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Forecasting the needs for mental health care services in Portugal

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Master in Management

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November, 2021

BUSINESS
SCHOOL

Marketing, Operations and General Management Department

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Acknowledgements

This Master's thesis represents the culmination of a cycle full of several years of education and of countless challenges that allowed my personal and professional development. During this journey, I had the opportunity to meet several people who have undeniably marked my path, to whom I am immensely grateful. I would like to express my gratitude:

To my supervisors, Prof. Teresa Grilo and Prof. Sofia Kalakou, for their support, availability, for all the sharing of knowledge demonstrated throughout the work and for the words of encouragement and confidence uttered in the most adverse moments.

To all the mental health professionals who dedicated part of their time to participate in the research, sharing their knowledge about the area in a scenario where a lawless adversary, the COVID-19 virus, tested worldwide the capacity and limits of our frontline soldiers, the health professionals.

To Iscte Business School, the institution I chose for my bachelor's and master's degrees, and to all the professors who crossed my academic path, for providing me with the necessary tools to complete this research.

Additionally, to my parents, siblings, maternal grandparents (guiding stars) and paternal grandparents who are my safe port, the first and eternal loves of my life, for being examples to follow, for all the values they have transmitted to me, for the trust and sacrifices they have made in the investment of my academic and personal development, for celebrating my achievements and for providing the strength to bounce back in moments of weakness. To you, who show me every day that love changes a life, the greatest thanks of all.

To Daniel Botas, my chosen companion in life, for his understanding, help and patience throughout the completion of this research, for supporting me in moments of adversity, for encouraging me when motivation seemed to fade, but essentially for believing in my abilities, always challenging me to put the best of myself in what I set out to accomplish.

To my close friends for the support and friendship they have always given me.

To all, my sincere thanks.

Resumo

A escassa oferta de cuidados de saúde mental em Portugal torna urgente o investimento num planeamento adequado destes serviços. Este planeamento deve assegurar que a oferta e as necessidades futuras de cuidados de saúde estejam em equilíbrio.

Este estudo visa prever as necessidades futuras destes cuidados, bem como identificar os fatores que influenciam estas necessidades para apoiar o planeamento da rede de saúde mental em Portugal. Para tal, uma revisão bibliográfica foi complementada com um conjunto de entrevistas a especialistas em saúde mental, proporcionando uma visão dos aspetos-chave que implicam as necessidades de cuidados de saúde mental. Estes resultados informaram o desenho de um modelo de árvore de ciclo de Markov que visa construir estimativas sobre as necessidades futuras de cuidados de saúde mental. De seguida, foi realizado um inquérito para estimar as probabilidades de transição entre os estados de Markov, dado que esta informação não estava disponível na literatura. O modelo desenvolvido foi aplicado à Região de Lisboa e Vale do Tejo. As estimativas obtidas distinguem-se entre necessidades efetivas, satisfeitas e insatisfeitas (percebidas ou não). Esta informação é útil para gestores de redes de saúde mental e políticos planearem e criarem políticas de prevenção e promoção da saúde mental, destinadas a reduzir as pessoas com necessidades insatisfeitas.

Os resultados revelam que as necessidades de cuidados de saúde mental irão aumentar até 2030, atingindo 68,62% da população local. Caso a capacidade de 2016 permaneça inalterada até 2030, as camas de internamento e residenciais serão inadequadas para satisfazer as necessidades efetivas.

Keywords: Cuidados de Saúde Mental, Previsão das Necessidades, Necessidades Efetivas, Necessidades Insatisfeitas, Modelo de Àrvore de Ciclo de Markov, Portugal

JEL: C53 – Métodos de previsão e predição • Métodos de Simulação; I11 – Análise dos Mercados de Cuidados de Saúde

Abstract

The scarce supply of mental health care in Portugal makes it urgent to invest in an adequate planning of these services. This planning should ensure that supply and future needs for care are in balance.

