Managerial approaches

From February 15th to16th, the CCT (and EOC) started developing management guidelines for COVID patients because about 50% of the CCT activities were emergency cases, for which time represented a critical life-saving factor. The guidelines became official on February 21st.

During the following weekend, news about the outbreak in the Codogno hospital (in Lombardy, Italy) reached the EOC management and the reconfiguration of the hospital system in Ticino changed. To cope with the emergency, the CCT created a Crisis Cell composed of four members:

the Executive Director, the Medical Director, the Head of the Nursing Staff and the Head of the Technical Service and Safety Group (each one with a designated substitute). The Crisis Cell held a meeting on a regular basis (every Monday) to share updated information about the pandemic situation and to make decisions. All the decisions resulted from the close interactions with the Crisis Cell of the EOC – where the CCT General Director was personally involved – and the Crisis Cell of the CLM (interactions with the latter regarded mainly as an opportunity of transferring specific cases).

The second phase (from April 27th) was more challenging than the initial phase of the pandemic. While during the crisis all the personnel looked for top-down decisions – perhaps as it was an unknown situation – the easing of the restrictions also required a communication effort to set clear (weekly or daily) steps to ensure a prudent re-opening of the activities (e.g., limited number of daily visits, surgical interventions). This period lasted about three weeks and the top management experienced several pressures to quicken the re-opening process. In particular, professionals had to ensure observable outcomes (i.e., avoidance of waiting rooms, constant respect of social distance, enhanced hygiene) while providing ambulatory care. At the end of May, volumes were close to the pre-crisis levels (during the two months of crisis the CCT worked at 50% of the ordinary level with an estimated loss of 10% of the revenues)[6].

The preparedness for a further emergency is currently (as of May 2020) based on the constant availability of one isolated intensive care room and an architectural change aimed to enable the prompt isolation of two rooms (as the equipment used for the COVID ward is already available and ready for a rapid re-set-up of a COVID-area (in practice, it would take less than the officially granted 48 hours). In addition, the second floor is going to be modified – in terms of

[6] Note: the reimbursement (Swiss-DRG) for COVID patients is not different from ordinary cases.

architecture and equipment – to enable the creation of an isolated ward with a capacity proportional to the actual needs (i.e., not necessarily the whole floor) and with two isolated nursing stations. By the end of June, this investment will allow, if needed, the recreation of the described emergency logistic configuration in 48 hours, eventually without any interference with the non-COVID activities. In addition, the CCT is going to eliminate the tent for the triage of the personnel and install thermo-scanners at the entrance. A second measurement would be undergone in case of a first high-temperature positive result and in case of a positive second measurement, a phone to call to the staff in charge of undertaking a manual measurement would eventually verify whether the person can or cannot actually access the hospital. Finally, another ongoing change consists of the installation of mask dispensers in strategic places of the building, as their prompt distribution was experienced to be a challenge especially for external people.

Equipment and new operating solutions

The logistical changes described were facilitated by the recent dismantling and substitution of some machinery. This allowed the Technical Service to requalify and put some equipment back into operation very quickly. In fact, the presence of machines in stock saved a lot of time, considering the difficulty to find ventilators during the emergency.

Retrieving materials other than the machineries, on the other hand, was reported as very challenging because such, at the time, rare items were being requested by many clinics simultaneously and receiving such supplies could even take months.

For the safety of the CCT's personnel and of people transitioning out of the building, a cheap but effective method was implemented to make sure that the air expelled from the patients' rooms would be filtered, thus avoiding the expulsion of infectious pathogens. Specifically, the

CCT adopted the same filters used for SARS some years before to clean the air pushed outside the red zone spaces. In this respect, the CCT did not report cases of infections among the nursing staff.

Access to newly developed safety guidelines was made easy by publishing them in a dedicated section of the CCT's intranet, which became a reference point for the personnel.

Human resources management

On March 7th, there were rumors about the possibility that borders could close. This would have meant a serious shortage of clinical personnel. The top management estimated the financial effort to ensure an at least one-month availability of the personnel (e.g., accommodation) needed for the operation of the hospital. Already before midnight on the same day, all necessary professionals who were residing in Italy were moved to Ticino. The personnel were accommodated in a four-star hotel during the whole emergency. All the personnel gained access for smart working and was invited to conduct at home all the activities that did not require physical presence at the CCT (e.g., typewriting documents, research). This measure was intended to reduce the risk of contagion among the personnel. From the beginning of the pandemic, the CCT decided to maintain the eight-hour shifts during the whole crisis period to avoid excessive workload. This was intended as an approach to limit the stress for the personnel already facing unusual and challenging circumstances.

Initially, the nursing staff showed some resistance to work in the COVID ward, due to the contrasting messages and images coming from abroad. The Cell Crisis decided not to force nursing personnel's decision in this respect: each nurse could voluntarily choose to serve on the COVID ward. However, over the course of the emergency, attitudes changed, and many staff members provided their proactive contribution (even for a whole month), despite the initial

fear of working with patients infected by the new disease. There was such a strong commitment that some staff had to be excluded. In total, around 40 to 50 nurses worked in the COVID ward during the emergency. It was reported that what made nursing staff choose to serve on the COVID ward was a kind of pride to be able to engage in the emergency activities and to learn the new procedures to take care of COVID patients.

Some nurses (e.g. medical practice assistants) were trained to support the ICUs, while some physicians who could not perform their ambulatory activities were either involved in the CCT emergency operations or transferred to the ODL. The training was based on the CCT's pre-existing networks with Swiss professional societies (e.g. SWISSNOSO) and small internal groups engaging in training activities (e.g., during the crisis there were repeated training sessions on the use of personal protection equipment or handwashing). For these activities the CCT took advantage of the ODL's experience in the previous two weeks. In fact, a CCT delegation went to Locarno in order to learn from the experience of the EOC COVID center, also recording practical procedures.

The CCT also transferred some of its skilled personnel to the ODL: specifically, two intensive care nurses and two intensive care physicians. This decision was based on the top-down information from the cantonal Crisis Cell to ensure overall coordination of resources across the hospitals. In particular, the medical specialization of the CCT made a naturally available abundance of skilled professionals dedicated to the care of COVID patients.

Supporting initiatives for the personnel

The need for psychological support for the personnel was not underestimated by the CCT Crisis Cell. When the COVID ward opened, an internal "Psychological Emergency Service" was set up for the personnel in collaboration with the cardio-psychotherapy service of the CCT.

The service consisted of one CCT counselor and one psychologist. Although it was addressed to the staff, it was also available for patients (COVID and non-COVID) and their relatives. Because of the emergency and risk of contagion, psychological support to the person/s requesting help was given through telephone calls. As a matter of fact, not many personnel's requests for support were reported.

Palliative care and family support

During the emergency, patients could not welcome visitors due to the rigid safety policy. Therefore, the CCT made several tablets available in all the wards, including the COVID ward. By using the tablets, patients could receive "virtual visits" from their relatives. This initiative was highly appreciated and allowed families to feel closer to their loved ones though remotely.

Exceptionally, in some end-of-life cases, the CCT patients could receive a visit from one of their closest relatives. However, there were also people who preferred to see their loved ones through the new technology since they worried about the risk of infecting someone.

In this respect, according to the CCT's nursing personnel, the health emergency highlighted the importance of discussing in advance people's end-of-life wishes.

Social capital: trust and community engagement

In the canton of Ticino physicians, nurses, and other front-line healthcare workers were celebrated as heroes during the COVID pandemic. During the health emergency, citizens and institutions constantly showed acts of kindness and solidarity towards the CCT staff, who benefited of little gifts, as well as gastronomic and other in-kind donations. In addition, priceless gestures of closeness helped the staff to perceive the situation as more bearable. The

CCT has used social media and its own official website to publicly thank all the community (Rusconi, 2020).

Discussion

During the emergency, the investments into infrastructure were rather low, compared to the other two COVID centers. However, the CCT made ex-post investments to prepare for eventual further pandemics.

The serious problems in finding personal protection equipment, especially considering the market prices during the emergency, emphasized the importance of reviewing inventory management practices in hospitals. In fact, ordinarily, inventory stocks are managed mainly to foster efficiency, at the expenses of safety in case of unexpected market conditions.

Like the ODL, also the CCT operated in a context of intra- and inter-organizational cooperation. Its recent agreement with the EOC made this private organization, on the one hand, closely linked to the public hospital and, on the other hand, still allowed it to take autonomous decisions. The involvement of the CCT's General Director in the EOC Crisis Cell, the transfer of highly skilled personnel and the close interaction with the ODL were signs of the strategic and operational alignment of the two management coalitions.

1.3.5. Case study 3: Clinica Luganese Moncucco

Logistical and organizational changes

The Clinica Luganese Moncucco (CLM) was a designated COVID center from mid-March until mid-April 2020. In this period the hospital closed all non-COVID activities including the ER, except for a few services targeting non-COVID patients who could not postpone their

treatments (namely, oncology, geriatrics, neurology, radiotherapy, cardiology and urology). The non-COVID activities ran at 20-30% of the normal level and were performed in a specific block ("Blocco B"), while COVID patients were located in a separate block ("Blocco A"). As far as the emergency service is concerned, an external triage had been set up in the ambulance hangar. The space was split into a checkpoint aimed to triage COVID-patients and an area where the ambulance could stop. In addition, they extended the opening hours of the emergency service from 7-22h/7 to 24h/7.

The initial plan consisted of converting CLM into a COVID center around March 21st. The management decided to reorganize all the activities in few days (the decision was taken on March 12th and fully implemented four days later, when the first COVID patient was admitted around noon). The conversion required accelerating some discharges and transferring some patients to other private clinics or to the EOC. The decision aimed at supporting the ODL that was saturating its maxiumum capacity, considering the ongoing epidemiological developments. With neither a federal directive assigning them to the role of a COVID center nor clarifications on what such a change would have meant financially, on March 16th the CLM activated four COVID wards, redefining the normal activities by merging, from a clinical and organizational point of view, the usually separated internal medicines (geriatrics, cardiology and reumathology) into a unique multidisciplinary context. Such a redefinition also concerned the internal medicine personnel which was complemented by the arrival of external specialists (i.e., pneumology and nephrology). This way the CLM has been able to increase the number of intensive care beds from six to 30.

During the peak of the emergency, the CLM provided intensive care for 23 to 24 patients. In case of necessity, they could have managed up to 30 to 32 intensive care beds (or 34 to 36 but with some compromises in terms of quality of care). As for the acute beds (level 2), the CLM

reached an occupation of 180 beds out of 200 available (or 240 with some compromises, such as converting single rooms into double or triple rooms).

Ex-post, the General Director reported that the initially prospected need for increased capacity was somewhat overestimated. From the beginning of April, after the peak had been reached, the drop of hospitalizations occurred faster than expected. After mid-April, the CLM started a backward transition to normality by slowly reopening the non-COVID activities and serving both COVID and non-COVID patients.

Managerial approaches

The CLM Crisis Cell was composed of the following members: the Director, two infectious disease specialists (one of whom is also the Health Director), the Heads of the three nursing units, the three managers of the acute care (emergency service, intensive care and anesthesia), the Head of the pharmacy, the Head of procurement, the Head of quality and patient safety, and the Head of human resources. Later, the Head of communication joined the Crisis Cell to help managing the media relations.

Daily plenary meetings (taking place at 7:30 am) were introduced and were open to all the personnel of the hospital. They were reported to be a very important part of the daily organization. The main goal of such meetings, other than passing on the day-night duties, was to circulate clear messages, clarify changes and evaluate the importance of various aspects of patient care. In addition, the Crisis Cell also used to meet daily to discuss managerial issues.

From a clinical and organizational perspective, the normal activities were completely upset by the merge of the usually separate internal medicine specialties (geriatrics, cardiology and rheumatology) – to obtain the necessary economies of scale – and by the arrival of several

external specialists belonging to other internal medicine specialties (e.g., pneumology, nephrology). However, this proved to be helpful when it soon became clear that COVID-19 did not only concern the respiratory system but also other organs, thus requiring the support of other specialists, such as cardiologists and immunologists.

As far as external communication is concerned, the relationship with the media was initially problematic due to the journalists' – what one might term – "obsessiveness" for new information, along with a lack of technical knowledge on the topic. The situation, however, improved over time with the Head of communication being able to efficiently filter requests and coordinate responses coherent with the CLM's vision and strategy.

Equipment and new operating solutions

The hospital was able to rent some machinery from their traditional suppliers and initially the staff temporarily used the ventilators usually adopted in the anesthesia unit. Such a solution worked well despite some limitations, until some ventilators were provided by the army, thus allowing a further increase in the number of ventilated beds.

However, during the crisis, it was reported being very hard to find personal protection materials, such as medical gowns and masks. Such goods were both rare and expensive and because the CLM did not want to increase the burden on the Cantonal Pharmacy – which itself was running out of stock – the management tried to find alternative solutions by collaborating with the EOC procurement services to search and contract with private facilities outside Ticino.

Human resources management

The shifts were extended to twelve hours each to address the continuous high volume of activities and to face the issue of commuters living in Italy. In fact, they were running the risk of

being unable to cross the Italian border due to the situation in Lombardy, Italy. This was a serious problem for the hospital operations, as one third of the personnel at the CLM consists of commuting employees (especially in the areas of intensive care, anesthesiology and emergency)[7]. From March 7th to mid-April/beginning of May, about 40 contracts of professionals were modified with an additional compensation and accommodation provided to make sure they would commit to stay in Ticino during the emergency. Another important change regards the fact that most of the doctors are normally employed at 50% FTE at CLM, with the remaining time available to run a private practice. During the emergency, however, professionals agreed to increase their working time up to 100% FTE (the same applied to the nursing team) – with a proportional increase in their salary. Since the hospital never reached the expected occupation levels, normal working shifts were guaranteed (with three consecutive days of work and two resting days) and changes were well accepted and even interpreted as an opportunity for professional growth by most of the workers.

The majority of the personnel working in intensive care was transferred from the surgery area (mainly anesthesiology physicians and nurses, and surgery nurses) to cope with the initial increase in COVID-related capacity. When intensive care beds further increased, the CLM also received support from personnel of other private clinics in Ticino (overall 13 FTEs): in particular, two physicians and some nurses experienced in intensive care or anaesthesiology. In addition, the CLM set up a temporary (10 days) exchange of physicians and nurses with the Clinic Hirslanden (outside Ticino), whose staff wanted to gain familiarity with the disease (overall 2 FTEs). On top of that, the CLM decided to hire some nurses no longer practicing but

[7] The situation is similar in EOC, as previously mentioned in the case of ODL.

still with sound professional skills. Overall, the personnel expanded from 674 to about 700 FTEs.

The management did not consider it necessary to involve volunteers, also because it was clear from the beginning that the most important resources were specialized professionals. The decision of excluding volunteering resources from the operations was preceded by the cantonal directives in this respect. The same holds true for the support of the army, which would have become of use only in circumstances of saturated capacity.

Support for the personnel

The CLM activated an internal psychological support service. Two psychologists of the hospital had to reorient their ordinary activity of supporting patients to also supporting the personnel during the emergency.

This proved to be useful, especially in the most critical phase, when the number of deaths were at their peak. In addition, external psychological support (via phone) was provided at the cantonal level, a service which was more keenly used by some collaborators, perhaps because of the weaker personal link.

Palliative Care and family support

During the emergency, the CLM set up a palliative care service mainly managed by the geriatrists and an internal consultant specialized in palliative care. However, such service was, to some extent, less necessary for COVID patients than for the usual (non-COVID) patients in need of palliative care. This because the average time from the moment the COVID patient would start suffering to the moment of her/his death is overall very short. Instead, what was

reported as particularly hard concerned the decision about whether putting a patient in intensive care with ventilation or not.

Another difficult aspect concerned the handling of the relationships between patients and their families. The personnel became a link between them because visits were not allowed unless in case of patients with a rapid and serious decline in their health status. In such cases, the visit of one family member was allowed for a maximum of 15 minutes. In all the other cases, tablets were promptly introduced from the first days to allow for virtual communication with relatives.

Ethical aspects

Especially at the beginning of the emergency, there was a fear that ethical decisions had to be made when getting close to the exhaustion of capacities. Such feelings prevailed, initially, in the ODL and mainly had to do with decisions on whether to transfer patients to intensive care or not. In practice, such decisions had to do more with the choice to avoid unnecessary care rather than with a shortage of beds, ventilators or other resources. Fortunately, as the full capacity was never reached, such ethical decisions never had to be taken in practice, although initially many potential alternative solutions to avoid such a possibility were investigated.

However, as also reported by the management of the CCT and of the ODL, during the emergency the CLM had to face the issue concerning the necessity of adopting a trial-and-error approach to cure patients with an unknown disease. In fact, initially, there was no scientific evidence regarding the effectiveness of the adopted therapies.

Social capital: trust and community engagement

The whole local population showed gratitude to the hospital, especially in private and professional contacts (even weeks after the first phase), and willingness to help. Many “thank

you" cards were received and exposed in a showcase placed in the hospital hall, together with gifts, such as chocolates and some meals received from the local shops and restaurants.

In addition, the CLM created a fund dedicated to patients, collaborators, and research on COVID and communicable diseases. Several important donations have gone into this fund.

Discussion

Similarly to the ODL and the CCT, the case of the CLM confirms the importance of operating in a context of intra- and inter-organizational cooperation.

As far as the intra-organizational relationships are concerned, the logistical reconfiguration, turned out to play a relevant role for implementing effective solutions to isolate "Block B" and "Block A" as well as the triage and ambulance areas. By leveraging its specific structural features, the CLM was able to maintain, albeit partially, its ordinary non-COVID activities.

From an inter-organizational point of view, the horizontal integrated approach has proven to be a meaningful factor for collaboration with other services of the territory, such as ambulances, cantonal psychologists and the army – other than the collaboration with other hospital facilities.

The CLM case also highlights the importance of generating economies of scale when facing an emergency of such magnitude, as exemplified with the creation of a single multi-disciplinary setting by merging usually separated internal medicine specialties.

