TÉCNICO LISBOA

Impact of the COVID-19 Pandemic on Portuguese Public Health Units:

Development and Analysis of a Survey

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Thesis to obtain the Master of Science Degree in

Biomedical Engineering

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November 2021

Declaration

I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade de Lisboa.

Preface

The work presented in this thesis was performed at *Instituto de Medicina Preventiva e Saúde Pública da Faculdade de Medicina da Universidade de Lisboa* (IMP-FML) between February and October of 2021. This study is part of a project funded by *Fundação Ciência e Tecnologia* (Research4COVID-19/818).

The work was supervised by Prof. Paulo Jorge Morais Zamith Nicola, from IMP-FML and *Instituto Superior Técnico* and Prof. Tânia Rodrigues Pereira Ramos, from *Instituto Superior Técnico*. This work was developed also with the scope of the EIT Health MSc Technological Innovation in Health.

Acknowledgements

Gostaria de agradecer aos meus orientadores, Professor Paulo Nicola e Professora Tânia Ramos, pelo apoio crucial durante todo este processo e por sempre encorajarem todo o meu trabalho. Professor Paulo, agradeço a honra ter trabalhado no IMP-FMUL e da oportunidade de trabalhar junto com dois médicos especialistas em Saúde Pública que tanto me ensinaram. Dr. Manuel Pereira e Dr. David Lopes muito obrigada por toda a ajuda ao longo da minha investigação.

Durante os últimos meses no IMP-FML, tive a privilégio de trabalhar ao lado de uma equipa incrível, que me forneceu inúmeros conselhos e bom humor diário. Obrigada, Elisa Marques, Catarina Camarinha, Catarina Silva e Brídiga Riso por todo o vosso apoio e principalmente pela vossa amizade. Foi tão melhor fazer este percurso ao vosso lado. Elisa Marques, não há palavras suficientes para agradecer todo o teu apoio, conselhos e conversas diárias. Serei-te eternamente grata por todo o teu acompanhamento constante.

Obrigada a todos os meus amigos, os de longa data e os de curta data, a todos os que, entretanto, entraram e saíram da minha vida.

À minha família, obrigada por tudo... Mãe e pai, nunca vos vou conseguir agradecer o suficiente por todo o vosso amor e apoio incondicional. Ao meu irmão um enorme obrigada por me tornares quem sou hoje. Ao meu sobrinho Gustavo, o mais recente membro da família, espero sempre ser um exemplo para ti e conseguir mostrar-te que com trabalho, empenho e foco, tudo se alcança.

Resumo

No contexto da pandemia COVID-19, as Unidades de Saúde Pública (USP) desenvolveram inúmeros esforços para responder de forma rápida ao crescimento do número de casos confirmados. Este estudo tem como objetivo descrever e analisar a forma como as USP se reorganizaram para responder aos vários períodos da pandemia, nomeadamente, as variações que ocorreram ao nível dos recursos humanos, das atividades, dos recursos materiais, entre outros, tendo como referência a situação pré-pandémica.

De modo a realizar-se um levantamento das mudanças ao nível nacional, foi desenvolvido e implementado um questionário online a todas as USP de Portugal Continental. Considerando os desafios inerentes à aceitação de participação nos questionários por parte dos coordenadores das USP, foi criada uma Rede de Investigação. Para proceder à análise estatística dos questionários foi utilizado o software R

Da análise dos questionários, verificou-se uma mobilização de todos os grupos profissionais, com um pico no 2ºperíodo (1/9/20-28/2/21). Ao nível dos recursos humanos e materiais observa-se uma necessidade destes para uma resposta adequada. As atividades não-COVID-19 foram particularmente afetadas pela pandemia. Adicionalmente, a mobilização dos profissionais para atividades COVID-19 é notória. As USPs identificaram uma elevada diversidade de implementações inovadoras no decorrer da pandemia, existindo um grupo de respostas que foram consistentes entre USPs, o que sugere robustez na utilidade dessas implementações.

É notório que não só há elevada assimetria nas unidades analisadas, como escassez de recursos. Forte evidencia sugere que a necessidade observada é anterior à pandemia. O número médio de implementações inovadores por unidade num curto espaço de tempo indica uma capacidade de adaptação e de desenvolvimento de resposta assinalável, que importará descrever e evidenciar, podendo várias destas inovações se constituírem como boas práticas.

Palavras-chave: Saúde Pública, COVID-19, impacto, questionário, rede de investigação.

Abstract

In the context of the COVID-19 pandemic, the Public Health Units (PHUs) made countless efforts to respond quickly to the growth in the number of confirmed cases. This cross-sectional study describes the variations in resources, activities, and other levels attached to PHU during the various periods of the pandemic, using the pre-pandemic situation as a reference.

To achieve this goal, an online questionnaire was elaborated and sent to all PHUs in mainland Portugal. Considering the challenges inherent to having a high response rate, a PH Research Network was created. The R software was used to perform the statistical analysis.

A mobilization of all professional groups was verified, with a peak in the 2nd period of the pandemic (from 1 September 2020 to 28 February 2021). In terms of human and material resources, there was a need to cover current needs. Non-COVID-19 activities were particularly impacted by the pandemic. Additionally, the mobilization of professionals for COVID-19 activities was notorious. Diverse innovative initiatives were implemented during the pandemic, although a group of initiatives was consistent across the PHUs, which suggests they were successful and relevant.

Taken together, the study findings demonstrate a significant asymmetry among the analysed PHUs, and also deficiencies in some areas. The reported limitations in their capacities and resources were present before the pandemic period. In addition, the impressive number of innovative initiatives implemented in such a short period indicates that the health workforce in the PHU has a remarkable capacity to adapt and develop a response. Several of these innovative actions may be considered good practices in PH.

Keywords: Public Health Unit, COVID-19, impact, questionnaire, Research Network.

Contents

1 Introduction 1

2 Problem Contextualization 5

2.1 Public Health 5

2.1.1 Public Health in General 5

2.1.2 Public Health in Portugal 7

2.2 Role of Public Health Measures in a Pandemic Context 11

2.2.1 Role of Public Health Measures in the Control of Pandemic 11

2.2.2 Track and Tracing Activities 13

2.3 Project Contextualization 15

2.4 Final Remarks 18

3 Literature Review 19

3.1 Guidelines for the Health Sector to deal with the COVID-19 Pandemic 19

3.2 Strategies to achieve the COVID-19 Guidelines for the Health Sector 23

3.3 Final Remarks 26

4 Methodology 29

4.1. Population Studied 29

4.2 Questionnaire Development 30

4.3 Questionnaire Structure and Description 33

4.4 Questionnaire Implementation 34

4.5 Data Analysis 37

4.5.1 Analytical Aims 37

4.5.2 Data Analysis Steps 37

5 Results and Discussion 47

5.1 Characterization of the Participants (PHUs) and Inhabitants' Coverage 47

5.1.1 Periods of Highest Demand 49

5.1.2 Discussion of the Characterization of the PHU Participants 50

5.2 Human Resources 50

5.2.1 Variation on PHU Human Resources during the Pandemic 50

5.2.2 Discussion of the Variation on PHU Human Resources 54
5.3 Material Resources 55
5.3.1 Variation on Material Resources during the Pandemic 55
Computer Resources 55
Telecommunication Resources 56
Other Material Resources 58
5.3.2 Discussion of the Variation on Material Resources 59
5.4 Activities 60
5.4.1 Non-COVID-19 Activities: Description and Variation during the Pandemic 60
5.4.2 COVID-19 Activities: Description during the Pandemic 64
5.4.3 Discussion of Activities 66
5.5 Information Systems 67
5.5.1 Use of Information Systems 67
5.5.2 Discussion of Information Systems usage 69
5.6 Innovation 70
5.6.1 Functional and Organizational Changes 70
5.6.2 Innovative Implementation 72
5.6.3 Discussion of Functional and Organizational Changes and Innovative Implementations 74
5.7 Discussion 74
6 Conclusion and Future Work 77
6.1 Conclusions 77
6.2 Limitations and Future Work 79
Bibliography 81
Appendix A 91

List of Tables

Table 2.1 – Summary description of the PH measures. 12

Table 2.2 – Specification of the strategic approaches of the component case definition and contact tracing. 13

Table 2.3 – Examples of cases delays that influence track and tracing activities. 14

Table 3.1 – Phases of increasing public health risk associated with the emergence of a new influenza virus subtype that may pose a pandemic threat, and the public health goals for each phase. 21

Table 4.1 – Professional groups and the respective professional categories. 40

Table 4.2 – Activity group, according to the essential functions of PH doctors, and the respective non-COVID-19 activities. 41

Table 5.1 – Number of participating PHUs grouped by health administrative regions according to questionnaire completeness. 47

Table 5.2 – Number of inhabitants covered by each unit with completed questionnaires. 48

Table 5.3 – Proportion of health professional involved in non-COVID activities during the year 2019. 61

Table 5.4 – Percentage of professionals in COVID-19 activities, standardized for the number of professionals in Jan 2020. 64

Table 5.5 – Percentage of professionals in COVID-19-related activities, standardized for the maximum number of professionals across the four periods. 65

Table 5.6 – Total weekly average hours and percentage of expected of COVID-19-related activities. 65

Table 5.7 – Typification and categorization of functional and organizational changes. 71

Table 5.8 – Categorization of innovative implementations. 72

Table 5.9 – Classification of innovative implementations. 73

List of Figures

Figure 1.1 – Evolution of new cases. Data source: esri Portugal (acessed 26/10/2021). 1

Figure 1.2 – Objective and methodology present in this thesis. 3

Figure 2.1 – Clustering of Essential Public Health Operations (EPHOs), to deliver PH services (EPHOs 1–5 can be thought of as core public health operations, while EPHOs 6–10 are overarching operations that enable the delivery of public health). From: [1] 6

Figure 2.2 – 55 PHU graphically represented in mainland Portugal. 8

Figure 2.3 – Epidemiologic curve with the representation of the goal of Public Health measures for pandemic influenza. From: [31] 11

Figure 2.4 – Some of the tasks performed in the case definition and contact tracing. (PID - Prophylactic Isolation Declaration). 14

Figure 2.5 – Steps involved in the main project. 16

Figure 4.1 – Steps involved in the questionnaire development. 30

Figure 4.2 – General questionnaire structure and main blocks of questions. 31

Figure 4.3 – Steps in the questionnaire implementation. 34

Figure 4.4 – Interactive module in the online questionnaire. 35

Figure 4.5 – Data analysis steps. 38

Figure 5.1 – Period of highest demand of human resources for each PHU, after March 2020. 49

Figure 5.2 – Variation in the total number of active professionals and the number needed to cover the needs of all professional groups in the PHUs. 51

Figure 5.3 – Variation in the total number of effective professionals and the number needed to cover the needs of the various professional groups in the PHUs. 53

Figure 5.4 – Variation in the total average number and ratio (standardization) of existing and needed computer resources. (Number of PHU accounted = 5). 56

Figure 5.5 – Variation in the total number and ratio (standardization) of existing and needed telecommunication resources. (Number of PHU accounted = 5) 57

Figure 5.6 – Variation in the total number of existing and needed hotspots, printers, and photocopiers. (Number of PHU accounted = 5). 58

Figure 5.7 – Percentage of PHU that had and that passes to have vehicles. (Number of PHU accounted = 5). 59

Figure 5.8 – Total number of weekly hours for the execution of each activity (in the four periods) (left). Average percentage of execution of each activity, before and during the pandemic, compared to expected (right).....63

Figure 5.9 – Percentage of information systems used (left panel) and not used (right panel). 68

Figure 5.10 – Percentage of usage of the Trace COVID-19 system, as well as the different features of the system, during the pandemic period. 69

Figure 6.1 – Contributions of this dissertation for research on Public Health. 80

List of Abbreviations

ACES	Agrupamento de Centros de Saúde (in english: Health Centers Groups)
ARS	Administração Regional de Saúde (in english: Regional Health Administration)
CDC	Centres for Disease Control and Prevention
COVID-19	Coronavirus SARS-CoV-2
DGS	Direção-Geral de Saúde (in english: General Health Direction)
DSP	Departamento de Saúde Pública (in english: Departments of Public Health)
ECDC	European Centre for Disease Prevention and Control
MDPI	Multidisciplinary Digital Publishing Institute
MGF	Medicina Geral e Familiar (in english: General and Family Medicine)
PDI	Prophylactic Isolation Declaration
PH	Public Health
PHU	Public Health Unit
PCC	Primary Care Clusters
REVIVE	Rede de Vigilância de Vetores (in english: National Network for Vector Surveillance)
RNU	Registo Nacional de Utentes (in english: National Register of Users)
RSSP	Rede de Serviços de Saúde Pública (in english: Public Health Services Network)
SINAVE	Sistema Nacional de Vigilância Epidemiológica (in english: National Epidemiological Surveillance System)
SINAVE-Lab	Sistema Nacional de Vigilância Epidemiológica – Laboratórios (in english: National Epidemiological Surveillance System – Laboratorial)
SINAVE-Med	Sistema Nacional de Vigilância Epidemiológica – Médicos (in english: National Epidemiological Surveillance System – Medical)
SNS	Serviço Nacional de Saúde (in english: National Health Service)
SNS24	Serviço Nacional de Saúde (in english: National Health Service)
SONHO	Sistema Integrado de Informação Hospitalar (in english: Integrating Hospital Information System)
SPMS	Serviços Partilhados do Ministério da Saúde (in english: Shared Services of the Ministry of Health)
SSP	Serviços de Saúde Pública (in english: Public Health Services)
UCSP	Unidade de Cuidados Saúde Personalizados (in english: Personalized Health Care Units)
UCC	Unidade de Cuidados na Comunidade (in english: Community Care Units)
ULS	Unidade Local de Saúde (in english: Local Heal Units)
URAP	Unidade de Recursos Assistenciais Partilhados (in english: Shared Care Resource Units)
USF	Unidades de Saúde Familiar (in english: Family Health Units)
WHO	World Health Organization

Chapter 1

Introduction

Public Health (PH) can be characterized by three essential pillars: health promotion, disease prevention and health protection [1]. In order to achieve these purposes, PH professionals perform several day-to-day activities to implement measures to promote favorable conditions for health maintenance, combat infectious diseases, reduce and control ‘disease’ in general, and educate and inform [2], [3].

Following the identification of the new coronavirus SARS-CoV-2 (COVID-19) in Portugal (on 2 March 2020) there were 1.085,451 confirmed cases, with 18,138 people having died (up to 26 October 2021) [4], [5]. Figure 1.1 presents the evolution of new cases. Consequently, and inevitably, the COVID-19 virus has become a PH priority. A proactive and targeted PH response is fundamental for interrupting human-to-human transmission chains and preventing further spread, thereby reducing the intensity of the epidemic [6]. A well-orchestrated action is thus necessary to avoid new symptomatic cases (which are directed to General and Family Medicine (MGF) units), severe diseases (which are directed to hospitals) and consequent deaths.

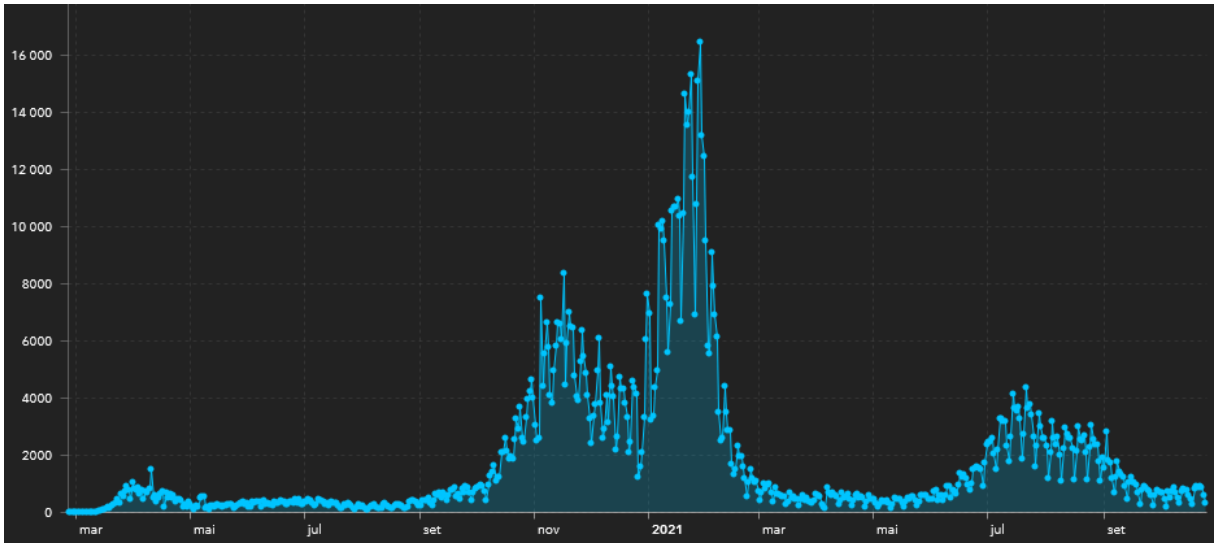


Figure 1.1 – Evolution of new cases. Data source: esri Portugal (acessed 26/10/2021). From: [5]

Furthermore, in a rapidly changing epidemiologic scenario, Public Health Units (PHUs) need to reorganize themselves to rationally allocate their available resources (expectedly limited, considering the unexpected and overwhelmed dimension of this disease). Although, the primary pandemic prevention system is governed by the PHUs, recommendations at national level are issued by the General Health Direction (DGS). Nonetheless, the guidelines regarding the health sector

(re)organization model emerged only after a year of pandemic. The pandemic induced the need for the PHUs to reorganize in terms of resources, activities, systems, among others in order to respond quickly to the growth in the number of suspected and confirmed cases. Therefore, this thesis aims to describe and analyse the impact of the COVID-19 pandemic on PHUs' organization. To answer to this goal, we developed a cross-sectional online survey sent to all PHU's coordinators (Figure 1.*2*).

Specifically, the current study aims to describe the variations in human and material resources, in non-COVID-19 activities, and in computer systems attached to PHU during the various periods of the pandemic, using the pre-pandemic situation as a reference. In addition, COVID-19 activities are described for the pandemic period. Temporal relationships will be analysed.

Finally, the last aim is to describe and evidence the functional and organizational changes, as well as the innovative implementations that occurred in the PHUs, allowing the identification of good practices. This analysis will be able to point out developments in PHUs responsiveness and indicate needs that these organizations manifest in situations of greater demand.

To answer to these goals, a research instrument to accomplish a national survey covering the various changes that occurred in the PHUs was developed. Therefore, a questionnaire addressed to the coordinators of each PHU was developed and implemented at a national level. Considering the growing complexity in PH and the challenges inherent to having a high response rate, a Research Network was created during this study. This Research Network consists of a support and articulation structure between focal points in PHUs and researchers in order to promote the carrying out of studies in view of local needs. Specifically for this study, each PH doctor included in the Research Network provide direct support to the coordinators of all participating PHUs to correctly complete the questionnaire. This network comprises public health medical residents and public health medical specialists. The Research Network worked also as a communication point for questions and/or doubts about the project and/or questionnaire.

The study presented in the thesis is part of a project funded by *Fundação Ciência e Tecnologia*, titled by *Cost-effectiveness and Optimization of the Public Health effort for COVID-19 Track and Tracing activities in Portugal*. The project discussed in the thesis arises as a side-track completion of the main project. The main project has as its primary objective to analyze the variability of the cost/resources-effectiveness of PH track and tracing activities for SARS-CoV-2, according to the pandemic phase, to understand resources and effectiveness optimization and draw implications for policy. The main project intends to provide a unique contribution to the discussion of the *Public Health Reform Proposal*, as well as to identify lessons for future pandemics and similar situations preparedness.

As this dissertation is being elaborated within the scope of an EIT Health MSc in Technological Innovation in Health it aspires to present an innovative study. In addition to the creation of the first PH

research network, to the best of our knowledge this is the first study of the impact of COVID-19 on PH facilities.

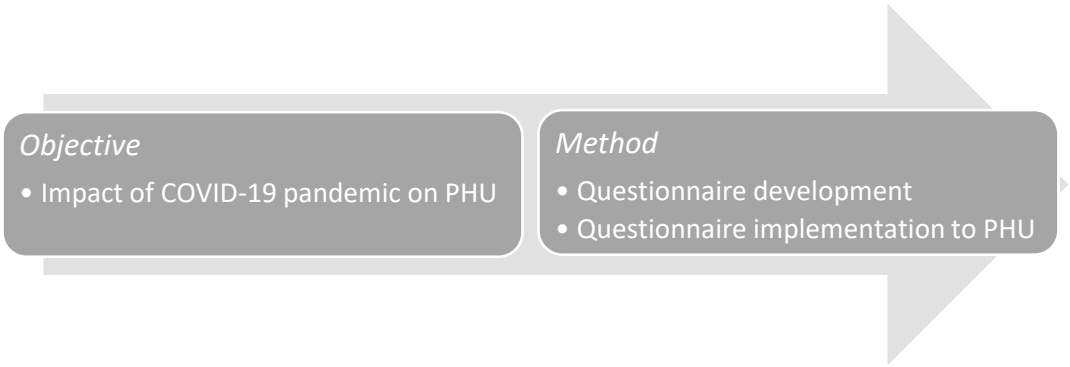


Figure 1.2 – Objective and methodology present in this thesis.

This thesis is organized in six Chapters. After the Introduction (Chapter 1), Chapter 2 starts with a general background on PH in worldwide and specifically in Portugal, and addresses topics such as the organization of PH, as well as its functions. Then, a literature review is included in the Chapter 3. This third Chapter presents the guidelines supported by international and national organizations, and describes the strategies to deal with the COVID-19 pandemic recommended in several studies (and adopted by several countries). Chapter 4 presents the development of the research instrument, and the methods for data analysis. Chapter 5 presents the questionnaire-derived results and provides a final discussion. Finally, the main aspects of this work are discussed, limitations of this research are clarified, and the key conclusions are summarized in Chapter 6.

Chapter 2

Problem Contextualization

This Chapter contextualizes public health in the intervention of a pandemic. Section 2.1 describes PH in general, being particularized in Portugal. In the following Section, Section 2.2, the role of PH measures in a pandemic context is described, being one of the most important measures - track and tracing activities – described in detail. Finally, Section 2.3 concludes this Chapter by identifying the challenge that this thesis wants to embrace.

2.1 Public Health

2.1.1 Public Health in General

It is easily understood that the meaning of what we now call public health has varied over time with the historical period and degree of evolution of the society.

Winslow, in 1923, gave a definition of public health, modified in the first report on Sanitary Administration (1953), of the World Health Organization (WHO): *"Public Health is the science and the art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing service for the early diagnosis and preventive treatment of disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health; organizing these benefits in such fashion as to enable every citizen to realize his birthright of health and longevity"* [7], [8].

Less detailed definitions and allowing, from the point of view of performance, all the expansion of services that the health policy requires, were given by Acheson: public health as "*the science and art of preventing disease, prolonging life and promoting health through the organized efforts of society"* (Acheson, 1988) [9], [10].

PH services are a fundamental pillar of the organisation of health systems [2]. Sometimes this is highly visible, as when they intervene to prevent the spread of an epidemic. More often it is largely invisible, taking place outside the public gaze, but equally important for safeguarding health [9].

The professional activities of PH focus on three essential pillars: health promotion, disease

prevention and health protection. To achieve these goals the WHO Europe proposed 10 "Essential Public Health Operations" (EPHOs) – shown in Figure 2.1 – as "essential public health functions" that PH physicians must develop training and competence [1].

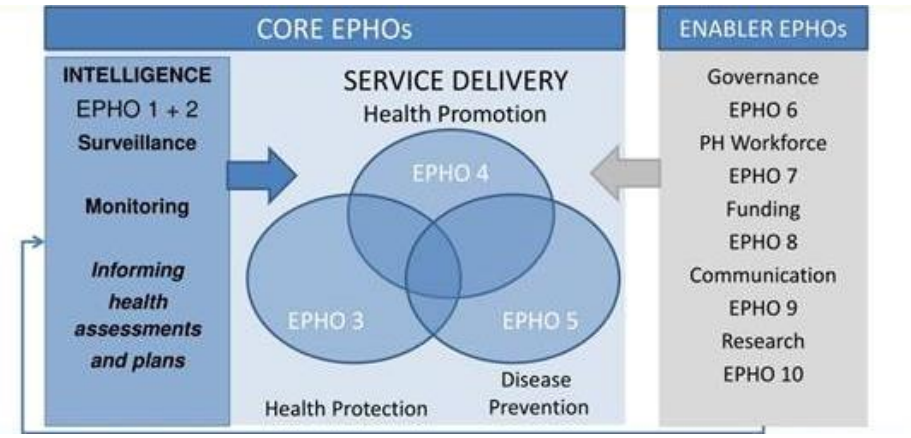


Figure 2.1 – Clustering of Essential Public Health Operations (EPHOs), to deliver PH services (EPHOs 1–5 can be thought of as core public health operations, while EPHOs 6–10 are overarching operations that enable the delivery of public health). From: [1]

In greater detail, due to its orientation and purpose, as health regulators, public health needs to employ its own working methods. These methods comprise a set of rules and organized means, from a legislative and administrative point of view, which allow the application of [3]:

- Measures to promote favourable conditions for the health, of its four concrete aspects that are the basis of hygiene or environmental health: potability of water supply, sewage facilities and treatment, removal of debris from community life; housing, workplaces, and recreational facilities; food and food surveillance; atmosphere and air pollution control.
- Measures to combat infectious diseases, chronic and occupational diseases, mental disorders, and accidents and, in general, against all epidemiological conditions that harm health or cause death.
- Measures that allow individuals, families, and community groups to use the means of diagnosis, treatment, recovery, and combat in diseases that are community problems, that is, that require an organized system of surveillance, prevention, diagnosis, treatment, and recovery that the individual alone is unable to achieve or maintain in efficient functioning, in the desired sense – that of reducing and controlling the 'disease' in general.
- Education and information measures that enable individuals to become aware of the dangers to which their health is subject and the means they can use to avoid or remedy them. Also, those that arouse in individuals and groups the interest in improving their health and get their active and conscious participation in the work of quickly adapting environmental conditions to collective life and in the acquisition of favourable hygiene habits.

2.1.2 Public Health in Portugal

Based on the recommendations of the WHO Europe – which aims at the sustainability of health and well-being – the Public Health Services Network (Rede de Serviços de Saúde Pública: RSSP) was created. One of the main purposes of this network is to identify, map and make known the various entities with relevant intervention in public health [11], [12].

The network components can be divided into three levels – Local, Regional and National [11], [12]. The Public Health Services (SSP) at the national level is the Directorate-General for Health (DGS), which is a structure for implementing the national health policy and integrating normative functions. The regional level SSP are made up of five Departments of Public Health (DSP), which are central services of the five Regional Health Administrations (ARS) that exist in mainland Portugal. And finally, the SSP at the local level are currently made up of 55 PHU that integrate the Local Heal Units (ULS) or the Health Centers Groups (ACES). This last structure, the ACES, are deconcentrated services of the respective ARS – more pointedly, each ARS has a defined number of ACES, depending on the geographic area it serves, and each ACES has only one PHU. The 55 PHUs existing in mainland Portugal are shown in Figure 2.2 – 24 units in the *North* region; 9 units in the *Central* region; 15 units in the *Lisbon and Tagus Valley* region; 4 units in the *Alentejo* region; and 3 in the *Algarve* region [13].

As previously mentioned, PH focuses on the full spectrum of health and well-being and not just the eradication of certain diseases [10]. For this, each PHU is based on a multidisciplinary team, with organizational and technical autonomy, and intercooperation with other functional units – such Family Health Unit (USF) – and ACES is guaranteed.

Figure 2.2 – 55 PHU graphically represented in mainland Portugal.

According to Tilson & Gebbie (2004) all those engaged in the work of creating the conditions in which people can be healthy broadly define the public health workforce. More peculiarly, the PHU team is composed of a coordinator, doctors, nurses and environmental health technicians, including, on a permanent or temporary basis, other professionals deemed necessary in public health – such as oral hygienists, psychologists, social assistants, administrative staff, technical assistants, and operational assistants. In addition, public health physicians may be appointed to exercise health authority functions at the ACES level [14].

In concrete, the nurses can be specifically categorized as nurses specialized in community health nursing, nurses specialized in other nursing specializations, and general nurses (non-specialized nurses).

Analogously, the doctors are divided into several categories, namely doctors specializing in public health medical specialists, Health Authorities; public health medical specialists, not health authorities; medical specialists from other medical specializations; medical residents from other medical specializations; public health medical residents; and medical residents of the general training year. Focusing on the last three professional categories, these are in the medical internship stage. This postgraduate medical training comprises the component of general training and specialized training. Interns begin their medical internship in general training – calling themselves medical residents of the general training year. These need to complete one year in four training blocks, not sequential: General Surgery, Internal Medicine, Medical Pediatrics, and Primary Health Care. This last block integrates the areas of MGF and PH [15]. After this training, they go on to specialized training, where they are designated as medical residents specialists (public health medical residents or medical residents from other medical specializations) continuing their medical internship in the respective place of placement on the first working day of each calendar year [16].

In the process of defining the quality levels of services to be provided to populations, it is highly relevant to realistically identify the human resources needed to pursue these quality levels (professional ratios), also considering the particular characteristics of the population served. Currently, Decree-Law No. 28/2008, of 22 February, is still in force, establishing the following ratios [17], [18]:

- One doctor with the degree of specialist in public health per every 25,000 inhabitants (i.e., 4 public health medical specialists per 100,000 inhabitants);
- One nurse per 30 000 inhabitants (i.e., 3 nurses per 100,000 inhabitants);
- One environmental health technician for every 15,000 inhabitants (i.e., 7 environmental health technicians for every 100 000 inhabitants).

In order for this entire public health workforce to perform its diverse functions, they need information systems. These fundamental public health components enable public health professionals to collect, store, manage, analyse, and optimize key data to their daily work. There are several health information systems, microsystems and subsystems, most of which are not integrated and not designed according to the same logic, with clear losses in efficiency and effectiveness. Undesirable, there is no single population-based Health Information System in Portugal, oriented towards health outcomes, which responds, in an integrated manner, to the different information needs of the Health System, its main actors and partners [11].

It is possible to account for several information systems specific to PH, notably the *SINAVE* (National Epidemiological Surveillance System), the *SONHO* (Integrating Hospital Information System), the *RNU* (National Register of Users), the *SClinico*, and the *REVIVE* (National Network for Vector Surveillance).

The *SINAVE* is a system designed to dematerialize the process of epidemiological surveillance of

mandatory reporting diseases [19]. *SINAVE* is composed of two parts: the *medical SINAVE* (*SINAVE-Med*) and the *laboratorial SINAVE* (*SINAVE-Lab*). *SINAVE-Med* contains data related to hospital consultations and observations, which are entered into the system by health professionals when they diagnose a disease with mandatory notification. In *SINAVE-Lab*, the data refer to the results of laboratory tests that are carried out to confirm the existence of communicable diseases that must be declared. Since 2017, laboratory notification of cases of communicable diseases has become mandatory, through *SINAVE-Lab* [20].

SONHO is an integrated hospital information system based on the philosophy of 'one patient – a unique identification number'. From a structural point of view, the main objective of this system is to create the minimum infrastructure necessary for an *Integrating Hospital Information System*, which allows for the full integration of modules/applications, as well as ensuring standardization criteria. From a functional point of view, this system supports the administrative service of hospitals, ensuring the control of production and billing, by controlling the flow of hospital patients [21], [22].

Regarding the *RNU*, is the national database that clearly and unequivocally aggregates and identifies users registered with the National Health Service (SNS) [22], [23].

The *SClinico* is part of the strategy defined by the Ministry of Health for the area of clinical computerization of the SNS, which provides for the standardization of procedures for clinical records, in order to guarantee the standardization of the information collected in the various institutions of health [24], [25].

Finally, the creation of *REVIVE* was due mainly to the need to monitor the activity of the vector species present in the country, characterize the species and its seasonal occurrence, and identify important pathogens in Public Health, depending on the density of the vectors, the level of infection or the introduction of exotic species to alert for control measures [26]–[28].

To all the information systems mentioned above, it is necessary to add other information systems in use in the health area (such as, for example, clinical decision support systems). These last information systems are used to record predominantly clinical activity, but whose information matters for the functions of observatory, surveillance and programmed public health intervention. The articulation with these systems and the possibility of using some of the information contained therein is essential for the activity of the services of a true RSSP. However, despite considerable advances in this area, there are still difficulties in accessing information considered more relevant and essential for the practice of public health [11], [12].

2.2 Role of Public Health Measures in a Pandemic Context

2.2.1 Role of Public Health Measures in the Control of Pandemic

A pandemic is a disease outbreak that spreads over a wide geographic area – such as multiple countries or continents [29]. Viral respiratory diseases, such as those caused by a new influenza virus or the coronavirus COVID-19, are the most likely to turn into a pandemic [30].

Following the identification of the new coronavirus SARS-CoV-2 in Wuhan, China, in December 2019 and its global spread, on March 11, 2020 the WHO has declared the COVID-19 outbreak a global pandemic [4]. Consequently, the COVID-19 was included in the list of mandatory notification diseases.

Consequently, and inevitably, the COVID-19 virus has become a PH priority. The fundamental work of PH during the pandemic is based on strategies of PH measures with specific objectives, specially [6]:

- To reduce the overall transmission and slow the rate of transmission of the novel or pandemic virus, thus lowering the total number of severely ill cases and deaths and delaying the accumulation of cases.
- To reduce peak demands on health care institutions, thereby protecting to the greatest extent possible against societal disruption and the overwhelming of community services, and buying time before an effective vaccine is produced.

The epidemiologic curve showed in Figure 2.3, illustrates the goal of flattening and delaying the peak of the epidemic by implementing public health measures to reduce and slow transmission of a novel virus [31].

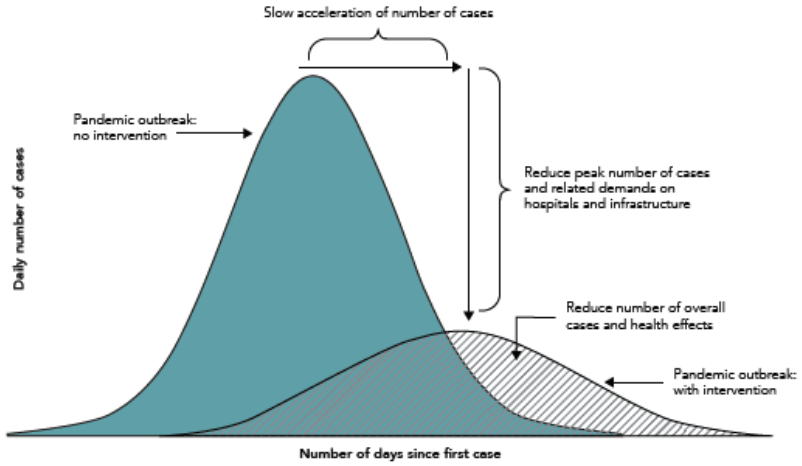


Figure 2.3 – Epidemiologic curve with the representation of the goal of Public Health measures for pandemic influenza. From: [31]

It is noteworthy that the defining features of PH measures are that they can be implemented early and involve multidisciplinary collaboration, between and across health and non-health sector settings, including homes, workplaces, public and educational settings, ports of entry, various community-based service organizations and correctional facilities. Precisely, PH measures include personal protective measures, community-based measures, track and tracing activities (case and contact management measure), travel and border-related actions, and public education (see Table 2.1) [3], [31]–[33].

Table 2.1 – Summary description of the PH measures [3], [31]–[33].

Public Health Measures	**Summary description of the measure**
Personal protective measures	Individual measures to prevent the spreading of infection: respiratory etiquette, hand hygiene, environmental cleaning of surfaces and staying home when ill (self-isolation).
Community-based measures	Measures to reduce transmission of infection within community settings such as schools, workplaces, and communal living facilities. Social distancing measures (e.g., minimizing close contact with others) – proactive school closures, public gathering cancellations and alternative workplace approaches (e.g., teleworking).
Track and tracing activities	Case and contact management measure. From a public health perspective, experience with SARS suggests that intensive system of contact tacking and other interventions (testing and quarantine) are critical to successful control of the outbreak. [33]
Travel and border-related actions	Provide disease information to travellers and measures taken with suspected cases and their contacts across the country's international borders.
Public education	Promote and to support the implementation and adoption of measures at the individual and community levels, based in a risk communications approach.

Given the importance of the track and tracing activities, they will be further detailed in the next sub-section.

2.2.2 Track and Tracing Activities

In order to respond quickly to the growth in the number of suspected and confirmed cases, the PHU made countless efforts in track and tracing activities. As mentioned before, track and tracing activities are core PH interventions to fight the ongoing epidemic of COVID-19, in conjunction with other measures (identified at Table 2.1). Predominantly, the role of track and tracing activities are: detection, isolation, testing, and management of confirmed cases of COVID-19; identification and isolation of high-risk and low-risk contacts; and the detection and containment of outbreaks and clusters [34], [35]. In addition, to rapidly identify potentially newly infected persons who may have contacted with existing cases, in order to reduce further onward transmission, the contact tracing measure is crucial. At the *Contact tracing for COVID-19: current evidence, options scale-up and an assessment of resources needed* by the ECDC (European Centre for Disease Prevention and Control), this essential measure is presented in detail [36]. Table 2.2 presents the strategic approaches of the component contact tracing as well the case definition, demonstrating how to support each of the objectives in advance identified [35]–[37].

Table 2.2 – Specification of the strategic approaches of the component case definition and contact tracing [35], [37].

Strategic Approaches	**Specification**
Case definition [37]	Defined by the set of clinical, laboratory or epidemiological features that characterize a particular infection or disease - confirmed case, probable, under investigation, suspected, or validated.
Contact tracing [36]	It includes all procedures from the identification, listing and follow-up of contacts, aiming to prevent the establishment of transmission chains, through the immediate adoption of prevention and control measures. ○ Contact identification: identify persons who may have been exposed to COVID-19 as a result of being in contact with an infected person. ○ Contact listing: to trace and communicate with the identified contacts, and to provide information about suitable infection control measures, symptom monitoring and other precautionary measures such as the need for quarantine / isolation [a]. ○ Contact follow-up: to monitor the contacts regularly for symptoms.

[a] separation or confinement of persons suspected of or infected with SARS-CoV-2, preventing the establishment of transmission chains and delays and reduces widespread community transmission.

Figure 2.4 illustrate some tasks to be performed in the case definition and contact tracing.

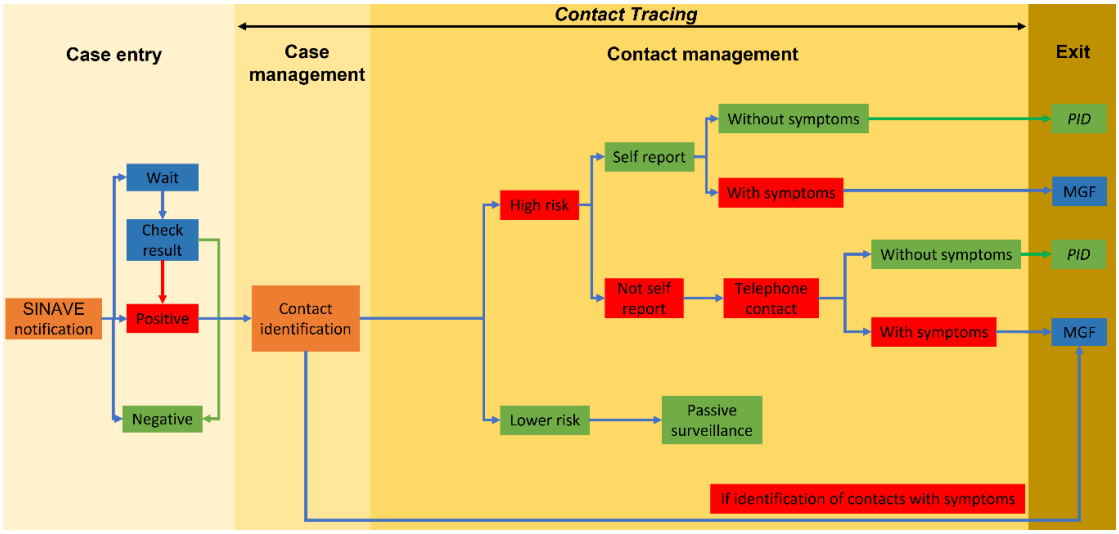


Figure 2.4 – Some of the tasks performed in the case definition and contact tracing. (PID - Prophylactic Isolation Declaration).

Tracking and tracing activities are time-demanding and dependent on the training and proficiency of the PH agent, as well as on the collaboration of the subjects. They also depend on the information system circuits and time-dependent articulation among different levels, for instance on the doctor who diagnoses, on the laboratory who tests, on hospital information, on death notifications, among others. Delays and the level of contact tracing coverage influence the effective reproduction number [38]. Table 2.3 shows a list of some cases delays that influence this activity [38], [39].

Table 2.3 – Examples of cases delays that influence track and tracing activities.

Factors	**Meaning**
Testing delays	Time between symptom onset and a positive test result – assuming immediate isolation, otherwise adds delays.
Tracing delays	Time to trace contacts (close contacts and other contacts) – assuming immediate testing and isolation if found positive, otherwise adds delays.
Asymptomatic cases	Case without symptoms. Asymptomatic cases are less likely to spread the disease than symptomatic cases. *The risk of spreading the disease exists. These cases are undetected without testing. Influences the effectiveness of contact tracking.*

To ease track and tracing activities, the *Trace COVID-19* platform was developed by DGS, in articulation with SPMS (Ministry of Health Shared Services) [40]. Developed in the pandemic, this platform is interconnected to other platforms, receiving data from other sources, namely: *SINAVE* (*SINAV-Med*, *SINAVE-Lab*) [19] and SNS24 (National Health Service 24) [41]. It should be noted that this platform was developed after the pandemic was declared, and its urgent design is noticeable. Since the appearance of *Trace COVID-19*, this platform has been updated several times.

This platform consists of a set of measures adopted for clinical and epidemiological surveillance. The *Trace COVID-19* supports professionals in Primary Health Care (MGF and PH) and Hospital Care, aiming to [40]:

- Perform detailed records of specific information about the cases, respective contact tracing, surveillance and clinical follow-up to patients with suspected or confirmed COVID-19
- Develop and maintain epidemiological surveillance during the COVID-19 pandemic, ensuring the dissemination of information and supporting the coordination of national epidemiological surveillance.

2.3 Project Contextualization

This project is developed in the context of the main project funded by *Fundação Ciência e Tecnologia*, titled by *Cost-effectiveness and Optimization of the Public Health effort for COVID-19 Track and Tracing activities in Portugal*.

As previously mentioned, PH contact tracing activities impact the rate of new infections, their severity and deaths. They are critical to ascertain vulnerability of settings (e.g., nursing homes, workplace, families, schools) and the ability to reduce actions limiting socio-economic activities, while maintaining acceptable rates of new infections and deaths. So, the purpose of the main study is, in a representative sample of the Portuguese population:

- To determine the effectiveness of the PH track and tracing activities carried during the COVID-19 pandemic, in terms of ratios of infected (asymptomatic / diseased / severely diseased / deaths) individuals detected and secondary cases prevented;
- To estimate the gains with the incremental resource allocation and performance optimization for PH Track and Tracing activities and their impacts (global and local), according to the infected prevalence and pandemic phase, informing policy options.

This main project is, up to this date, ongoing. Data is to be retrieved as pseudo-anonymous datasets exported from the platform *Trace COVID-19* (collaboration of SPMS, DGS). Data pseudo-anonymization will allow the linkage of individuals and operators (e.g., PH doctors and other human resources) in an anonym analysis. Geographic data will be classified to the four digits postal code, institutions will not be anonymized, and dates will be kept as accurate as registered. This will allow the use of geographic and time-series analysis, as well as the request for institutions to validate or confirm the situation of outliers or impossible values.

All variables will be examined in an exploratory and descriptive data analysis approach, in order to understand its distribution, outliers, missing data, classification, and classification changes across time, etc. A particular attention will be given to correlation structures within the data (e.g., clusters and principal component analysis). For each index-cases[1], the resources needed to account the management of the case and of the contacts will be calculated, as well as the variation between the resources needed, the resources used and the difference between both [42]. This information will be correlated with the local R indicator and / or indicators for progression at the local setting, taking into account lockdown and restrictive measures in place.

Several key steps from the main project were developed by the student, with the support of the research team. These steps are depicted in Figure 2.5 and shortly described afterwards.

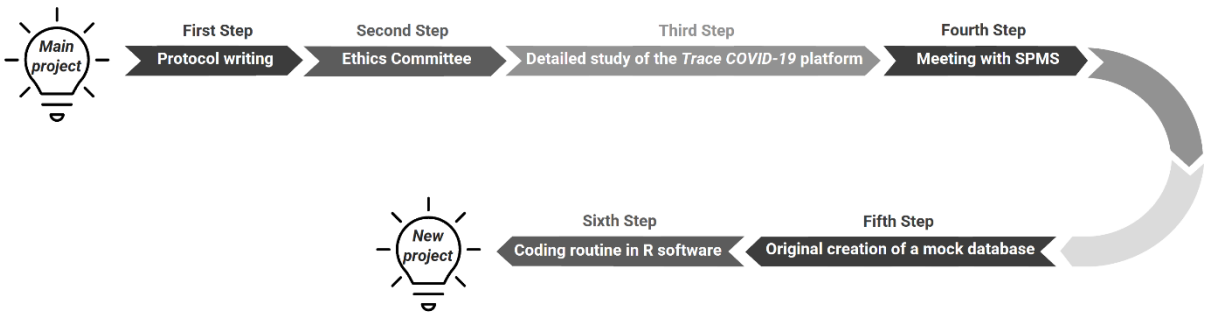


Figure 2.5 – Steps involved in the main project.

[1] first case in a family or other defined group to come to the attention of the investigator [42].

First step and second step – Protocol writing & Ethics Committee

A literature search and a detailed scientific protocol was written covering various topics relating to the main project, namely: the scope, rationale, specific aims, methods, ethical considerations, research potential, and elements of the team and partnerships.

Consequently, the study was submitted and subsequently approved by the *Ethics Committee of the CHLN – Centro Hospitalar Lisboa Norte* and *CAML – Centro Académico de Medicina de Lisboa*.

Third step – Detailed study of the Trace COVID-19 platform

For preparing the request for data concerning the *Trace COVID-19* platform, a careful study and visualization of the *Trace COVID-19* platform was done. This allowed to understand the variables, classification, and data entry rules. Detailed discussions regarding the data needed for the study in question and the platform's data model was done with Informatic engineers.

Fourth step – Meeting with SPMS

Several meetings with SPMS technical staff were held in order to discuss the data needed for the study in question and clarify existing issues.

Fifth step and sixth step – Original creation of a mock database & Coding routine in R software

In order to be able to advance in the design of the statistical analysis, these two steps were performed.

Firstly, after understanding the platform at a structural and functional level, a mock database was created based on the expected information that could be on the true dataset. This database was created in MSAccess. This tool thus allows to design an approximate database of the platform. After inserting data in the created database, it was possible to have some data close to those on the platform. Subsequently, a coding routine was developed in the R software using the small database created. Thus, when data from the Trace COVID-19 platform is made available, one will be run in the code already created, which will allow for a countless reduction in time.

The current study constituted a new and previously unforeseen project, derived from the main project. The new project (under study) emerged, given the perception that obtaining the data would extend beyond an acceptable calendar time. Also, the importance of having the opportunity to address and characterize how PHUs were responding during the COVID-19 pandemic became clear. It was equally important to have additional information from the organization and resources of the PHUs, which was not included in the data provided by the Trace COVID-19 platform. As a result, and after the work

developed (Figure 2.5), the writing of the new protocol for the study presented in this thesis emerged, as well as other steps that will be presented in the Chapter Methods.

2.4 Final Remarks

PH is currently in deep evolution that may be, at least in part, attributed to the fast progress of knowledge. The performance of PH is progressively more efficient and more adapted to their tasks. Thus, this evolution is due to the theoretical investigation carried out by the academic disciplines of research and exploratory work, the study of the concrete problems that constitute the dominant pattern of diseases in the population, and professional work conducted directly at individuals. Consequently, the research, study, and practical actions must be pursued accordingly [2], [3]. The pandemic highlighted this proclamation.

After approximately one year of pandemic, on February 19, 2021, the DGS updates norm 015/2020, indicating for the first time a model for the *Operationalization of Tasks in Public Health Services* [43]. This document indicates how professionals allocated to the response to COVID-19 in PH Services should organize themselves into teams to perform the various activities in a structured and sequential manner. It is suitable for each type of COVID-19 task – case entries and assignment to case manager; carrying out epidemiological surveillance; and other tasks – the distribution of teams and the roles to be performed. Nonetheless, between this norm and the start of the pandemic, a year passed. Promptly, assignable to the presence of the new virus, all PHUs had to make changes and reorganize their activities and function to rationally allocate the available resources to cover the enormous workload that came with the pandemic. As aforementioned, because the severity of the pandemic is influenced by several factors, the efforts done by each unit to control the disease transmission are extremely variable over time to match the local dynamics of the pandemic.

With this dissertation, the objective is to analyse all the dynamic reorganization that occurred in the PHUs in mainland Portugal caused by the presence of COVID-19. For this purpose, we collected data reflecting the reality of the units before the pandemic, allowing us to assess the changes caused by the pandemic regarding the reorganization, functionally, structuring, resources, among others – considering the various phases of the pandemic.

Chapter 3

Literature Review

This Chapter is concerned with the published literature of interest to this work. First, a brief review of the guidelines regarding emergency preparedness for COVID-19 pandemics is presented in Section 3.1. In Section 3.2, we describe the strategies to deal with the pandemic recommended in several studies and adopted by several countries. Finally, Section 3.3 provides concluding remarks.

3.1 Guidelines for the Health Sector to deal with the COVID-19 Pandemic

Small-scale hazardous events with limited health consequences occur on a regular basis, while other events – including the COVID-19 pandemic – may lead to emergencies or disasters with significant consequences for public health and well-being and for health as well as other sectors (economic, social, etc.) [44].

Accordingly, the existence of recommendations regarding emergency preparedness is essential. Emergency preparedness is defined as: *"...the knowledge and capacities and organizational systems developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from the impacts of likely, imminent, emerging, or current emergencies"* [45], [46].

Contagious virus infections are common in human history, with influenza A virus being the most common. The new viruses that caused the most recent large-scale infections are viruses that are very different from current and common circulating human viruses. These viruses are constantly changing, infecting humans, harming their health (with different severity levels), and are capable of an efficient human-to-human transmission. Consequently, the contagion rates, associated complications, as well as other factors, are very different between the different viruses [47], [48].

The COVID-19 pandemic is the first pandemic caused by a coronavirus [45]. Prior to the pandemic caused by the SARS-COV-2 virus, there were several flu pandemics, namely: 1918 Spanish flu pandemic (H1N1 virus), 1957-1958 Asian flu pandemic (H2N2 virus), 1968 Hong Kong flu pandemic (H3N2 virus), and 2009 Swine flu pandemic (H1N1pdm09 virus) [50]–[55].

International and multi-nation organizations (example: United Nations and European Union) have developed guidelines that encompass comprehensive recommendations to all types of emergency

preparedness. In this Chapter, we selected the recommendations related to the COVID-19 pandemic. Complementary, information regarding how to address resources, as well as the activities to be carried out for the health sectors, particularly in the public health sector (when possible), will be included. It is important to highlight that the recommendations for the influenza pandemic also apply to the COVID-19 pandemic since both are viral respiratory diseases.

Regarding the *WHO global influenza preparedness plan*, this document, published in 2005, was prepared to assist 'those responsible for public health, medical and emergency preparedness to respond to threats and occurrences of pandemic influenza' [56].

The *WHO global influenza preparedness plan* includes a sequence of phases of increasing PH risk associated with the emergence of a new influenza virus subtype that may pose a pandemic threat (Table 3.1) [56].

In the pandemic alert period – phase 5, in order to ensure that health systems are ready to increase response and implement changes in triage and treatment priorities, and that these actions occur as soon as a country becomes affected, the WHO recommends that the affected countries arrange for additional human and material resources, and alternative means of health-care delivery, based on forecasted needs and contingency plans. In parallel, to determine and monitor public health resources required for pandemic response, it is also recommended to implement real-time monitoring of essential resources (for example: medical supplies, pharmaceuticals, infrastructure, vaccines, hospital capacity, and human resources, …) [56].

Reached the last phase, pandemic period – phase 6, the main objective is to minimize the impact of the pandemic. For this, several recommendations are addressed; some of the recommendations presented are the implementation in full pandemic contingency plans for health systems and essential services, at national and local levels; optimizing the management of human and material resources; monitoring health system status; the deployment of additional workforce and volunteers; as well as ensuring staff support. Regarding public health interventions, actions such as coordination and facilitation of the assessment of interventions and updating of recommendations, if necessary, as mentioned, as well as reiteration of appropriate and inappropriate measures for affected and unaffected countries. Only the last point specifies recommendations for nonpharmaceutical public health interventions [56].

Table 3.1 – Phases of increasing public health risk associated with the emergence of a new influenza virus subtype that may pose a pandemic threat, and the public health goals for each phase [56].