Finally, the case emphasizes two strategic aspects. The first aspect refers to the different institutional setting of the CLM compared to the other two cases operating within or in strict partnership with the EOC. Not being part of a network such as the EOC did not allow the hospital to easily take advantage of sharing skilled professionals (though the pre-existing relationships with other private organizations somewhat filled the gap). The less rigid

hierarchy of CLM, however, (where healthcare activities take place in competence centers and one of the organizational core values is that each physician – hired as an independent accredited professional, rather than an employee – is "primus inter pares")[8] called for less frequent daily coordination and communication practices. The second aspect refers to the timing of engagement on the front line of the pandemic, that allowed the CLM to partly build on the ODL's experience thus taking more stable decisions of organizational reconfiguration (e.g., less consecutive changes to reach the final logistical setting).

1.4. Conclusion and recommendations

The analysis of the response organized by the Ticino hospital system highlighted, above all, the importance of operating in a context of intra- and inter-organizational cooperation and the relevance of institutionalizing public-private collaborations in times of crisis. In this respect, relevant examples of such a horizonal integration are: the coordinated transfer of patients across the different hospital sites, the concentration of specific medical technologies and professionals in the COVID center, and the sharing of knowledge and practices.

The important role of the public-private partnerships became particularly evident when the CLM and the CCT came into play as COVID centers. The ODL, could be considered a game starter catalizying the collaborative efforts of the other providers. The CLM opened to COVID patients to support the activities of the ODL that was reaching its full capacity. Such processes took place with neither ex-ante directives assigning them the role of COVID centers nor clarifications on what such role would have meant financially. The CCT reacted with its

[8] See also the CLM's official site: https://moncucco.ch/la-clinica/organizzazione/ (accessed on July 2020).

reconfiguration to care for a specific target of patients and facilitated the distribution of skilled personnel at the cantonal level.

Another relevant common aspect emerging from the analysis, with special reference to the CLM and the ODL, is the importance of taking advantage of economies of scale when facing an emergency of such a magnitude. Through the concentration of technologies and personnel in a few multi-disciplinary settings, by merging usually separated internal medicine specialties (internal integration), the two hospitals were able to face the emergency efficiently.

Moreover, in all three cases showed how social capital and trust played a prominent role during the health emergency, with the local community representing a source of material and emotional support for the hospital. Similarly, informal social networks showed to be very important to carry out urgent and practical tasks.

Differences between the cases analyzed are on the other hand found in their managerial styles. While the ODL and the CLM showed participatory approaches to decision-making, with daily meetings open to all the personnel; the CCT instead, seemed to adopt a less participatory approach as compared to the other two cases, as it was more based on a close interaction between the CCT and the EOC Crisis Cells. This may also be due to the smaller size of the CCT compared to the other two organizations.

In the ODL the change management appeared to be “fluid”, since priorities and objectives required constant updates according to the logic of “learning by doing” and with the explicit intention of boosting creativity and inventiveness. Contrarily, the management of logistical and organizational changes were driven by logic, technical knowledge, and clearly defined objectives in the CCT and CLM.

Another relevant aspect was the attention that the top management of all three hospitals dedicated to containing the indirect psychological effects the emergency had on the "two populations" hit by the crisis: the patients and the hospitals' personnel. In particular, the ODL activated a specific and well articulated initiative in this respect (SoStare project). The CLM reported a moderate use of its internal and external psychological support. Also, the CCT activated a psychological support service, reporting a moderate volume of requests. All the organizations did proactively cope with the risk of depending on professionals living in a foreign country, namely Italy.

Finally, the ODL and the CCT built preparedness for potential further emergencies by investing in the ability to recreate the emergency logistic configuration in 48 hours, eventually without the necessity of stopping the non-COVID activities.

Table 1.4 below outlines a comparative summary of the discussed aspects across the three case studies analyzed.

Table 1.4: Comparative synthesis of the analyzed case studies

Aspect	ODL	CLM	CCT
Intra- and inter-organizational collaboration	Relevant	Relevant	Relevant
Social capital contribution	Yes	Yes	Yes
Managerial approach	Participatory style «Open meetings»	Participatory style «Open meetings»	Close interaction between CCT and EOC Crisis Cell
Change management	Learning by doing Inventiveness	Focus on logic, technical knowledge and clearly defined objectives	Focus on logic, technical knowledge and clearly defined objectives
Mental wellbeing of healthcare workers	Articulated internal initiative (SoStare project)	Internal and external psychological support	Internal "Psychological Emergency Service"
Preparedness for the second wave	Yes	Not mentioned	Yes

In summary, the findings from the three case studies suggest that collaboration towards a common goal, constant communication, and pre-existing personal connections among key actors of the hospital system played a critical role to cope with the crisis. The emergency also highlighted the importance of managing the dependence from other countries both in terms of skilled personnel and supplies.

Based on the evidence collected through the case studies, the authors identified some actionable recommendations:

Recommendation 1: Recognize the importance of public-private partnerships to reach effective collaborations when an emergency threatens the health of the whole population. To this extent, defining a legal and institutional framework might ensure the efficient application of the rules

and principles when roles and responsibilities of each party must dramatically change due to unexpected contingencies.

Recommendation 2: Consider the importance of economies of scale associated with the concentration of technologies and personnel. Such an approach also fosters the resilience of the health system in case of an intra-hospitals nosocomial outbreak.

Recommendation 3: Find the right balance between "control", with the high-level authorities defining uniform rules and processes, and "participation", allowing the local actors to have a voice and transmit a realistic picture of the situation in the field. The final goal consists of fostering efficiency while maintaining a grip on the real developments of the phenomenon.

Recommendation 4: Inventory and supply chain management should be revised considering the challenges posed by a pandemic, as usual supplier conditions, product requirement, and lead times are considerable challenged in such a contingency. Hospitals' management rules and practices should be inspired not only by efficiency principles but should also account for the likely shortage of equipments necessary to cope with a pandemic and the demand and price changes occurring in such circumstances.

Recommendation 5: Care about the psychological effects on the "two populations" hit by the crisis: the patients and the hospitals' personnel. Developing interventions designed to tackle the indirect social and psychological effects of the pandemic is of paramount importance to foster systemic resilience.

Recommendation 6: Prepare for potential future waves of the pandemic or further pandemics. Building hospitals' logistic and organizational preparedness is very important to be ready for being able to deal with eventual re-configurations in a short timeframe.

2. Effects of the bio-psycho-social frailty dimensions on healthcare utilization among elderly in Europe: A cross-country longitudinal analysis.

2.1. Introduction

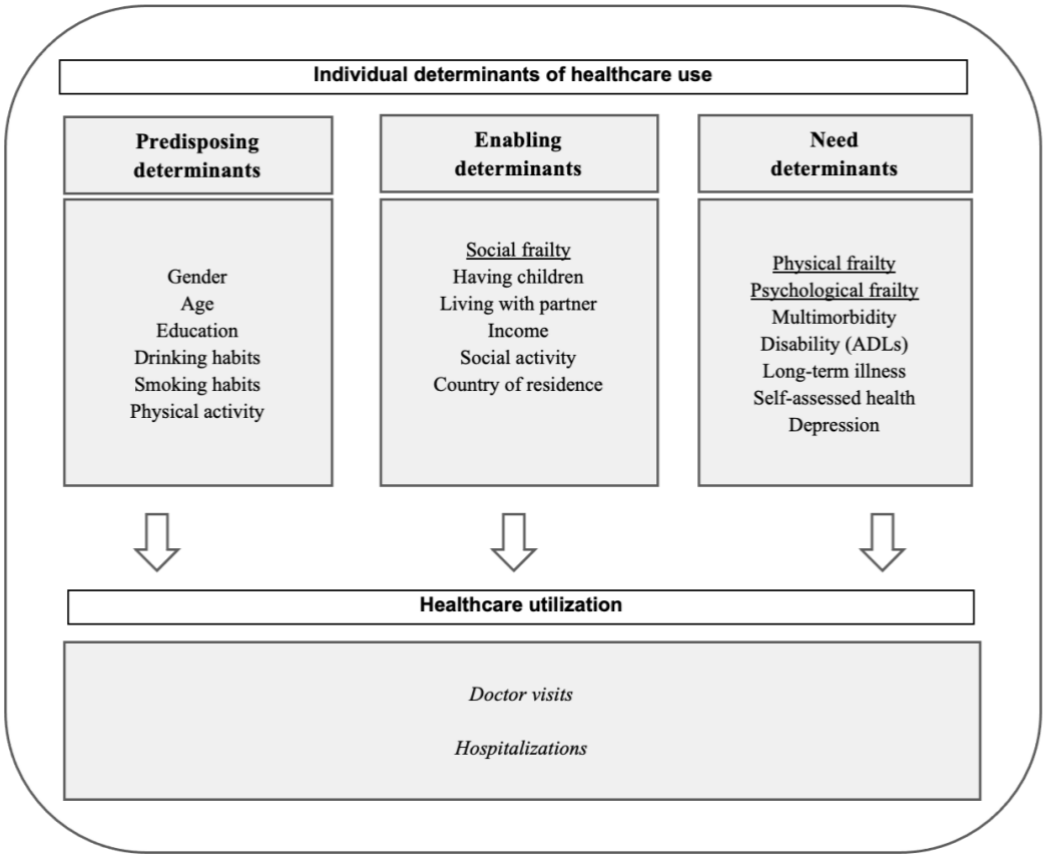
The growth of population aging in developed countries has raised concerns about the sustainability of health systems because of the burden of delivering appropriate health and social care to a growing number of elderly people (Anderson & Hussey, 2000; de Meijer et al., 2013; Gregersen, 2014; Miller, 2001; Payne et al., 2007; Reinhardt, 2000; Westerhout, 2006; Williams et al., 2019).

The relationship between ageing and growth in health expenditure has often been debated. The "*red herring theory*" argued that health care costs are positively correlated with age mainly because the likelihood of mortality rises with age (Carreras et al., 2018; Fuchs, 1984; Howdon & Rice, 2018; Zweifel et al., 1999). However, this theory does not hold up when other factors associated with ageing are considered.

Our analysis is based on the conceptual model developed by Andersen & Newman (1973). Andersen & Newman initially and de Meijer and colleagues (2013) later, argued that health-service utilisation is driven by three factors: *predisposing*, *enabling*, and *need determinants*. *Predisposing determinants* are demographic and social conditions, such as age, sex, marital status, co-residence status, and socio-economic status (SES). They influence the individual's decision to use services without being directly responsible for it. *Need factors* are directly responsible for the use of healthcare services, as they represent the underlying reasons why

individuals seek care. These factors encompass various forms of poor health, including chronic diseases, self-assessed health status, physical and mental illnesses, and disabilities. Finally, *enabling determinants* represent the resources that facilitate healthcare use, ranging from the level of health insurance coverage to income to informal care supply. Refer to Figure 2.1 for our revised version of the conceptual framework.

Figure 2.1: Conceptual framework



Source: adapted from the Andersen and Newman's behavioural model (Andersen & Newman, 1973).

Although *enabling* and *predisposing factors* play a significant role in predicting healthcare use and expenditures, health status—and the overall need for healthcare—remains the primary determinant of healthcare consumption (Hajek et al., 2021). Once controlled for the *need determinants* the effect of ageing on acute healthcare use is modest (de Meijer et al., 2011, 2013), whereas such an effect is strong when analysing long-term care and primary care expenditures

(Atella & Conti, 2014; de Meijer et al., 2013). Therefore, this relationship may vary across different care levels and needs.

As far as the *need determinants* are concerned, frailty is a condition associated with ageing and a growing challenge for health systems, in terms of both clinical practice and financial sustainability (Cesari et al., 2016). Frailty is a clinical geriatric condition characterised by increased vulnerability resulting from diminished physiological reserves and function of multiple organs, compromising the ability to cope with every-day or acute stressors (Clegg et al., 2013; Fried et al., 2001, 2005; Fried L.P. & Walston J., 2003; Mitnitski et al., 2001; World Health Organization, 2017b). Frailty and chronic diseases represent the clinical manifestations of accumulated biological deficits that occur with age. However, frailty is yet to be evaluated in routine clinical practice.

Different definitions and measures of frailty have been developed from 2001 onwards, when two distinct approaches, currently dominating the field, the Frailty Phenotype and the Frailty Index, were elaborated. Subsequently, the concept has continuously evolved, with increasing focus on a more integrated approach to the condition, shedding attention also on social and cognitive aspects of frailty (Panza et al., 2015). Nevertheless, evidence on this latest definition is still limited.

The first approach, the Frailty Phenotype (FP) - also known as Fried's definition or Cardiovascular Health Study (CHS) definition - was developed by Fried and colleagues, using the CHS cohort in 2001. It defined frailty as a biological syndrome characterized by the assessment of five phenotypic criteria: weakness (measured by grip strength), slowness (measured by reduced walking speed), unintentional weight loss; lack of energy and endurance (measured by self-reported exhaustion); low activity (measured by inability to perform demanding activities

such as gardening and heavy housework) (Fried et al., 2001). The "frailty phenotype" is defined by the evidence that an individual meets at least three of the mentioned criteria: in such a case the individual is classified as "frail". While individuals who have none of the criteria are defined as "non-frail" or "robust"; and individuals who meet one or two criteria are classified as "pre-frail" (Fried et al., 2001). The CHS clearly distinguished frailty from disability – measured by limitation in ADLs – and comorbidity – defined by the presence of more than one chronic disease among nine: myocardial infarction, angina, congestive heart failure, claudication, arthritis, cancer, diabetes, hypertension, COPD (Fried et al., 2001, 2004). Nevertheless, the study shows some overlap across the three conditions/diseases and emphasize that they represent important confounders for frailty assessment (Leng et al., 2014). The importance of frailty as a factor independent from age and comorbidity, has been demonstrated in a large prospective observational cohort study in older Germans (Bock et al., 2016).

The second approach, the Frailty Index (FI), was developed by Rockwood and Mitnitski and tested on the data of the Canadian Study on Health and Aging (Mitnitski et al., 2001). It measures frailty according to the cumulative presence of age-related deficits: the higher the number of deficits, the higher the likelihood to be frail. The index ranges between 0 (no deficits) and 1 (all deficits) and is calculated as the ratio between the number of deficits in an individual and the total number of deficits considered (between 30 and 40). Differently from Fried's definition, the FI considers other common geriatric syndromes as well as psychological and social aspects, on top of physical and cognitive limitations. However, FI makes no discrimination between frailty, disability, and comorbidity, as all three conditions are included in the model. Such an approach does not allow to distinguish frailty from other clinical geriatric syndromes and thus to investigate the pathogenesis of frailty (Leng et al., 2014).

Both the FP (Fried et al., 2001; Gill et al., 2010) and the FI (Drubbel et al., 2013; Rockwood et al., 2006; Song et al., 2010) have shown to be associated with relevant adverse outcomes in older people. More specifically, they help predicting disability (Fried et al., 2001; Kojima, 2017), hospitalization (Fried et al., 2001; Kojima, 2018) and length of stay (Makary et al., 2010), admission to long-term care (Kojima, 2018; Rockwood et al., 2006), and mortality (Fried et al., 2001; Kojima, 2018). Evidence has also shown that both instruments represent a useful risk assessment tool, because they predict health outcomes in specific sub-conditions or treatments, such as elective surgery (Makary et al., 2010), cardiac surgery (Afilalo et al., 2009), cancer (Aaldriks et al., 2013; Audisio & van Leeuwen, 2011; Hamaker et al., 2012; Rønning et al., 2010). However, some studies reported greater capacity of the FI to predict adverse outcomes compared with the FP (Rockwood et al., 2006), perhaps because FI includes several aspects and conditions. In addition, the FI better discriminates moderate from severe frailty (Kulminski et al., 2008), likely due to FI's continuous scaling. Nevertheless, FP is the most widely used instrument for assessing frailty (Buta et al., 2016; Collard et al., 2012), perhaps because it analyzes specific biologic mechanisms and etiology of the syndrome, thus distinguishing frailty from disability and morbidity (Dent et al., 2019; Fried et al., 2004; Leng et al., 2014; Sternberg et al., 2011). In addition, the measurability of its components is easier compared to FI (Sternberg et al., 2011).

Most international frailty instruments emphasize physical factors. However, it has been recently argued that the concept should be widened to adopt a multidimensional approach and include psychological and social components (Gobbens et al., 2017). Rockwood (2005) recognized the multidimensional nature of frailty by including cognitive impairment among the identifying factors in the FI. Almost in the meantime, Rolfson and colleagues (2006) provided a more comprehensive measure with the Edmonton Frail Scale, which also considered cognition, social support and sadness or depression. In 2010, Gobbens and colleagues, developed the Tilburg

Frailty Indicator (TFI), based om the definition of frailty as "a dynamic state affecting an individual who experiences losses in one or more domains of human functioning - physical, psychological, social - that are caused by the influence of a range of variables, and which increases the risk of adverse outcomes" (Gobbens et al., 2010). Hence, in their view, an appropriate definition of frailty would have to reflect multidimensionality and dynamicity, capacity to predict adverse outcomes, clear differentiation from comorbidity and disability, clinical sensibility (i.e., acceptance of the definition by its practical users) and practicability (i.e., inclusion of aspects which are the object of preventive interventions).

Despite being the most widely used instrument, a debate regarding the incompleteness of Fried's definition (Ferrucci et al., 2006) has focused on the importance of including cognitive, psychological, and social components to the index. The gap was partially filled by two studies: one adding a measure of cognitive impairment and depression symptoms to the FP (Rothman et al., 2008), and the second study adding a measurement of cognitive impairment (Avila-Funes et al., 2009). Both studies concluded that adding cognitive impairment to the FP improves its predictive validity regarding adverse health outcomes, such as disability (Avila-Funes et al., 2009; Rothman et al., 2008), hospitalization (Avila-Funes et al., 2009), long-term nursing home stay (Rothman et al., 2008), and mortality (Rothman et al., 2008).

Moreover, several studies found evidence of the adverse health outcomes attributable to social and psychological frailty. Social frailty represents a risk factor for mortality (Tanskanen & Anttila, 2016a; Yamada & Arai, 2018a) and disability (Yamada & Arai, 2018a), and the same conclusion can be drawn about psychological frailty (Yamada & Arai, 2018a). In addition, there is evidence of a cumulative effect: individuals suffering from both social and psychological and physical frailty, are at greater risk of adverse health outcomes such as mortality and disability (Teo et al.,

2019; Yamada & Arai, 2018a), as well as nursing home referral (Teo et al., 2019), compared to subjects affected by only one or no frailty trait.