Period	Phase	Description
Interpandemic	1	No new influenza virus subtypes have been detected in humans. An influenza virus subtype that has caused human infection may be present in wild birds or other animal species. If present in animals, the risk of human infection or disease is considered to be low, however does not mean that no action is needed*. Strengthen influenza pandemic preparedness at the global, regional, national and subnational levels.*
	2	No new influenza virus subtypes have been detected in humans. However, a circulating animal influenza virus subtype poses a substantial risk of human disease. *Justify public health measures to protect persons at risk. Minimize the risk of transmission to humans; detect and report such transmission rapidly if it occurs.*
Pandemic alert	3	Human infection(s) with a new subtype, but no human-to-human spread, or at most rare instances of spread to a close contact. *Ensure rapid characterization of the new virus subtype and early detection, notification and response to additional cases.*
	4	Small cluster(s) with limited human-to-human transmission but the virus is not well adapted to humans and spread is highly localized. *Contain the new virus within limited foci or delay spread to gain time to implement preparedness measures, including vaccine development.*
	5	Larger cluster(s) but human-to-human spread still localized, suggesting that the virus is becoming increasingly better adapted to humans, but may not yet be fully transmissible (substantial pandemic risk). *Maximize efforts to contain or delay spread, to possibly avert a pandemic, and to gain time to implement pandemic response measures.*
Pandemic	6	Increased and sustained transmission in general population. *Minimize the impact of the pandemic.*

In line with the WHO guidelines, the DGS formulated the *National Contingency Plan* with recommendations for planning the response to public health emergencies [57]. This *National Contingency Plan* specifies for in hospitalizations and outpatient sector, the need to ensure the necessary material and human resources at their maximum limit, admitting, if necessary, the mobilization and recruitment of retired health professionals, on unpaid leave and students in the health

area. This last consideration is widely recommended by the WHO, which warns for the importance of providing the resources and other types of support for severely affected countries [56].

Taken together, all the recommendations mentioned above pointed the human resources as the essential pillars in preparedness, response and recovery during any public health emergency.

Specifically, for the COVID-19 pandemic, the technical guidance paper *Strengthening the health system response to COVID-19* was developed by the WHO Regional Office for Europe, to provide practical information and resources for decision makers on measures to strengthen the health system response to COVID-19 [58], [59]. Following these WHO guidelines, the DGS developed the *National Plan for Preparedness and Response to New Coronavirus Disease (COVID-19)* [57]. Both technical guidance papers identify as an action strategy the estimation of the health workforce available for surge capacity[2] demands that would otherwise severely challenge or exceed the present capacity of the system [60], [61].

Also, in the essential health services, it is recommended the mobilization of the health workforce according to priority services, to ensure the human resources needed for the COVID-19 preparation and a suitable response to each pandemic phase. In addition, the sources for temporary health workforce surge capacity and essential health care services, including public health services, are enumerated [57]–[59] :

- recruit part-time staff to expand hours and full-time staff to work remunerated overtime;
- recruit additional health workers (using registers and certification records to identify qualified candidates), including licensed retirees and medical trainees for appropriate supervised roles;
- mobilize non-governmental, military, Red Cross or Red Crescent, and private sector health workforce capacity;
- Invite volunteers and/or health workers working outside the health sector.

In addition, the WHO Regional Office for Europe identifies action plan to improve PH preparedness and response in the *WHO European Region 2018-2023*. One of the guidelines refers to ensuring the adequate distribution of the emergency preparedness and response workforce throughout the health system [62].

Moreover, recommendations regarding material resources were addressed in the technical documents mentioned above. However, the guidelines refer only to medicines and medical devices,

[2] ability of a health system to maintain a sudden, unexpected increase in patient volume (such during mass casualty situations and disasters) [60], [61].

without reference to the material resources used by public health professionals, and indispensable to allow the daily work of controlling the pandemic (e.g., computers, phones and mobile phones) [57].

Currently, the health care services worldwide are being confronted with increased demand generated by the COVID-19 outbreak. The WHO Regional Office for Europe emphasizes the importance of maintaining the essential services[3] while freeing up the workforce capacity for COVID-19 response [59]

The *National Plan for Preparedness and Response to New Coronavirus Disease (COVID-19)* from DGS mentions the importance of documenting all the processes, activities, the decisions, and the associated results. Importantly, the observed results must be analysed to verify if their actions and consequences occurred as planned. This assessment enables to incorporate the lessons learned into a model to inform future revisions of the plan [57].

3.2 Strategies to achieve the COVID-19 Guidelines for the Health Sector

The general recommendations supported by international organization (such as WHO) and national organization (DGS in Portugal), required at the local level the definition of strategies that maximized compliance with the recommendations within the health sectors, particularly in the public health sector when attainable. The strategies referenced in this Section are related with the human resources and activities in the health sector.

Several articles presented some strategies of how to safely increase the number of providers within health worker cadres in the context of the COVID-19 (except for an example of a strategy referring to the Spanish epidemic, which is accurately referenced), namely [63]–[69]:

i. <u>Existing health workforce:</u>

This seems to be the most common strategy adopted around the world. This strategy includes asking health professionals to work extra hours, including moving from part-time to full-time work or allowing extra overtime; modifying work schedules; suspending ongoing or scheduled external rotations for residents in training; and cancelling leaves of absence or foreign-travel.

[3] services that remain necessary, even during a pandemic, to reduce avertable mortality.

During the first wave of the COVID-19 pandemic, Portugal used this type of strategy to maintain or scale up the health workforce capacity.

ii. Fast-tracking trainees near the end of their programs

Many countries recruited medical and nursing students to support health professionals. For example, in Australia, nursing students were employed as assistant nurses to free up registered nursing time to deal with more acute disease cases.

iii. Recalling inactive / retired health workers:

Some countries launched campaigns to bring retired or inactive health professionals back to the workforce. This specific measure resulted in a large number of health professionals volunteering to return to work. For example, in Germany, retired doctors were called to return to medical work or to help with case tracing or telephone helplines. In the Netherlands, at the end of March more than 3 000 health works returned to the health sector in response to COVID-19. Another example is the case of Ireland, where 72 000 people signed up to 'Be on call for Ireland', and 260 nurses and 63 doctors were hired by mid-April [68].

iv. Emergency recruitment procedures:

Several countries launched emergency procedures to hire new health workers.

In June 2020, the Portuguese Government published (in the Republic Diary) the information regarding the duration of contracts, to reinforce the human resources needed to respond to the pandemic caused by COVID-19. This refers to the possibility of starting into fixed-term contracts, for a period of four months [70]. Thus, owing to the fact that the hiring of health professionals was facilitated through exceptional procedures, 137 doctors and 1 100 nurses were hired by the end of the summer, 2020.

v. Extra staff

Many countries have also redeployed or employed graduated or current student in health-related and non-health-related subjects to work in different settings.

For example, in Germany, civil servants (from different fields, such as sociology, pedagogy, or sports sciences) were redeployed to public health from elsewhere and employed to support health authorities with pandemic-specific tasks and fulfil accurate contact tracing [65], [66].

In fact, a similar measure was used many years ago, during the Spanish flu epidemic of 1918-

1919, the hospitals were unable to accommodate all the patients, even the most serious cases; therefore, visiting nurses experienced an enormous demand. One of the experiences related to nurses, reported in this article, was the case of Cleveland. Visiting nurses in Cleveland, from the 'Cleveland Visiting Nurse Association', had a 400% increase in work during this time [68].

vi. Expedited Onboarding of New Staff [67]

Creation of a system to nimbly secure and on-board temporary staff during emergencies, and address contingency plans to overcome staff shortages. This strategy (although never implemented) could have been an enormous asset. For example, to avoid the shortage in the availability of temporary nursing staff that has therefore severely affected Emergency Department operations, in New York City.

vii. Migrant health workers, health professionals from the private sector

Recruitment strategies have targeted to bring foreign-trained health professionals into the workforce for a temporary period or to speed up recognition procedures (of their professional certificate). For example, in Ireland, refugees and asylum seekers with medical qualifications were able to work in support roles such as health care assistants, while registration fees for foreign-trained doctors have been waived. Foreign-trained doctors, nurses, and paramedics already working in there in United Kingdom, but with visas due to expire by October 2020 have had them automatically renewed for a year. Another example is the case of Austria, 24-hour carers from Eastern European countries were allowed to continue to enter the country to ensure that people with live-in carers continue to receive care.

viii. Armed forces

In several countries medical and support personnel from the army were also recruited to help with the pandemic in health or long-term care settings.

Additionally, complementary strategies to increase the flexibility of health professionals across the workforce are presented, specifically [64].

i. Task shifting and new skill mixing

Transfer or delegation of tasks and new skills, combining innovations and taking advantage of the full range of skills available within and outside the health workforce. In Australia and Canada,

there was a shift of health professionals released from cancelled elective surgeries to other sectors with greater need.

ii. Rapid expansion of virtual care

Evidence regarding the suspension of non-urgent activities is verified for example in Italy. Practical measures, managed directly by the Department of Prevention, have been instituted for the containment and mitigation of the epidemic. In particular, the rescheduling of non-urgent activities and maintaining only essential programs, telemedicine, assigning of staff to COVID-19 tasks, and protection of the workforce [71].

Resembling, in Australia there have been substantial drops in a wide range of healthcare activities (such primary care face-to-face consultations and breast screening activity) across the New South Wales health system between March and June 2020 due to the impact of the COVID-19 pandemic. Although activity levels were recovering in September 2020, they had not yet returned to 'normal' [72].

Overall, there is consistent evidence of large reductions in the utilisation of healthcare services during the pandemic period to May 2020, compared to previous years [73].

3.3 Final Remarks

Most of the measures described in the WHO technical guidance have been adopted, in particular to increase surge capacity. Nonetheless, one of the great paradoxes of all the above recommendations is that '*pandemic response plans in country after country often failed to explicitly address the health workforce requirements and implications on the workforce itself*' [74].

Specifically, many pandemic preparedness plans were not Covid-19 specific and planning for health professional capacity expansion was limited. It can be seen that the above mentioned DGS recommendations covered the health workforce to at least some extent, but most were not very specific, and majority were not up to date in light of the Covid-19 situation.

In addition, databases such as *PubMed/Medline*, *Google Scholar*, *Medrxiv* (preprints), and *Multidisciplinary Digital Publishing Institute* (*MDPI)* were used as search engines for publications similar to this study. Similar studies outside the PH sector and besides outside the COVID-19 area were researched, covering the most macro level possible. However, no similar studies were found.

Specifically, publications were found relating to qualitative studies and without attempt to associate with results / impact (mostly studies relating to the description of strategies related to human resources, and non-COVID-19 activities and COVID-19 activities) as represented in Section 3.2.

However, no similar studies were found. Only, studies relating to the description of strategies related to human resources, and non-COVID-19 activities and COVID-19 activities, were found and presented in Section 3.2.

It is important to emphasize the gap found in the literature regarding studies in PH units. The present study is the first addressing these issues and will contribute for identifying good practices and fostering evidence-based public health.

Chapter 4

Methodology

In this Section, the methodology employed to address the objectives of this dissertation is describe in detail. An original survey, targeting all PHU, was developed and implemented for collecting and analysing qualitative and quantitative data. How the online questionnaire was prepared, is explain in detail in four sub-sections: the target population (Section 4.1), the preparatory steps for developing the questionnaire (Section 4.2), the design of the questionnaire (Section 4.3), and finally, the preparatory steps for effectuation of the study (Section 4.4). In Section 4.5 we describe the questionnaire analyses. The full questionnaire is presented in Appendix A.

4.1. Population Studied

A cross-sectional online survey was elaborated to understand the reality of PHU before the pandemic, and therefore what changes the pandemic brought in terms of reorganization, functionally, structuring, resources, among others.

The questionnaire was addressed to all PHUs in mainland Portugal – a total of 55 PHUs. However, there are PHUs constituted by only one sub-unit, the main unit (the headquarter), and PHUs constituted by more than one sub-unit (the headquarter and other(s) sub-unit(s)). This different organization depends on the geographical area covered by the PHU (as it very extensive and it is not feasible to have only one sub-unit (the headquarter) due to the time lost in travel). In the case of PHUs with more than one sub-unit that were also autonomously involved in management tasks related to the pandemic, an additional questionnaire was sent for those sub-units (six PH sub-units were identified and received a questionnaire). Thus, a total of 61 questionnaires were sent to the respective PHUs (*Alentejo* region, n=4; *Algarve* region, n=3; *Central* region, n=9; *Lisbon and Tagus Valley* region, n=21; and *North* region, n=24).

4.2 Questionnaire Development

The development of the questionnaire consisted of several phases (steps), depicted in Figure 4.1.

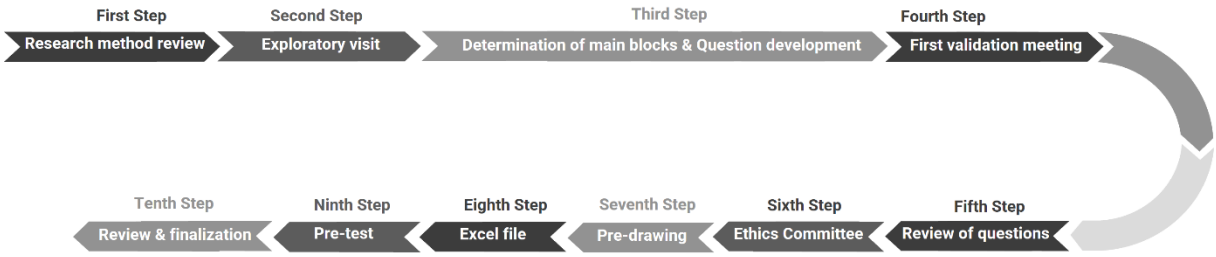


Figure 4.1 – Steps involved in the questionnaire development.

First step – Research method review

The first phase involved researching efficient methods for developing a questionnaire, and type of questions included in questionnaires design to assess health units or PHUs [75]–[81].

An extensive review of existing literature was performed using medical search engines such PubMed and Google Scholar. ‘Questionnaire development or survey design’, ‘organizational models or management’, ‘health units or public health units’ are some of the keywords used to search for relevant articles.

Second step – Exploratory Visit

An exploratory visit to the PHU Loures-Odivelas was conducted to allow a real perception of the daily work performed by health professionals in a PHU. It was possible to monitor the different activities performed by the unit in question, as well as the human and material resources that were used in the day-to-day work at a PHU.

Furthermore, it was attainable to observe the training given to the various professional groups, which would help fight the pandemic. Specifically, it was training with reference to knowledge of the various DGS standards, the operation of the Trace COVID-19 platform, the process of carrying out epidemiological surveys and other topics related to the unit's functioning. Additionally, during the visit period, it was also possible to monitor the epidemiological survey and active surveillance carried out by the health professionals of the unit.

Third Step – Determination of main blocks & Questions development

Considering the information gathered in the previous steps, in second step, the overall structure and main blocks/themes of questions were defined (Figure 4.2).

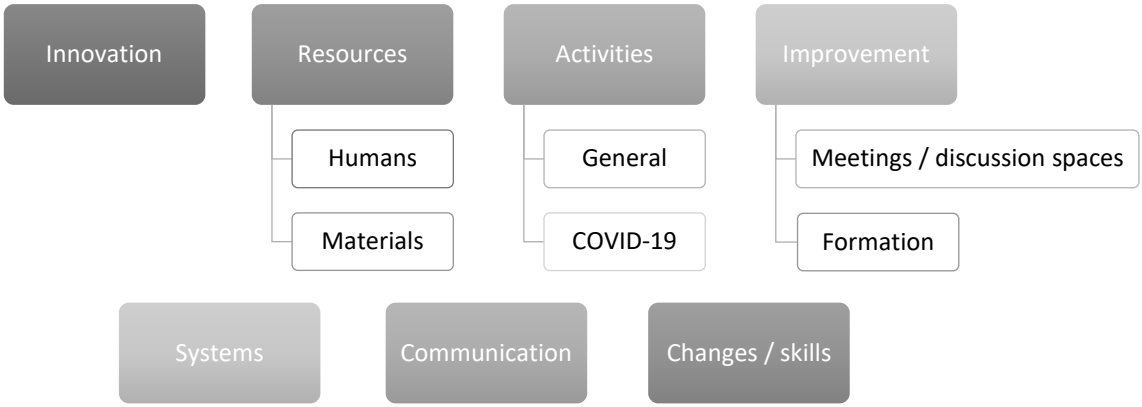


Figure 4.2 – General questionnaire structure and main blocks of questions.

Subsequently, relevant items, for each main block, were generated with specific attention to the proper framing of questions in a lucid language, using expressions in the first person. Each item was carefully framed to refer to a single concept, avoiding ambiguity and double negatives. Therefore, the questions elaborated in detail for each block in a paper version were then transferred to Microsoft Word (first version of the questionnaire).

Fourth Step – First validation meeting

In this step, two physicians (specialized in public health) evaluated the first draft of the questionnaire, providing a critical appraisal and content validation. For qualitative content validity, each expert was asked to comment on the relevance and lucidity of individual items.

Fifth Step – Review of questions

The suggestions mentioned in fourth step were incorporated in the revised version of the questionnaire. This includes, for example, a reordering of questions and clarification of some topics, namely the meaning of changes and innovative implementations.

Sixth Step – Ethics Committee

The study was submitted and subsequently approved by the *Ethics Committee of the CHLN – Centro Hospitalar Lisboa Norte* and *CAML – Centro Académico de Medicina de Lisboa.*

Seventh Step – Pre-drawing

During this step, we focused on improving the readability and clearness of the questionnaire, trying to avoid as much as possible open-answer questions. Thus, in this step we converted (as much as possible) the previously developed questions into closed-ended answers, through the insertion of filling tables.

Eighth step – Questionnaire version in Excel file

After the perception that the questionnaire consisted mostly of tables the format was changed from Word to Excel.

For many questions, the participants need to search to gather the required data. For example, the number of professionals in each health professional category working at the PHU during the period before the pandemic requires the access to the archives. Additionally, the participants responsible of filling the questionnaire have numerous responsibilities and a heavy workload, which could compromise the quality and completeness of the responses. Therefore, and after discussion with medical specialists in public health, it was decided that the best method to implement the questionnaire would be through the *Google Sheets* software. This format allows the entry of data in real time and a simultaneous and collaborative edition of the survey by several health professionals within each unit, through a shared link. *Google Sheets* also allows closing and resuming the questionnaire filling, without losing any information.

Ninth step and tenth step – Pre-test and Review & finalization

The pre-test of the final version of the questionnaire was carried out by two public health medical specialists and by the coordinator at the *Loures-Odivelas Unit.* The aim of this phase was to evaluate the acceptance, relevance, and lucidity of the questionnaire. Based on their feedbacks, relevant modifications were done. For example, some clarifications for a correct filling in all fields were included to clarify that the number of entries, dropouts and absences of health professionals is not cumulative.

After this step, the design of the final version of the questionnaire was terminated. All these ten phases ensured that the items in the final questionnaire were appropriate, and data could be accurately collected.

4.3 Questionnaire Structure and Description

Grouping the different main blocks in a methodical and logical way, the final questionnaire, in *Google Sheets*, was organized in 10 separate sections ('tabs'). In some sections, the questions refer to different pandemic periods – before (2019 and January 2020) and during the pandemic. In the period during the pandemic, this may be subdivided into 3 periods – 1st period (from 1 March 2020 to 31 August 2020), 2nd period (from 1 September 2020 to 28 February 2021), and 3rd period (from 1 March 2021 to 31 July 2021). This subdivision is in line with the evolution of the pandemic, considering the pandemic peaks (Figure 1.1).

The 10 sections of the questionnaire are presented below:

- '*0.Apresentação'* – brief presentation of the project and thanks for participating.
- '*1.Coordenação*' – confirmation of data and request for information regarding the PHU and its coordinator, such as the time that the participant (the coordinator) works in the respective PHU and the time that the participant works as a coordinator.
- '*2.Inovação*' – general reflection of the pandemic. It is questioned what innovative changes have occurred in the PHU – a solution created by the unit to respond to a need or requirement, with existing resources or created by the PHU, with or without collaboration from external entities – and what innovative implementations the PHU had – technical and/or produced by the unit to respond to a need.
- '*3.Recursos*' – subjects related to human resources are questioned, namely by professional category, the number of health professionals (number of entries, exits and absences), the total weekly hours, and the number of professionals that the unit needed to cover current needs. Furthermore, the period of highest demand for human resources was asked. In addition, subjects related to material resources are also questioned, namely the number of material resources that the unit had and the number of material resources that the unit needed to cover current needs. In this section such subjects are discussed for the four time periods.
- '*4.Atividades Gerais*' – for each activity not related to COVID-19, the number of each health professional group required and the total weekly hours to carry out the activity, the percentage of execution of the activity in relation to the expected, among other topics, are asked. In this section such topics are discussed for the four time periods.
- '*5. Atividades COVID*' – for each COVID-19 activity, the number of each health professional group required and the total weekly hours to carry out the activity, the percentage of execution of the activity in relation to the expected are asked. Such questions are asked in relation to the most demanding period of the pandemic for the respective PHU.

- '*6.Organização*' – this section cover how the work is organized. Specifically, it is asked, regarding two periods of time (before the pandemic and during the pandemic) whether the unit worked/works in crisis mode, the existence of meetings and spaces for discussions.
- '*7.Formação COVID*' – the point addressed is related to internal training in the context of the COVID-19 pandemic (organized by the PHU or with the collaboration of the PHU)
- '*8.Sistemas*' – access to systems and constraints on systems such as *SINAVE*, *Trace COVID-19*, *SONHO* are some of the topics covered in this section.
- '*9.Comunicação*' – internal guidelines (for the unit and/or community), protocols and/or articulation mechanisms with external entities and communication difficulties felt by the PHU.
- *'10.Reflexões finais*' – final reflection; other kind of changes and lessons

4.4 Questionnaire Implementation

The implementation of the questionnaire consisted of nine steps (Figure 4.3). Given the knowledge of the extreme workload of the PHUs, all these steps were schedule to obtaining the highest response rate.

Figure 4.3 – Steps in the questionnaire implementation.

First Step – Creation of the Research Network

A Public Health Research Network was created to provide direct support to the coordinators of all participating PHUs to complete the questionnaire correctly. This network comprises public health residents and public health medical specialists. The Research Network also worked as a communication point for questions and/or doubts about the project and/or questionnaire.

Second step – Meeting with Internship Coordinators

On June 21st, 2021, we organized a meeting with the PHU' coordinators of the internship to increase the visibility of this study and rise the interest to be involved. Following the presentation of the project,

the coordinators were asked about the possibility of sending an email to the public health residents of their coordination area. After they accept, an email was sent with all the project information, as well as a link to a form, where it would be possible to indicate an expression of interest of being included in the Research Network.

Third step – Webinar

On June 29 at 6:30 pm, a scientific session to present and discuss the project was held. This session was open to the community, and all physicians who expressed interest in participating in the research network, as well as PHU coordinators, were directly invited to attend the webinar.

Fourth step – 1st Meeting of Research Network

Approximately one month later, 31 public health residents and public health medical specialists were interested in participating in the Research Network. Thus, the first meeting of the research network was organised on July 19, at 6:30 pm. In this meeting, the objectives and mode of operation of the Research Network were presented and discussed, and further details and plans concerning the project.

Fifth step – Subgroup sent

Between July 20 and 22, 2021, the questionnaire was sent by email to a subgroup of 11 PHUs that have public health doctors who are in the research network. Thus, the coordinators will receive support from these physicians that are more involved in the project.

Sixth step – Interactive module

Having the perception that the developed questionnaire is complex and time demanding, and there is the possibility of being filled out by several health professionals external to the project, and with no direct contact with the general email contact created to provide support, some minor changes were made in the questionnaire. Figure 4.4 represents the interactive module created in the online questionnaire.

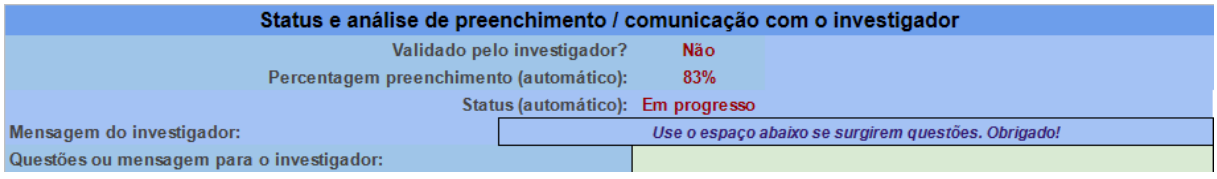


Figure 4.4 – Interactive module in the online questionnaire.

This interactive module, added at the beginning of each section ('tab'), allows a direct communication with researchers, through which notes and questions can be exchanged. The information is received in real time, simplifying communication and allowing all health professionals (who support the completion

of the questionnaire) to be in direct contact with the project researchers. Additionally, it automatically indicates the percentage and the status of filling, which alerts the coordinators to any possible missing data. Additionally, it automatically indicates the percentage and therefore the completion status ('not started' - if the percentage is 0% -, 'in progress' - if the percentage is between 0% and 99% - and 'await validation' - in case the percentage is 100%).

Seventh step – Reinforcement of filling to the subgroup

On August 4, an email to reinforce the participation in the study was sent to the 11 coordinators and doctors of the Research Network. The importance submitting fully completed questionnaires was reinforced, and that a new interactive module was added. Also, we announced that because the first newsletter containing the preliminary data analysis was expected to be sent on August 20, questionnaires should be submitted (with no missing data) until August 15th.

Eighth step – Sending the questionnaire to the remaining PHUs

On August 5, the questionnaire link was sent by email to the remaining PHUs coordinators (44), and the information about the newly created Public Health Research Network, which was available for any question / clarification / help, via email or by telephone.

Because two *PHUs* have sub-units, we sent more six questionnaires to each sub-unit addressed to the coordinator and the Health Authority physician.

Ninth step – Tableau de Bord

Because accessing the information contained in the interactive module of each questionnaire individually is not efficient, we developed a *'Tableau de Bord'* in excel. This consists of a page that has the status of completion and validation of each survey, as well as a warning in the situation of questions or problems. In this way, through this single excel file, it is possible to know the status of all questionnaires.

4.5 Data Analysis

4.5.1 Analytical Aims

The data analysis performed aimed to:

- Determine the variation in human resources – considering the different professional groups and categories existing in the PHU – in the face of the pandemic. The year of 2019 is used as reference and the variation is examined across the three different pandemic periods. The number of human resources considered needed is also analysed for each time period.
- Determine the variation in non-COVID-19 activities performed by the PHUs, having 2019 as reference, in terms of average weekly hours and percentage of tasks execution compared to planned/expected.
- Determine the variation, considering the pre-pandemic and pandemic periods, in terms of:
    - The material resources (reported as existing and needed)
    - The information systems
- Identify the main changes and innovative implementations in response to the pandemic, developed by the PHU.