The extant literature has focused on the effects of physical frailty on the patterns of healthcare utilisation and costs in different contexts: Canada (Mondor et al., 2019), the United States (Wilkes et al., 2019), France (Sirven & Rapp, 2017), Belgium (Hoeck et al., 2012), Germany (Bock et al., 2016; Hajek et al., 2018), England (Han et al., 2019a), Spain (Álvarez-Bustos et al., 2022; García-Nogueras et al., 2017), Ireland (Roe et al., 2017), Sweden (Zucchelli et al., 2019), and ten European countries (Ilinca & Calciolari, 2015). Several studies have found evidence of adverse health outcomes attributable to social and psychological frailty (Rothman et al., 2008; Tanskanen & Anttila, 2016b; Teo et al., 2019; Yamada & Arai, 2018b), suggesting increased healthcare use. However, while the above-mentioned empirical evidence indicates that physical and psychological frailty are associated with increased supplied care, the literature on informal care suggests that social frailty is likely to hinder healthcare access (Bolin et al., 2008; Torbica et al., 2015; Weaver & Weaver, 2014).

There is a paucity of literature investigating the effects of different frailty dimensions on health care utilisation and their eventual cumulative effects. Analysing their simultaneous effects is important because these three dimensions play different roles in the above-mentioned model. While physical and psychological frailty can be classified as need factors, social frailty can be conceptualised as an enabling factor (Figure 1).

2.1.1. Aim of the study

This study aimed to provide evidence of the importance of adopting a broader approach in defining and measuring frailty to explain healthcare utilisation in Europe. In particular, we addressed the question: “does the physical, social and psychological frailty status influence

healthcare utilisation among the elderly?". To this end, we analysed repeated measures of frailty from a multi-wave cohort study of individuals aged 50 years or older, covering a period of nine years. The measurement of health service utilisation focuses on hospitals and ambulatory care, as they account for the largest proportion of healthcare expenditures (40% and 25%, respectively) in almost all European countries (OECD Health Statistics, 2022) and are expected to further increase because of population ageing.

We use a multivariate, non-linear regression modelling approach controlling for individual-level characteristics and for country effects, and exploiting the longitudinal structure of the data to control for time-fixed unobserved heterogeneity (Wooldridge, 2010). This allowed us to account for potentially confounding factors and thus draw sound conclusions about the effects of frailty.

Based on the previously reviewed literature on the relationship between the three frailty dimensions and health-service utilization, we defined three hypotheses:

H1. *Individuals with higher levels of physical frailty tended to utilize healthcare more often.*

H2*. Individuals with higher levels of social frailty tended to have lower levels of healthcare utilisation.*

H3. *Individuals with higher levels of psychological frailty tended to utilize healthcare more often.*

2.2. Methods

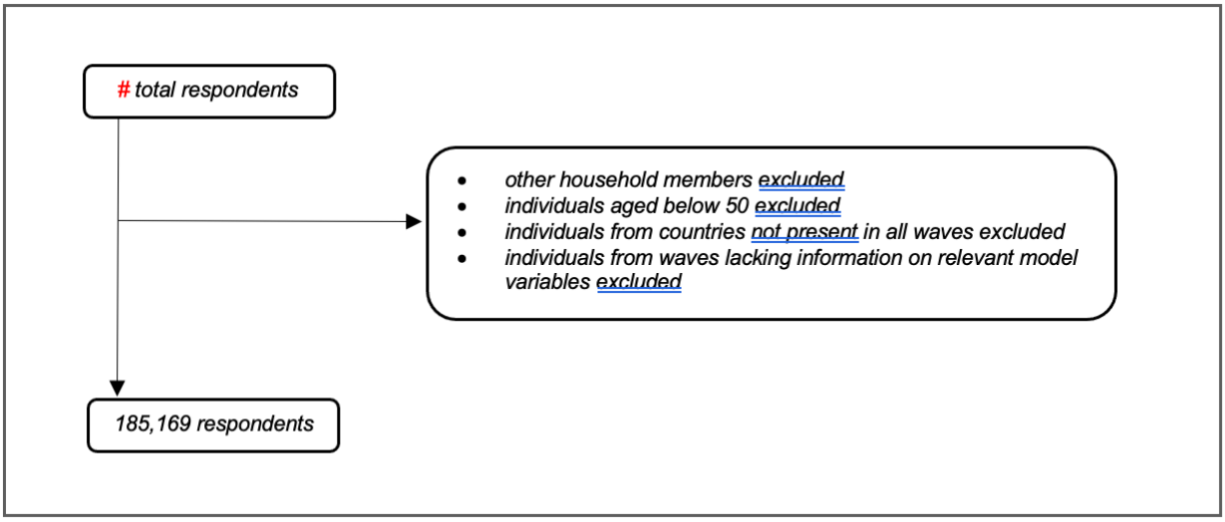
2.2.1. Data and analysis sample

We used data from the Survey of Health, Ageing and Retirement in Europe (SHARE), a longitudinal dataset consisting of micro-data on the health and socio-economic status of individuals aged 50 or older, covering 28 European countries and Israel.

The SHARE questionnaire is harmonized with the U.S. Health and Retirement Study (HRS) and the English Longitudinal Study of Ageing (ELSA) and has become a role model for several ageing surveys worldwide. Data collection started in 2004 and takes place every two years and to represent the European population aged 50+, SHARE employs a sample design that includes baseline samples of households with individuals aged 50+ and regular refreshment samples of those who have turned 50 since the original baseline.

Figure 2.2 shows the sample exclusion criteria followed in the study, which is based on data from regular waves 4, 5, 6, and 8 – as published in release 8.0.0. Data collection ran in the periods 2011/2012, 2013, 2015, and 2019/2020, respectively (Börsch-Supan, 2022a, 2022b, 2022c, 2022d; Börsch-Supan et al., 2013). The exclusion criteria, mainly related to our longitudinal approach, led us to retain a sample of 185,169 observations from the 12 countries that participated in all four waves (Austria, Belgium, the Czech Republic, Denmark, Estonia, France, Germany, Italy, Slovenia, Sweden, Switzerland, and Spain).

Figure 2.2: Sample exclusion criteria flow chart



2.2.2. Measures

Outcome variables

The two outcome variables used to measure individual health care consumption are:

- Number of doctor visits in the last 12 months, a count response variable in the range 0-98.
- Having been hospitalised in the last 12 months, a binary response variable.

Exposure

To measure physical frailty, we adopted the phenotype definition of frailty (Fried et al., 2001), based on the assessment of five dimensions: grip strength, energy, walking speed, physical activity, and unintentional weight loss. Using SHARE data on each of the five dimensions, we built a composite physical frailty score, according to which an individual is *frail* if three or more of the above dimensions are compromised, *robust* when none of the deficits are present, and *prefrail* in intermediate situations (Romero-Ortuno et al., 2010; Santos-Eggimann et al., 2009). The estimated Cronbach's alpha of the generated Physical Frailty index was 0.58, which is consistent with the results of previous studies (Jankowska-Polańska et al., 2019; Leshabari, 2021; Zhang et al., 2020). To measure social and psychological frailty, we used the Tilburg Frailty Indicator (TFI) (Gobbens et al., 2010a; Gobbens et al., 2010b; Makizako et al., 2018). The social domains of the TFI are defined using three items: living alone, social relations, and social support. Using SHARE data on each of the three dimensions, we built a composite social frailty score, according to which an individual was classified as *socially frail* when all three domains are compromised, *socially robust* when no domain was compromised, and *socially prefrail* in any intermediate situation. The psychological domains of the TFI were identified by four items: memory problems, feeling

down in the previous month, feeling anxious or nervous in the previous month, and being able to cope well with problems. Using SHARE data on each of the four dimensions, we built a composite psychological frailty score, according to which an individual was classified as *psychologically frail* when all four domains were compromised, *psychologically robust* when no domain was compromised, and *psychologically prefrail* in any intermediate situation. The estimated Cronbach's alpha of the generated Social Frailty index was 0.31, similar to that reported in other studies (Freitag et al., 2016), and the estimated Cronbach's alpha of the Psychological Frailty index was 0.46, aligned with previous research on the matter (Gobbens & Uchmanowicz, 2021).

Covariates

Our analyses include the two main correlates of frailty, *that is,* multimorbidity and disability (Buchman et al., 2009; Heuberger, 2011)– the latter measured as the number of activities of daily living (ADLs) limitations accumulated in six dimensions (Katz et al., 1970) – together with a number of additional control variables grouped into four categories, *that is,* health status, socio-demographic status, socio-economic status, and behavioural risks (Espinoza & Fried, 2007; Woods et al., 2005), and country (see Table 1). Finally, we included the interactions between each frailty index and multimorbidity. This approach was driven by the fact that physical frailty and multimorbidity often co-exist in elderly individuals, and the latter potentially acts as a moderator of the effect of frailty on adverse outcomes (Lujic et al., 2022). Therefore, we decided to test whether the effects of psychological and social frailty on healthcare use were moderated by multimorbidity. In addition, the first interaction term helps fostering comparability with the results in Ilinca & Calciolari (2015).

Therefore, the estimation was controlled for demand-side factors at the individual level and country-specific characteristics.

2.2.3. Statistical analysis

SHARE suffers from sample attrition: repeated observations in the dataset account for 59.2% of the total observations, despite refreshment samples aimed at compensating for the reduction in panel sample size due to attrition (Bergmann et al., 2017). We refrained from using a balanced longitudinal subsample because death and incapacity are likely to be important sources of nonresponse; therefore, such an approach would introduce bias by eliminating frailer individuals from the analysis (Jones et al., 2013). To ensure that attrition did not affect our estimates, we ran variable addition tests (Verbeek & Nijman, 1992), and the results rejected the hypothesis of a significant correlation between the pattern of missing values and our outcome variables.

The SHARE dataset, like all large household surveys, also suffers from item non-response. We addressed the problem of missing values using Multiple Imputation (MI). We opted for a MI approach because Full Information Maximum Likelihood (FIML) methods, which rely on observed data to estimate parameters by determining the values most likely to have produced the observed data, are typically used with linear models (Enders, 2010). However, our study employs non-linear models, making MI a more suitable choice. We excluded single imputation methods, as they cause standard errors to be excessively small, because uncertainty around imputations is not accounted for.

Among MI methods, are Fully Conditional Specification (FCS) and Joint Modelling (JM), initially developed by (Rubin, 1996). These methods address missing data by generating multiple imputations for each missing value, resulting in several complete datasets. Each dataset is

analyzed separately, and the estimates are combined using Rubin's rules to account for the variability due to missingness. The process involves three key steps (Jakobsen et al., 2017; Sterne et al., 2009):

- *Imputation Step*: Missing values are replaced with multiple sets of imputed values, creating multiple datasets that differ only in the imputed values. Imputed values are sampled from their predictive distribution based on observed data, incorporating appropriate variability to reflect uncertainty.
- *Completed-Data Analysis (Estimation) Step*: Each imputed dataset is analyzed separately, resulting in different estimates from each dataset.
- *Analyses Pooling Step*: Estimates from the different imputed datasets are averaged to produce a single estimate. Standard errors are calculated using Rubin's rules, which account for both within-dataset and between-imputation variability.

We chose the FCS method for some important reasons:

- JM assumes that the joint distribution of incomplete variables is multivariate normal. However, as most of our incomplete variables do not follow a normal distribution, FCS is a more suitable option.
- FCS imputes missing values using univariate conditional distributions for each incomplete variable. This method is particularly useful when imputing variables that have specific value constraints, such as binary or count variables.
- Various simulation studies have demonstrated that FCS and JM produce comparable estimates, ensuring the reliability of FCS as a method (Lee & Carlin, 2010; van Buuren, 2007).

- Additionally, SHARE also utilized FCS for generating its imputed variables, further supporting its effectiveness and applicability.

We implemented FCS in two steps. First, Rubin's rule (Rubin, 1996) was used to combine the five SHARE imputed datasets (Malter & Börsch-Supan, 2015) to obtain pooled estimates and standard errors for the variables of interest. Second, after observing *missing at random* (MAR)[9] and a non-negligible number of remaining missing values[10], we applied the FCS method using all our models' main variables[11] and generating seven imputed datasets[12] (van Buuren, 2007, 2018) to obtain pooled estimates and standard errors.

The post-imputation diagnostics showed coherence between the imputed and original values[13] (Nguyen et al., 2017), with a maximum percentage of missing values per variable equal to 0.7%.

We selected the econometric approach based on two data features: (1) the dataset is longitudinal; and (2) the selected outcomes are all limited variables: the number of doctor visits in the last year and the occurrence of hospitalization in the last 12 months. We used Poisson regression models for the count dependent variable and logistic regression models for the binary response variable. Exploiting the panel structure of the data allowed us to relax the homogeneity assumption and control for unobserved individual heterogeneity and for potential differences between waves. Two empirical models estimated the influence of frailty on health

[9] The Little's chi-squared test ($p < 0.05$), a logit model used to test whether any of the variables could predict missingness, and t-tests to check whether the variables vary between missingness groups, led us to conclude that values are not Missing Completely At Random (MCAR). Hence, without MI, our results would be less efficient, inconsistent and biased.
[10] As a rule of thumb, proportions of missing values greater than 5% are considered non-negligible for the estimation process (Jakobsen et al., 2017).
[11] It is generally recommended to include as many variables as possible, including their interactions and any transformed variables, to enhance the accuracy of imputations (Collins et al., 2001). The selection of variables should be guided by theoretical considerations (Sterne et al., 2009).
[12] We generated two additional imputed datasets beyond the five provided by SHARE. Although many scholars argue that five imputed datasets are theoretically sufficient (Allison P.D., 2010; Carpenter J.R. & Kenward M.G., 2008), Horton & Lipsitz (2001) recommend using at least 20 datasets to reduce sampling variability in the imputation process. We chose seven imputed datasets to balance between increasing accuracy and avoiding excessive time burdens for estimation.
[13] Coherence was shown by: comparison of means and standard deviations of imputed, observed and complete values; comparison of kernel densities of imputed and observed values; comparison of regression's Confidence Intervals (CIs) before and after imputations.

services utilisation (Table 2.2): Model 1 focuses on hospitalization assuming a logistic probability distribution, while Model 2 focuses on doctor visits assuming a Poisson probability distribution.

All statistical analyses were performed using the statistical software package STATA 15.0 (StataCorp, College Station, TX, USA).

Model 1: hospitalization

A longitudinal multivariate model, assuming a cumulative standard logistic distribution, was used to analyse the influence of frailty on the probability of hospitalisation during the observation period. The model assumes that this probability over time is a function of the subject's frailty, health status, socio-demographic status, socio-economic status, behavioural risk, and country of residence:

$$y_{it} = \mathbf{X}_{it}\boldsymbol{\beta} + \mathbf{W}_i\boldsymbol{\delta} + \boldsymbol{\varepsilon}_{it}$$

The model has a binary dependent variable (y_{it}) and two types of covariates: time-constant variables (represented by the matrix $\mathbf{W}_i$) and observed characteristics changing over time ($\mathbf{X}_i$), with – respectively – $\boldsymbol{\beta}$ and $\boldsymbol{\delta}$ representing the vectors of the corresponding parameters. Time-invariant covariates included the subjects' gender and country of residence. The time-varying covariates (including the three dimensions of frailty and multimorbidity) belonged to the four categories mentioned above.

The error term ε_{it} in the model is a linear function of two components:

$$\varepsilon_{it} = \varsigma_i + \mu_{it} \qquad (2)$$

The first component (the unobserved heterogeneity ς_i) represents unobserved time-constant variables – *that is*, shared between the four waves on the same subject *i* – affecting total healthcare utilization. The second component (μ_{it}) consists of unobserved time-varying variables – *that is*, unique to each wave and subject – and might include economic and health shocks.

We estimated the parameters by means of MLE (Greene, 2003), and compared the random effects (RE) with the fixed effects (FE) model, because RE is an efficient approach for analysing longitudinal data, but it is more vulnerable than FE to omitted variable bias caused by unobserved heterogeneity (Allison, 2009). The Hausman test (comparing FE with RE) and the Mundlak specification test (comparing FE with a correlated random effect model) were used to find evidence suggesting risks of bias in the RE (Wooldridge, 2010). The two tests provided evidence that FE was preferred to RE.

The coefficients ($\boldsymbol{\delta}$) of the time-varying covariates were interpreted as odds ratios (ORs), which are measures of the strength of the association between two events. In our case, OR measures the ratio between the odds of hospitalisation and the odds of hospitalisation not occurring, given a certain value of an explanatory variable.

Model 2: number of doctor visits

A longitudinal multivariate model, assuming a cumulative Poisson distribution, analyzed the influence of frailty on the likelihood of the number of doctor visits during the observation period. This model assumes that the cumulation of doctor visits is a function of the same covariates used in Model 1. We estimated the parameters using MLE and applied the same tests as those used for Model 1 to select the most appropriate approach for analysing longitudinal data. The test results led us to select a FE model for the RE.

Although our test of overdispersion (Cameron & Trivedi, 2009; Fávero et al., 2020) led us to reject the assumption of equi-dispersion for the outcome variable, we opted for a Poisson estimation because many scholars argue that a Negative Binomial estimation, which relaxes this assumption. implies several important drawbacks when dealing with panel data (Allison & Waterman, 2002; Greene, 2006; Guimarães, 2008; Wooldridge, 1999). In addition, Wooldridge (1999) argued that the FE Poisson model is robust even in the presence of overdispersion.

In Model 2 the exponentiated coefficients ($\boldsymbol{\delta}$) of the time-varying covariates were interpreted as incidence rate ratios (IRRs). The IRR measures the factor change in the expected number of doctor visits, given a certain value assumed by the associated explanatory variable.

2.3. Results

The sample is composed of 56% female and 44% male individuals, with females being slightly more prevalent in the lowest (50-60 years old) and highest age group (over 80 years old) (see Appendix A2-1). Approximately half of the sampled individuals were physically frail or pre-frail (49.9%) and suffer from multimorbidity (49.5%). The prevalence of physical frailty and multimorbidity increases over time, whereas the prevalence of social and psychological frailty showed the opposite trend (see Appendix A2-2). The average respondent had visited a doctor seven times in the previous year and 16% of the sample has been hospitalized in the previous 12 months, with an increase over time (see Appendix A2-3).

Table 2.1 shows that, with the aggravation of physical frailty, psychological frailty worsens, while social frailty increases at both its highest and lowest levels. As physical frailty worsened, all remaining variables measuring health status indicated a deterioration in the average individual's health, including mental health. In addition, physical frailty is more prevalent in females, older

subjects, individuals suffering from financial distress, those with low/middle household wealth, and those who are not socially active.

Table 2.1 - Descriptive statistics

Variable	Physically robust		Physically pre-frail		Physically frail		
	Mean (SD)/ Proportion	N	Mean (SD)/ Proportion	N	Mean (SD)/ Proportion	N	Range
Healthcare utilization							
No of doctor visits	4.8 (6.3)	91,977	7.9 (10.5)	73,798	13.4 (17.7)	18,048	0-365
Hospital admission	0.1	91,980	0.2	73,806	0.4	18,072	0-1
Health Status							
Social Frailty							
Robust	8.3	7,634	9.6	7,085	11.6	2,094	0-1
Pre-frail	89.3	82,139	85.5	63,101	81.6	14,733	0-1
Frail	2.4	2,208	4.9	3,616	6.8	1,228	0-1
Psychological Frailty							
Robust	42.0	38,631	18.7	13,800	6.0	1,083	0-1
Pre-frail	57.0	52,427	75.0	55,348	77.3	13,948	0-1
Frail	1.0	920	6.3	4,649	16.7	3,013	0-1
Multimorbidity	0.4	91,982	0.6	73,807	0.8	18,074	0-1
Long-term illness	0.4	91,972	0.6	73,789	0.9	18,072	0-1
Limitations with ADLs[1]	0.0 (0.2)	91,982	0.2 (0.7)	73,807	1.6 (1.9)	18,074	0-6
SAH[2]							
Excellent	11.6	10,669	3.4	2,509	0.3	54	0-1
Very good	25.9	23,823	10.5	7,750	1.1	199	0-1
Good	43.2	39,734	34.4	25,389	10.3	1,862	0-1
Fair	17.6	16,188	39.3	29,005	37.7	6,814	0-1
Poor	1.7	1,564	12.4	9,152	50.6	9,146	0-1
EURO-D[3]	1.3 (1.4)	91,978	3.3 (2.1)	73,795	5.2 (2.5)	18,054	2.479 0-12
Demographic and Socio-Economic Status							
Male	0.5	91,982	0.4	73,807	0.4	18,074	0-1
Living with the partner	0.7	91,981	0.7	73,804	0.5	18,072	0-1
Have children	0.9	91,982	0.9	73,807	0.9	18,073	0-1
Age							
50-60	28.1	25,847	21.6	15,942	7.7	1,391	0-1
60-70	40.9	37,621	31.6	23,323	16.1	2,910	0-1
70-80	24.6	22,628	29.5	21,773	30.0	5,423	0-1
80+	6,4	5,887	17.3	12,769	46.2	8,351	0-1
Education							
Primary or less	13.9	12,785	22.9	16,900	44.2	7,987	0-1
Secondary	59.0	54,268	57.5	42,435	46.8	8,457	0-1
Tertiary or more	27.1	24,927	19.6	14,465	9.0	1,626	0-1
Financial Distress[4]							
With great difficulty	5.2	4,779	10.7	7,866	18.8	3,332	0-1
With some difficulty	20.0	18,380	27.6	20,290	32.8	5,813	0-1
Fairly easily	32.1	29,500	31.6	23,231	28.1	4,980	0-1
Easily	42.7	39,241	30.1	22,128	20.3	3,598	0-1
Household Wealth Quartile							
Low	20.3	18,661	30.1	22,166	43.2	7,730	0-1
Middle-low	21.7	19,948	24.2	17,821	24.9	4,455	0-1
Middle-high	27.7	25,463	25.0	18,410	20.5	3,668	0-1
High	30.3	27,853	20.7	15,244	11.4	2,040	0-1
Behavioural risk							
Has ever smoked	0.5	91,975	0.5	73,782	0.4	18,051	0-1

Frequent drinker	0.2	91,918	0.2	73,660	0.1	17,913	0-1
Socially Active	0.9	91,900	0.9	73,517	0.6	17,722	0-1

Notes:

Standard Deviations (SD) in parenthesis
[1] ADLs = Activities of Daily Living; [2] SAH = Self-Assessed Health (1 = excellent; 5 = poor); [3] EURO-D = European Depression Scale; [4] The levels reported are answers to the question "Are you able to make ends meet?"

The use of healthcare services increases with physical frailty. The average number of doctor visits for a frail subject is almost three times that of a robust subject, and the proportion of hospitalised frail subjects is four times the one of robust individuals. A similar pattern holds for psychologically frail individuals (see Appendix A2-4). However, a lower share of socially frail respondents (18%) was hospitalised than socially robust respondents (21%), while doctor visits were the same in both groups (30%) (see Appendix A2-4).

The first multivariate model confirmed most of the trends suggested by the descriptive statistics on hospitalisation and our three research hypotheses (Table 2.2). All else being equal, the odds of hospitalization were significantly higher in physically frail and pre-frail individuals without multimorbidity (+90% and +27%, respectively) than in robust, non-multimorbid, subjects. Interestingly, frailty per se tended to increase the odds of hospitalisation much more than multimorbidity without concomitant frailty (+34%), whereas the combined effect of both conditions increased the odds of hospitalisation (+108%). Notably, a concomitant multimorbidity moderates the effect of frailty on hospitalisation by reducing (–18%) the sum of the effects associated with the two separate conditions.

Table 2.2 - Estimates of the two models

	Model 1 *OR*		**Model 2** *IRR*	
	A (95% CI)	***B*** (95% CI)	***A*** (95% CI)	***B*** (95% CI)
Health Status				
Physical Frailty (ref. Robust)				
Pre-frail	1.271*** (1.180-1.370)	1.284*** (1.193-1.382)	1.129*** (1.114-1.144)	1.137*** (1.122-1.152)
Frail	1.898*** (1.617-2.229)	1.944*** (1.657-2.28)	1.296*** (1.242-1.353)	1.317*** (1.264-1.372)
Physical Frailty × Multimorbidity (ref. Robust × Multimorbidity)				
Pre-frail × Multimorbidity	.982 (.895-1.078)	.975 (.89-1.068)	.977** (.959-.996)	.968*** (.95-.986)
Frail × Multimorbidity	.819*** (.696-.964)	.799*** (.681-.937)	.919*** (.897-.942)	.901*** (.879-.923)
Social Frailty (ref. Robust)				
Pre-frail	.730*** (.653-.817)		.895*** (.881-.908)	
Frail	.529*** (.425-.660)		.896*** (.871-.922)	
Social Frailty × Multimorbidity (ref. Robust × Multimorbidity)				
Pre-frail × Multimorbidity	1.024 (.894-1.172)		1.051*** (1.032-1.070)	
Frail × Multimorbidity	1.116 (.867-1.437)		.999 (.966-1.033)	
Psychological Frailty (ref. Robust)				
Pre-frail	1.067 (.987-1.153)		1.061*** (1.050-1.073)	
Frail	1.305** (1.064-1.601)		1.074*** (1.039-1.110)	
Psychological Frailty × Multimorbidity (ref. Robust × Multimorbidity)				
Pre-frail × Multimorbidity	1.004 (.910-1.107)		.953*** (.94-.966)	
Frail × Multimorbidity	.766** (.613-.957)		.924*** (.895-.954)	
Multimorbidity	1.340*** (1.149-1.563)	1.370*** (1.277-1.47)	1.175*** (1.15-1.201)	1.190*** (1.176-1.204)
Long-term illness	1.188*** (1.127-1.251)	1.197*** (1.136-1.261)	1.173*** (1.165-1.181)	1.175*** (1.167-1.183)
Number of limitations with ADLs	1.103*** (1.074-1.132)	1.105*** (1.076-1.134)	1.046*** (1.041-1.050)	1.046*** (1.042-1.05)
Self-Assessed Health (ref. Excellent)				
Very good	1.219*** (1.077-1.38)	1.223*** (1.081-1.384)	1.158*** (1.139-1.178)	1.162*** (1.142-1.181)
Good	1.778*** (1.569-2.014)	1.788*** (1.579-2.025)	1.347*** (1.324-1.369)	1.353*** (1.331-1.376)
Fair	2.635*** (2.309-3.007)	2.663*** (2.334-3.038)	1.605*** (1.577-1.633)	1.615*** (1.587-1.644)
Poor	3.914*** (3.384-4.527)	3.948*** (3.414-4.565)	1.955*** (1.917-1.994)	1.965*** (1.927-2.004)
EURO depression scale	1.060*** (1.045-1.074)	1.062*** (1.049-1.076)	1.019*** (1.015-1.022)	1.020*** (1.017-1.023)
Demographic and Socio-Economic Status				
Male[§]	-	-	-	-

Living with Partner	.881**	0.939	1.072***	1.086***
	(.781-.995)	(.833-1.058)	(1.05-1.094)	(1.064-1.111)
Have Children	1.200*	1.217**	.984	.984
	(.994-1.449)	(1.009-1.469)	(.960-1.008)	(.961-1.008)
Age group (ref- 50-60)				
60-70	.944	0.940	.980***	.979***
	(.862-1.034)	(.858-1.029)	(.969-.991)	(.968-.989)
70-80	1.032	1.023	1.007	1.006
	(.902-1.182)	(.894-1.172)	(.99-1.024)	(.989-1.023)
80+	1.090	1.085	.998	.998
	(.909-1.307)	(.905-1.301)	(.975-1.021)	(.976--1.022)
Education (ref. Primary or less)				
Secondary	1.151	1.158	1.028	1.029
	(.609-2.174)	(.613-2.188)	(.857--1.233)	(.855-1.239)
Tertiary or more	1.085	1.091	.990	.991
	(.443-2.660)	(.448-2.656)	(.8-1.224)	(.801-1.23)
Able to make ends meet (ref. with great difficulty)				
With some difficulty	1.028	1.029	.981***	.981***
	(.946-1.117)	(.947-1.117)	(.971-.991)	(.971-.991)
Fairly easily	1.040	1.042	.963***	.964***
	(.947-1.141)	(.95-1.143)	(.952-.975)	(.952-.975)
Easily	.992	.993	.961***	.961***
	(.899-1.095)	(.9-1.095)	(.947-.975)	(.947-.975)
Household Wealth quartile (ref. Low)				
Middle-low	1.014	1.019	1.003	1.004
	(.948-1.085)	(.953-1.089)	(.984-1.023)	(.984-1.024)
Middle-high	1.007	1.013	1.014	1.015
	(.935-1.086)	(.939-1.093)	(.992-1.036)	(.993-1.037)
High	1.034	1.040	1.035**	1.037**
	(.953-1.123)	(.958-1.128)	(1.005-1.067)	(1.006-1.069)
Behavioral Risk				
Ever smoked daily	1.070*	1.074*	1.037***	1.038***
	(.994-1.152)	(.998-1.155)	(1.026-1.048)	(1.027-1.049)
Frequent Drinker	.897***	.897***	.970***	.970***
	(.842-.956)	(.842-.956)	(.957-.984)	(.956-.984)
Socially Active	1.090**	1.099**	1.036***	1.038***
	(1.012-1.174)	(1.020-1.184)	(1.025-1.048)	(1.026-1.05)
Context and Time				
Country dummies§	-	-	-	-
Time Fixed Effects (ref. Wave 8)				
Wave 4	.833***	.819***	.852***	.849***
	(.771-.9)	(.758-.884)	(.843-.861)	(.840-.857)
Wave 5	.896***	.885***	.914***	.912***
	(.838-.953)	(.829-.943)	(.907-.922)	(.904-.920)
Wave 6	.927***	.924***	.893***	.893***
	(.876-.980)	(.874-.977)	(.887-.9)	(.886-.899)
Number of observations	*56,442*†	*56,442*†	*161,105*†	*161,105*†

*** p<.01, ** p<.05, * p<.1

§ *Time-invariant variables (male and country) omitted in the fixed effects model*

† *The estimation sample varies across imputations, a regular circumstance when imputed variables are used as independent variables or when independent variables contain missing values (Models 1A and 1B: 56,442-56,473; Models 2A and 2B: 161,105-161,121)*

Hospitalisation is also more likely for individuals who were psychologically frail without multimorbidity, with 31% higher odds compared to psychologically robust, non-multimorbid

subjects. Similar to the first frailty dimension, the joint effect of psychological frailty and multimorbidity further increased the odds of hospitalisation (+34%), with the latter having a moderating effect (–23%) on the sum of the two separate effects.

In contrast, the odds of being hospitalised were significantly lower in socially frail individuals without multimorbidity (–27% and –47% for medium and high frailty, respectively) than in socially robust non-multimorbid subjects. The combined effect of both conditions was not subject to any moderation, with the joint condition of social prefrailty almost fully absorbing the influence of multimorbidity on the odds of hospitalization and social frailty reducing the odds by –29% compared with socially robust non-multimorbid subjects.

The second multivariate model confirmed most of the trends suggested by the descriptive statistics of doctor visits and our three research hypotheses (Table 2.2). All else being equal, the annual number of expected doctor visits was notably higher for physically pre-frail and frail individuals without multimorbidity (+13% and +30%, respectively) than for robust and non-multimorbid subjects. Similar to the previous measure of healthcare utilisation, frailty per se tended to increase the expected number of doctor visits more than multimorbidity without concomitant frailty (+18%), whereas the combined effect of both conditions increased the odds of seeing a doctor (+30 and +40%, respectively). Notably, a concomitant multimorbidity moderates the effect of frailty on the number of visits reducing the sum of the effects associated with the two separate conditions (–2% and –8%, respectively).

In addition, a higher number of doctor visits is more likely for psychologically pre-frail and frail individuals without multimorbidity (with the associated IRR increasing by 6% and 7%, respectively) than for psychologically robust non-multimorbid subjects. The joint effect of psychological frailty and multimorbidity further increases the expected number of doctor visits

(+19% and +17%, respectively), with the latter having a moderating effect (–5% and –8%, respectively) on the sum of the two separate effects.

Social frailty has the opposite effect on doctor visits; social frailty without concomitant multimorbidity tends to decrease the IRR by 10% compared to socially robust individuals without multimorbidity. The concomitance of multimorbidity had a slight moderating effect on the likelihood of an increased number of doctor visits only for socially pre-frail subjects (with a joint increase of over 10%).

2.4. Discussion

To the best of our knowledge, this study is the first to uncover the multidimensional nature of frailty and investigate the independent role of the physical, social, and psychological traits of frailty on the use of healthcare resources in a general, large cohort of subjects from different countries. These results provide novel and robust evidence of crucial importance for the sustainability of health systems.

We confirmed previous results regarding the effect of physical (or biological) frailty on increased healthcare utilisation, after adjusting for the main *need*, *predisposing,* and *enabling determinants*. We confirmed the results of Ilinca & Calciolari (2015), especially regarding the fact that physical frailty alone has a stronger positive influence on healthcare utilization than multimorbidity, and we took some further steps. First, the larger sample size and systematic approach to managing item non-response foster the accuracy and robustness of our results. Second, when considering the version "B" of each model, our updated results suggest that European health systems are progressively more stressed by demographic and epidemiologic trends in terms of resource utilisation over time, because the odds associated with the waves are progressively higher over

time. Third, the three considered dimensions of frailty have a different influence on healthcare use; while physical and psychological frailty are associated with increased resource utilisation, social frailty tends to reduce healthcare use. The latter trend may highlight the issue of accessibility rather than the actual lower needs for healthcare, challenging the relevant assumptions on which universal health system access relies.

Therefore, frailty ranks highly among *need* and *enabling determinants* of healthcare access, especially in ageing societies. In this respect, using appropriate tools to measure frailty and thus identify the frail population should be the first step in prioritising such a relevant condition in health policies (Van Kan et al., 2008). However, as of today, convergence towards a standardized definition of the condition is still a "work in progress" at the international level, thus challenging prevention, clinical management, and research alike (Rodríguez-Laso et al., 2019; World Health Organization, 2017a). In addition, several frailty instruments have been developed: some are short and fast measures, while others are sophisticated and time-consuming tools; others seem to perform better for population-level screening, while others are more suitable for clinical settings (Dent et al., 2016); several tools focus on physical frailty, while others measure cognitive and socio-psychological domains (Collard et al., 2012). The most important associations focused on aging – the International Association of Nutrition and Aging (IANA), the joint-action ADVANTAGE, the Royal College of Physicians, the French Society of Geriatrics and Gerontology – have been working to agree on a uniform definition of frailty. Although a common definition or assessment tool (Rodríguez-Laso Angel et al., 2019; Rolland et al., 2011; Royal College of Physicians, 2020; Van Kan et al., 2008) has not been achieved yet, a consensus has been achieved on the need for such a tool to be quick to administer, easy to use in clinical settings, validated, reliable, meant for screening, inexpensive, and requiring no special equipment. According to these recommendations, instruments such as the FRAIL or Edmonton Frail scales would fulfil

the aforementioned conditions (Kojima et al., 2019), although only the latter aims to measure the three domains of frailty investigated in our study. Valid and easy-to-use instruments could allow a two-step approach. In the first phase, frailty would be pragmatically measured by any physician or nurse to rapidly identify cases at risk, in the second step, a more comprehensive assessment could be performed by an experienced practice nurse or a specialized health professional (de Lepeleire et al., 2009). In addition, it is important to consider that electronic medical records may help measure frailty automatically (Kojima et al., 2019), based on data collected in the clinical setting and eventually shared across care settings. In the UK and Scotland, the electronic Frailty Index (eFI) is used to identify people with frailty on a population basis, using routinely collected primary care data (de Lepeleire et al., 2009). The use of the eFI may also support the thesis of the two-steps approach, in which the eFI represents a fast, easy-to-use, and clinically valid tool for the preliminary and rapid identification of frail older people at risk.

Frailty assessment could become a relevant factor for risk stratification and prevention; however acknowledging its complexity and multidimensionality is fundamental for its appropriate management.

The multidimensionality of frailty, as shown in our findings, suggests the importance of designing and implementing integrated and comprehensive care strategies, addressing both somatic and psycho-social issues, and being carried forward by all providers and professionals from different sectors, including healthcare, social care, housing, and community support. Most European countries, with a few exceptions, do not have frailty-specific programs in place and, overall, health systems tend to seek integration within the health care sector but neglect the lack of continuity between primary and hospital care, and between health and social care. In Norway (Norwegian Ministry of Health and Care Services, 2019) and in the Netherlands (Hoedemakers et al., 2019), the integration of health care and social care is considered a political priority to

address the unmet needs of the frail elderly. The Dutch "Care Chain Frail Elderly" program targets community-dwelling frail elderly patients and aims to keep them at home and reduce secondary and long-term care by relying on well-defined primary care pathways (Hoedemakers et al., 2019). Similar models have been implemented in England (NHS England, 2014) and Scotland (Hendry et al., 2016) for complex elderly patients. In Cataluña, five-year regional health plans fostered the integration of health and social services with attention to frail chronic patients (Baltaxe et al., 2019).