4.5.2 Data Analysis Steps

Descriptive statistics were used for the study data analysis, focusing on changes in the PHU during the different pandemic periods. Analyses were performed using R Software (version 4.0.5) [82]. A total of 2 181 variables were directly extracted from the questionnaire. The information collected were of three different types: numeric, open text and categorical. Figure 4.5 illustrates the steps related to the data analysis.

1st step – *Variable map* (metadata) *MSExcel* file

Data analysis started with the creation of a file in *MSExcel*, with 10 *tabs*, called *'variable map'*. The first *tab* contained the links to the questionnaires on *Google Sheets*. The *tabs* in *'variable map'* refer to the sections presented in the questionnaire, excluding the first section of the questionnaire – '*1.Coordenação', '2.Inovação', '3.Recursos', '4.Atividades Gerais', '5. Atividades COVID', '6.Organização', '7.Formação COVID', '8.Sistemas', '9.Comunicação',* and *'10.Reflexões finais'.* Each of these 10 *tabs* of the *'variable map'* file, includes the respective variables. In addition to the variable name, their spreadsheet coordinates are indicated (number of the row and column where the variable is located in the corresponding section of the questionnaire).

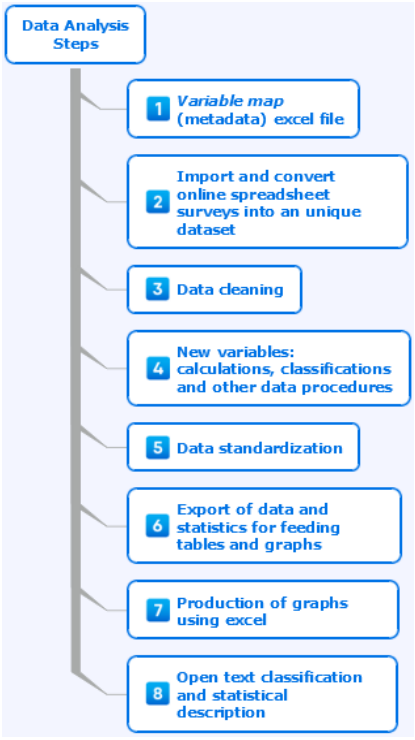


Figure 4.5 – Data analysis steps.

2nd step – Import and convert online spreadsheet surveys into a unique dataset

Using the R software, a code (Box 4.1) was developed that allowed importing and downloading the *Google Sheet* links to a local folder.

```
# Routine for downloading all online googlesheets forms as excel files)
Create directory (excel_files_dir) # creates a directory for the excel files
Read (Sheet_with_PHU_links) # load the list of PHU links for online access

# Goes PHU link by link, loading the googlesheet file and saving it as an excel file
For (each_link) in Sheet_with_PHU_links
        Jumps if there is no link, NA
        each link url = get_googlesheet_function (each_link) # Uses the gs_url function to access
            the googlesheet file
        downloads_and_save_googlesheet_file (each_link_url, excel_files_dir) # Downloads and
            saves the googlesheet file using the gs_download function
```

Box 4.1 – Code to import and download the Google Sheet links to a local folder.

Subsequently, using the R software we built a single database (*DataBase*) that compiled all variables (lines and columns refer to the variables and PHUs, respectively). The creation of the single database was aided by the creation of a single matrix, *Variable_matrix* with the variable information contained in the '*variable map'* file – variable name, tab number, row number and column number (Box 4.2).

```
# Routine for constructing a single matrix (Variable_Matrix) with the name of all variables, and correspondingly the tab, row and column numbers where the variable is in the googlesheets files
For (each_sheet in Variable map)
        Temporary sheet = read (Variable_map for each sheet)
        Temporary_variable_list = column bind (variable name, number of tab, number of line, number of column) # Uses the cbind function to combine arguments by columns
        Variable_Matrix = row bind (Variable_Matrix, Temporary variable list) # Use rbind to add the information from each_sheet into the Variable_Matrix

# Routine for constructing a DataBase that compiles all variables, referring to all PHUs. For each original data file, goes variable-by-variable (according to Variable_Matrix), retrieves the information and places it in the DataBase matrix.
DataBase = data.frame(data = default 0, ncol = 0, nrow = Variable_Matrix number of variables) # Create a matrix with the number of rows of Variable_Matrix
rownames (DataBase) = Variable_Matrix[, 1] # Names the rows with the variable names

For (each_file in (googlesheet_files in excel_files_dir)) # Goes data-file by data-file
    PHU_name = substitute in each_file the pattern '.xlsx' with ' ' # Gets the PHU name from the googlesheet_file name, after some text cleaning
    DataBase = column bind (DataBase, NA); Column names (DataBase) = combine (column names (DataBase), PHU_name) # Creates a new column in DataBase, with the PHU name

    For (each_sheet in 1:number of tabs in Variable_map) # For each data files, goes sheet-by-sheet, loading the information
        Temporary_file_sheet = read (each_file in excel_files_dir) # Reads the data file
        Each_sheet_list_of_variables = Variable_Matrix[which (Variable_Matrix[,"tab"] == each.sheet), "variables_names"] # Gets the list of variables expected in each sheet

        For (each_variable in Each_sheet_list_of_variables) # Goes variable-by-variable, getting the googlesheet coordinates of the information, retrieving its value and saving it in the DataBase
            x = (number of line of (each_variable) in Variable_Matrix)
            y = (number of column of (each_variable) in Variable_Matrix)
            value = Temporary_file_sheet [x,y]
            DataBase [each variable, PHU name] = value
```

Box 4.2 – Code to built a single database (DataBase) that compiled all variables.

Using this routine, a Database with all the variables can be easily created, from all current units, in seconds.

3rd step – Data cleaning

When questionnaires had blank spaces, an email was sent to the respective PHU, requesting their completion with the zero digit '0', with 'NA' (not applicable), or another value if applicable. Additionally, in several spaces for filling out the questionnaire, the insertion of numerical values was requested, namely, the number of hours and the number of health professionals. The data cleaning was performed in the case of spaces requiring a numerical value, but text was also inserted.

Along with all data cleaning, the questionnaires were validated to verify that all answers were clear, coherent, and complete. Specifically, it was verified if the values entered were logical, namely if the insertions in the number of human resources in each period are not a cumulative number (as requested). Similarly, it was checked if the units have not changed the structure of the questionnaire, particularly if they have not added and/or removed lines and/or columns, and if they have not changed the order of the sections.

4th step – New variables: calculations, classifications, and other data procedures:

Different data were grouped in order to create a clear and concise discussion. Firstly, the health professionals categories were grouped into 5 commonly used professional groups: doctors, nurses, senior technicians, administrative, and 'others' (Table 4.1). Therefore, new variables were created to group the different professionals.

Table 4.1 – Professional groups and the respective professional categories.

Professional Group	Professional categories
Doctors	Public Health Medical Specialists, Health Authorities;
	Public Health Medical Specialists, not Health Authorities;
	Medical Specialists from other Medical Specializations;
	Medical Residents from other Medical Specializations;
	Public Health Medical Residents;
	Medical Residents of the General Training year.
Nurses	Nurses Specialized in Community Health Nursing;
	Nurses Specialized in other Nursing Specializations;
	General Nurses (non-specialized).

Senior Technicians	Environmental Health Technicians;
	Oral Hygienists;
	Psychologists;
	Social Assistants.
Administrative	Administrative Staff;
	Technical Assistants;
	Operational Assistants.
Others	Military;
	Nursing students;
	Dentists;
	Nutritionists;
	Senior Diagnostic and Therapeutic Technician;
	Orthoptist;
	Physical Therapist;
	Occupational Therapist.

Secondly, some material resources were grouped, namely the fixed computers with laptops into computer resources, and phones with mobile phones into telecommunications resources. These resources (in pairs) were aggregated because they complement each other. It was considered that, in an approximation of the ideal, each health professional should have access to a computer resource (a fixed computer or a laptop), as well as a telecommunication resource (a mobile phone or a telephone). New variables were created in order to group these resources.

Thus, the activities were grouped to reduce the number of categories, and consequently to optimize their discussion. The activities were grouped according to the essential functions of public health doctors, present in the legislation of the power of health authority (Decree-law No. 82/2009, of 2 April) [83]. The Table 4.2 presents the main activities performed by PH professionals according to their name of the group type, as well as the various activities it groups.

Table 4.2 – Activity group, according to the essential functions of PH doctors, and the respective non-COVID-19 activities.

Activity Group	**Non-COVID-19 activities**
Health Authority	Mental Health Law Enforcement;
	Verification of deaths;
	Health Surveillance of food and beverage establishments (homes, industry, commerce, technical inspections, …);
	Epidemiological Surveillance of Notifiable Diseases;
	Medical assessment related with issuing a driving license.

Environmental Health	Vector Surveillance Network (REVIVE); Sanitary Surveillance programs for drinking water (industry, homes, commerce, technical inspections, ...).
Governance and Planning in Health	Health Planning: Local Health Plan and Monitoring Priority Programs at ACES (Mental health, diabetes, tuberculosis, HIV/AIDS, hepatitis, ...); Protocols and Partnerships (Chamber, hospital, UCCs, …); Participation in the Clinical and Health Council.
Health Promotion and Protection	School Health; National Program for the Promotion of Oral Health; National Vaccination Program (PNV); Occupational Health.
Collaborative Services and Quality	Audit and Accreditation Programs; Infection Prevention and Control and Antimicrobial Resistance Program (PPCIRA).
Other Services	Disability Assessments and Multipurpose Certificate Issuance (Medical Boards + Households); Pre-travel Consultation; International Vaccination; Training and Research.

In addition, several variables were derived from computations. Some of the examples of variables created are: total number of entries for each professional group (and for each professional category) for each pandemic period; total number of professionals (for each professional group and category) existing in the four periods (example of the calculation in equation (4.1)); total number of professionals (for each professional group and category) active in the four periods (example of the calculation in equation (4.2)).

$$\begin{aligned} &Total\ number\ of\ existing\ doctors\ in\ 2nd\ period \\ &= number\ of\ existing\ doctors\ in\ 1st\ period + number\ of\ doctors\ entries \\ &- number\ of\ doctors\ dropouts + number\ of\ temporary\ absent\ doctors \end{aligned} \tag{4.1}$$

$$Total\ number\ of\ active\ doctors\ in\ 2nd\ period$$
$$= number\ of\ existing\ doctors\ in\ 1st\ period + number\ of\ doctors\ entries \quad (4.2)$$
$$- number\ of\ doctors\ dropouts - number\ of\ temporary\ absent\ doctors$$

In total 289 new variables were created.

5th step – Data standardization

Considering that the PH units are dependent on the population they serve, it was necessary to adjust the values to the size of the inhabitants that each unit serves. Thereby, data relating to the human resources existing and needed, in each unit, was standardized by population size. The population served by each PHU, in its geographical area of responsibility, was interrogated in the questionnaire.

While it is also accurate to divide values by population to find a *per capita* rate, those very small decimals would be challenging to interpret by most people, so we multiplied by 100,000 to present the results more clearly. That means that the values shown represent the total number per 100,000 inhabitants. Equation (4.3) is related to standardization for the total number of health professionals.

$$\frac{human\ resources}{number\ of\ inhabitants} * 100{,}000 \quad (4.3)$$

In addition, the activities (COVID and non-COVID-related) were also standardized. The average number of health professionals involved to perform each non-COVID activity (or designated as general activity) in 2019 (pre-pandemic period), by professional group, are standardized. Considering that each activity could be performed by doctors, nurses, technical superiors, and administrative; the number of health professionals involved in each non-COVID activity reported for 2019 were standardized considering the total number of active professionals in 2019 (from each professional group). So, the standardized values represent the average percentage of each professional group (compared with the total number of professionals in the respective group) involved in each non-COVID activity in 2019. Equation (4.4) is related to standardization for each non-COVID activity.

$$\frac{number\ of\ professionals\ (per\ group)\ involved\ to\ perform\ each\ nonCOVID\ activity\ in\ 2019}{total\ professionals\ (per\ group)\ in\ 2019} * 100\ \% \quad (4.4)$$

In addition, the COVID-19-related activities were also standardized, considering two types of standardization. First, for each unit, the average number of each health professionals involved in each activity was standardized considering the total number of active professionals for each group in 2019 (see equation (4.5)).

$$\frac{number\ of\ professionals\ (per\ group) involved\ to\ perform\ each\ COVID\ activity}{total\ professionals\ (per\ group)\ in\ 2019} * 100\ \% \qquad (4.5)$$

Second, the average number of each health professionals required in each activity was standardized considering the maximum number of each active professional group observed, in each unit, during the four analysed periods (2019, 1st period, 2nd period, and 3rd period) (see equation (4.6)).

$$\frac{number\ of\ professionals\ (per\ group)\ involved\ to\ perform\ each\ COVID\ activity}{\max(total\ number\ of\ professionals\ (per\ group)\ in\ the\ 4\ analysed\ periods)} * 100\ \% \qquad (4.6)$$

The total average number of weekly hours dedicated to the execution of each activity and the percentage of execution of each activity compared to expectations are not undergo any type of standardization.

Finally, the values related to some of the material resources (such as fixed computers, laptops, phones, and mobile phones), reported by each unit, were also standardized. The average ratio of availability of computer and telecommunication resources relative to the active human resources and the average ratio of availability of these resources reported as needed are performed. This standardization was performed considering that one professional will have access to each of these material resources, in the ideal scenario. So, an average ratio is presented: the case of 1 material resource for every 2 professionals (an average ratio of 1:2); case of 1 material resource for every 1 professional (an average ratio of 1:1); the case of 1.5 material resource is for every 1 professional (an average ratio of 1.5:1), and so on.

Subsequently, code was developed in order to proceed with standardization.

6th step – Export of data and statistics for feeding tables and graphs

In a similar vein, we developed code to calculate averages of each of the variables of interest and their maximum and minimum values. The R software has the enormous advantage of calculating statistics of the several variables of interest in seconds, regardless of the number of questionnaires.

7th step – Production of graphs using excel

The averages of each of the variables and their respective maximum and minimum value were used to create graphs and tables in *MSExcel*.

It should be noted that some PHUs did not performed certain general activities. For such cases, these units will not be included in the analysis of the respective activities regarding the level of hours and percentages of execution, as well as the level of health professionals involved in carrying out the same. Likewise, any other topic that any unit has not completed or has inconsistent answers was not added to the calculations. When applicable, the number of units included in the calculation were indicated in the legend.

As a result of all this automated code, a dynamic analysis emerged, enabling the repetition of the same analysis, and it is possible to illustrate and present data in graphs and/or tables, in seconds.

8th step – Open text classification and statistical description

Regarding the *'2.Inovação'* section, its analysis was divided into two blocks. Firstly, we analysed the functional and organizational changes understood as innovative and the period of activity. Firstly, the content analysis of the answers to the question under study was performed, verifying the coherence and analysing whether the response was related to a change (if not, the answer is divided by mentioned changes). Therefore, the type of innovative changes was defined, and then each change was categorized.

Secondly, an analysis was made in view of the innovative implementations i.e., the technical and operational aspects produced by the PHU to respond to a need. In the first instance, the content analysis of the answers to the question under study was performed, identifying for each implementation, the active period, the purpose, the negative consequences that the implementation brought to the PHU, and skills (the resources needed for the implementation). Implementations were typified and subsequently allocated to defined categories. Therefore, each implementation were also classified in terms of the purpose, negative aspects, and skills.

Chapter 5

Results and Discussion

This Chapter aims to present and discuss the study results obtained from the quantitative and qualitative analysis, described in Chapter 4. Finally, Section 5.7, a discussion is presented based on the general recommendations, as well the strategies in the health sector described in Chapter 3. It is important to highlight that for ethical reasons the anonymity of the participating units had to be ensured.

5.1 Characterization of the Participants (PHUs) and Inhabitants' Coverage

From the 61 questionnaires sent to each PHUs, including headquarters and some sub-units, 11 (18% from the total 61) questionnaires were submitted, but 2 were discard due to extreme incomplete data. Thus, from the 9 valid questionnaires, 6 (67%) were fully completed, corresponding to the study analytical sample, except for the question Innovation, where the total sample (9 questionnaires) was considered. After the data cleaning and validation, 5 units were contacted to provide minor clarifications.

Considering the 9 PHUs under study, the descriptive statistical analysis showed that coordinators had an average time of work in the respective PHU of 11 years and 9 months (minimum 7 and maximum 25 years) and had assumed this role for 6 years and 2 months (between 4 months and 11 years).

Table 5.1 presents the characteristics of the PHUs included in this study (grouped by health administrative region) according to the level of completeness of the questionnaire (incomplete and complete).

Table 5.1 – Number of participating PHUs grouped by health administrative regions according to questionnaire completeness.

Health Administrative Region	**Questionnaires incomplete**	**Questionnaires complete**	**Total questionnaires**
	n (% [a])	*n (% [a])*	*n (% [a])*
Alentejo (n=4)	1 (25%)	1 (25%)	2 (50%)
Algarve (n=3)	0 (0%)	0 (0%)	0 (0%)
Central (n=9)	1 (11%)	0 (0%)	1 (11%)
Lisbon and Tagus Valley (n=21)	0 (0%)	4 (19%)	4 (19%)
North (n=24)	1 (4%)	1 (4%)	2 (8%)

[a] represents the percentage relative to the number of PHU in each region

Table 5.2 presents the total number of inhabitants covered by each unit, the relative frequency based on the total population of mainland Portugal (9 802 128 inhabitants) and based on the total population covered by the 6 units with complete data (1 260 991 inhabitants) [84].

Table 5.2 – Number of inhabitants covered by each unit with completed questionnaires.

Inhabitants			
Region	**Number of PHU (inhabitants covered)**	**Proportion relative to the mainland Portuguese population [a]**	**Proportion relative to the 6 PHUs with complete data**
Alentejo	1 (151 624)	1.6%	12%
Lisbon and Tagus Valley	4 (949 367)	9.6%	75%
North	1 (160 000)	1.6%	13%

[a] n= 9 802 128

The PHU with complete data covers 13% of the mainland Portugal population. As expected, the PHUs from the *Lisbon and Tagus Valley* region covers the highest proportion of inhabitants, representing 9.6% of the mainland Portugal population and 75% of the PHU (with complete data) population. Of note, this region included 4 units, with an average of 237 342 inhabitants (minimum 52 435 and maximum 375 461). Thus, the remaining PHUs cover 3.2% of the mainland population and 25% of the total PHU (with complete data) population.

The PHUs with incomplete data, the PHU in *Alentejo* region cover 1% of the mainland population and 15% of the total PHU with incomplete data; the PHU in *Central* region cover 3.7% of the mainland population and 59% of the total PHU with incomplete data; finally, the PHU in *North* region cover 1.6% of the mainland population and 26% of the total PHU with incomplete data.

The PH human resources needed to perform a given activity will also depend on the population that the specific unit covers. For instance, one of the PHU in *Lisbon and Tagus Valley* region is the unit that covers the smallest number of inhabitants. This unit is considered a sub-unit (the only sub-unit analysed; the remaining PHU are headquarters). Therefore, it is expected that the number of resources in the sub-unit in *Lisbon and Tagus Valley* region will be smaller than at the PHU in *Lisbon and Tagus Valley* region that covers the highest number of inhabitants (375 461 inhabitants).

5.1.1 Periods of Highest Demand

Each unit identified the period of highest demand of human resources, after March 2020. Figure 5.1 represents the periods under analysis, and also over the 3 pandemic periods, the distribution of new daily cases of COVID-19 at national level (between March, 2020 and July, 2021) to illustrates the match with those periods [5].

The Figure 5.1 depicts each PHU by the length of the period (from the longest to the shortest, in days), and the respective duration in days.

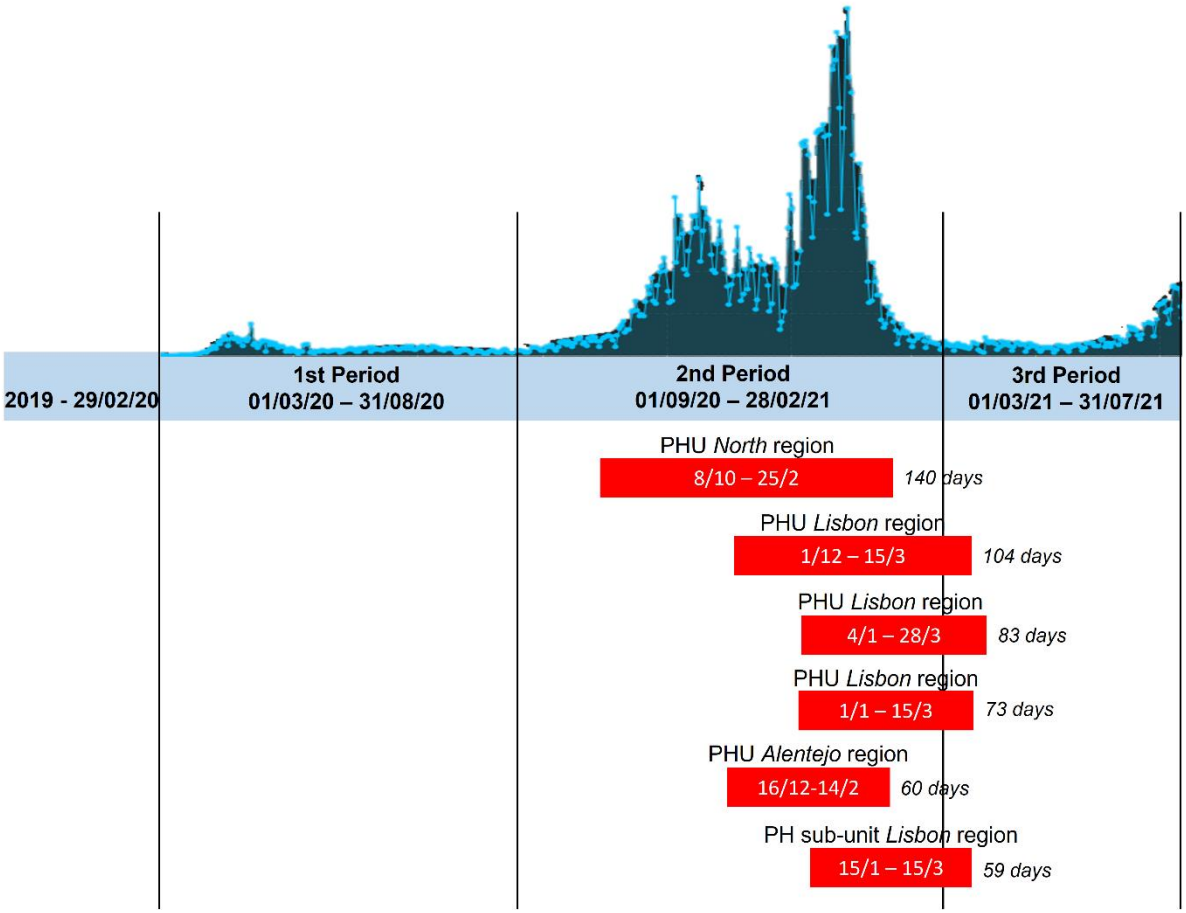


Figure 5.1 – Period of highest demand of human resources for each PHU, after March 2020.

As depicted in the Figure 5.1, the PHU in *North* region is the unit with the longest period (140 days), and the sub-unit in *Lisbon and Tagus Valley* is the unit with the shortest period (59 days). The length of the period indicated does not depend on the total number of inhabitants covered by each unit.

Notoriously, the 4 units in the *Lisbon and Tagus Valley* region indicated a period of highest demand vastly similar. In addition, a high degree of overlapping of the periods indicated by the PHUs is observed. As expected, the 2nd period was the most demanding for all PHUs, which matches the period containing the 2 peaks of new COVID-19 cases (top part of the Figure 5.1).

5.1.2 Discussion of the Characterization of the PHU Participants

One of the major building blocks of any health system it is human resources. As previously observed, the 2nd period was the most demanding for all PHUs. Specifically, January 2021 was the month considered for all units as one of the months of highest demand. Accordingly, all the 6 PHUs needed human resources mobilization to strengthen the screening capacity in January 2021. However, during this period, added to the limitation of human resources, many health professionals were infected by the COVID-19 virus, which prevent them to work, and consequently, increased the difficulty in mobilizing professionals.

5.2 Human Resources

5.2.1 Variation on PHU Human Resources during the Pandemic

In the analysis of the pandemic impact on human resources, we considered the different professional groups and, within each group, the professional category.

This analysis was based both on the existing number of health professionals, and the number needed to cover the existing needs, in January 2020, and over the three defined periods of 2020-2021 (Figure 5.2). For the total number of professionals in each period (blue line), the maximum and minimum value are represented by amplitude bars (vertical black lines). In addition, the entries, exits, and temporary absences in each pandemic period are illustrated by the green, red and black vertical chart bars, respectively. The average number of professionals that PHUs identified as needed to cover each period is illustrated by the brown line.

The healthcare needs of a population are better assessed or met with the knowledge of the population size [85], [86]. Thus, in parallel, this analysis was also performed with standardized values (per 100,000 inhabitants), represented by the patterned bars and dotted lines.

Compared to January 2020, PHUs reported an average increase of 9 professionals (minimum 0 and maximum 13) in the 1st period, 60 (15 and 163) in the 2nd period and 32 (6 and 77) in the 3rd period. This corresponds to a ratio of 7 (0 e 17), 28 (9 e 55) and 18 (4 e 34) per 100,000 inhabitants, respectively. However, it is notorious that after the period of highest demand, there is an apparent decrease in the number of health professionals, given the registered exits in the 3rd period. Specifically, the percentage average increase, compared to January 2020, corresponds to a 32% in the 1st period, 200% in the 2nd period (129% when compared to the 1st period), and 106% in the 3rd period (30% of decrease compared to the 2nd period).

Figure 5.2 – Variation in the total number of active professionals and the number needed to cover the needs of all professional groups in the PHUs.

In order to analyse the contribution of the professional groups to this variation, the same analysis was stratified for the various professional groups (doctors, nurses, senior technicians, administrative, and others). In addition, these groups are subdivided, considering the specific professional categories (Figure 5.3; except for the administrative and others).

In January 2020, 55% of the total PHU professionals were doctors, 11% nurses, 22% senior technicians, and 12% administrative. In the 1st period, a 36% increase (compared with January 2020) in the total number of professionals was attributed to senior technicians (mainly environmental health technicians) and a 30% increase was due to doctors (mainly medical residents of the general training year). In the 2nd period, compared with the 1st period, a 49% increase in the total number of professionals was attributed to doctors. On the other hand, the professional group 'others' (mainly military personnel) contributed to a 19% increase in the number of human resources, especially in the 2nd period.