The delivery of care is often fragmented and organ- or disease-specific, and healthcare provision is mostly driven by the need of cost containment, relying on easily measurable proxies for illness or disability, such as multimorbidity, polypharmacy, or symptoms, rather than treatment pathways and the patient journey. Appropriate care for frail patients require health systems to shift away from such an approach, and attention to frailty represents a turning point towards the integration and coordination of health and social care, embracing a holistic, multidimensional, bio-psycho-social approach (De Lepeleire et al., 2009b): a view also advocated by the WHO and joint-action ADVANTAGE (Rodríguez-Laso Angel et al., 2019; World Health Organization, 2017a, 2017b). This should encourage policy makers, health care professionals, researchers in geriatrics and stakeholders in general alike, to shift from disease- to *healthy aging*-focused care.

In addition, since the influence of frailty on the likelihood of hospitalization is greater than that on doctor visits, one might wonder whether improving the assessment and treatment of frailty may help shift the burden from acute to other care settings, with consequential economic relief at the system level, providing appropriate integration across care settings (Hendry et al., 2019; Royal College of Physicians, 2020; Wodchis et al., 2015). In fact, if frailty is detected in acute care settings, a greater level of coordination between emergency and acute medical units, and between primary and geriatric care, would likely reduce duplications while improving

outcomes. In other words, the interplay between health and community care greatly influences the impact of frailty on the access and use of healthcare services.

2.4.1. Limitations

Our study aimed to be as representative of the European population as possible. However, we had to exclude some countries and waves because of different points-in-time country-entries in the dataset, variations in the data collection methods (*that is*, selected variables measured differently across waves), and an excessive share of missing values in the main selected variables in some waves. Despite this, our data and analytical approach provided results that were generalizable to several European national contexts. Nevertheless, further research at the country level may help to design interventions that are optimised for the relevant specificities of a target health system.

SHARE is not exempted from non-sampling errors, thus challenging the theoretical conditions of inference (Börsch-Supan et al., 2013). In fact, the randomness of probability sampling is not met because the SHARE baseline and refreshment samples drawn in each wave: 1) suffer from unit non-response; 2) are subject to attrition at each follow-up; 3) do not allow us to understand the evolution of the population drawn in the first wave. We addressed the first issue using the most advanced methods aimed at dealing with missing data so that the extent of the problem was almost negligible in the used dataset. However, two other issues were not addressed because out of our control.

Although confident in accounting for individual unobserved heterogeneity by using fixed effects to model each of the two target outcomes, we were unable to measure some likely relevant *enabling factors*, such as health insurance status (complimentary vs. basic).

2.5. Conclusions

The current study provides evidence for the importance of measuring frailty along its physical, social, and psychological dimensions, especially when analysing healthcare use. Hospital admissions and number of doctor visits were significantly and differently influenced by different facets of frailty in elderly Europeans. Therefore, it is important to reach consensus on a standardised definition and measurement tool for frailty by adopting a holistic and multidimensional approach. This would be fundamental in helping professionals detect frail older adults, select the most suitable interventions which should follow an integrated care approach based on treatment pathways rather than on organ- or disease specific delivery of care, and support policymakers in defining the appropriate conditions and priorities to cope with the needs of an ageing society.

Appendix

Appendix A: Descriptive statistics

Table A2- 1: Proportion age-group by gender

	Female	**Male**
50-60	58.17%	41.83%
60-70	54.53%	45.47%
70-80	54.80%	45.20%
80+	58.90%	41.10%
N	*185,169*	

Table A2- 2: Proportion physical frailty, social frailty, psychological frailty and multimorbidity over time

	Wave 4	**Wave 5**	**Wave 6**	**Wave 8**
Physical Frailty[i]				
Robust	49.15%	50.68%	50.37%	49.53 %
Pre-frail	40.97%	39.67%	39.98%	40.00%
Frail	9.88%	9.65%	9.66%	10.46%

Social Frailty[II]				
Robust	7.57%	8.54%	10.37%	10.44%
Pre-frail	87.71%	87.78 %	86.14%	85.68%
Frail	4.73%	3.69%	3.49%	3.88%
Psychological Frailty[III]				
Robust	27.93%	29.30%	29.65%	29.36%
Pre-frail	66.99%	65.69%	65.99%	66.47%
Frail	5.08%	5.01%	4.36%	4.18%
Multimorbidity[IV]	48.35%	48.62%	48.98%	53.98%

[I] *N=183,864;* [II] *N=184,563;* [III] *N=184,497;* [IV] *N=185,169*

Table A2- 3: Hospitalizations over time

	Wave 4	**Wave 5**	**Wave 6**	**Wave 8**
Hospitalized[I]	15.8%	15.8%	15.9%	16.9%
Mean doctor visits[II]	6.75	6.96	6.77	7.51

[I] *N=185,067;* [II] *N=184,829*

Table A2- 4: Doctor visits quintile by frailty and multimorbidity status

		Doctor visits quintile				**Hospitalized**
		Low	**Middle-low**	**Middle-high**	**High**	
Physical frailty[I]	Robust	41.85%	23.24%	20.88%	14.03%	9.95%
	Pre-frail	25.43%	19.95%	25.06%	29.56%	18.59%
	Frail	12.64%	13.12%	22.69%	51.54%	35.17%
Psychological Frailty[II]	Robust	42.46%	22.67%	20.27%	14.60%	11.16%
	Pre-frail	29.03%	20.56%	23.68%	26.72%	17.30%
	Frail	16.54%	14.88%	24.19%	44.39%	26.73%
Social Frailty[III]	Robust	27.23%	19.43%	23.81%	29.53%	21.47%
	Pre-frail	33.14%	21.11%	22.55%	23.20%	15.31%
	Frail	26.75%	19.72%	23.77%	29.76%	17.66%
Multimorbidity[IV]	Yes	17.25%	19.91%	27.34%	35.50%	22.29%
	No	47.04%	21.82%	18.15%	12.99%	9.87%

Doctor visits: [I] *N=183,824*; [II] *N=184,367*; [III] *N=184,429*; [IV] *N=185,829*
Hospitalization: [I] *N=183,859*; [II] *N=184,482*; [III] *N=184,549*; [IV] *N=185,067*

Table A2- 5: Proportion of physical frailty by country

	Physically Robust	**Physically pre-frail**	**Physically frail**	**Total**
Austria	59.03%	32.35%	8.62%	100%
Germany	55.68%	38.00%	6.32%	100%
Sweden	56.46%	38.43%	5.12%	100%
Spain	38.57%	43.11%	18.32%	100%
Italy	43.61%	41.90%	14.49	100%
France	47.59%	42.18%	10.23%	100%

Denmark	60.14%	34.58%	5.28%	100%
Switzerland	60.17%	36.00%	3.83%	100%
Belgium	50.25%	40.13%	9.62%	100%
Czech Republic	53.04%	38.50%	8.46%	100%
Slovenia	53.64%	36.63%	9.73%	100%
Estonia	36.34%	51.45%	12.21%	100%
N		*183,864*		

Appendix B: Analytical models

Table B2- 1: Fixed-effects logistic regression: Hospitalization

	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Frailty and Multimorbidity				
Physical Frailty (ref. Robust)				
Pre-frail	1.541*** (1.434-1.656)	1.286*** (1.192-1.388)	1.277*** (1.183-1.378)	1.275*** (1.182-1.376)
Frail	3.275*** (2.836-3.781)	2.028*** (1.738-2.367)	2.006*** (1.711-2.351)	2.008*** (1.713-2.354)
Physical Frailty x Multimorbidity (ref. Robust x Multimorbidity)				
Pre-frail x Multimorbidity	.984 (.9-1.077)	.984 (.898-1.079)	.98 (.894-1.075)	.979 (.893-1.073)
Frail x Multimorbidity	.790*** (.679-.919)	.817** (.698-.956)	.802*** (.683-.94)	.800*** (.682-.938)
Social Frailty (ref. Robust)				
Pre-frail	.692*** (.623-.768)	.717*** (.645-.798)	.721*** (.648-.802)	.723*** (.65-.805)
Frail	.518*** (.419-.639)	.518*** (.418-.642)	.516*** (.416-.641)	.519*** (.418-.645)
Social Frailty x Multimorbidity (ref. Robust x Multimorbidity)				
Pre-frail x Multimorbidity	1.059 (.932-1.203)	1.042 (.915-1.186)	1.033 (.907-1.177)	1.033 (.907-1.176)
Frail x Multimorbidity	1.157 (.905-1.478)	1.17 (.912-1.5)	1.132 (.88-1.456)	1.132 (.88-1.456)
Psychological Frailty (ref. Robust)				
Pre-frail	1.250*** (1.161-1.345)	1.074* (.995-1.16)	1.067* (.988-1.152)	1.067 (.988-1.152)
Frail	1.864*** (1.532-2.266)	1.326*** (1.082-1.626)	1.302** (1.061-1.598)	1.304** (1.062-1.602)
Psychological Frailty x Multimorbidity (ref. Robust x Multimorbidity)				
Pre-frail x Multimorbidity	.996 (.904-1.098)	1.003 (.91-1.106)	1.007 (.913-1.111)	1.006 (.911-1.11)
Frail x Multimorbidity	.739*** (.593-.922)	.751** (.6-.94)	.763** (.609-.956)	.759** (.605-.952)
Multimorbidity	1.507*** (1.301-1.746)	1.343*** (1.156-1.559)	1.338*** (1.152-1.555)	1.339*** (1.153-1.556)
Other Health Status				
Long-term illness		1.199*** (1.139-1.263)	1.193*** (1.132-1.257)	1.19*** (1.129-1.253)
Number of limitations with ADLs		1.114*** (1.086-1.143)	1.107*** (1.079-1.136)	1.107*** (1.079-1.136)
Very good		1.234*** (1.091-1.396)	1.232*** (1.088-1.394)	1.227*** (1.084-1.389)
Good		1.834*** (1.620-2.076)	1.811*** (1.599-2.052)	1.801*** (1.589-2.040)
Fair		2.732*** (2.395-3.115)	2.693*** (2.36-3.072)	2.674*** (2.343-3.052)

Poor		4.039*** (3.495-4.668)	3.992*** (3.452-4.617)	3.963*** (3.426-4.584)
EURO depression scale		1.056*** (1.043-1.07)	1.058*** (1.044-1.072)	1.059*** (1.045-1.073)
Demographic and Socio-Economic Status				
Male			-	-
Living with partner			.840*** (.745-.947)	.847*** (.751-.955)
Have children			1.201* (.995-1.449)	1.202* (.995-1.450)
Age group (ref. 50-60)				
60-70			1.054 (.972-1.144)	1.042 (.96-1.131)
70-80			1.283*** (1.151-1.43)	1.249*** (1.118-1.395)
80+			1.490*** (1.299-1.710)	1.433*** (1.244-1.651)
Education (ref. Primary or less)				
Secondary			1.122 (.66-1.910)	1.123 (.657-1.922)
Tertiary or more			1.108 (.541-2.27)	1.105 (.537-2.272)
Able to make ends meet (ref. with great difficulty)				
With some difficulty			1.034 (.952-1.123)	1.035 (.953-1.124)
Fairly easily			1.056 (.964-1.156)	1.056 (.964-1.157)
Easily			1.020 (.925-1.125)	1.020 (.924-1.125)
Household Wealth Quartile (ref- Low)				
Middle-low			.993 (.93-1.061)	.993 (.929-1.061)
Middle-high			.971 (.895-1.053)	.97 (.894-1.052)
High			1.002 (.909-1.103)	1.001 (.908-1.104)
Behavioral risk				
Ever smoked daily				1.023 (.954-1.097)
Frequent drinker				.877*** (.825-.931)
Socially active				1.085** (1.008-1.168)
Context and Time				
Country dummies				
Time Fixed Effects				
Number of observations	56,940	56,885	56,567	56,451

Table B2- 2 Fixed-effects Poisson regression: Number of doctor visits

	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Frailty and Multimorbidity				
Physical Frailty (ref. Robust)				
Pre-frail	1.231*** (1.214-1.248)	1.136*** (1.119-1.153)	1.132*** (1.116-1.148)	1.132*** (1.116-1.148)
Frail	1.676*** (1.623-1.731)	1.344*** (1.304-1.385)	1.319*** (1.278-1.361)	1.320*** (1.278-1.363)
Physical Frailty x Multimorbidity (ref. Robust x Multimorbidity)				
Pre-frail x Multimorbidity	.981** (.964-.997)	.979** (.963-.996)	.978** (.961-.995)	.977** (.960-.994)
Frail x Multimorbidity	.886*** (.856-.918)	.902*** (.874-.932)	.908*** (.878-.938)	.907*** (.877-.938)
Social Frailty (ref. Robust)				
Pre-frail	.875*** (.860-.890)	.890*** (.875-.905)	.895*** (.880-.910)	.896*** (.881-.911)
Frail	.874*** (.850-.899)	.88*** (.856-.905)	.892*** (.867-.918)	.894*** (.869-.919)
Social Frailty x Multimorbidity (ref. Robust x Multimorbidity)				
Pre-frail x Multimorbidity	1.054*** (1.026-1.083)	1.048*** (1.022-1.075)	1.047*** (1.021-1.074)	1.047*** (1.022-1.074)
Frail x Multimorbidity	.988 (.954-1.024)	.995 (.961-1.031)	.994 (.96-1.03)	.994 (.96-1.03)
Psychological Frailty (ref. Robust)				
Pre-frail	1.136*** (1.121-1.15)	1.069*** (1.056-1.081)	1.064*** (1.051-1.076)	1.063*** (1.051-1.076)
Frail	1.267*** (1.224-1.311)	1.092*** (1.059-1.125)	1.091*** (1.058-1.125)	1.091*** (1.058-1.125)
Psychological Frailty x Multimorbidity (ref. Robust x Multimorbidity)				
Pre-frail x Multimorbidity	.955*** (.941-.969)	.952*** (.939-.966)	.954*** (.941-.968)	.954*** (.94-.968)
Frail x Multimorbidity	.905*** (.875-.937)	.917*** (.889-.947)	.916*** (.888-.946)	.916*** (.887-.945)
Multimorbidity	1.272*** (1.239-1.305)	1.193*** (1.165-1.222)	1.187*** (1.158-1.216)	1.187*** (1.159-1.216)
Other Health Status				
Long-term illness		1.180*** (1.172-1.188)	1.176*** (1.168-1.184)	1.175*** (1.167-1.183)
Number of limitations with ADLs		1.054*** (1.051-1.058)	1.051*** (1.048-1.054)	1.051*** (1.048-1.055)
Self-Assessed Health (ref. Excellent)				
Very good		1.178*** (1.159-1.197)	1.167*** (1.148-1.187)	1.167*** (1.148-1.186)
Good		1.378*** (1.356-1.401)	1.362*** (1.34-1.385)	1.36*** (1.338-1.383)
Fair		1.644*** (1.615-1.672)	1.627*** (1.599-1.656)	1.624*** (1.596-1.652)
Poor		2.005*** (1.966-2.043)	1.982*** (1.945-2.021)	1.979*** (1.942-2.017)
EURO depression scale		1.017*** (1.015-1.02)	1.019*** (1.016-1.021)	1.019*** (1.017-1.022)
Demographic and Socio-Economic Status				
Male			-	-
Living with partner			1.035*** (1.017-1.052)	1.037*** (1.02-1.055)
Have children			.987 (.96-1.015)	.987 (.96-1.015)
Age group (ref. 50-60)				
60-70			1.060*** (1.05-1.071)	1.056*** (1.045-1.066)
70-80			1.18***	1.169***

			(1.164-1.196)	(1.153-1.186)
80+			1.257***	1.241***
			(1.235-1.28)	(1.218-1.264)
Education (ref. Primary or less)				
Secondary			1.089*	1.088*
			(.984-1.205)	(.982-1.206)
Tertiary or more			1.055	1.053
			(.908-1.226)	(.905-1.225)
Able to make ends meet (ref. with great difficulty)				
With some difficulty			.983**	.982**
			(.969-.996)	(.968-.996)
Fairly easily			.969***	.968***
			(.952-.986)	(.951-.985)
Easily			.972***	.971***
			(.955-.989)	(.954-.988)
Household Wealth Quartile (ref- Low)				
Middle-low			1.000	1.000
			(.985-1.015)	(.985-1.014)
Middle-high			1.012	1.011
			(.993-1.031)	(.992-1.031)
High			1.037***	1.037***
			(1.015-1.06)	(1.015-1.059)
Behavioral risk				
Ever smoked daily				1.001
				(.992-1.011)
Frequent drinker				.959***
				(.948-.971)
Socially active				1.032***
				(1.022-1.043)
Context and Time				
Country dummies				
Time Fixed Effects				
Number of observations	161,622	161,583	161,362	161,137