Specifically in the 2nd period, compared with the 1st period, the greatest increase in the number of doctors was attributable to medical residents of the general training year 80.4% (77% when standardized), followed by medical residents from other medical specializations 12.7% (11%), public

health medical residents 5.1% (8.5%) and medical specialists from other medical specializations 2.5% (2%).

Regarding the nurse professionals, there is also a peak of entries in the 2nd period, especially from nurses specialized in community health nursing (90.3% [78.5% when standardized] increase in the number of nurses was attribute to this category, in the 2nd period). Additionally, for senior technicians, the same peak is verified. Concretely, in the 2nd period, 46.5% (39.1% when standardized) and 30.2% (29.4% when standardized) increase in the number of senior technicians was attribute to psychologists and environmental health technicians, respectively.

Although our study revealed an increase in the number of health professionals during the period of highest demand, this increase was not sufficient to cover the experienced needs. As depicted in Figure 5.3, there is an average need for 7 (7 when standardized) more health professionals in 1st period. In addition, this need is sixfold in the period of highest demand (specifically it is indicated a total of 133 [22 when standardized] professionals as needed to cover the 2nd period). Curiously, despite the number of active professionals in the 3rd period, compared with the 1st period, has doubled, the PHUs identified a similar need in these two periods (total of 8 [7 when standardized] more professionals as needed).

Furthermore, in the 2nd period, most of the extra professionals indicated as needed compared to active professionals were doctors (65%), mainly public health medical residents and medical residents of the general training year. Also in the 2nd period, it is evident a need for 5 times more public health medical residents of (5 out of a total of 25 required) compared to the active professionals. Regarding the nurses, senior technicians, and administrative, the reported need is constant over the various periods.

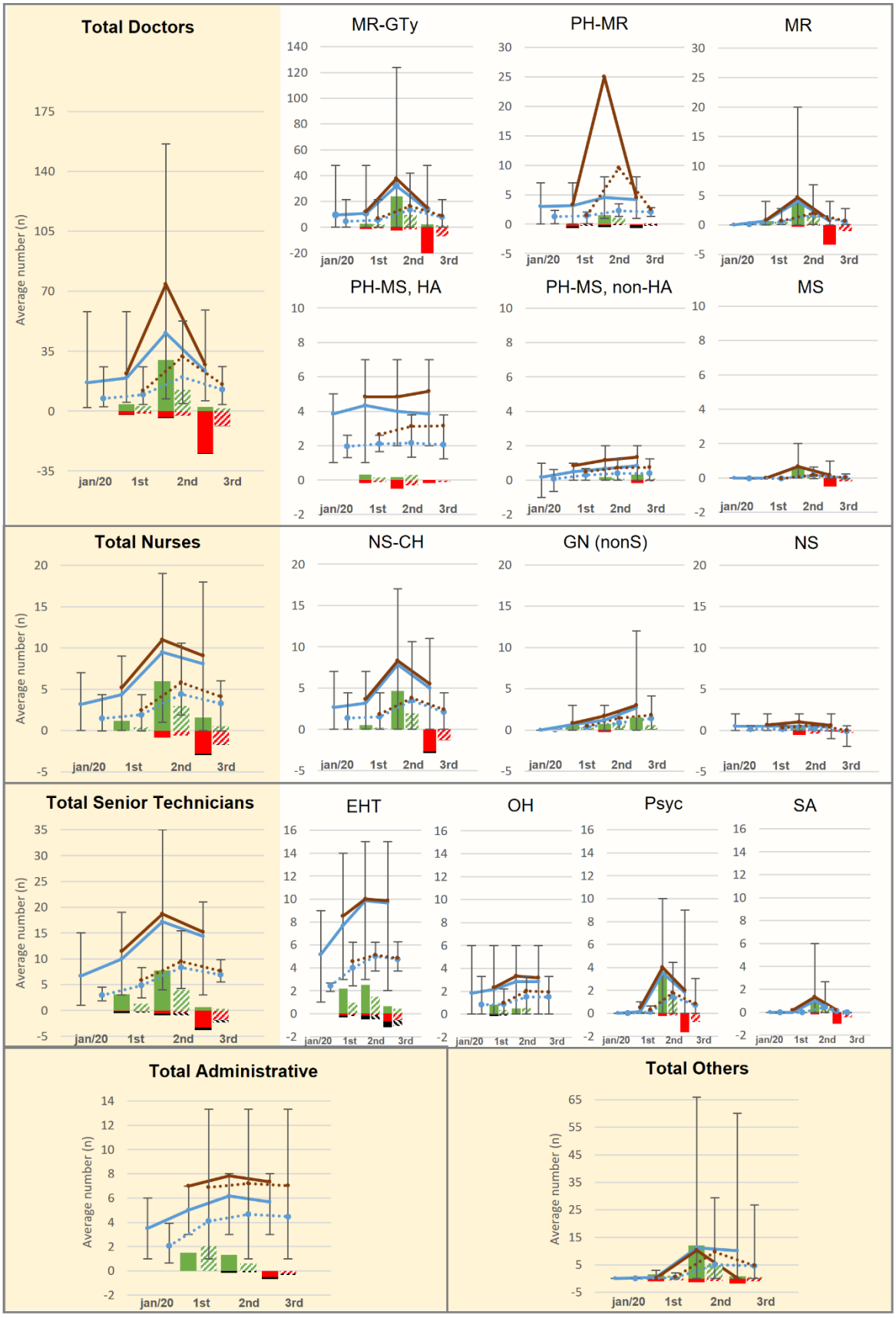


Figure 5.3 – Variation in the total number of effective professionals and the number needed to cover the needs of the various professional groups in the PHUs.

***EHT** – Environmental Health Technicians; **GN (nonS)** – General Nurses (non-specialized); **MR** – Medical Residents from other Medical Specializations; **MR-GTy** – Medical Residents of the general training year; **MS** – Medical Specialists from other Medical Specializations; **NS** – Nurses Specialized in other Nursing Specializations; **NS-CH** – Nurses Specialized in Community Health Nursing; **PH-MR** – Public Health Medical Residents; **PH-MS, HA** – Public Health Medical Specialists, Health Authorities; **PH-MS, non-HA** – Public Health Medical Specialists, not Health Authorities; **OH** – Oral Hygienists; **Psyc** – Psychologists; **SA** – Social Assistants.*

5.2.2 Discussion of the Variation on PHU Human Resources

As previously evidenced, the study data shows a need for more human resources to cover each period. As depicted in Figure 5.1 the number of new cases COVID-19 varies over time and, therefore, the workload of the units. Although, in the 1st and 3rd periods, the demand of the response to the pandemic is different as well as the number of active health professionals reported, the need indicated in each of the periods is constant over time. Thus, this seems to indicate that the need for more human resources was already present before the pandemic, which represents a structural need. It is possible to observed that, in the 2nd period, despite the peak of entries in the total professionals, an extreme need is revealed (Figure 5.2). As previously noted, the 2nd period was the most demanding for all PHUs, leading to a higher need than the need identified as structural. Concretely, a contextual need was verified. Regarding, the professional group doctors and 'others' the same conclusions emerged (see Figure 5.3). Considering nurses, senior technicians, and administrative, our data shows a structural need (i.e., a constant need over time).

It is curious and noteworthy that the professional categories indicated as most needed for an adequate response were categories without specialization, such as public health medical residents and medical residents in the general training year. In addition, as depicted in the amplitude bars in Figure 5.3 in, it appears that the mobilization of professionals was quite unequal among PHU, even adjusting to their population coverage (for example, in 2nd period, 22 vs 188 active professionals).

5.3 Material Resources

5.3.1 Variation on Material Resources during the Pandemic

The following analyses consider the data from 5 PHUs regarding the different types of material resources separately and grouped, as mentioned in Chapter 4.

Computer Resources

Figure 5.4 presents the average number of existing computer resources (fixed computers and laptops), and the number needed for an adequate response of the PHUs, in January 2020, and over the three defined pandemic periods. This figure also describes the maximum and minimum number (reported by a given unit) of material resources existing in each period, which are represented in the form of amplitude bars. Figure 5.4A corresponds to non-standardized graphs. These represent the average number (existing and needed to cover current needs) of each type of computer resource, separately and grouped. Figure 5.4B corresponds to standardized graphs, which present the average ratio of availability of each type of computer resource relative to the PHU active human resources (reported as existing and as needed).

The observed increase in laptops from January 2020 to the 2nd period led to an increase in computer resources. However, the standardized show that this increase was apparently not enough considering the total number of active health professionals within the unit (which increased between January 2020 and the 2nd period, as verified in the human resource analysis). Unexpectedly, despite the decrease in the average ratio of computer resources throughout the pandemic, units reported a constant need over time, without an increase in the 2nd period as expected.

Therefore, it is possible to verify that in the period of highest demand (2nd period), on average there was 1 computer resource for every 2 health professionals (approximately 1 fixed computer for every 2 health professionals and 1 laptop for every 14 health professionals).

In addition, as depicted in Figure 5.4 in the amplitude bars, it appears that the mobilization of computer resources was quite unequal among PHU, even adjusting to their active professionals (for example, in 1st period, average ration of less than 1 computer resource for every 2 professionals versus 1 computer resource for every 1 professional).

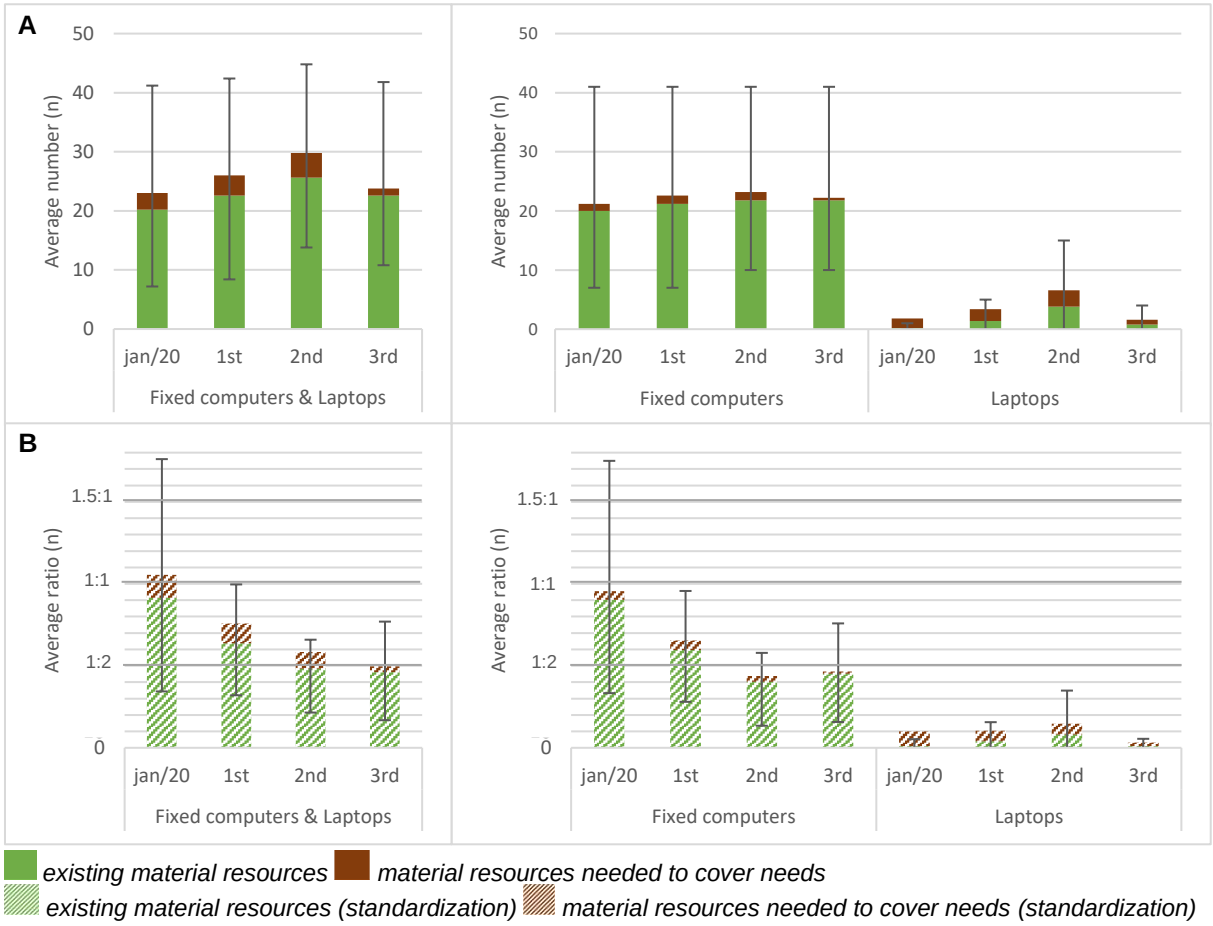
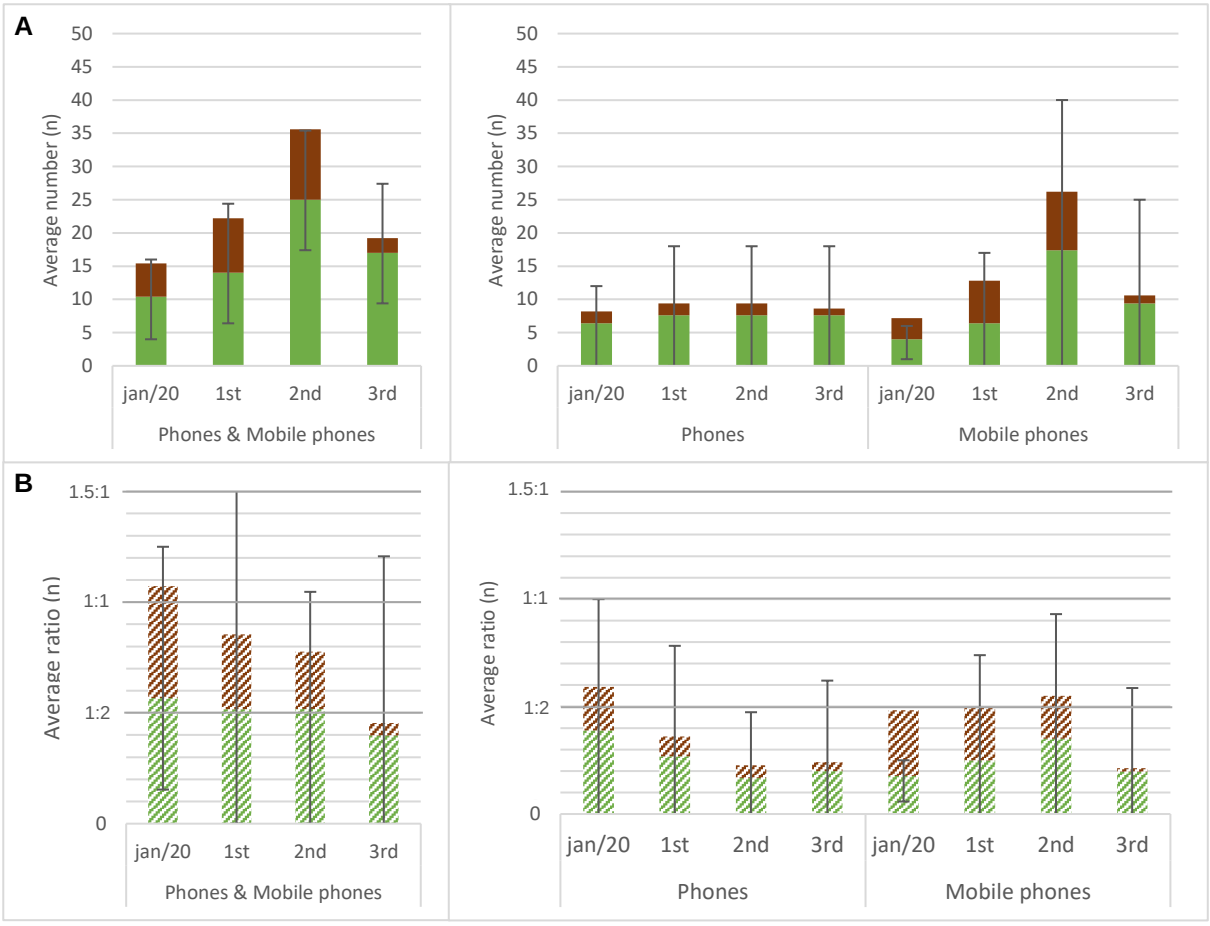


Figure 5.4 – Variation in the total average number and ratio (standardization) of existing and needed computer resources. (Number of PHU accounted = 5).

Telecommunication Resources

A similar analysis was performed for telecommunication resources. In Figure 5.5 the average number of phones and mobile phones existing, and the number needed to cover the needs of the PHUs are represented. Figure 5.5A presents the non-standardized analysis. These represent the average number of each type of telecommunications resources, separately and grouped. Figure 5.5B presents the standardized analysis. These graphs present the average ratio of availability of each type of telecommunications resources relative to the existing human resources (and as well as the reported human resources as needed).



existing material resources *material resources needed to cover needs* *existing material resources (standardization)* *material resources needed to cover needs (standardization)*

Figure 5.5 – Variation in the total number and ratio (standardization) of existing and needed telecommunication resources. (Number of PHU accounted = 5).

Although the number of phones increased on average from January 2020 to the 2nd period, the highest increase is observed in mobile phones, especially in the 2nd period, where on average, the number of mobile phones available triple (6 and 17 mobile phones in the 1st and 2nd periods, respectively). In addition, the standardized graphs show that from the 1st period to the 2nd period, more mobile phones by healthcare professionals were available. However, seemingly, such an increase was not enough, given the total number of active health professionals in the unit (reported need of 1 mobile phone for every 2 professionals).

Although the available number of mobile phones increased, the percentage of availability of telecommunications resources remained approximately constant over the four periods (1 mobile phone or telephone for every 2 professionals). Depicted in Figure 5.5B, the reported need in pre-pandemic period is 1 mobile phone or telephone for every 1 professional, surprisingly this reported need decrease over the three pandemic periods, reaching a reported need of 1 telecommunication resource for every 2 professionals.

In addition, as depicted in Figure 5.5 in the amplitude bars, it appears that the mobilization of telecommunication resources was quite unequal among PHU, even adjusting to their active professionals. Thus, in the period of highest demand it is observed an unbalanced average ratio of availability of each type of telecommunications resources relative to existing human resources (units with 0 telecommunication resource versus units with 1 telecommunication resource for every 1 active professionals). Regarding the unit that reported the non-existence of telecommunication resources, given the need for these resources for daily public health activities, the only plausible explanation is the use of personal mobile phones.

Other Material Resources

The non-standardized analysis is presented for hotspots, printers, and photocopiers in Figure 5.*6*.

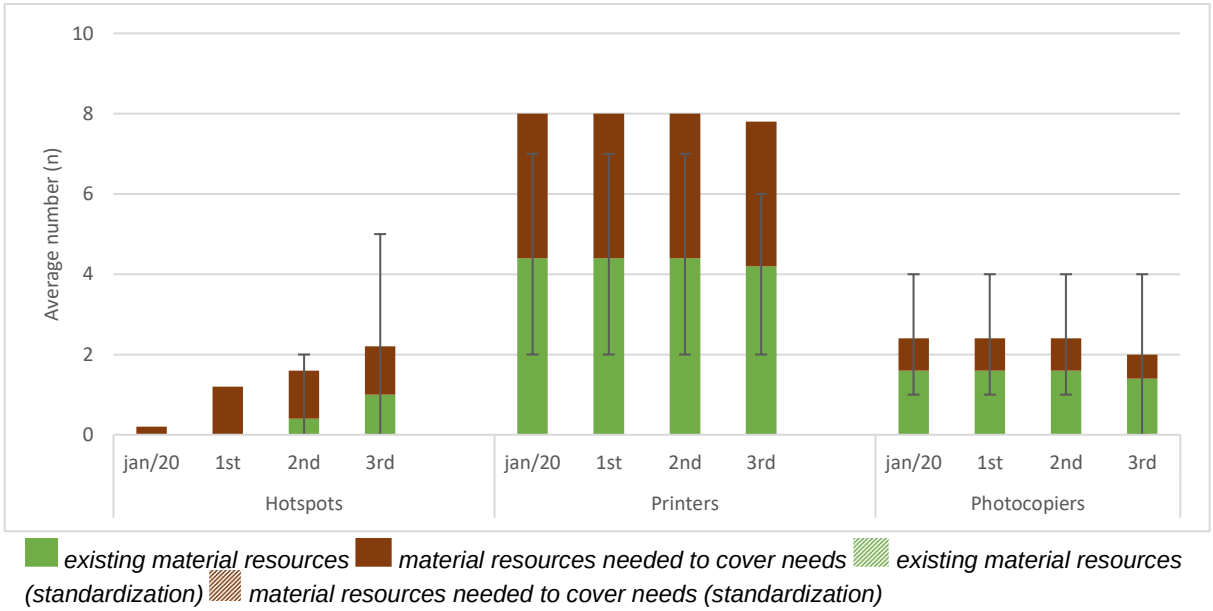


Figure 5.6 – Variation in the total number of existing and needed hotspots, printers, and photocopiers. (Number of PHU accounted = 5).

The Figure 5.6 shows that the number of hotspots increased during the pandemic, while the number of printers and photocopiers remained constant. Concretely, in hotspot resources the indicated need prior to the pandemic differs noticeably from the need reported in the remaining periods 2020-2021, which highlights the need for this type of resource in the units during the pandemic period. However, the inequality in the existence of this type of resource is notorious. It is important to clarify that the internet access should be mostly done by fixed-internet network. However, the possibility of difficult access to the fixed-internet network could be one of the explanations for the need for hotspots during the pandemic. Regarding, the printers and photocopiers, the average number (existing and needed to

cover current needs) for these types of resources did not differ during the four periods.

Finally, for the analysis of motorized vehicles we assessed the number of units that reported having vehicles. Figure 5.7 shows in percentage the number of units that already had vehicles and the number of units that started to have vehicles. As depicted in Figure 5.7, only one PHU (out of five) had access to vehicles, having acquired the largest number of vehicles in the 2nd period. This seems to indicate that this resource was not essential for those units in the pandemic period.

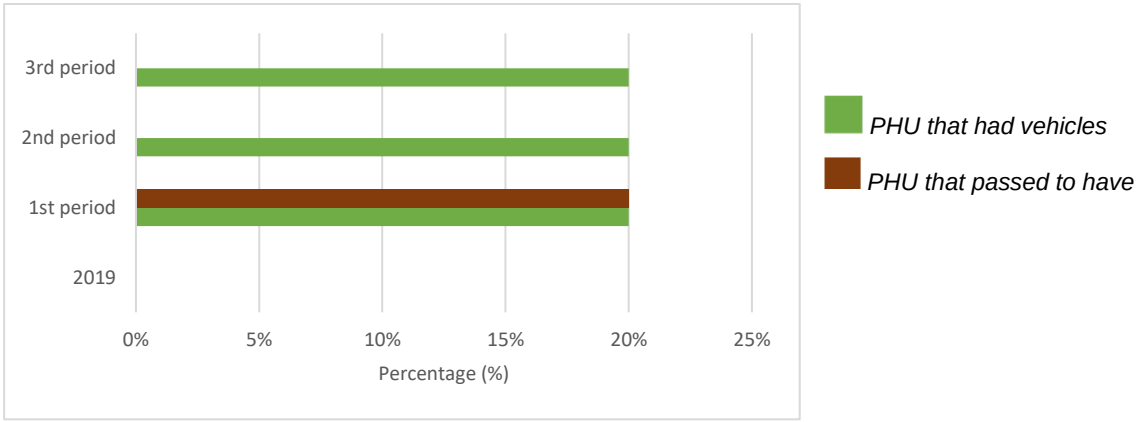


Figure 5.7 – Percentage of PHU that had and that passes to have vehicles. (Number of PHU accounted = 5).

5.3.2 Discussion of the Variation on Material Resources

As depicted in Figure 5.4, the highest need is for laptops, with the set of computer resources being an approximately constant need, regardless of the accentuated mobilization of human resources in the 2nd period. Whereby it is possible to infer a structural need in computer resources. Additionally, the same scenario in telecommunication resources, printers, and photocopiers is verified. Specifically, it is reported a need, for an adequate response, of 1 mobile phone for every 2 health professionals over the four periods. As depicted in Figure 5.5, the PHUs reported need for hotspots in the pandemic period, identifies a contextual need.

Combining the data from human resources, presented in Section 5.2, we found interesting results. The average number of active professionals was higher in the 3rd period compared with the pre-pandemic period and the 1st period; however the units reported that they needed fewer computer resources in the 3rd period. This finding may be partially explained by the difficulty associated with the subjective assessment of the needs after experiencing high demands in the PHUs. In addition, there were periods of less demand that contrasted with others of great difficulty to respond. There were periods of less demand that contrasted with others of great difficulty to respond, whereby the calculation of the material resources needed for an adequate response becomes even more difficult.

As depicted, there is a lack of material resources throughout the pandemic response. The pre-pandemic period was the period where 1 computer and telecommunication resources were available for 1 health professional. During the pandemic periods the increase reported in these material resources did not match the increase in the number of human resources. As mentioned before, data show that in the 2nd period on average 1 computer resource and telecommunication resource for every 2 health professionals. This finding may be partially explained by 2 factors that may co-exist: shift work and/or teleworking.

Finally, it appears that the mobilization of all the material resources presented was quite unequal among PHU, even after adjusting to their active professionals.

5.4 Activities

5.4.1 Non-COVID-19 Activities: Description and Variation during the Pandemic

The description of non-COVID activities during the period before the pandemic (year 2019) can be found in Table 5.3. This table also shows the average percentage of each professional group involved in each non-COVID activity in 2019.

Concerning each professional group, we can observe that, in 2019, activities such as ‘disability assessments and multipurpose certificate issuance’, ‘mental health law enforcement’, ‘medical assessment related with issuing driver license’, ‘death verification’, and ‘health surveillance of food and beverage establishments’ individually required approximately 50% of active doctors.

Regarding nurses, in 2019, activities such ‘health planning’, ‘national vaccination program’, ‘epidemiological surveillance of notifiable diseases’, ‘infection prevention and control and antimicrobial resistance program’, ‘audit and accreditation programs’, and ‘training and research’, individually required approximately 50% of the number of available nurses.

For the professional group senior technicians, ‘national program for the promotion of oral health’, ‘audit and accreditation programs’, and ‘vector surveillance network’ are activities that, in 2019, required (each one) approximately five out of ten active senior technicians. Moreover, we can observe that activities such as ‘sanitary surveillance programs for drinking water’ and ‘health surveillance of food and beverage establishments’ required on average eight out of ten senior technicians.

Finally, in 2019, the activity ‘disability assessments and multipurpose certificate issuance’ executed by the administrative group, required approximately 50% of this professional class.

Table 5.3 – Proportion of health professional involved in non-COVID activities during the year 2019.

Non-COVID-19 Activity	**Health professional group** *% [min% - max%]*			
	Doctors	Nurses	Senior Technicians	Administrative
Disability Assessments and Multipurpose Certificate Issuance (Medical Boards + Households)	**42.6** [a] **[6.9 - 75]**	0	0	**52.8** [a] **[0 - 100]**
Mental Health Law Enforcement	**44.1** [a] **[3.4 - 75]**	0	0	19.4 [0 - 50]
*Medical assessment related with issuing driver license ***[4]***	**43.7** [a] **[1.7 - 75]**	0	0	29.2 [0 - 50]
School Health	9.8 [0 - 25]	29.2 [0 - 50]	21.3 [0 - 100]	5.6 [0 - 33.3]
Health Planning	23.3 [1.7 - 50]	**55.5** [a] **[14.3 - 100]**	22.4 [0 - 100]	22.2 [0 - 100]
National Program for the Promotion of Oral Health	17.9 [1.7 - 50]	8.6 [0.0 - 42.9]	**42** [a] **[0 – 83.3]**	30.6 [0 - 66.7]
Sanitary Surveillance programs for drinking water	27.1 [0 - 50]	0	**81.4** [a] **[57.1 - 100]**	33.3 [0 - 100]
Verification of deaths	**44.7** [a] **[6.9 - 75]**	0	0	0
Health Surveillance of food and beverage establishments	**43.9** [a] **[1.7 - 75]**	0	**83.8** [a] **[60 - 100]**	27.8 [0 - 100]
*National Vaccination Program ***[5]***	11.5 [1.7 - 25]	**49.2** [a] **[20 - 100]**	0	13.3 [0 - 33.3]
Epidemiological Surveillance of Notifiable Diseases	34.6 [1.7 - 75]	**53.5** [a] **[14.3 - 100]**	24.6 [0 - 100]	5.6 [0 - 33.3]
Infection Prevention and Control and Antimicrobial Resistance Program	12.3 [0 - 33.3]	**49.7** [a] **[20 - 100]**	36.2 [0 - 100]	5.6 [0 - 33.3]
*Audit and Accreditation Programs ***[2]***	4.3 [0 - 8.6]	**50** [a] **[0 - 100]**	**41.7** [a] **[0 - 83.3]**	16.7 [0 - 33.3]
Protocols and Partnerships	25.8 [1.7 - 50]	32.9 [0 - 100]	30.2 [0 - 100]	5.6 [0 - 33.3]
*Participation in the Clinical and Health Council ***[5]***	18.1 [1.7 - 50]	0	0	0
*Pre-travel consultation ***[3]***	8.9 [3.4 - 16.7]	0	0	11.1 [0 - 33.3]
*International Vaccination ***[3]***	0	23.3 [0 - 50]	0	11.1 [0 - 33.3]
*Occupational Health ***[3]***	11 [1.7 - 25]	40 [20 - 50]	12.5 [6.7 - 16.7]	11.1 [0 - 33.3]
*Vector Surveillance Network ***[5]***	8.1 [0 - 25]	0	**52.7** [a] **[13.3 - 100]**	0
Training and Research	23.6 [5.2 - 50]	**53.5** [a] **[14.3 - 100]**	36.5 [0 - 100]	0

[a] activities that require approximately 50% of active professionals

* [number of units, when less than 6 units]

To analyse the impact of the pandemic on non-COVID activities, we considered the variation in the total average number of weekly hours used for the execution of each activity (comparing the four periods) – left panel of Figure 5.*8*. Additionally, the variation in the percentage of execution of each activity was analysed – percentage of execution in 2019 based on the planned percentage, compared to the percentage of execution in the pandemic period based on the expected percentage without the pandemic – right panel of Figure 5.*8*.

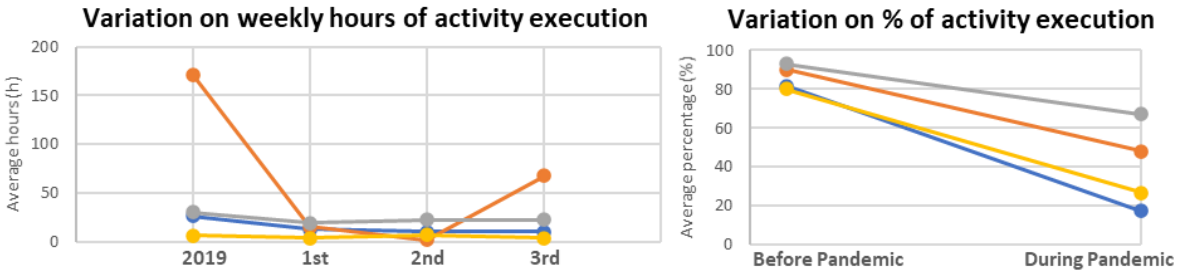
Figure 5.8 shows an evident impact of the pandemic on the hours of execution of the various activities. Mostly, there is an immediate accentuated decrease in the 1st period, which continued to decrease in the 2nd period. Of the activities with a high number of hours of execution, the 'sanitary surveillance programs for drinking water' had the smallest reduction.

The activities, grouped according to the essential functions of public health doctors [80], with the highest impact on the number of total weekly hours are (in ascending order of variation): 'health surveillance of food and beverage establishments', 'health planning', 'sanitary surveillance programs for drinking water', 'disability assessments and multipurpose certificate issuance', and 'national program for the promotion of oral health'.

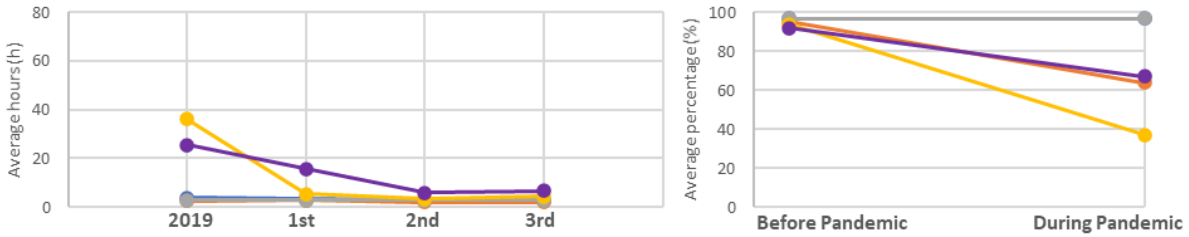
After the period of higher demand, there were activities that partially recovered their hourly levels, such as 'audit and accreditation programs', 'vector surveillance network', 'sanitary surveillance programs for drinking water', and 'national program for the promotion of oral health' (an activity that recovered more). However, it should be noted that these activities did not return to the 2019 values.

Regarding the variation in the percentage of execution of activities compared to planned, two activities were clearly not executed during the pandemic – 'disability assessments and multipurpose certificate issuance (medical boards + households)' and 'pre-travel consultation'. In addition, other activities had a decrease in the percentage of execution greater than 50%, such as 'school health', 'health planning', and 'occupational health'.

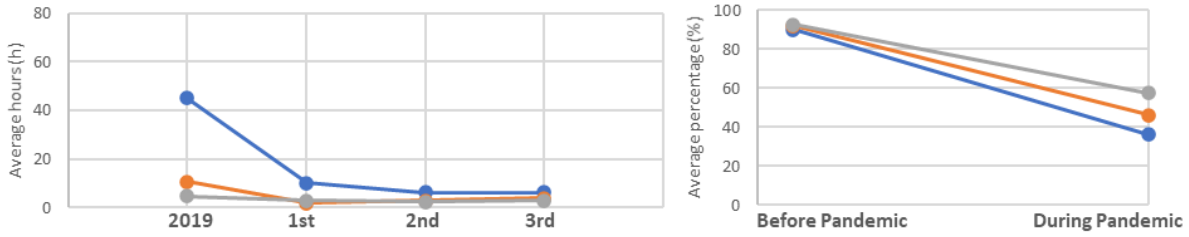
Depicted in Figure 5.*8*, the activities 'verification of deaths' and 'mental health law enforcement' (lines overlapped in the *Health Authority* group) were the only ones that maintained their percentage of execution compared with 2019. This strongly suggests that these activities are essential activities in PH, without the possibility of being completely suspended.



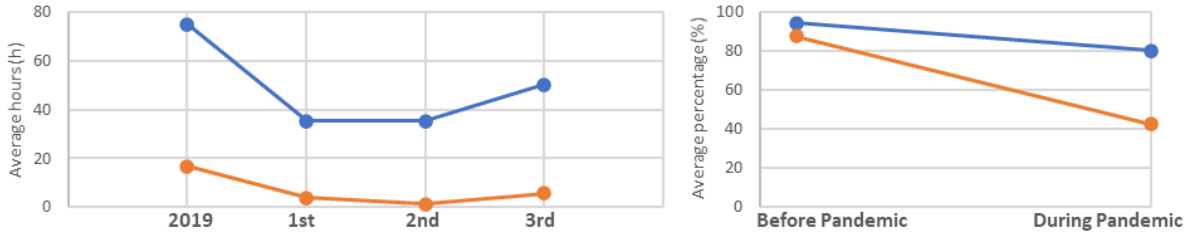
Health Promotion and Protection – *Blue: School Health; Gray: National Vaccination Program (PNV)**[5]*; *Orange: National Program for the Promotion of Oral Health**[5]*; *Yellow: Occupational Health**[3]*.



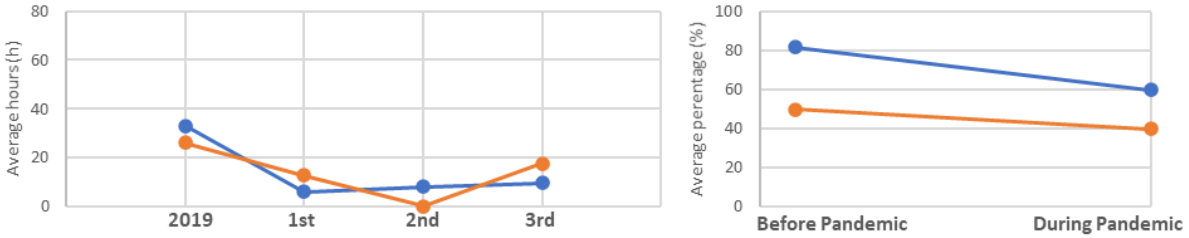
Health Autority – *Blue: Mental Health Law Enforcement; Gray: Death verification; Orange: Medical assessment related with issuing driving license**[4]*; *Purple: Epidemiological Surveillance of Notifiable Diseases**[5]*; *Yellow: Health Surveillance of food and beverage establishments**[5]*.



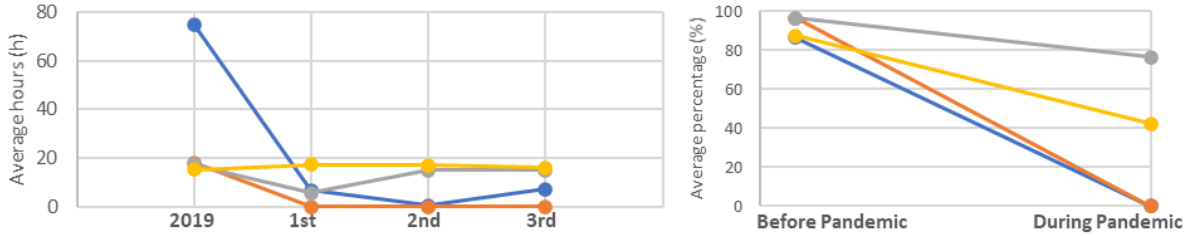
Governance and Planning in Health – *Blue: Health Planning**[5]*; *Gray: Participation in the Clinical and Health Council**[4]*; *Orange: Protocols and Partnerships**[5].*



Environmental Health – *Blue: Sanitary Surveillance programs for drinking water**[6]*; *Orange: Vector Surveillance Network**[4]*.



Collaborative Services and Quality – *Blue: Infection Prevention and Control and Antimicrobial Resistance Program**[5]*; *Orange: Audit and Accreditation Programs**[2]*.



Other services – *Blue: Disability Assessments and Multipurpose Certificate Issuance; Gray: International Vaccination**[3]*; *Orange: Pre-travel consultation**[3]*; *Yellow: Training and Research**[5]*.

Figure 5.8 – Total number of weekly hours for the execution of each activity (in the four periods) (left). Average percentage of execution of each activity, before and during the pandemic, compared to expected (right). [* referring to the number of units when this is less than 6 units]

5.4.2 COVID-19 Activities: Description during the Pandemic

The COVID-19 activities performed during the pandemic were assessed considering two different standardizations, as mentioned in Chapter 4.

Table 5.4 shows the percentage of health professionals involved in COVID-19-related activity during the period of highest demand, standardized to the total number of active professionals before the pandemic (January 2020). It is observed that, in some cases, the number of health professionals involved in COVID-19-related activities is higher than the average number of active health professionals in January 2020 (percentages greater than 100%). Of note, the 'contact management' activity represented the highest workload for the various professional classes. Specifically, such activity required twice as many active nurses and senior technicians working on January 2020. The strong need for human resources for this type of activity is thus evident in comparison with the remaining COVID-19-related activities.

Table 5.4 – Percentage of professionals in COVID-19 activities, standardized for the number of professionals in Jan 2020.

COVID-19 Activity	**Health professional group** *% [min% – max%]*			
	Doctors	Nurses	Senior Technicians	Administrative
Case entry	64.2 [13.8 - 150]	**106** [a] **[0 - 280]**	59.5 [0 - 300]	66.7 [0 - 300]
Case management	**149.1** [a] **[13.8 - 430.8]**	86 [0 - 25]	78.6 [0 - 300]	50 [0 - 300]
Contact management	**128.4** [a] **[0 - 353.8]**	**194.6** [a] **[0 - 350]**	**192.6** [a] **[114.3 - 300]**	75 [0 - 300]
Prophylactic Isolation Declaration	49.7 [6.9 - 150]	37.1 [0 - 100]	82.5 [0 - 300]	**113.9** [a] **[0 - 300]**

[a] activities that require more than 100% of active professionals.

Table 5.5 shows the percentage of health professionals needed for COVID-19-related activities, during the period of highest demand standardized to the maximum number of active professionals in the four periods. Our findings demonstrate that the activity 'contact management' had the greatest need for nurses and senior technicians. For doctors, 'case management' was the leading COVID-19-related activity, followed by 'contact management' activity. Regarding the need for administrative in COVID-19 activities, these professionals were mostly requested for 'prophylactic isolation declarations'.

Table 5.5 – Percentage of professionals in COVID-19-related activities, standardized for the maximum number of professionals across the four periods.

COVID-19 Activity	**Health professional group** *% [min% – max%]*			
	Doctors	Nurses	Senior Technicians	Administrative
Case entry	26.6 [3.8 - 85.7]	26.2 [0 - 83.3]	16.7 [0 - 75]	18.3 [0 - 66.7]
Case management	38.3 [13.6 - 85.7]	20.2 [0 - 83.3]	22.9 [0 - 75]	7.1 [0 - 42.9]
Contact management	33.4 [0 - 100]	52.9 [0 - 127.3]	69.4 [31.4 - 110]	18.8 [0 - 57.1]
Prophylactic Isolation Declaration	14.1 [2.6 -25]	11.9 [0 - 36.4]	25.1 [0 - 75]	47.8 [0 - 114.3]

In a last analysis, the number of total weekly average hours and the percentage of execution compared with the expected value for each of the four COVID-19 activities is presented in Table 5.6. It is possible to verify that PH professionals spent most of their time in ‘case management’ and ‘contact management’ activities during the COVID-19 period. In addition, it appears that the total weekly average hours to perform such activities was quite unequal among PHU. These values are absolute values, and as these activities were considered a priority during the pandemic, two plausible hypotheses emerge to explain the minimum value in the number of hours: low number of confirmed daily COVID-19 cases to be managed by the unit and a great lack of human resources.

Table 5.6 – Total weekly average hours and percentage of expected of COVID-19-related activities.

COVID-19 Activity	**Total weekly average hours** *h [min(h) – max(h)]*	**Percentage of execution** *% [min% – max%]*
Case entry	379.9 [20 - 1545]	93 [75 - 100]
Case management	548.4 [77 - 1545]	87 [60 - 100]
Contact management	741.5 [192.5 - 980]	78 [50 - 95]
Prophylactic Isolation Declaration	151.4 [10 - 350]	87 [60 - 100]

5.4.3 Discussion of Activities

The activities that had the highest impact on the total amount of weekly hours were the activities that required the highest number of hours for their execution before the pandemic. Thus, the longer the hours required for its execution in 2019, the high the decrease in time spent during the pandemic. Added to this factor is the mobilization of professionals – as observed in Table 5.3. Specifically, all these non-COVID activities need approximately half or more of the active professionals of one of the professional groups.

Three possible variations in non-COVID activities were verified: activities continued at the levels presented before the pandemic, activities were completely suspended, or activities levels partially decreased in the face of the onset of the pandemic. Notably, although in the 3rd period some activities recovered some of their "usual time", they did not return to the 2019 values.

It is important to emphasize that although the hours spent in non-COVID activities decreased (as well as in their percentage of execution), several of these activities did not reach the null value (i.e., 0 hours and 0%). This indicates that, during the pandemic, several PH activities had to be executed, without being possible to suspend them.

Notoriously, the activities 'case management' and 'contact management' had the highest mobilization of PH professionals. This is expected since these COVID-19-related activities (compared to the remaining two activities) are the activities performed in contact tracing (see Figure 2.4). In addition, according to the *Contact tracing for COVID-19: current evidence, options for scale-up and an assessment of resources needed* by the ECDC, the range of estimates from country interviews was also estimated [35]. From our findings and the estimate described by the ECDC, strong evidence demonstrates that these activities are highly time demanding [35].

It is acknowledged that mostly non-COVID activities are dependent on medical specialists in public health for their performance. Nonetheless, COVID-19-related activities have higher flexibility in terms of the specialization of the health professionals who perform them (as telephone contact in the 'contact management activity'). This is supported by our study findings on human resources, presented in section 5.2. The PH medical residents and general-trained residents were the professional categories indicated as most needed for an adequate response. Curiously, the categories of doctors with a degree of specialization were not identified as the most needed, specifically these categories had a structural need (not dependent on the pandemic). Thus, based on these findings it is possible to speculate that these professional categories were not identified as necessary because of the previous knowledge that they were not available. Thus, it is not that these doctors with a degree of specialization were not needed, but the reality is that it would not make sense to indicate the need for these professionals who were not available (such public health medical specialists).

Considering all this information, it is possible to infer that the need for additional human resources reported by the units did not intend to restore to the 'normal' levels of non-COVID activities, but instead a need targeting only COVID-19 activities.

It is evident the strong need for human resources to performed COVID-19-related activities. Therefore, it was expected a strong impact on non-COVID-19 activities. Remarkably, the percentage of health professionals involved in COVID-19-related activities during the period of highest demand reported by the units was very uneven. Based on this finding it can be speculated that each unit (re)organized their health professionals by COVID-19-related activities in different ways, which was made evident in the present study.

5.5 Information Systems

5.5.1 Use of Information Systems

As previously mentioned, information systems are essential for many public health functions. Hence, it is crucial to analyse the impact of the COVID-19 pandemic on the different existing systems (Figure 5.9). In this analysis the 6 PHUs were examined, except for the *SINAVE-Lab* system that included only 5 PHUs.

Despite being a system used for activities such as 'pre-travel consultation' and 'international vaccination', it is observed that the *SONHO* system was never used. This observation may be explained by the fact that these units use alternative systems, or the PHUs' coordinators may not know this system well. In addition, one of the units reports not having access to the *RNU* system. This system, as well as the *SINAVE Public Health module*, were used before and during the pandemic. Additionally, the use of the systems *SINAVE-Med*, *SINAVE-Lab* and *Excel* software increased during the pandemic.

Notably, systems such as *SINAVE-Med*, *SINAVE-Lab, SINAVE Public Health module,* and *Excel* software had a pivotal use during the pandemic. On April 22, 2020, the DGS, informed that all confirmed or suspected cases of COVID-19 disease had to be registered/notified in the *SINAVE* system, despite the limitations of the platform, which were acknowledged by the DGS [87]. Thereby, after the beginning of COVID-19 cases in Portugal on March 2, 2020, only after approximately 2 months, the notification of the COVID-19 disease became mandatory on the *SINAVE* platform. Therefore, it was somewhat expected that all units would use the *SINAVE* system during the pandemic.

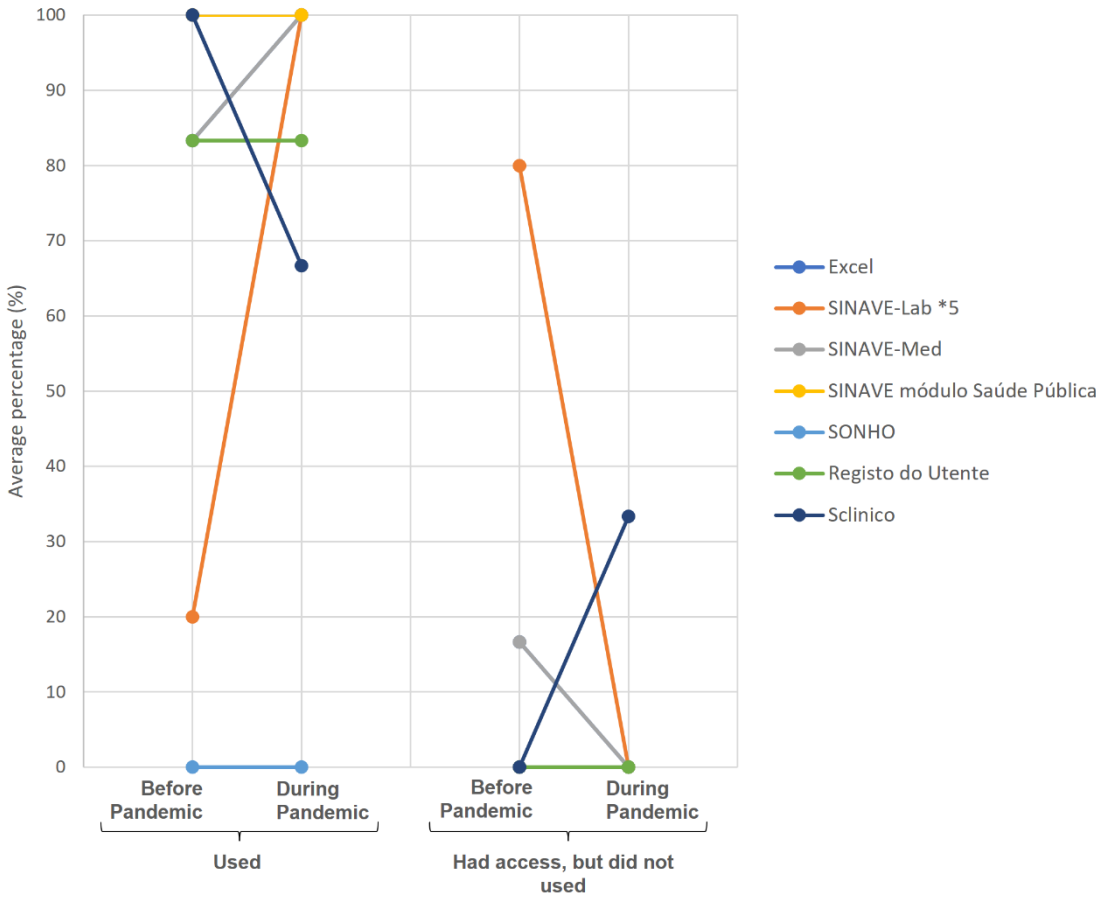


Figure 5.9 – Percentage of information systems used (left panel) and not used (right panel).

The *Trace COVID-9* system, implemented during the pandemic, in addition to being integrated with *SINAVE-Med* and *SINAVE-Lab* has several additional features, including the task manager, information on priority tasks, and offers the user code needed for the *StayAway COVID* application[4]. Figure 5.*10* shows the percentage of usage of the *Trace COVID-19* system, as well as the different features of the system.

All 6 units analysed used *Trace COVID-19*, and the task manager functionality was used by most (67%), while only a small fraction of PHUs supported the priority managed by the platform to perform COVID-19 tasks.

[4] application for mobile phones that aims to assist the country in tracking COVID-19. The application allows each of us to be informed about risk exposures to the disease by monitoring recent contacts [85].

The implementation of the mobile phone application, *StayAway COVID-19*, aimed to assist the country in tracing COVID-19; however, only one PHU referred having used it. In the weekly meetings with the two PH doctors who are part of the PH research network (for status points and definition of the next steps of the project, as previously described), we inquired about their perception regarding the use of the application *StayAway COVID-19*. It was reported that most PH professionals were not aware of this feature of the *Trace COVID-19*, being practically unremembered its use.

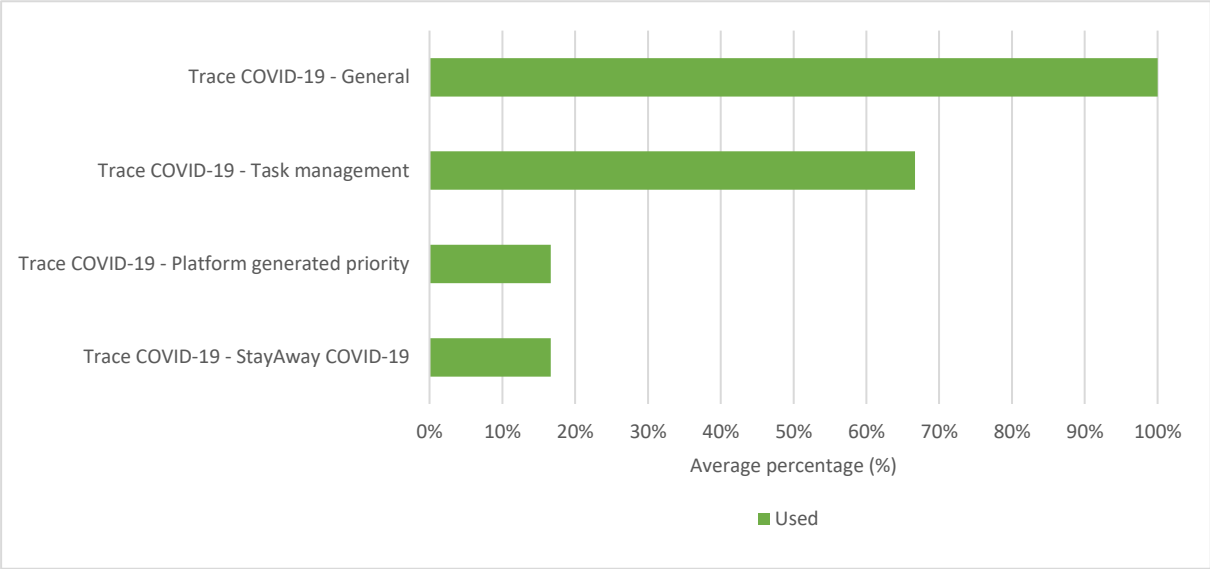


Figure 5.*10 – Percentage of usage of the* Trace COVID-19 *system, as well as the different features of the system, during the pandemic period.*

5.5.2 Discussion of Information Systems usage

In order to support contact tracing and other PH interventions, all 6 units analysed used the *Trace COVID-19* platform – system created during the pandemic. This system was used together with the *SINAVE* platform (*SINAVE-Med* and *SINAVE-Lab*). One of the mandatory systems for reporting COVID-19 cases, *SINAVE* system, has several limitations, also acknowledged by the DGS, thereby it is essential to improve this system to better support contact tracing and others PH interventions [87].