Figure B2- 1: Graph coefficient plot: Hospitalization

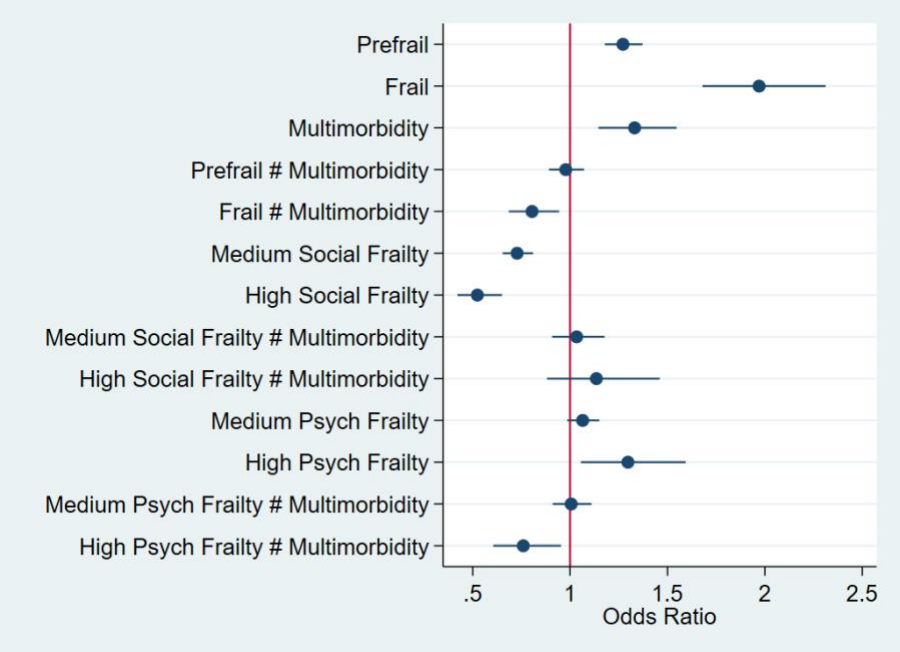
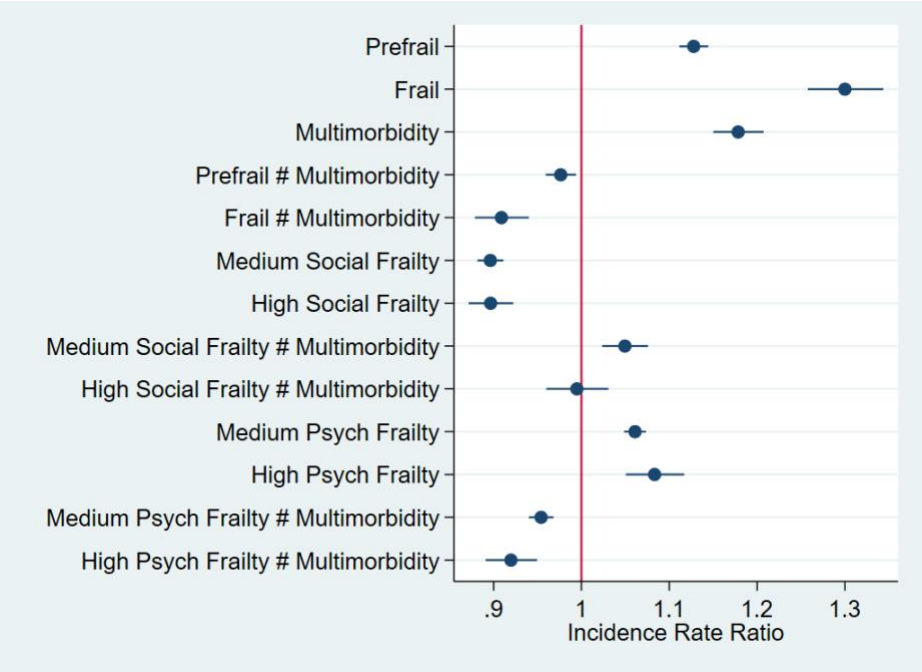


Figure B2- 2: Graph coefficient plot: Doctor visits



3. Does the Swiss gatekeeping model optimize healthcare access in frail elderly? Evidence from the Swiss Health Survey.

3.1. Introduction

For decades, discussions have centered around the challenges posed by care fragmentation in health and social care systems. Widespread consensus and evidence suggest that such fragmentation can compromise patient outcomes, depersonalize care, foster inequality, inefficiency, ineffectiveness, and result in significant additional costs (Frandsen et al., 2015; OECD, 2023; Stange, 2009).

In one of his seminal works, Enthoven highlighted a paradox where the growing prevalence of chronic conditions necessitates a multidimensional approach and heightened coordination, yet increased specialization exacerbates fragmentation by fostering narrowly trained specialists (Enthoven, 2009). The main message of his work emphasizes the importance of integrating and coordinating care delivery, a crucial point for enhancing healthcare quality, improving outcomes, and mitigating costs, especially for patients with complex needs (Enthoven, 2009). In fact, fragmented care becomes even more relevant in patients with multiple chronic conditions, functional disability, and complex biopsychosocial needs (Bilazarian, 2021; Calciolari & Luini, 2023; Lloyd et al., 2017), as they require care from various providers across multiple settings, often experience repeated referrals, navigate concurrent outpatient pathways, and necessitate social care services (OECD, 2023; Prior et al., 2023).

To address care complexity, many countries are pursuing holistic, patient-centered, and integrated healthcare models instead of disease-focused approaches (OECD, 2023). In this respect, the role of primary care is increasingly acknowledged as crucial for achieving efficiency, equity, and improved health outcomes. This is accomplished through heightened coordination, appropriateness, and prevention, minimizing unnecessary interventions, duplications, and polypharmacy while maintaining or improving the quality of care (EXPH, 2014; Halm et al., 1997; Kringos et al., 2013; Scott, 2000). Such functions are especially relevant in health systems where General Practitioners (GPs) have a gatekeeping role (Brekke et al., 2007; EXPH, 2014; Scott, 2000). In Europe, gatekeeping systems are present in both tax-funded healthcare systems – such as those in the UK, Scandinavian countries, and Spain – and social insurance systems, as those in Switzerland, the Netherlands, and Germany (Velasco Garrido et al., 2011).

However, the extant literature lacks empirical research examining the consequences of healthcare insurance schemes incorporating the gatekeeping principle on healthcare utilization. Moreover, there is a notable absence of such literature specifically dedicated to addressing patient populations with complex needs.

In a systematic review, Sripa and colleagues (2019) concluded that gatekeeping associates with reduced healthcare utilization and expenditure, improved quality of care, but diminished patient satisfaction. Most of the reviewed research focused on the United States (US), with one study encompassing 19 European countries and focused on a target population dealing with complex or chronic conditions—namely, cancer patients. Notably, in this study, the investigated outcome was the survival rate, which in gatekeeping schemes was significantly lower compared to those with direct access, despite primary care gatekeeping was not found associated with delayed patient referral (Vedsted & Olesen, 2011). Another study compared patients with

mental disorders treated in Germany and the Netherlands, respectively without and with a gatekeeping system for access to specialist visits. The study showed that the gatekeeping was associated with a reduction in the number of contacts with other physicians and the intensity of treatment, but also with an increased rate of hospital admissions (Linden et al., 2003). Likewise, Delnoij and colleagues (2000), in their study on the general population across 18 OECD countries, found that gatekeeping systems showed capacity to limit ambulatory care expenditures. However, they emphasized the need for further research to disentangle the effects of micro-level mechanisms (such as gatekeeping) from other structural aspects of health systems. In European health systems, including Switzerland, Kringos and colleagues (2013) found an association between a robust primary care[14] and better population health, reduced rates of avoidable hospitalizations, and lower socioeconomic inequality. A study conducted in Italy, where general practitioners serve as gatekeepers, revealed that extending the opening hours of primary care practices to up to 12 hours per day is associated to a decrease in the inappropriate utilization of emergency services (Lippi Bruni et al., 2016).

Among the studies conducted in the US, it was found that gatekeeping slightly increases the number of primary care physician visits (Ferris et al., 2001), but reduces outpatient visits, hospitalization rates (Schillinger et al., 2000) and Emergency Department (ED) visits (Franco et al., 1997).

Switzerland serves as an ideal laboratory for investigating the impact of gatekeeping models on the use of various types of care services. This is due to the patients' freedom to choose between different schemes of mandatory health insurance. In particular, the basic scheme provides unrestricted access to secondary care, while alternative schemes limit the choice to a preferred

[14] The authors classify primary care systems according to five key dimensions: structure, access, coordination, continuity, and comprehensiveness.

network of providers or mandate specific decisional procedures to access care services in exchange for lower insurance premiums. Such alternative schemes include: 1) the Health Maintenance Organizations (HMOs), which requires the patient to use an HMO[15] as first point of contact; 2) the General Practitioner (GP) scheme, requiring an initial consultation with a selected family physician to access any further care; 3) the Telmed (CC) scheme, where patients are required to contact a consultation hotline before accessing any healthcare service. All the alternative schemes apply limitations on provider selection and act on the principles of gatekeeping (Berchtold & Peytremann-Bridevaux, 2011).

The individual choice of health insurance scheme is based, other than on the degree of freedom of provider choice or the autonomy in accessing covered services, also on the premiums and on the annual deductible (individuals can choose between six different levels of deductible). Health insurance companies compete in terms of premiums, which must be community-rated based on three age categories and are prohibited from generating profits from their basic insurance schemes (De Pietro et al., 2015; Sturny, 2020). In addition to a basic insurance scheme, individuals can voluntarily purchase complementary health insurance for additional coverage that may include, among others, alternative medicine, private hospital rooms, or additional dental care. Unlike basic health insurance, insurers are permitted to generating profits out of the complementary insurance (De Pietro et al., 2015; Sturny, 2020).

In Switzerland, the rise of alternative health insurance models based on the principle of gatekeeping has been notable in recent years and reflects ongoing efforts to optimize healthcare

[15] In Switzerland, an HMO practice is a collaborative healthcare model housed within a group practice or health center, where family physicians, specialists, and therapists across diverse medical disciplines operate synergically. This arrangement affords patients access to a comprehensive array of medical services, contingent upon the scale of the practice. Notably, HMO practices are delimited by catchment areas, delineating specific regions within which each practice extends its services.

delivery, promote preventive care, and manage healthcare costs more effectively through coordinated primary care management.

Primary care holds a central role in Switzerland's healthcare system and is highly valued by the population. This importance was highlighted in 2014 when an overwhelming majority approved Article 117a of the Federal Constitution. This article recognizes primary care as essential for providing universal, adequate, and high-quality healthcare to the population. Primary care in Switzerland can be examined from two perspectives: medical practices and outpatient centers as enterprises, and independent physicians. Medical practices are smaller setups where individual or groups of doctors provide primary and specialist care, ranging from solo practitioners to collaborative group practices sharing resources. Outpatient centers are larger facilities offering a wide range of medical services without requiring overnight stays. They house multiple specialties, including diagnostics, minor surgeries, and therapies, providing efficient, coordinated care so patients can receive various treatments and consultations in one location. There are several networks of medical practices and outpatient centers (MediX, Medbase, Santémed among others); they vary in size, scope of services, and geographic coverage, but they share a common goal of improving healthcare delivery through collaboration, integration of services, and patient-focused care models (Ufficio Federale di Statistica, 2023).

As of December 31, 2021, there were 13,931 medical practices and outpatient centers, 40.4% of which focused on primary care. Single-doctor primary care practices have declined, dropping from 52.5% in 2018 to 49.9% in 2021, as more independent primary care physicians are joining group practices, increasing from 38.4% in 2018 to 41.1% in 2021, with most groups being small in size. In 2021, 44.7% of independent doctors worked with one other colleague, while 36.7% worked with two or three colleagues. Most practices and centers are located in

urban areas (73.3%), compared to 18.2% in peri-urban areas and 8.5% in rural areas (Ufficio Federale di Statistica, 2023).

In Switzerland, only one study analyzes the effect of a gatekeeping plan introduced in the region of Aarau in 1997 and compared it with an ordinary plan in the general population (Schwenkglenks et al., 2006). The authors employ multivariate regression analyses on a randomly selected sample of (N=466) individuals. They found that gatekeeping is linked to cost savings, ranging between 15% to 19% per insured. However, the study traces back to 2006, a period when alternative health insurance schemes were still in their infancy and it was conducted on individuals aged 18 and above, with no specific medical condition.

This research gap warrants attention, particularly considering the growing relevance of care coordination for chronic and complex patients. Notably, frail elderly individuals emerge as a critical focus for preventing unnecessary spending, requiring targeted interventions and personalized solutions that address social needs, offer home support, and provide long-term services (Figueroa et al., 2017).

3.1.1. Aim of the Study

This research aims to fill a gap in the extant literature by investigating the influence of alternative health insurance schemes on the use of health care services in the Swiss elderly frail population. Specifically, we seek to answer the following research question: "Considering the elderly frail population, does the choice of insurance schemes with a gatekeeping mechanism influence the use of health care services?" The overarching aim is to derive policy implications on the adoption of gatekeeping mechanisms for a specific target population of complex patients.

Our investigation entails an econometric analysis, whose analytical timeframe spans a decade, covering three repeated cross-sectional waves of data. To achieve robust findings, we first implemented a matching technique to pair individuals with a gatekeeping health insurance scheme (treatment group) with subjects covered by a standard health insurance scheme (control group). Then, we used the matched sample to conduct six distinct regression models, tailored to the nature of the outcome variable, specifically: number of GP visits, number of specialist visits, number of other outpatient visits[16], access to day-hospital, number of hospitalizations, number of emergency service admissions.

As the theoretic basis for our analyses, we employed a revised version of the Behavioral Model of Access to Medical Care (Andersen, 1995; Andersen & Newman, 1973), a conceptual framework that provides a structured interpretive lens through which we selected and examined our data (Figure 3.1)

Based on the previously reviewed literature, we defined the following hypotheses:

H1*: Individuals with a gatekeeping model tend to use more primary care.*

H2*: Individuals with a gatekeeping model tend to use less specialist care and less other outpatient services*

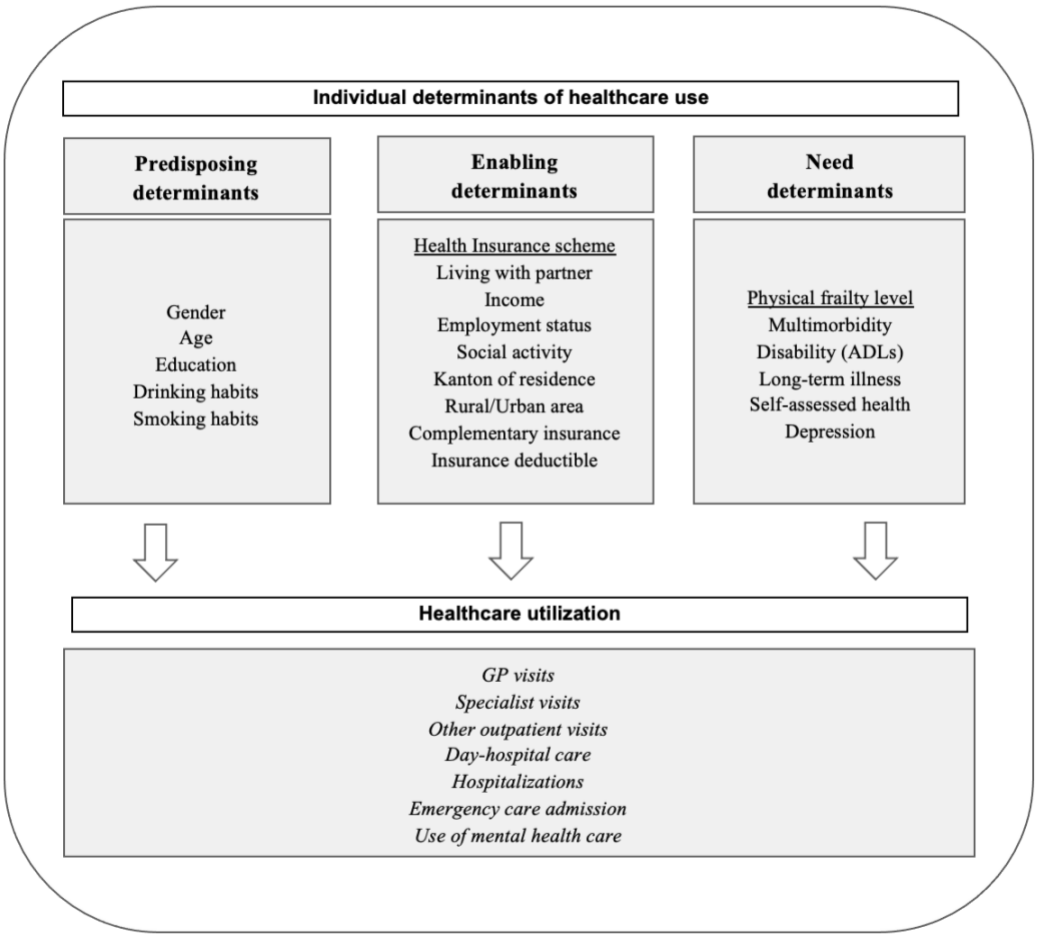
H3: *Individuals with a gatekeeping model tend to use less day-hospital care.*

H4*: In Individuals with a gatekeeping model hospitalization is reduced.*

H5*: In Individuals with a gatekeeping model emergency service admissions are reduced.*

[16] Other outpatient services encompass appointments with a dentist, dental hygienist, psychologist, psychotherapist, chiropractor, physiotherapist, optometrist, podiatrist, and naturopath.

Figure 3.1: Conceptual framework



Source: adapted from the Andersen and Newman's behavioral model (R. Andersen & Newman, 1973).

3.2. Methods

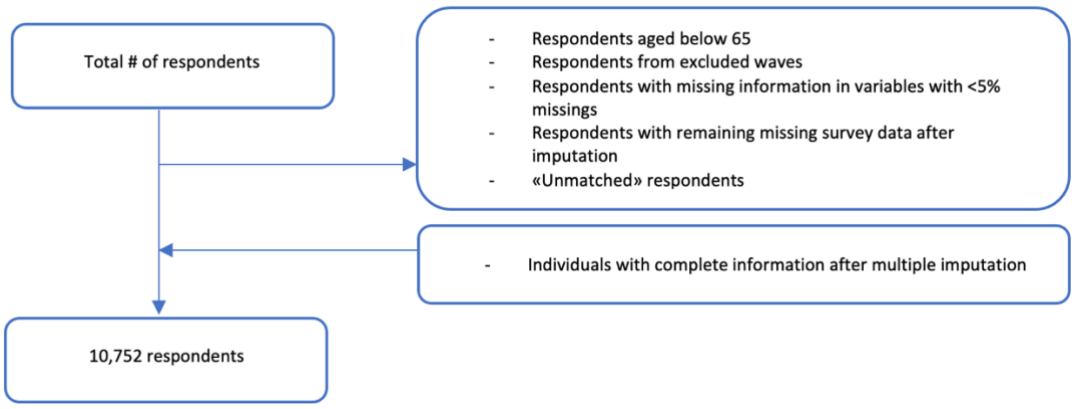
3.2.1. Data analysis and sample

This study is based on pooled data from the Swiss Health Survey (SHS), years 2007, 2012, and 2017. The SHS is an extensive cross-sectional database, conducted every five years since 1992 and representative of the Swiss population. The SHS gathers information on health, demographic and socio-economic status, lifestyle choices, healthcare utilization, and health insurance scheme of individuals aged 15 and above. We made the decision to omit the most recent wave of data (from 2022) because it lacked crucial information regarding health

insurance scheme, our exposure variable. Similarly, we chose to exclude data from waves prior to 2007 due to the limited availability of alternative health insurance schemes before such year.