5.6 Innovation

In response to the pandemic, the PHUs developed several innovative changes, such as functional and organizational changes, and initiatives implemented, such as technical and operational strategies, to effectively respond to their needs. Therefore, main changes and innovative implementations were identified for the 9 PHUs with valid responses.

5.6.1 Functional and Organizational Changes

The functional and organizational changes understood as innovative that occurred in the PHUs were analysed through a content analysis of the received answers. The innovative changes were typified and then categorized as shown in Table 5.7.

Thirty-two functional and/or organizational changes were identified, with an average of 3.4 changes per PHU (from 1 to 7 changes). These changes were grouped into 21 types, of which 6 (28.6%) occurred in more than one PHU. It should be noted that the type ‘Inclusion of professionals outside the PHU’ (n= 4, 12.5%) is the most frequent type of change. Of the total changes, 15 (46.9%) are unique in the respective PHU.

Regarding the categorization of the described changes, ‘Team and work management’ was the most common (n=10, 47.6%, of all 21 types of change). Seven PHUs (77.7%) reported changes in ‘Reorganization of internal functions’, 5 (55.5%) in ‘Team and work management’, 4 (44.4%) in ‘Human resources reinforcement’, and 2 (22.2%) in the ‘Organization of knowledge resources’.

Nineteen changes (59.4%) occurred between March and August 2020 and were mostly related to ‘Team and work management’ (n= 9, 47.4%) and ‘Reorganization of internal functions’ (n= 7, 36.8%). Additionally, 16 (50%) of the changes remained active beyond the date of our study data collection.

Table 5.7 – Typification and categorization of functional and organizational changes.

Category	Type of functional and organizational changes	Proportion changes (n= 32)	Proportion PHU (n= 9)
		n (%)	*n (%)*
Team and work management	Preparation of monthly scales;	1 (3.1%)	1 (11.1%)
	Definition of internal communication channels (teams, emails);	1 (3.1%)	1 (11.1%)
	Definition of external communication channels (email, telephone contacts);	1 (3.1%)	1 (11.1%)
	Teams matching PHU and non-PHU professional;	1 (3.1%)	1 (11.1%)
	Moving from geographic base management to task flow management;	1 (3.1%)	1 (11.1%)
	Centralization of decision resources (COVID support office);	3 (9.4%)	3 (33.3%)
	Delegation of actions to entities (collaboration of schools for epidemiological surveys and active surveillance in school cases);	1 (3.1%)	1 (11.1%)
	Use of *Teams* as a work management platform;	1 (3.1%)	1 (11.1%)
	Use of *WhatsApp* to communicate with the migrant population;	1 (3.1%)	1 (11.1%)
	Organization of regular online meetings for sharing among PHU professionals.	1 (3.1%)	1 (11.1%)
Reorganization of internal functions	Definition of daily tasks for each professional;	1 (3.1%)	1 (11.1%)
	Specialization of resources / teams (homes, schools, sports/gyms, …);	3 (9.4%)	3 (33.3%)
	Specialization of teams (cases / contacts / tests / data reporting);	3 (9.4%)	3 (33.3%)
	Creation of mixed / multidisciplinary / multidisciplinary teams;	2 (6.3%)	2 (22.2%)
	Adequacy of the training internships of PH interns.	1 (3.1%)	1 (11.1%)
Human resources reinforcement	Request for monthly availability to external elements;	1 (3.1%)	1 (11.1%)
	Inclusion of professionals external to the PHU;	4 (12.5%)	3 (33.3%)
	Training other health professionals in the response;	1 (3.1%)	1 (11.1%)
	Creation of an emergency or reinforcement team, to act when justified;	1 (3.1%)	1 (11.1%)
	Creation of pilot models for epidemiological surveillance (municipal base).	1 (3.1%)	1 (11.1%)
Organization of knowledge resources	Centralization of support resources (multiple links to support professionals, answering questions, supporting users).	2 (6.3%)	2 (22.2%)

5.6.2 Innovative Implementation

Regarding the innovative implementation that occurred in PHUs, again a content analysis was performed. For each innovative implementation, the purpose, negative aspects eventually reported, and the skills involved were typified and categorized (Table 5.8).

Forty-seven innovative implementations were reported, with an average of 5.2 implementations per PHU (minimum 1 and maximum 10). Therefore, these innovative implementations were grouped into 15 non-exclusive types (see Table 5.8). 'Organization of notification data' (n= 10, 21.3%) is the most frequent type of implementation.

Table 5.8 – Categorization of innovative implementations.

	Type of innovative implementation	**Proportion implementations (n= 47)** n (%)	**Proportion PHU (n= 9)** n (%)
Innovative implementation category	Organization of notification data;	10 (21.3)	7 (77.8)
	Report optimization;	9 (19.1)	6 (66.7)
	Procedure for sending standard information;	6 (12.8)	3 (22.3)
	Management of prophylactic isolation declarations;	5 (10.6)	4 (44.4)
	Procedures for sending SMS;	4 (8.5)	2 (22.2)
	Task management / team organization;	4 (8.5)	2 (22.2)
	Creation / reinforcement of articulation between entities;	4 (8.5)	3 (22.3)
	Management of telephone contacts (organization of the epidemiological survey);	3 (6.4)	3 (22.3)
	Simplification of information collection (epidemiological survey);	3 (6.4)	2 (22.2)
	Educational material / general information;	3 (6.4)	3 (22.3)
	Management of telephone contacts (active surveillance);	2 (4.3)	2 (22.2)
	Inclusion of georeferencing information;	2 (4.3)	2 (22.2)
	Community testing team / testing center;	2 (4.3)	2 (22.2)
	Automated test prescription;	1 (2.1)	1 (11.1)
	Internal guidelines / protocols.	1 (2.1)	1 (11.1)

‘Management/ reduction of workload’ (n= 38, 80.9%) and ‘Efficiency improvement / error reduction’ (n= 35, 74.5%) were the two purposes in which most implementations fitted (see Table 5.9). This was expected, as the COVID-19 pandemic contributes to an unprecedented increase in the workload volume.

Six (12.8%) implemented strategies brought negative results to the PHUs, mostly related to ‘Human resources overload’ (n= 3, 6.4%) and to ‘Difficulty in data transmission’ (n= 2, 4.3%). In addition, ‘Information/ computing/ data management’ was reported as the most required skill to execute the innovative strategies (n= 29, 61.7%).

Table 5.9 – Classification of innovative implementations.

Classification	**Type**	**Proportion implementations (n= 47)**	**Proportion PHU (n= 9)**
		n (%)	*n (%)*
Purpose	Management / reduction of workload;	38 (80.9)	8 (88.9)
	Efficiency improvement / error reduction;	35 (74.5)	9 (100)
	Support / information to users / context;	12 (25.5)	5 (55.6)
	Specialization of human resources;	10 (21.3)	6 (66.7)
	Obtaining data for (general) management;	10 (21.3)	4 (44.4)
	Support to multidisciplinary / institutional articulation.	8 (17)	3 (33.3)
Barriers / negative results	Human resources overload;	3 (6.4)	2 (22.2)
	Need for user collaboration;	1 (2.13)	1 (11.1)
	Difficulty in data transmission.	2 (4.3)	2 (22.2)
Skills	Information / computing / data management;	29 (61.7)	7 (77.8)
	Management / administration;	11 (23.4)	5 (55.6)
	Decision in Public Health;	10 (21.3)	7 (77.8)
	Content / multimedia production;	4 (8.5)	3 (33.3)
	Institutional organization;	2 (4.3)	1 (11.1)
	Logistics.	1 (2.1)	1 (11.1)

Regarding the temporal distribution, the implementations occurred mostly (n= 27, 57.4%) during the 1st period, from March 2020 to August 2020, and were mainly related to 'Organization of notification data' and 'Report optimization'. In the following period, September 2020 to February 2021, the remaining 20 implementations took place. No innovative implementations have occurred since March 2021. In addition, 21 (44.7%) implementations are still in use (after the response date).

5.6.3 Discussion of Functional and Organizational Changes and Innovative Implementations

Noteworthy, all PHUs (n= 6) analysed in the section human resources increased their number of PH professionals during the pandemic. Therefore, at least 6 units should report changes in 'Human resources reinforcement' in the topic innovative changes. Considering that the question related to changes was an open text question, the units did not identify several changes, possibly due to an oversight or fail to recall.

5.7 Discussion

In this Section, we will discuss the study main findings considering the recommendations supported by international and national organizations, as well the strategies in the health sector described in Chapter 3.

To ensure the human resources needed for the COVID-19 preparation and a suitable response to each pandemic phase, several recommendations emerged from the WHO Regional Office for Europe and the DGS [57]–[59]. Indeed, these two entities recommend the mobilization of the health workforce according to essential health services, such PHUs. Accordingly, it is possible to observe from this study that there was a mobilization of all professional groups, with a peak in the 2nd period of the pandemic. This mobilization was possible through strategies such as the existing health workforce, extra staff and armed forces, and emergency recruitment procedures. This last strategy was mentioned in the Republic Diary in June 2020, having been applied at the end of the summer [66]. Therefore, the observed peak in the 2nd period was supported by these strategies.

Notoriously, the mobilization of professionals mostly included doctors, specifically by medical residents of the general training year. This category of doctors is the group with the greatest flexibility of mobilization. During this year of general training, 3 months are spent in the Primary Health Care training block, which includes General and Family Medicine and Public Health (2 weeks of internship in PH) [15]. Due to the pandemic, MGF consultations were suspended and these physicians were directed

to a longer internship time in the PH area (1 month of internship in PH with the possibility of extension).

Due to the possibility of resolved term employment contracts, for a period of four months, and the suspension of the existential activity, the PHUs were able to mobilize nurses, senior technicians, and administrative [67]. Particularly, the nurses specialized in community health nursing were the most mobilized, due to the request of these professionals from the various functional units of the respective ACES.

Regarding the mobilization of the military, curiously these professionals were counted only in some PHUs. A clarification will be needed from the PHUs regarding this event. Two scenarios are possible: there was no mobilization of military personnel for the referring units or the military were considered as external to the PHUs (from the regional intervention office).

Taking as reference the recommended ratios of doctors with a degree of specialization in PH (referring to public health medical specialists, health authorities and not health authorities), nurses and environmental health technicians (see Chapter 2), some observations emerged. Regarding the standardized values in relation to the number of professionals in 2019, none of these professional groups reached the recommended ratios. Specifically, in 2019, the ratios were on average 2 physicians with a public health specialist degree per 100 000 inhabitants; 2 nurses for every 100 000 inhabitants; 3 environmental health technicians for every 100 000 inhabitants. Evidently, the maximum number of professionals per 100 000 inhabitants occurred in the 2nd period, however only the group nurses managed to reach the recommended ratio (3 nurses per 100 000 inhabitants).

In addition, it appears that the mobilization was quite unequal among PHUs, even adjusting to its population coverage (ratio of on average increase between 9 and 55 of total professionals). In addition, the WHO Regional Office for Europe guidelines regarding ensuring adequate distribution of the emergency preparedness and response workforce across the health system, specifically for the PH units, were not met [62].

It is also verified that the increase in human resources did not reach the level of no needs, especially in the phase of highest intensity of the pandemic (2nd period). However, the pandemic is not the cause of the lack of public health professionals, the pandemic just intensified the need that already existed. Between 2002 and 2011 the number of PH professionals fell by 24.4% (PH is one of the 14 medical specialties with diminishing personnel numbers) [2].

Faced with the COVID-19 pandemic, new essential activities had to be executed by PH professionals, thus increasing their total activities. Therefore, and in view of the recommendations of the WHO Regional Office for Europe, it was necessary to have a mobilization of health professionals, bearing in mind that the various non-COVID activities would have to continue to be performed [57]–[59].

Attributable to the closure of several commercial establishments that require the surveillance of PH professionals, as well as the recommendations of the international and national organizations, non-COVID activities were affected. Some activities were completely suspended, and contrariwise other activities continued at the same levels after the onset of the pandemic. Also, many non-COVID activities markedly reduced the number of hours required for their execution as well as the percentage of execution during the pandemic, compared to what would be expected without the pandemic. One such case was the 'health surveillance of food and beverage establishments, homes, industry, commerce, technical inspections' activity. Due to the closure of several commercial establishments, the number of hours and the percentage of execution this activity was noticeably reduced.

Regarding the material resources needed for non-COVID activities, most COVID activities depend on computer and telecommunication resources. For example, the ‘case management’ and ‘contact management activity’ both require resources (mostly a computer) to perform the contact tracing (Figure 2.4) in *Trace COVID-19*. Evidently, the number of material resources existing in the PHUs did not keep up with the increase in the mobilization of health professionals. However, the need reported by the units was structural and did not depend on the pandemic pattern. This need is alarming. A critical point to consider during the pandemic phase is the replacement availability of computer equipment in the event of a breakdown. However, this replacement availability was not verified in any unit, being indisputable the lack of material resources (essential for the control of the pandemic) in the units. The pivotal role of *Trace COVID-19* in PH was evident as well other information systems. However, no recommendations and strategies in terms of implementations and use of information systems are currently available.

Finally, the DGS *National Plan for Preparedness and Response to New Coronavirus Disease (COVID-19)* [57] highlights the importance of documenting all the processes, activities, the decisions, and the associated results. Thus, our study questionnaire included open-ended questions regarding innovative changes and initiatives that occurred in the PHUs. Several changes and implementations emerged from the analysis performed.

Recognized the scarcity of guidelines for PH, all the present results are relentlessly important for the study of public health and additionally for the public health future. Our findings exhibit the number of human and material resources reported as needed by units to perform various PH interventions, before and during a pandemic. Additionally, the mobilization of health professionals, as well as the percentage of each professional group needed to perform public health activities (non-COVID-19 and COVID-19-related) was truly asymmetrical. It will be of interest understand if the mobilization of professionals and their (re)organization was adequate to the level of the pandemic in the PHU's area of influence and therefore to predict the optimal mobilization and an optimal model of (re)organization given the number of daily cases of COVID-19. Several strategies reported by the units can be real and valuable examples for the control of the pandemic, and good practices to be followed in future pandemics can be identified.

Chapter 6

Conclusion and Future Work

The conclusions of this work are now presented, followed by a discussion of the limitations and future work suggestions.

6.1 Conclusions

This dissertation describes and analyses the impact of the COVID-19 pandemic on PHUs' organization, based on a cross-sectional study design. To perform this mapping of the reality of the units, an online questionnaire for PHU's coordinators was developed and applied. The study targeted all PHUs, including headquarters and some sub-units, in mainland Portugal (eligible n= 61). The questionnaire was developed through online spreadsheets (*Google Sheets*) and covered topics such as resources (human and material), activities (non-COVID-related and COVID-related), information systems, innovation, and others. In addition, some topics covered different periods, before the pandemic and during the pandemic – 1st period (from 1 March 2020 to 31 August 2020), 2nd period (from 1 September 2020 to 28 February 2021), and 3rd period (from 1 March 2021 to 31 July 2021). The questionnaire was developed throughout several phases to ensure its appropriateness and accuracy. Moreover, a PH Research Network was created to provide direct support in completing the information for this survey. At the time of the completion of this thesis, 45 public health medical residents and public health medical specialists were members of this Research Network. From the 61 questionnaires sent to PHUs, 11 questionnaires were submitted by the PHUs' coordinator. However, 2 were discard due to extreme incomplete data. Thus, from the 9 valid questionnaires, 6 were fully completed, corresponding to the study analytical sample, except for the question *Innovation*, where the 9 questionnaires were considered.

In a rapidly changing epidemiologic scenario, the PHUs had to reorganize themselves. Predictably, a mobilization of all professional groups was verified, with a peak in the period of highest demand of human resources reported by the units observed in the 2nd period (an increase of, on average,129% in total professionals compared to 1st period). In addition, a rise of 49% in the total number of professionals was attributed to doctors. Furthermore, ascribe to the overlapping of the periods of highest demand of human resources in the analysed units, the results observed in terms of quantity and distribution of PH professional were expected. It is noteworthy that a great asymmetry and shortages were observed among the analysed PHUs. Precisely, a structural need was verified in all professional categories, being notorious a contextual need in doctors in the 2nd period. Strong evidence pointed for the fact that limitation capacities and resources existed before the pandemic.

Notably, non-COVID activities have been particularly impacted by the pandemic. The epidemiology of the virus contributes to an unprecedented increase in the workload. Specifically, contact management activity (with an average of total weekly hours of 741) where PH professionals occupy a unique position in response to COVID-19. Moreover, there was a limitation of the material resources essential to perform COVID-19 activities. Nevertheless, this deficit existed before the pandemic (formally, a structural need was verified).

Regarding, the functional and organizational changes generated by the PHUs during the COVID-19 pandemic showed high diversity, with responses consistent between the PHUs, which suggests an essential adaptive capacity and autonomy in the reorganization of the PHUs. Several changes had a transient nature, possibly because they responded to temporary needs, and others remain active, suggesting their usefulness and effectiveness. Regarding the innovative initiatives that were implemented in such a short and demanding time in the PHUs during the COVID-19 pandemic, they showed high diversity, with a group of consistent responses among the PHUs, which suggests robustness in the validity of the implementations. The need to increase efficiency in processes and activities, as well as reduce the workload, were the common reasons that led to their implementation. In addition to the mobilization capacity of the PH professionals, it was notable their innovative capacity. Interestingly, most of the implemented initiatives required competencies from the health workforce outside the health area (such as computing/ data management).

The instrument originally developed allowed a careful and rich analysis, and it should be noted that no similar resource or study analogous to this, to our level of knowledge, was found.

The current study demonstrated the real impact of the pandemic COVID-19, by evidencing in the numerous, and diverse, changes that occurred in the PHUs analyzed. This was to be expected considering that the DGS only launched a model for the Operationalization of Tasks in Public Health Services one year after the start of the pandemic [43].

When planning the health system preparedness, given each country limited resources, decision-makers have to decide between strengthening the PH capability for pandemic control (prevention) or the hospital / intensive care capability for assuring the care for severe disease on those infected (treatment).

This study uses methods that retrieve, analyse and present real data from the pandemic situation and its impact with semi-automated routines. This allows very quick updates and to inform decision makers in timely manner. Methods and procedures developed with this study may be used by PH entities and decision-makes, such as DGS, to deal with similar health threats.

6.2 Limitations and Future Work

The present study was inevitably affected by the adherence of PHU coordinators. One of the main limitations of this study is the small number of completed questionnaires, which strongly limited the statistical power of the study and the generalizability of the study findings for all Portuguese PHUs. The time of application of the questionnaire, although it cannot be postponed, was not ideal – because it corresponded to a period of elevated workload in the PHUs, and simultaneously coincided, in part, with the summer vacations.

It is imperative to continue the individualized awareness of PHUs' coordinators to increase their participation in the study, making possible a nationwide analysis. Furthermore, as previously mentioned, the development of data analysis in the R software has the enormous advantage of updating the results almost automatically. In the future, it would be interesting to perform inferential statistics to compare groups regarding relevant characteristics (e.g., health region, urban vs. non-urban setting).

The present work is not free from some limitations, mainly related to the reported data quality. The analysed data are considered estimates, as several units do not record the requested information (such as available resources). Additionally, as a resource deficit occurred throughout the pandemic response, forecasting needs is considered problematic. The evolution of the disease and its unpredictability make this prediction even more challenging (periods of great calm contrasted with others of great difficulty in responding). Furthermore, a semi-structured interview could be performed with the coordinators to clarify their answers to the questionnaire.

The present study also contributed to identifying innovative functional and organizational changes and innovative initiatives that occurred in the analysed PHUs. However, because different innovative changes and initiatives were identified, the data analysis required the definition of different categories. Thus, it would improve the study findings quality if the analysis was sent to the respective unit to verify the answers' consistency and completeness. In addition, some topics in the questionnaire were not analysed, due to inconsistency and incompleteness of the data. In future studies, it is important to add these missing topics as well validate the data related to the innovative changes and initiatives implemented.

The number of active health professionals needed by the unit was adjusted to each unit's population. However, this standardization is not ideal. As the COVID-19 activities workload depends directly on the number of cases of COVID-19 disease, the values should have been adjusted to the number of confirmed cases in each region (i.e., that each unit had to respond to). Since that information is not publicly available over the different periods under analysis, we requested DGS and SPMS as part of the data from the platform *Trace COVID-19*. Currently, DGS/SPMS are still working on the data

authorization process. Assuming the data becomes available, standardization adjusted to the number of confirmed cases will be a crucial analysis. It will be of interest understand if the mobilization of professionals was adequate to the level of the pandemic in the PHU's area of influence.

It is important to emphasize that the project presented in this dissertation, as well as the main project (*Cost-effectiveness and Optimization of the Public Health effort for COVID-19 Track and Tracing activities in Portugal*), will be continued by the PH Research Network. Additionally, these projects will be accelerated by the code developed in the R software, which allows the updating of results practically automatically. The central contributions of this dissertation for research on Public Health are presented in Figure 6.1. Key evidence will emerge from the characterization and study of the PH units using the data from these two projects. This evidence may be a unique contribute to the discussion of the *Portuguese Public Health Reform Proposal*, as well as for the identification of lessons for future pandemics and similar situations. Complementary, the processes and research structure built will promote research at local, regional, and national levels to identify good practices and foster evidence-based public health.

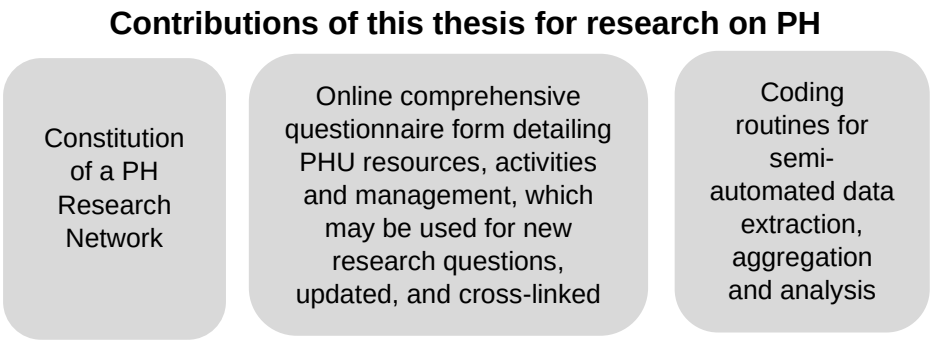


Figure 6.1 – Contributions of this dissertation for research on Public Health.

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Appendix A

Questionnaire

The questionnaire developed for PHUs (Original Portuguese version) to assess the impact of the COVID-19 pandemic on their activities is presented below.

Section ‘0.Apresentação’

O presente ficheiro consiste num inquérito a ser preenchido no âmbito do trabalho de investigação intitulado **'Práticas de Gestão e Recursos em Unidades de Saúde Pública - Inquérito sobre o Impacto da Pandemia COVID-19'.**

O propósito de preenchimento do inquérito consiste em levantar, de forma sistematizada, os dados subjacentes às variáveis em análise de acordo com o protocolo de investigação elaborado, tendo como objetivo analisar a realidade das USP antes e durante a pandemia COVID-19, e quais as transformações que ocorreram durante a pandemia, nomeadamente no seu funcionamento e recursos. Todos os dados serão analisados **sem identificação das USP ou dos interlocutores.**

Muito obrigado pela participação no estudo e pela disponibilidade demonstrada!

Section ‘1.Coordenação’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

	SIM (X)	NÃO (X)
É coordenador da USP Arco Ribeirinho		
Pertence à ARS Lisboa-Vale-do-Tejo		
É uma autoridade de Saúde?		
Esta USP tem mais do que um polo?		

- Se tem mais do que um polo, indique qual / quais?

Há quanto tempo trabalha nesta USP?		anos	(se <1 ano, quantos meses?:	)
Há quanto tempo exerce funções de coordenador?		anos	(se <1 ano, quantos meses?:	)

Que outro tipo de funções ou responsabilidades exerce atualmente, na USP ou fora da USP, relacionadas com a Saúde Pública?

Qual total de horas do seu horário semanal como coordenador? (em horas)

horas semanais

Section ‘2.Inovação’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q1. PRIMEIRO CASO DE COVID-19 NA USP

Q1.1 Qual a data do primeiro caso de COVID-19 registado nesta unidade? *(dia/mês/ano)*

__/ /__ (dia/mês/ano)

Q1.2 Antes do primeiro caso de COVID-19 registado nesta USP, o que foi feito a nível de preparação (treino/formações, reorganização/reestruturação de equipas, etc) nesta unidade?

Q2. PIOR FASE NA USP

Q2.1 Desde março de 2020, qual foi o período de maior exigência nos recursos humanos na respectiva unidade? *(dia/mês/ano)*

de __/ /__ *(dia/mês/ano)* a __/ /__ *(dia/mês/ano)*

Q3. REFLEXÃO GERAL DA PANDEMIA

Q3.1 Na resposta à pandemia, que **mudanças identifica como inovadoras** – a nível da organização, gestão, funcionamento, recursos, entre outras – ocorreram nesta unidade que considera importantes?