We focused on the elderly population, aged 65 years and above, residing in their own homes, and matched based on various attributes to create treatment and control groups for our study. Finally, observations with incomplete survey data were disregarded. The final sample is composed of 10,752 individuals: 2,702 from the 2007, 3,850 from the 2012 and 4,200 from the 2017 wave (Figure 3.2).

Figure 3.2 – Sample exclusion criteria flow chart



3.2.2. Measures

Outcome variables

The outcome variables used to measure health services utilization are the following:

1. Number of GP visits in the last 12 months, a count response variable in the range 0-97
2. Number of specialist visits in the last 12 months, a count response variable in the range 0-97

3. Number of other outpatient visits in the last 12 months, a count response variable in the range 0-117
4. Having used day-hospital care in the last 12 months, a binary response variable
5. Number of hospital admissions in the last 12 months, a count response variable in the range 0-60
6. Number of Emergency Service admissions in the last 12 months, a count response variable in the range 0-15

Exposure

Our independent variable of interest, the presence of gatekeeping in the insurance scheme, was operationalized through an original variable of the SHS denoting the type of insurance scheme held by respondents, *i.e.,* standard scheme, GP scheme, HMO scheme, or Telmed scheme. From this categorization, we derived the exposure, a binary variable wherein a value of 1 indicated possession of gatekeeping (comprising the GP, HMO, or Telmed), while a value of 0 denoted adherence to the standard scheme.

Covariates

The relationship between gatekeeping and healthcare use is adjusted for *need, predisposing, enabling factors*, as well as survey year. *Need factors* include frailty level and other healthcare status such as multimorbidity, self-assessed health, long-term illness, limitations with ADLs, and major depression; *predisposing factors* include age, gender, education, and lifestyle behaviors such as smoking and drinking status; *enabling factors* include other health insurance status such as annual deductible and complementary health insurance, home care or informal care, wealth, occupation, social activity, living alone, canton of residence, residence in urban/rural area. To measure physical frailty, we embraced the Frailty Phenotype (FP)

definition proposed by Fried et al. (2001), which assesses five dimensions: grip strength, energy levels, walking speed, physical activity, and unintentional weight loss. Utilizing SHS data across the five dimensions, we constructed a composite physical frailty score. According to this score, an individual is deemed frail when three or more of the dimensions are compromised, robust in the absence of any deficits, and pre-frail in intermediate cases[17]. For the purposes of our study, we simplified the measure into two categories, consolidating frail and pre-frail subjects into a single category. While Le Pogam et al., (2022) categorized pre-frail and robust individuals as non-frail, our classification includes pre-frail individuals within the frailty group, aligning with the results of Calciolari & Luini (2023) showing similar healthcare utilization patterns for pre-frail and frail individuals. Additionally, by consolidating frail and pre-frail individuals, we bolstered the statistical power of our analysis, a useful strategy considering the limited number of frail subjects in our sample.

3.2.3. Statistical Analysis

To enhance the validity of causal inference, we employ a three-steps approach: 1) we impute missing values using multiple imputation; 2) we use Coarsened Exact Matching to improve balance between treatment and control groups; 3) we run multivariate regressions to correct for the remaining confounding. All statistical analyses are performed using the statistical software package STATA 18.0 (StataCorp, College Station, TX, USA).

Imputation of missing values

The SHS dataset, like many large surveys, encounters issues with item non-response. To address this, we employed listwise deletion for variables with missingness below 5%, while

[17] For a thorough description of various frailty measurements and the rationale for selecting one measurement over another, please refer to Chapter 2, paragraph 2.1.

adopting the *Fully Conditional Specification (FCS),* a multiple imputation method, for those exceeding 5% missingness[18].

Despite, typically, STATA would automatically perform listwise deletion during regression runs, due to potential complications arising from including regular variables with missing values in the FCS model, we performed this step beforehand.

Multiple imputation entails generating several datasets, which are identical to the original except for the imputed missing values in each. Upon confirming that missing values were *Missing at Random (MAR)* we applied the FCS method for variables falling above the 5% threshold, namely frailty index, multimorbidity, major depression, household wealth, complementary health insurance, and annual deductible. We generated forty imputed datasets to derive pooled estimates and standard errors (van Buuren, 2007, 2018). The so-called regular variables used to impute the values of the ones with missing values are a subset of the variables later used in the regression models.

Post-imputation diagnostics indicated coherence between imputed and original values (Nguyen et al., 2017), with the no remaining missing values.

Coarsened Exact Matching

Observational data, while cost-effective to gather, lack the randomized assignment inherent in experimental designs, posing challenges in establishing causal relationships between exposures and outcomes (Greifer & Stuart, 2022; Iacus et al., 2012). Chief among these challenges is the issue of confounding. In addition to traditional analytical methods such as

[18] For a detailed explanation of multiple imputation methods and the rationale for choosing one method over another, see Chapter 2, section 2.2.3.

regression, matching methods have gained prominence in addressing this concern (Greifer & Stuart, 2022). Matching techniques strive to emulate the balance between the treated and control groups observed in randomized trials, by pruning observations from the data to ensure that exposure statuses become independent of measured covariates (Iacus et al., 2012).

Typically, a matching technique involves isolating – within a sample – a subset of the unexposed group of cases with a covariate distribution similar to the one of the exposed group, resulting in a matched sample where causal effects can be estimated with reduced confounding (Greifer & Stuart, 2022). Matching techniques range from parametric approaches like Propensity Score Matching (PSM) or Mahalanobis Distance Matching (MDM), to non-parametric methods such as Nearest Neighbor Matching (NNM), kernel matching, and Coarsened Exact Matching (CEM) (Greifer & Stuart, 2022). They all serve the purpose of mitigating model dependence, controlling for estimation error, and addressing statistical bias in the target causal parameter. Nevertheless, their efficacy in achieving these objectives can vary. Although widely used, both PSM and Mahalanobis Distance Matching MDM don't consistently address imbalance reduction or model dependence in every scenario. This limitation arises from their properties, which hold on average across samples and are contingent upon a set of typically unverifiable assumptions about the data generation process (Iacus et al., 2012).

In our analysis, we have chosen Coarsened Exact Matching (CEM) for its proven superiority over existing matching techniques in reducing imbalance, model dependence, estimation error, bias, variance, and mean square error (Iacus et al., 2008, 2012; King et al., 2011). Additionally, CEM excels in handling scenarios with categorical confounders, which aligns with the nature of our study. CEM works by "coarsening" selected covariates into fewer categories, thereby narrowing the range of potential matching values for each covariate (Ripollone et al., 2020). This strategic discretization facilitates exact matching on categorical variables, effectively

minimizing the risk of residual confounding. Since our model covariates were already in categorical form, we maintained their original coarsening rather than enforcing fixed bin sizes, thus preserving meaningful breaks in the data distribution (Iacus et al., 2008).

CEM represents a balanced compromise between conventional matching techniques, which can incorporate numerous covariates but may not find exact matches, and the rigidity of exact matching, which becomes impractical with numerous covariates (Iacus et al., 2012). Furthermore, by not relying on parametric assumptions, CEM exhibits greater resilience in circumstances where such assumptions may not be valid (Iacus et al., 2012). Besides, it enhances local balance (i.e., the balance achieved between treatment and control groups within each stratum or "cell" of the covariate space after matching), and subsequent efficiency compared to typical matching methods by striving to emulate the advantages of a superior randomized block experimental design (Iacus et al., 2008; Mielke & Berry, 2007). Finally, CEM works well with imputation of missing data and is implemented in STATA through a dedicated command (Blackwell et al., 2009; Iacus et al., 2008).

We assessed the degree of pre-matching imbalance between the treatment and control groups using the absolute standardized mean difference for each covariate (commonly referred to as the L1 distance). Although the literature does not prescribe a specific threshold for determining imbalance, it is generally recommended to aim for standardized differences as close to zero as feasible (Linden & Samuels, 2013). In our study, we adopted the conservative approach proposed by Normand and colleagues (2001), who advocate for a threshold of 0.1. Instead, Rubin (2001) suggests a threshold of 0.25 and Cohen (2013) defines a cutoff of 0.20 as indicative of a "small" imbalance. Utilizing the conservative criterion, we identified covariates with standardized differences exceeding 0.10 for inclusion in our CEM procedure. Hence, we matched the treatment and control group by the following covariates: household wealth,

multimorbidity, socially active, canton, annual deductible, complementary insurance, and wave number.

Post-matching standardized differences revealed that balance was attained across all covariates slated for inclusion in the multivariate regression analysis, with values consistently below the threshold of 0.1.

Multivariate regression

In a third phase, we employed the matched sample to execute six separate multivariate, non-linear regression models, tailored to the nature of each outcome variable. We analyzed the effect of having a gatekeeping health insurance scheme on healthcare use, comparing the effect in frail and robust individuals.

SHS is a repeated survey, *i.e.*, each wave comprises a random sample of the population drawn at each time point, making observations independently distributed over time. Hence, we decided to conduct a pooled regression analysis, consolidating data from the 2007, 2012, and 2017 waves into a single regression model. Despite the drawbacks of not having a panel dataset, a repeated cross-sectional dataset allowed us to increase sample size, which increases the precision of estimates, assuming that the relationships being estimated are temporally stable (Wooldridge, 2013).

We used Negative Binomial regression models to examine the impact of GK on the five count dependent variables: the number of GP visits, specialist visits, other outpatient visits, hospital admissions and emergency care admissions, during the observation period. We refrained from employing a Poisson regression model due to overdispersion observed via conditional and unconditional mean and variance in all count variables (Fávero et al., 2020).

We modelled the effect of GK on the probability of day hospital care, the binary response variable, using a logistic regression model, assuming a cumulative standard logistic distribution.

Both models assumes that the likelihood of healthcare use is a function of the subject's frailty, health status, socio-demographic status, socio-economic status, behavioral risk, canton of residence and time. While individuals in both the treatment and control groups exhibit similar patterns regarding the covariates incorporated into the matching procedure, we further adjusted for additional individual-level characteristics to mitigate residual confounding bias, as outlined in Section 2.2.3. Moreover, we incorporated cantonal and time effects to account for potential variations over time and across regions. The models can be written as:

$$y_{it} = \mathbf{X}_{it}\boldsymbol{\beta_1} + \boldsymbol{V_{it}}\boldsymbol{\beta_2} + \mathbf{X}_{it}\boldsymbol{V_{it}}\boldsymbol{\beta_3} + \mathbf{Z}_{it}\boldsymbol{\beta_4} + \mathbf{W}_i\boldsymbol{\beta_5} + \boldsymbol{\varepsilon}_{it} + \boldsymbol{u_t}$$

Where y_{it} is the dependent variable for observation *i* at time *t*, $\mathbf{X}_{it}$ is the main independent variable of interest for observation *i* at time *t* and $\boldsymbol{V_{it}}$ is the variable with which $\mathbf{X}_{it}$ is interacted, $\mathbf{Z}_{it}$ represents additional time-varying confounders for observation *i* at time *t*, $\mathbf{W}_i$ represents time-fixed confounders for observation *i.* $\boldsymbol{\beta_1}, \boldsymbol{\beta_2}, \boldsymbol{\beta_3}, \boldsymbol{\beta_4},$ and $\boldsymbol{\beta_5}$ are the coefficients associated with the respective independent variables and interaction term, $\boldsymbol{u_t}$ represents time-fixed effects capturing unobserved time-specific factors and $\boldsymbol{\varepsilon}_{it}$ is the error term.

All six models are estimated using Maximum Likelihood Estimation (MLE), which accounts for the nonlinear relationship between predictors and outcomes in the case of Negative Binomial and logistic regression models (Cameron & Trivedi, 1999; Hosmer Jr et al., 2013).

The coefficients $\boldsymbol{\beta}$ derived from our models are interpreted distinctly based on the regression technique employed. In the context of negative binomial regression, the coefficients are

interpreted as Incidence Rate Ratios (IRRs), namely the factor change in the expected number of GP visits, specialist visits, other outpatient visits, hospital admissions and emergency care admissions, given a certain value assumed by the variable for GK status. In the context of logistic regression, the coefficients are interpreted as Odds Ratios (ORs), namely measuring the ratio between the odds of day hospital occurring and the odds of day hospital not occurring, given a certain value assumed by the variable for GK status.

Besides, in each regression we also use the weights provided with the matching results to compensate for the differential strata sizes (the proportion of treated vs. control units within the matched stratum), as in scenarios where different numbers of treated and control units are present in different strata, such as in exact matching, the analytical model must adjust for or weight the different stratum sizes (Blackwell et al., 2009; Iacus et al., 2008). Consequently, lower weights are assigned to control group observations that are disproportionately represented in a specific stratum, while allocating higher weights to treated group observations that are relatively underrepresented.

3.3. Results

3.3.1. Summary Statistics

The descriptive statistics, examined prior to matching and after multiple imputation, reveal notable trends in the dataset.

First, the proportion of frail individuals has overall declined over time, with 5.4% of the sample classified as frail in 2007, figure dropping to 3.4% in 2012 and slightly rising to 4.2% in 2017. Similarly, the percentage of pre-frail individuals decreased from 81% in 2007 to 68% in 2012, and then slightly rose to 70% in 2017 (see Table A3-1 in Appendix). The observed trend is

positive, assuming no measurement change, and almost aligned with the European trend and levels (Calciolari & Luini, 2023).

Another interesting trend is the steep increase in the adoption of a GK insurance scheme among the elderly. During the observation period, the proportion of elderly opting for a GK scheme rose from 11% to 47%. Despite such increase over time, most frail elderly have consistently opted for a standard health insurance scheme (see Table 3.1). However, considering the steep increase among all elderly one might expect to observe GK schemes becoming predominant among frail elderly.

Table 3.1: Adoption of GK insurance scheme over time by frail category

	2007	**2012**	**2017**
Robust	11%	41%	46%
Pre-frail	10%	38%	47%
Frail	12%	34%	39%
Overall subjects with GK	**11%**	**39%**	**47%**

As anticipated and explained, in our work we grouped frail and pre-frail elderly under the label "frail" for analytical convenience. Therefore, we will address both frail and pre-frail subjects with the term "frail" hereafter.

The mean respondent in our sample is female (54.2%), has no multimorbidity (72.7%), is frail (75.9%), has no long-term illness (54.1%), has a GK health insurance model (65%), has complementary health insurance (60.7%), has seen a GP about 3 times in the previous year, a specialist 1.5 times, other specialists 6.5 times, was not admitted to hospital (mean=0.3 times), was not admitted to day-hospital (87%), and hasn't been admitted to emergency care (mean=0.1 times). Most of the sample is aged 65-75 (61.3%), has a secondary education

(54.4%), is retired (85.1%), and has low wealth status (47.4%). Table 3.2 analytically shows the descriptive statistics of our variables in the three last columns on the right.

Table 3.2 also breaks down the descriptive statistics by type of basic insurance scheme: with or without GK. The GK group has slightly higher proportions of elderly who are robust, male, aged 65-75, have secondary or tertiary education, are married or in a domestic partnership, multimorbid, have a long-term illness, are not depressed, have good self-assessed health (SAH), no limitations with ADLs, are non-smokers, drinkers, socially active, have complementary health insurance. The GK group also shows a rather similar number of GP visits and emergency care admissions, a lower number of specialist visits and hospital admissions, while it shows a higher number of other outpatient visits and day-hospital visits.