Indique aproximadamente em que períodos surgiram (quando se iniciou e, se ficaram concluídas, quando ocorreu essa conclusão)

Mudança inovadora: *solução criada pela USP para responder a uma necessidade ou exigência. com recursos existentes ou criados pela USP, com ou sem colaboração de entidades externas.*

Período de ocorrência		Mudanças Inovadoras que ocorreram na unidade *(descreva de forma breve essas mudanças)*
Quando se iniciou *(mês / ano)*	Quando deixou de existir *(mês / ano)*	

Q3.2 Que **implementações inovadoras** esta USP teve? (por exemplo: estratégias de forma a reduzir o número de novos casos diários a serem trabalhados; estratégia para diminuir o tempo dos inquéritos epidemiológicos por telefone – excel para a população referida preencher; estratégia de forma a alertar algum individuo que esteve em contacto com um caso positivo – chamada a avisar que esteve em contacto com tal individuo; estratégias de forma a reduzir a carga de trabalho; etc…)

Implementação inovadora; *Aspeto técnico e/ou operacional, produzida pela USP para dar resposta a uma necessidade.*

Implementações Inovadoras *(indique uma designação)*	Descreva de forma breve como funcionava / funciona	Descreva de forma breve como foi implementada	Descreva de forma breve qual foi / é a sua finalidade	Indique em que período surgiram *(mês / ano)*	Indique em que período deixaram de ser aplicadas na USP *(mês / ano)*	Caso tenha tido um resultado positivo / esperado, indique os benefícios que trouxeram à Unidade	Caso tenha tido um resultado negativo / não esperado, indique o porquê bem como as consequências negativas que advieram

Section ‘3.Recusos’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Nota:
Para compreendermos o impacto e as mudanças que a pandemia trouxe às Unidades de Saúde pública, temos que fazer um retrato sobre como eram as atividades, os recursos e o funcionamento previamente à pandemia e por conseguinte durante a pandemia. O primeiro caso em Portugal foi a 3 de março de 2020. Por favor, considere **duas fases** temporais:
- **Fase prévia à pandemia,** Janeiro de 2020;
- **Fase pandémica** (desde Março de 2020) - separada em 3 períodos.

Q4. DIMENSÃO DA POPULAÇÃO SERVIDA

Qual o número de habitantes que esta unidade serve, na sua área geográfica de responsabilidade? _____ habitantes

Q5. RECURSOS HUMANOS

Na tabela seguinte, por favor indique:
- o número total de horas semanais de cada grupo (horário completo).
- qual o número máximo de profissionais de saúde trabalhavam nesta unidade, **antes da pandemia** e nos **vários períodos identificados durante a pandemia** (dividindo em tempo inteiro, parcial, em ausências - ex. licenças, baixas, ... NÃO inclua férias).

Durante a pandemia, de acordo com os períodos indicados (de 1 Março 2020 a 31 Agosto 2020; de 1 Setembro 2020 a 28 Fevereiro 2021; de 1 Março 2021 a 31 Julho 2021), refira:
- Qual foi o máximo de **entradas** de cada grupo profissional?
- Qual foi o máximo de **saídas** de cada grupo profissional?
- Qual foi o máximo de **ausências** (ex. baixas, licenças, ... - NÃO inclua férias) de cada classe profissional?
- Qual o número de profissionais que **necessitava para cobrir as necessidades corrente**?

(o número (de entradas/saídas/baixas/profissionais) não é cumulativo mas sim referente a apenas cada período, isto é, insira o número para cada período sem contar com o período anterior; ex. se entrou apenas um higienista oral em Julho 2020 --> 1 / 0 / 0)

(na linha onde tem '...se outros recursos, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

Recursos Humanos	ANTES DA PANDEMIA (Janeiro 2020)				DURANTE A PANDEMIA												Notas / comentários			
	Total de horas semanais (horas)	Profissionais a tempo inteiro (número)	Profissionais a tempo parcial (número)	Profissionais ausentes (ex. licenças/baixas) (número) nota: não inclua férias	Entradas (número)			Saídas (número)			Ausências (Baixas, Licenças) (número) nota: não inclua férias			Nº profissionais que necessitou para COBRIR NECESSIDADES CORRENTE (número)			Antes da pandemia (Janeiro 2020)	de 1/3/20 a 31/8/ 20	de 1/9/20 a 28/2/21	de 1/3/21 a 31/7/21
					de 1/3/20 a 31/8/ 20	de1/9/20 a 28/2/21	de 1/3/21 a 31/7/21	de 1/3/20 a 31/8/ 20	de 1/9/20 a 28/2/21	de 1/3/21 a 31/7/21	de 1/3/20 a 31/8/ 20	de 1/9/20 a 28/2/21	de 1/3/21 a 31/7/21	de 1/3/20 a 31/8/ 20	de 1/9/20 a 28/2/21	de 1/3/21 a 31/7/21				
Médicos especialistas SP autoridades de saúde																				
Médicos especialistas SP não autoridades de saúde																				
Médicos internos de Saúde Pública																				
Médicos internos de formação geral																				
Médicos internos de especialidade																				
Médicos especialistas de outras especialidades																				
Enfermeiros especialistas em Saúde Comunitária																				
Enfermeiros não especialistas																				
Enfermeiros de outras																				

especialidades																				
Técnicos de saúde ambiental																				
Higienistas orais																				
Pessoal administrativo																				
Psicólogos																				
Assistentes sociais																				
Assistentes técnicos																				
Assistentes operacionais																				
...Se outros recursos, indique quais:																				

Q6. RECURSOS MATERIAIS

Relativamente aos recursos materiais, indique quantos recursos materiais tinha na sua unidade e qual o número de recursos materiais que necessitou para cobrir as necessidades corrente.
(o número (de recursos materiais que tinha e de recursos que necessitou) não é cumulativo mas sim referente a apenas cada período, isto é, insira o número para cada período se contar com o período anterior; ex. 7 / 5 / 1) (na linha onde tem '...se outros, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

Recursos Materiais	**ANTES DA PANDEMIA (Janeiro 2020)**		**DURANTE A PANDEMIA**						**Nota/ Comentários**			
	Nº de recursos materiais que tinha *(número)*	Nº recursos materiais que necessitou para COBRIR NECESSIDADES CORRENTES *(número)*	Nº de recursos materiais que tinha número *(número)*			Nº recursos materiais que necessitou para COBRIR NECESSIDADES CORRENTE *(número)*						
			de 1/3/20 a 31/8/ 20	de1/9/20 a 28/2/21	de 1/3/21 a 31/7/21	de 1/3/20 a 31/8/ 20	de1/9/20 a 28/2/21	de 1/3/21 a 31/7/21	Antes da pandemia (Janeiro 2020)	de 1/3/20 a 31/8/ 20	de1/9/20 a 28/2/21	de 1/3/21 a 31/7/21
Computadores fixos												
Computadores portáteis												
Hotspots/ internet portátil												
Telefones fixos												
Telemóveis												
Veículos												
Fotocopiadoras												
Outros (de relevância para a atividade de resposta à pandemia COVID-19)												
... Se outros, indique quais:												

Q7. INFORMAÇÃO ADICIONAL

Há algum aspeto que queria acrescentar a nível dos recursos que não foi questionado anteriormente, relativamente ao período antes da pandemia (Janeiro de 2020) e durante a pandemia (de Março 2020 até atualmente)?

Section ‘4.Atividades gerais’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q8. PRINCIPAIS ATIVIDADES NÃO COVID-19

Situando-se antes da pandemia (ano 2019), relativamente às principais atividades que esta unidade exercia. Para cada atividade indique:
- o número médio de cada classe profissional de saúde necessário para a realização da atividade,
- o total de horas médias semanais necessárias para a realização de cada atividade,
- em 2019, a percentagem de execução da atividade, face ao planeado.

Situando-se no período pandémico, indique para cada **atividade NÃO relativa à COVID-19**:
- o total de horas médias semanais necessárias para a realização de cada atividade, *(o número total de horas não é cumulativo com o período anterior, isto é, insira o número total de horas para cada período sem contar com o período anterior; ex. 25h / 15h / 0h)*
- a percentagem de execução da atividade, face ao esperado sem a pandemia,
- caso se aplique, o mês / ano que a atividade foi suspensa e quando foi retomada.

'0' equivale a atividade totalmente suspensa

(na linha onde tem '...se outras atividades, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

Atividade	ANTES DA PANDEMIA (durante 2019)						DURANTE A PANDEMIA						Notas /comentários			
							Horas médias semanais para cada atividade *Coloque 0 se atividades 100% suspensas*									
	Médicos *(número médio)*	Enfermeiros *(número médio)*	Técnicos *(número médio)*	Administrativos *(número médio)*	Total de horas médias semanais de trabalho para cada atividade *(somatório aproximado de toda a equipa)*	Em 2019, qual a % de execução face ao planeado? *(%)*	de 1/3/20 a 31/8/ 20	de1/9/20 a 28/2/21	de 1/3/21 a 31/7/21	Qual a % de execução face ao esperado sem a pandemia? *(%)*	Em que altura foram SUSPENSAS *(mês/ano)*	Em que altura foram RETOMADAS *(mês/ano)*	Antes da pandemia (durante 2019)	de 1/3/20 a 31/8/ 20	de1/9/20 a 28/2/21	de 1/3/21 a 31/7/21
Avaliações de Incapacidade e Emissão de AtestadoMultiusos (Juntas Médicas + Domicílios)																
Aplicação da Lei da Saúde Mental																
Avaliação Especial no âmbito da emissão de carta decondução																
Saúde escolar																
Planeamento em Saúde: Plano Local de Saúde e Monitorização dos Programas Prioritários no ACES –Programa de saúde mental, diabetes, tuberculose, HIV/SIDA, hepatites, ...																
Programa Nacional de Promoção da Saúde Oral																
Programas de vigilância sanitária das águas de consumo humano (indústria, lares, comércio, vistorias técnicas, ...)																
Verificação de óbitos																
Vigilância Sanitária de estabelecimentos de restauração ebebidas, lares, indústria, comércio, vistorias técnicas																
Programa Nacional de Vacinação (PNV)																
Vigilância Epidemiológica de Doenças de NotificaçãoObrigatória																
Programa de Prevenção e Controlo de Infeções eResistência																

aos Antimicrobianos (PPCIRA)																
Programas de Auditoria e Acreditação																
Protocolos e parcerias – Câmara, hospital, UCCs, etc.																
Participação no Conselho Clínico e de Saúde																
Consulta do Viajante																
Vacinação Internacional																
Saúde Ocupacional																
REVIVE																
Formação e Investigação																
... Se outras atividades, indique quais:																

Q9. INFORMAÇÃO ADICIONAL

Há algum aspeto que queria acrescentar a nível das ATIVIDADES GERAIS (NÃO COVID-19) que não foi questionado anteriormente, relativamente ao período antes da pandemia (durante 2019) e durante a pandemia (de Março 2020 até atualmente)?

Section '5.Atividades COVID'

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q10. PRINCIPAIS ATIVIDADES RELACIONADAS COM COVID-19

Situando-se no **período mais exigente da pandemia para a sua USP**, indique para cada **atividade relativa à COVID-19:**
- a percentagem aproximada de execução de cada atividade, face ao esperado,
- como eram compostas as equipas de resposta - número médio de profissionais de saúde para a realização de cada atividade, por classe profissional.
- o total de horas médias semanais necessárias para a realização de cada atividade (somatório médio aproximado de toda a equipa para a realização de cada atividade).

Recorde-se que, na questão **Q2**, indicou que o período mais exigente da pandemia para a sua USP foi de:	/ /	a	/ /	

(na linha onde tem '...se outras atividades, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

Atividades COVID no pico máximo da pandemia na sua USP		DURANTE O PICO MÁXIMO DA PANDEMIA NA SUA USP										Notas
	Face ao esperado, qual foi a % aproximada de execução? (%)	Profissionais de saúde número médio de elementos para a realização de cada atividade									Total de horas médias semanais de trabalho para cada atividade (somatório médio aproximado de toda a equipa)	
		Autoridade de Saúde	Outros Médicos SP	Médicos internos SP	Outros médicos não SP	Enfermeiros	Técnicos de Saúde Ambiental	Higienistas Orais	Administrativos	Outros Indique quais		
Entrada de caso												
Gestão de caso												
Gestão de contactos												
Declaração isolamento profilático												
... Se outras atividades de vigilância epidemiológica ativa, indique quais:												
Coordenação												
Sistemas de Informação												
Lares												
Empresas												
Escolas												
Surtos (noutros locais)												
... Se outras atividades, indique quais:												

Q11. INFORMAÇÃO ADICIONAL

Há algum aspeto que queria acrescentar a nível das ATIVIDADES COVID que não foi questionado anteriormente?

Section ‘6.Organização’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q12. MODO DE CRISE

Relativamente ao modo de trabalho, para cada período de tempo (antes da pandemia e durante a pandemia), indique (com X, no quadrado respetivo) se a USP em causa trabalhava em 'modo de crise'. Em caso '*SIM*': refira qual / quais as situações mais particulares (na respetiva coluna). Para as situações, que ocorreram durante a pandemia, indique o período da(s) ocorrências (*mês / ano*).

	SIM	NÃO	Em caso 'SIM': qual / quais as situações mais particulares		
			Situação	Descrição	
ANTES DA PANDEMIA (durante 2019) Considera que a unidade referida trabalhava em ‘modo de crise’ antes da pandemia (isto é, ‘tendo que priorizar a resposta, sabendo que essa resposta vai ser insuficiente para as necessidades’) tentando fazer o máximo possível, o mais rápido possível?			#1		
			#2		
			#3		
			#4		
			#5		
			Situação	**Descrição**	**Período da(s) ocorrências *de (mês / ano) a (mês / ano)***
DURANTE A PANDEMIA (de Março 2020 a atualmente) Considera que a unidade referida trabalha/trabalhava em ‘modo de crise’ durante a pandemia (isto é, 'tendo que priorizar a resposta, sabendo que essa resposta vai ser insuficiente para as necessidades’) tentando fazer o máximo possível, o mais rápido possível?			#1		
			#2		
			#3		
			#4		
			#5		

Q13. REUNIÕES

ANTES DA PANDEMIA e **DURANTE A PANDEMIA**

Para cada período (antes da pandemia e durante a pandemia), relativamente há existência de reuniões
- Indique com (*X*) se existiam '*SIM*' ou não existiam '*NÃO*'
- Caso '*SIM*', indique se são '*OCASIONAIS*' ou '*REGULARES*'
- Caso sejam '*REGULARES*', indique o período de regularidade (use a lista que encontra na seta, no canto inferior direito, da respetiva coluna), bem como os períodos que deixaram de existir (*de mês/ano até mês/ano*)

ANTES DA PANDEMIA (durante 2019)					DURANTE A PANDEMIA (de Março 2020 a atualmente)				
NÃO (X)	SIM (X)	Se *'SIM'*			NÃO (X)	SIM (X)	Se *'SIM'*		
		OCASIONAL (apenas quando necessário) (X)	REGULAR				OCASIONAL (apenas quando necessário) (X)	REGULAR	
			Indique período de REGULARIDADE	Períodos que deixaram de existir (de mês / 19 a mês / 19)				Indique período de REGULARIDADE	Períodos que deixaram de existir (de mês / ano a mês /ano)

Reuniões gerais com todos os elementos, de todasas equipas, da USP				*Usar lista ->*					*Usar lista ->*	
Reuniões gerais com que cada equipa da USP sereunia				*Usar lista ->*					*Usar lista ->*	

Q14. ASSUNTOS DE DISCUSSÃO

ANTES DA PANDEMIA e **DURANTE A PANDEMIA**

Para cada período (antes da pandemia e durante a pandemia), indique o local onde os seguintes aspetos eram trabalhados, bem como a sua ocorrência

	ANTES DA PANDEMIA (durante 2019)			DURANTE A PANDEMIA (de Março 2020 a atualmente)		
Aspetos trabalhados	Reuniões	Outros espaços de discussão	Ocasionalmente	Reuniões	Outros espaços de discussão	Ocasionalmente
Discussão de assuntos relativos a processos de melhoria e prevenção de erros?		Usar lista ->			Usar lista ->	
Discussão de assuntos relativos à organização as tarefas / funções dos profissionais		Usar lista ->			Usar lista ->	
Discussão de assuntos relativos à gestão da USP		Usar lista ->			Usar lista ->	

Q15. INFORMAÇÃO ADICIONAL

Há algum aspeto que queria acrescentar a nível do funcionamento da USP que não foram questionados anteriormente?

Section ‘7.Formação COVID’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q16. FORMAÇÃO INTERNA NO CONTEXTO DA PANDEMIA COVID (ORGANIZADAS PELA USP OU COM A COLABORAÇÃO DA USP)

Q16.1 Em que data se iniciaram as formações internas aos profissionais de saúde para ajudar a combater a pandemia?

Se nunca iniciou (X): ____ Se iniciou, qual a data de início *(mês/ano):* ____/____

Q16.2 Relativamente às atividades associadas à resposta da pandemia:
- indique o tipo de formação associada a cada atividade de resposta à pandemia
- indique as classes profissionais de saúde que davam a formação associado a cada atividade de resposta à pandemia

(na linha onde tem '...se outras atividades, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

Formação interna associada a atividades de resposta à pandemia	**Tipo de formação**							Formação organizada em parceria? Se sim, com que entidade	**Tipo de profissionais de saúde que lecionavam / participavam na organização da formação**					Notas / comentário
	Formação presencial (X)	Formação à distância / online (X)	Estágio de observação (X)	Formação em supervisão / exercício (X)	Outro tipo de formação; indique o tipo	Duração total (média aproximada, em horas)	Formação certificada? (emissão de certificado) (X)		Autoridade de Saúde	Outros Médicos Especialistas em SP	Outros Médicos Internos em SP	Técnicos de Saúde Ambiental	Outros Indique quais	
Entrada de caso														
Gestão de caso														
Gestão de contactos														
Coordenação (sistemas de informação)														
Lares (gestão de casos, surtos, trabalho com)														
Empresas (gestão de casos, surtos, trabalho com)														
Escolas (gestão de casos, surtos, trabalho com)														
...Se outras atividades, indique quais:														

Q16.3 Quais e quantos profissionais de saúde tiveram formações, relativas à COVID-19?

Formação interna associada a atividades de resposta à pandemia	**Que, e quantos, profissionais de saúde tiveram formação interna relativa à COVID-19?**																	**Notas / comentário**
	Autoridades de Saúde (número)	Outros Médicos especialistas SP (número)	Médicos internos SP (número)	Médicos internos de formação geral (número)	Médicos internos de especialidade (número)	Médicos especialistas de outras especialidades (número)	Enfermeiros especialistas Saúde Comunitária (número)	Enfermeiros não especialistas (número)	Enfermeiros de outras especialidades (número)	Técnicos de Saúde Ambiental (número	Higienistas orais (número)	Assistentes operacionais (número	Assistentes sociais (número)	Assistentes técnicos (número)	Pessoal administrativo (número)	Psicólogos (número)	Outros Indique quais	
Entrada de caso																		
Gestão de caso																		
Gestão de contactos																		
Coordenação (sistemas de informação)																		
Lares (gestão de casos, surtos, trabalho com)																		
Empresas (gestão de casos, surtos, trabalho com)																		
Escolas (gestão de casos, surtos, trabalho com)																		
...Se outras atividades, indique quais:																		

Q17. INFORMAÇÃO ADICIONAL

Há algum aspeto que queria acrescentar a nível das FORMAÇÕES INTERNAS da USP que não foram questionadas anteriormente?

Section ‘8.Sistemas’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q18 SISTEMAS DE INFORMAÇÃO / SISTEMAS INFORMÁTICOS

Q18.1 Indique que sistemas de informação / sistemas informáticos:
- tinham acesso, mas não usavam,
- tinham acesso e usavam,
- não tinham acesso (não existiam na vossa USP).

Para os sistemas que tinham e usavam indique para que tipo de atividades eram usados (indique para todas as atividades – atividades NÃO covid e covid)

(*) *por exemplo, no caso da prioridade gerada pelo Trace COVID-19, caso não usassem tal funcionalidade da plataforma, como definiam a prioridade das tarefas?*

(na linha onde tem '...que outros sistemas, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

SISTEMAS	Antes da pandemia (Janeiro 2020)			Durante a pandemia		
	Usavam *Especifique para que tipo de finalidade + Frequência de uso*	Tinham acesso, mas não usavam *assinale com (X) e indique que sistema ou outro método usavam para substituir tal sistema* ***(*)***	Não tinham acesso *assinale com (X)*	Usavam *Especifique para que tipo de finalidade + Frequência de uso*	Tinham acesso, mas não usavam *assinale com (X) e indique que sistema ou outro método usavam para substituir tal sistema* ***(*)***	Não tinham acesso *assinale com (X)*
Excel						
SINAVE-Lab						
SINAVE-Med						
SINAVE módulo Saúde Pública						
Trace COVID-19						
Gestão de tarefas						
Prioridade gerada pela plataforma						
StayAway COVID-19						
SONHO						
Registo do Utente						
SClinico						
...Que outros sistemas, indique quais:						

Q18.2 Situando-se no período pandémico, para os seguintes tópicos aborde-os em relação aos três sistemas (SINAVE-Lab, SINAVE-Med e Trace COVID-19). Refira também o período em que tal tópico foi mais evidente

(na linha onde tem '...se outros constrangimentos, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

	PARA CADA TÓPICO E PERÍODO DESCREVA								
	de 1 Março 2020 a 31 Agosto 2020			**de 1 Setembro 2020 a 28 Fevereiro 2021**			**de 1 Março 2021 a 31 Julho 2021**		
	SINAVE-Lab	**SINAVE-Med**	**Trace COVID-19**	**SINAVE-Lab**	**SINAVE-Med**	**Trace COVID-19**	**SINAVE-Lab**	**SINAVE-Med**	**Trace COVID-19**
Para que funções e com que frequência (horas por dia) era usada a plataforma									
Que constrangimentos iniciais tiveram na plataforma (ex. difícil acesso, falha do sistema, …)									
Que outras dificuldades tiveram na utilização com as plataformas									
Que ajuda a plataforma trouxe na reorganização desta USP									
Que constrangimentos ocorreram com a integração entre as diferentes plataformas – SINAVE-Lab, SINAVE-Med e Trace COVID-19									
Que outras dificuldades ocorreram com a integração entre as diferentes plataformas – SINAVE-Lab, SINAVE-Med e Trace COVID-19									
...Se outros constrangimentos, indique quais:									

Q18.3 Na USP em questão tiveram / têm algum técnico de informática ou tiveram / têm algum apoio a nível informático? SIM (X) NÃO (X)

No caso de ter respondido (SIM):

de	/ /	(dia/ mês/ ano)	a	/ /	(dia/ mês/ ano)
de	/ /	(dia/ mês/ ano)	a	/ /	(dia/ mês/ ano)
de	/ /	(dia/ mês/ ano)	a	/ /	(dia/ mês/ ano)
de	/ /	(dia/ mês/ ano)	a	/ /	(dia/ mês/ ano)

-Que tipo de apoio a níve informático é dado? (ex: os profissionais de saúde que utilizam o Trace COVID-19 requerem/chamam os técnicos quando necessitam de explicações de uso ou outro tipo de ajuda com o Trace COVID-19.)

No caso de ter respondido (*SIM*) ou (*NÃO*):

-A quem recorrem quando têm problemas com a plataforma Trace COVID-19

Q19. INFORMAÇÃO ADICIONAL

Há algo que queria acrescentar a nível dos sistemas da Unidade que não foram questionadas anteriormente?

Q20. SITUAÇÕES MENOS FAVORÁVEIS

Para além de situações eventualmente referidas, reflita que outros problemas tiveram na sua USP.

Refira quais e descreva-os de forma breve. Refira igualmente quando começaram (*mês / ano*) e caso se aplique quando terminaram

(Caso o problema seja recorrente, e nunca tenha sido resolvido, mencione 'permanece' na coluna 'Quando terminou o problema'.)

(na linha onde tem '...se outras atividades, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

Problemas	***Indique com (X)***		***Indique período (mês / ano)***	
	SIM (X) *descreva o problema*	**NÃO (X)**	**Quando começou o problema**	**Quando terminou o problema**
Impossibilidade de manter as normas da DGS nas instalações, relativamente à ocupação das salas				
Problemas na linha telefónica				
Problemas de internet				
... Se outras atividades, indique quais:				

Section ‘9.Comunicação’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q21. ORIENTAÇÕES INTERNAS SIM (X) NÃO (X)

Q21.1 A USP criou orientações internas (para a unidade e/ou comunidade) no que diz respeito à COVID-19?

Q21.2 Caso tenha respondido (*SIM*), refira quais. Indique, igualmente, o período em que foram criadas

Período (*mês/ano*)	**Orientações internas** ***refira quais, de forma breve***

Q22. PROTOCOLO / MECANISMO DE ARTICULAÇÃO SIM (X) NÃO (X)

Q22.1 Foi elaborado um protocolo e/ou um mecanismo de articulação com entidades externas, no que diz respeito à COVID-19?

Q22.2 Caso tenha respondido (*SIM*), refira com que entidades. Indique, igualmente, em que períodos aconteceram.

Período (*mês / ano*)	**Protocolos / mecanismos de articulação com entidades externas** ***Refira com que entidades e caso se adeque descreva-as, de forma breve***

Q23. DIFICULDADES DE COMUNICAÇÃO

Relativamente às dificuldades sentidas entre esta USP e as diferentes entidades, descreva-as para cada período mencionado.

exemplo de dificuldades: dificuldades de comunicação, de articulação, de trabalho conjunto, …

(na linha onde tem '...que outras entidades, indique quais:' ... escreva nas linhas abaixo tal informação; caso seja necessário insira novas linhas.)

Entidades	ANTES DA PANDEMIA			DURANTE A PANDEMIA								
	Descreva as atividades	Dificuldades entre SP e outras entidades	Soluções para as dificuldades	Descreva as atividades			Dificuldades entre SP e outras entidades (caso não tenham sido resolvidas repita-as nos períodos em que continuaram) (caso tenham sido resolvidas… como as dificuldades foram ultrapassadas)			Soluções para as dificuldades		
				de 1 Março 2020 a 31 Agosto 2020	de 1 Setembro 2020 a 28 Fevereiro 2021	de 1 Março 2021 a 31 Julho 2021	de 1 Março 2020 a 31 Agosto 2020	de 1 Setembro 2020 a 28 Fevereiro 2021	de 1 Março 2021 a 31 Julho 2021	de 1 Março 2020 a 31 Agosto 2020	de 1 Setembro 2020 a 28 Fevereiro 2021	de 1 Março 2021 a 31 Julho 2021
A nível geral												
A nível específico com a entidade												
Outras SP												
MGF												
ARS												
CM												
DGS												
DSP												
...Que outras entidades, indique quais:												

Section ‘10.Reflexões finais’

Status e análise de preenchimento / comunicação com o investigador	
Validado pelo investigador?	Não
Percentagem preenchimento (automático):	0%
Status (automático):	Não iniciado
Mensagem do investigador:	*Use o espaço abaixo se surgirem questões. Obrigado!*
Questões ou mensagem para o investigador:	

Q24. MUDANÇAS / LIÇÕES

Q24.1 Pensando agora com uma distância, que outro tipo de mudanças / lições, a nível de gestão / organização / funcionamento, considera importantes referir que não foram questionadas?

Q24.2 Como é que esta USP poderia ter estado mais preparada?

SIM (X) NÃO (X)

Q24.3.1 Face à situação experienciada, considera que um maior apoio – a nível de gestão das equipas, mais formações, entre outros aspetos – teria sido necessário?

Q24.3.2 Caso tenha respondido *(SIM),* que tipo de apoio considerava necessário para a USP estar mais preparada?