Table 3.2: Descriptive statistics

	GK (35%)			**No GK (65%)**			**Overall (100%)**		
	Mean (SD) / Prop.	***N***	***Range***	***Mean (SD) / Prop.***	***N***	***Range***	***Mean (SD) / Prop.***	***N***	***Range***
Use of healthcare services									
N. GP visits	3.221 (4.728)	3,734	0-97	3.241 (4.768)	7,018	0-97	3.234 (4.754)	10,752	0-97
N. specialist visits	1.482 (4.080)	3,734	0-97	1.534 (3.916)	7,018	0-97	1.516 (3.974)	10,752	0-97
N. other outpatient visits	6.504 (9.767)	3,734	0-103	6.373 (9.460)	7,018	0-117	6.419 (9.568)	10,752	0-117
N. hospital admissions	0.270 (1.107)	3,734	0-35	0.308 (1.380)	7,018	0-60	0.295 (1.292)	10,752	0-60
N. Emergency Care admissions	0.140 (0.433)	3,734	0-7	0.139 (0.455)	7,018	0-15	0.140 (0.448)	10,752	0-15
Access to Day-hospital	0.158 (0.365)	3,734	0-1	0.119 (0.324)	7,018	0-1	0.133 (0.339)	10,752	0-1
Health Status									
Frailty	0.729 (0.445)	3,734	0-1	0.776 (0.417)	7,018	0-1	0.759 (0.427)	10,752	0-1
Multimorbidity	0.278 (0.448)	3,734	0-1	0.271 (0.444)	7,018	0-1	0.273 (0.446)	10,752	0-1
Major Depression	0.027 (0.163)	3,734	0-1	0.036 (0.185)	7,018	0-1	0.033 (0.178)	10,752	0-1
Long term illness	0.469 (0.499)	3,734	0-1	0.454 (0.498)	7,018	0-1	0.459 (0.498)	10,752	0-1

Self-Assessed Health									
Very good	0.263			0.215			0.227		
Good	0.526	3,533	1-5	0.519	6,498	1-5	0.521	10,752	1-5
Medium	0.177			0.222			0.211		
Bad	0.028			0.038			0.035		
Very bad	0.006			0.006			0.006		
Limitations with ADLs									
Severely limited	0.054	3,533	1-3	0.065	6,498	1-3	0.062	10,752	1-3
Not severely limited	0.293			0.291			0.295		
Not limited	0.653			0.644			0.643		
Demographic and Socio-economic Status									
Male	0.472 (0.499)	3,734	0-1	0.451 (0.498)	7,018	0-1	0.458 (0.498)	10,752	0-1
Age group									
65-75	0.642	3,533	1-3	0.616	6,498	1-3	0.613	10,752	1-3
75-85	0.307			0.319			0.324		
85+	0.051			0.065			0.064		
Education									
Compulsory school	0.188	3,533	1-3	0.241	6,498	1-3	0.233	10,752	1-3
Secondary	0.560			0.541			0.544		
Tertiary or more	0.252			0.218			0.223		
Occupation									
Inactive	0.847	3,533	1-3	0.847	6,498	1-3	0.851	10,752	1-3
Unemployed	0.001			0.001			0.001		
Active	0.151			0.152			0.148		
Household wealth									
Low	0.428	3,533	1-4	0.482	6,498	1-4	0.474	10,752	1-4
Middle-low	0.232			0.195			0.206		
Middle-high	0.209			0.175			0.182		
High	0.131			0.148			0.138		
Marital status									
Not married/domestic partnership	0.164	3,533	1-3	0.178	6,498	1-3	0.173	10,752	1-3
Married/domestic partnership	0.678			0.590			0.613		
Widower	0.158			0.231			0.214		
Rural/Urban									
Urban	0.624	3,533	1-3	0.660	6,498	1-3	0.646	10,752	1-3
Peri-urban	0.200			0.134			0.156		
Rural	0.176			0.206			0.198		
Behavioral risk									
Socially active									
Very often	0.366	3,533	1-5	0.299	6,498	1-5	0.317	10,752	1-5
Often	0.188			0.151			0.161		
Sometimes	0.120			0.118			0.119		
Rarely	0.091			0.073			0.080		
Never	0.235			0.359			0.323		
Smoker									
Never smoker	0.511	3,734	1-3	0.519	7,018	1-3	0.516	10,752	1-3
Former smoker	0.360			0.339			0.346		
Smoker	0.129			0.143			0.138		
Drinking risk									
Abstemious	0.133	3,734	1-3	0.176	7,018	1-3	0.161	10,752	1-3
Middle-low risk	0.813			0.753			0.774		
Middle-high risk	0.053			0.072			0.065		
Further Health Insurance conditions									
Complementary	0.655	3,734	0-1	0.581	7,018	0-1	0.607	10,752	0-1

Health Insurance	(0.475)			(0.493)			(0.488)		
Annual deductible (in CHF)									
300	0.619			0.568			0.589		
500	0.173	3,533	1-6	0.249	6,498	1-6	0.223	10,752	1-6
1,000	0.043			0.051			0.048		
1,500	0.063			0.065			0.063		
2,000	0.019			0.015			0.016		
2,500	0.084			0.052			0.062		

As means may be misleading when dealing with variables characterized by skewed frequency distributions, we also looked at the proportion of elderly with a GK scheme, by frailty status[19], falling in high healthcare utilization groups. High utilization was identified using the highest tercile for the count dependent variables number of GP visits, number of specialist visits, and number of other outpatient visits alongside dummied versions for hospitalization, emergency care visits, and access to day-hospital[20] (see Table 3.3).

Table 3.3: Proportion of high healthcare users in GK and no-GK enrollees, overall and by frailty.

	High N. GP visits	**High N. Spec. visits**	**High N. other Outp. visits**	***Access to Day-Hospital***	***Access to Hospital***	***Access to Emergency Care***	***N***
No GK & Robust	21.9%	23.7%	26.2%	11.4%	13.7%	9.5%	*1,558*
GK & Robust	22.1%	24.6%	28.0%	14.4%	13.8%	9.9%	*994*
No GK & Frail	32.6%	27.8%	32.8%	12.1%	18.2%	12.4%	*5,423*
GK & Frail	31.9%	27.4%	32.6%	16.3%	17.4%	12.4%	*2,706*
No GK (overall)	30.2%	26.9%	31.3%	11.9%	17.2%	11.7%	*7,018*
GK (overall)	29.2%	26.6%	31.4%	15.8%	16.4%	11.7%	*3,734*

[19] Frailty includes both pre-frail and frail sub-groups.
[20] For the count variables "number of EC admissions" and "number of hospital admissions," we opted to utilize a dichotomized version of the variables because no observations were present in the second tercile.

We observe that robust subjects with GK more frequently incur in high utilization of all types of services. Conversely, frail subjects with GK are less frequently high users of GP, specialist, other outpatient services and hospitalizations, while having more day hospital admissions on average and not showing differences on Emergency Care admissions. When considering the overall elderly population, regardless of frailty status, however, the results are mixed: individuals enrolled in GK schemes exhibit lower rates of high utilization of GP, specialist care, and hospitalizations, compared to those enrolled under standard insurance schemes, but the opposite situation is observed for other outpatient visits and access to day hospital, and no difference is observed for Emergency Care admissions.

3.3.2. Econometric models

The results of our multivariate regressions partially validated our hypotheses, with some findings diverging from our anticipated outcomes or lacking statistical significance, thus not supporting our expectations (Table 3.4).

Specifically, our analysis revealed that having a GK insurance scheme, regardless of frailty status, does not influence the frequency of GP visits, other outpatient visits and emergency care. These findings deviate from our initial expectations about a potential increase in GP visits and decrease in the other services use.

Furthermore, results unveil distinct effects of the GK insurance scheme on other care services within the elderly population. Notably, it significantly diminishes the utilization of specialist, day-hospital, and hospital care among frail patients (IRR= .713; IRR=.523; OR=.674, respectively), while it seems to increase the utilization among robust elderly individuals (IRR=1.241; OR=1.65; IRR=1.482, respectively).

Table 3.4: Estimates of six multivariate regression models

	N. GP visits (IRR)	N. specialist visits (IRR)	N. other outpatient visits (IRR)	Access to Day Hospital (OR)	N. hospital admissions (IRR)	N. Emergency Care admissions (IRR)
Gatekeeping & Frailty (ref. no GK & Robust)						
Robust & GK	1.082	1.241*	1.033	1.650*	1.482*	1.304
Frailty & no GK	1.033	1.275**	.961	1.617**	1.123	.906
Frailty & GK	1.005	.713**	1.047	.523**	.674*	.821
Health Status						
Multimorbidity	1.253***	1.18**	1.376***	1.408**	1.368**	1.26*
Self-Assessed Health (ref. Very good health)						
Good health	1.346***	1.154*	1.103*	1.482**	1.556***	1.415**
Medium health	1.633***	1.465***	1.094	1.756***	1.736***	1.518*
Bad health	2.130***	2.399***	1.274*	2.152**	2.982***	2.670***
Very bad health	3.276***	3.661***	2.242***	4.964***	2.808*	2.248*
Long-term illness	1.281***	1.512***	1.104**	1.343**	1.081	1.146
Limitations with ADLs (vs. Severely limited)						
Not severely limited	.896	.908	.883	.848	.877	1.011
Not limited	.771***	.660***	.651***	.617*	.724	.883
Major depression (ref. No)						
Yes	1.291***	.908	1.180	.615	.977	1.143
Demographic and Socio-Economic Status						
Age group (ref. 65-75)						
75-85	1.121***	.912	.996	1.032	1.123	.879
85+	1.261***	.683***	.776***	.507**	.922	.769
Male (ref. female)	1.206***	.923	.725***	1.031	1.223*	.960
Household wealth (ref. Low)						
Middle-low	.973	1.1	1.101	1.174	1.393*	.912
Middle-high	.849**	1.173	1.092	1.022	1.191	.885
High	.837*	1.377**	1.312**	1.268	1.224	.753
Occupation (ref. Inactive)						
Unemployed	.757	.831	2.237	1.000	1.402	0.000
Active	.943	.943	1.179**	1.054	.863	1.144
Education (ref. compulsory school)						
Secondary	.95	1.383***	1.193***	.974	1.131	1.181
Tertiary	.919	1.549***	1.374***	1.296	1.111	1.486**
Rural/Urban/Peri-urban area (ref. Urban)						
Peri-urban	.859***	.912	.905*	.715**	1.038	.734*
Rural	.974	.93	1.039	.88	.888	.773*
Behavioral risk						
Smoker (ref. Never smoker)						
Former Smoker	1.009	1.153**	1.053	1.265*	1.236*	1.210*
Smoker	.893**	1.040	1.024	1.063	.989	1.028
Drinking risk (ref. Abstemious)						
Middle-low risk	.905**	1.083	1.13**	.829	.714**	.768*
Middle-high risk	.781***	.967	1.124	.907	.466***	.580*
Socially active (ref. Very often)						
Often	.996	1.166*	.859**	1.028	1.043	.768*
Sometimes	1.138**	.863	.898	.930	1.139	.580*
Rarely	.942	1.114	.909	1.044	1.18	.768*
Never	.923*	.870*	.882**	.855	1.200	.580*

Other Health Insurance status						
Complementary HI	1.134***	1.204**	1.35***	1.255*	.998	1.155
Annual deductible (ref. 300 CHF)						
500 CHF	1.014	.946	.983	1.09	1.093	1.015
1000 CHF	1.233	1.069	.86	.674	1.479	1.365
1500 CHF	.645**	.699	.938	1.45	.899	.593
2000 CHF	.655	.370	.816	1.266	.834	0.000
2500 CHF	.865	.762	.921	.797	1.030	.666
Informal or home care	1.426***	1.573***	1.753***	1.206	3.268***	2.42***
Context and Time						
Kanton (on request)						
Year (ref. 2007)						
2012	.893*	.957	1.001	.931	.661**	.936
2017	.885*	1.074	.831**	4.878***	.663**	1.451*
Number of observations	*4,877*	*4,877*	*4,877*	*4,873*	*4,877*	*4,877*

*Significance levels: *** p<.001, ** p<.01, * p<.05*

3.3.3. Sensitivity analyses

We performed robustness checks revealing consistent findings across various frailty categorizations. Specifically, when using a three-levels categorization (*i.e.,* frail, pre-frail, robust) of the Fried frailty phenotype, pre-frail enrollees in a GK insurance scheme experience lower specialist visits and probability of day hospital access compared with subjects who are pre-frail and without GK, while we observe the opposite among those classified as robust with a GK insurance scheme compared to the counterpart without GK. Furthermore, our analysis indicated that the GK insurance scheme is associated with increased specialist and outpatient visits among robust elderly individuals, with no significant effect observed among frail subjects.

In addition, we replaced the interaction between the insurance scheme and frailty with the interaction between the insurance scheme and long-term (LT) illness in the model. This change is intended to allow us to investigate the influence of GK on healthcare use in another cluster of complex patients compared to non-complex counterparts. The findings mirror those of the original model centered around the frailty metric. Notably, the presence of a GK insurance

scheme was associated with reduced specialist visits and hospitalizations among LT-ill elderly individuals, while non-LT-ill patients experienced a significant increase. Following the same logic, we interacted GK with multimorbidity to test the effect of GK on healthcare utilization in multimorbid patients compared to those without multimorbidity. Results revealed that the presence of a GK scheme is associated with increased utilization of GP visits and other outpatient services among non-multimorbid elderly individuals, whereas the effect was negligible among multimorbid patients.

Finally, we examined the impact of a GK insurance scheme on healthcare utilization across the entire elderly population, without interacting it with any indicator of complexity (*i.e.*, frailty, long-term illness, or multimorbidity). Results show an increase in GP visits and other outpatient visits linked to the GK, while no significant effects for the other care services. Altogether, these results suggest divergent effects of GK on healthcare for complex and non-complex patients.

3.3.4. Limitations

Our study has some limitations. Firstly, the Swiss Health Survey is a cross-sectional dataset. Such fundamental characteristic of the data limits our ability to control for time-fixed (or individual) heterogeneity. In fact, such task is more feasible with longitudinal data. Unfortunately, public longitudinal datasets including information on health insurance schemes are not accessible in Switzerland. Obtaining such data would necessitate collaboration from health insurance providers, enabling researchers to access enrollee information for research purposes. Consequently, despite our efforts, potential confounding variables may not remain accounted for.

Moreover, the Swiss Health Survey prompts respondents to report their current health insurance plan during the interview, while querying about healthcare service utilization over the previous twelve months. As Swiss people can change health insurance every year, the chronologic structure of available data compelled us to operate under the assumption that individuals enrolled in a specific insurance scheme in any wave year have not changed insurance plan from the previous year. The assumption is necessary to align the insurance scheme option with the measurement timeframe of healthcare service utilization. Our analysis focus on the GK feature of the insurance scheme, and we expect this aspect being less subject to change compared with the change of insurance company.

3.4. Conclusions

Gatekeeping is designed to regulate and optimize healthcare utilization, particularly for complex patients. Our study, conducted within the Swiss context, highlights the role of alternative health insurance schemes based on gatekeeping principles in coordinating care.

Our findings indicate that these schemes effectively manage complex patient groups, especially the frail elderly, as supported by existing literature. However, our analysis also reveals potentially unintended consequences for robust elderly patients. For these individuals, gatekeeping may increase healthcare utilization by recommending additional services or referrals even when not medically necessary. This aligns with the concept of supplier-induced demand (SID), where physicians can influence a patient's demand for healthcare, as described by Richardson (1981).

Several factors may explain this phenomenon, contrasting with the trend observed in frail individuals. These include medical uncertainty (Ghosh, 2004), the desire to fulfill patient

expectations for care (Webb & Lloyd, 1994), and the pressure from patients to refer (Armstrong et al., 1991). Physicians might suggest additional diagnostic tests or specialist consultations to address perceived health risks or for fear of overlooking needed care, thereby stimulating demand for healthcare services among non-complex patients. In addition, physicians may play a role in shaping patient perceptions of their health status and treatment options, potentially encouraging healthy patients to seek more services. To this regard, a study conducted in Denmark, where GPs serve as gatekeepers to secondary care, revealed several key factos influencing referral decisions. The study found that GPs considered medical necessity in 93% of cases. Patient preference played a role in 43.7% of cases, while 27.5% of referrals aimed at preventing oversight, and 14.6% were intended to reassure the patient (M. K. Andersen et al., 2017).

It's important to recognize that increased referral rates are not necessarily due to malicious intent but arise from various factors within the health system, including financial incentives, patient expectations, and clinical judgment. Policymakers and healthcare stakeholders should design mechanisms to mitigate unnecessary utilization while ensuring access to appropriate care.

To optimize gatekeeping mechanisms, policymakers should refine referral management and healthcare access based on medical necessity. This can be achieved by revising incentive structures and establishing clearer referral guidelines. Promoting interdisciplinary collaboration and integrated care models is essential to enhance care coordination and ensure effective healthcare delivery, especially for frail individuals. Systematic coordination between different levels of care and sectors is crucial for effective care integration. This approach not only enhances the quality of life and functional abilities of frail elderly patients but also reduces healthcare utilization and overall costs.

Despite its importance, integrated care models specifically designed to prevent and manage frailty remain scarce and have only recently begun to receive more attention (Hendry et al., 2019). Most European countries lack such programs, except for a few like Norway (Norwegian Ministry of Health and Care Services, 2019), the Netherlands (Hoedemakers et al., 2019), UK (NHS England, 2014), Scotland (Hendry et al., 2016) and Cataluña (Baltaxe et al., 2019) Generally, health systems focus on integration within the healthcare sector but often overlook the continuity between primary and hospital care, as well as between health and social care.

In Switzerland, the Federal Office of Public Health (FOPH) launched the "coordinated care" project in early 2015 as part of the Health 2020 conference. The main objective was to improve care coordination across the treatment pathway, particularly within hospital units and between different care settings (e.g., hospital and home) for very old multimorbid patients (Bundesamt für Gesundheit, 2015). In September 2022, the Federal Council proposed draft law 22.062, "Measures for Cost Containment – Package 2," which aims to strengthen coordinated care by defining coordinated care networks as independent service providers (Bundesamt für Gesundheit, 2022). As of July 2024, a final decision has yet to be made. It's important to note that in June 2012, the Managed Care project proposal was rejected by the population, and recent institutional documents have not specified detailed funding or financing options for optimizing long-term care.

In December 2016, service providers, associations, cantonal authorities, and insurers met at the invitation of the FOPH and the Swiss Conference of Cantonal Health Directors to optimize the hospital discharge process for frail patients with multiple conditions. The discussion highlighted successful Swiss models that improve patient outcomes and reduce re-hospitalizations and costs when transitions between acute care and follow-up (at home or in a medico-social institution) are well-coordinated and adequately resourced. However, it was

noted that these models might not be directly transferable to other Swiss contexts (Bundesamt für Gesundheit, 2016).

The objectives and actions of Health2020 have been extended in the Health2030 program. This program emphasizes that "targeted incentives can lead to better coordination between service providers; payment systems should be based on treatment success rather than the number of steps in the examination and treatment process. Duplication needs to be avoided, treatment should be more evidence-based, and quality must be assured" (Objective 5, Line of Action 5.1)(Bundesamt für Gesundheit, 2019).

Besides, continuous monitoring and evaluation of healthcare utilization patterns under alternative health insurance schemes are essential. This helps policymakers identify trends, assess the impact of policy changes, and adjust strategies to optimize healthcare delivery and resource allocation. Educating healthcare providers on the appropriate use of gatekeeping mechanisms and the implications of healthcare utilization patterns can improve decision-making and reduce unnecessary referrals or treatments. Similarly, educating patients about the role of gatekeeping and the importance of appropriate healthcare utilization can empower them to make informed decisions about their health. Engaging patients in care planning and management can also help reduce unnecessary healthcare visits.

On a side note, while the GK insurance scheme appears to correlate with increased healthcare utilization among robust elderly individuals and decreased utilization among frail ones, one could argue that the net cost incurred by the whole elderly population may diminish. This consideration would rely on the assumption of relatively lower costs associated with care services used by robust patients, coupled with their lower prevalence in the elderly population, juxtaposed with frail elderly individuals. Policymakers should aim to balance the cost-

effectiveness of healthcare services with the quality of care provided. This involves assessing the economic impact of increased utilization among robust elderly patients while ensuring sufficient resources for frail patient populations, thereby maintaining an efficient and equitable healthcare system.

In conclusion, recognizing the complexities of alternative health insurance schemes and their varying impacts on healthcare utilization allows policymakers and healthcare professionals to adopt a more nuanced and informed approach to health policy and service delivery. This balanced approach can help optimize healthcare outcomes and resource allocation across different patient groups.

Appendix

Table A3- 1: Prevalence of frailty over time

	2007	**2012**	**2017**
ROBUST	13.8%	28.5%	26.7%
PRE-FRAIL	5.4%	3.4%	4.2%
FRAIL	80.8%	68.1%	69.1%
TOTAL	***100%***	***100%***	***100%***

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