This study aims to forecast the future needs for this care, as well as to identify the factors influencing these needs to support the planning of the mental health network in Portugal. To achieve the objective, a literature review was complemented with a set of interviews to mental health experts, both providing an overview of key aspects entailing mental health care needs. These results informed the design of a Markov cycle tree model aiming to build estimates on the future numbers of people in need of mental health care. In a third phase, a survey was conducted to estimate the transition probabilities between the Markov states, since this information was not available in the literature. The developed model was then applied to the Lisbon and Tagus Valley Region. The estimates obtained distinguish between effective, met and unmet needs (perceived or unperceived). This information is useful for mental health network managers and politicians to plan and create mental health prevention and promotion policies aimed at reducing people with unmet needs.

The results reveal that mental health care needs will increase by 2030, reaching 68.62% of the local population. Assuming 2016 capacity remains unchanged by 2030, the number of inpatient and residential beds will be inadequate to meet effective needs.

Keywords: Mental Health Care, Forecast Needs, Effective Needs, Unmet Needs, Markov cycle tree model, Portugal

JEL: C53 – Forecasting and Prediction Methods • Simulation Methods; I11 - Analysis of Health Care Markets

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List of abbreviations

AC Ambulatory Care

AS Significant Symptoms of Anxiety

DS Significant Symptoms of Depression

DSM-IV Diagnostic and Statistical Manual of Mental Disorders

ESRN End-stage Renal Disease

EU European

GAD-7 General Assessment of Anxiety Disorders

GHQ-12 General Health Questionnaire

HADS Hospital Anxiety and Depression Scale

HBC Home-based Care

HC Health Care

HCN Health Care Needs

IC Inpatient Care

ICD-10 International Classification of Diseases

INE Instituto Nacional de Estatística (National Statistical Institute)

IPSS Instituições Particulares de Solidariedade Social

KD Kawasaki Disease

LOS Length of Stay

LTC Long-term Care

LTV Lisbon and Tagus Valley

MC Markov Chain

MD Mental Disorders

MH Mental Health

MHC Mental Health Care

MHCN Mental Health Care Need

MINI Mini International Neuropsychiatric Interview

NGO Non-Governmental Organization

NHS National Health System

OA Osteoarthritis

OC Socio-occupational Care

PHC Primary Health Care

PHQ-9 Patient Health Questionnaire-9

PN Perceived Needs

PS Public Sector

QL Quality of Life

RC Residential Care

SCS Social and Convention Sector

SD System Dynamics

SRQ-20 Self-Report Questionnaire

UN Unperceived Need

UPN Unmet but Perceived Need

WAS Without Significant Symptoms of Anxiety

WDS Without Significant Symptoms of Depression

WHO World Health Organization

WQL Without Quality Life

YLD Years Lived with Disability

CHAPTER 1

Introduction

Mental health (MH) and well-being is essential for people to enjoy a meaningful life experience and active participation in the community. (World Health Organization [WHO], 2005). Conversely, mental disorders (MD) are classified according to the 10th Revision of the ICD-10 (WHO, 2013) and relate to "MH problems and strain, pain-associated malfunction, diagnosable mental symptoms and disorders"(European Commission, 2005). The prevention, diagnosis and treatment of MD is one of the most challenging priorities to include in the public health agenda of European (EU) countries, considering that the most recent estimates verify that more than 1 in 6 individuals in EU countries had a MD in 2016, which amounts to a total of approximately 84 million people. Aside from this fact, more than 84 000 deaths in EU countries were associated with MD or suicide in 2015 (OECD/EU, 2018).

Despite the recognition of the importance of MH at the socio-economic level, the WHO reports that the supply of mental health care (MHC) in the world is scarce compared to the existing needs (WHO, 2013), estimating that between 76% to 85% of individuals with severe MD in developing countries and 35% to 50% in developed countries, did not receive the necessary care (Demyttenaere et al., 2004). The current gap in the treatment of MD can be justified by stigma, fragmentation of service delivery models, lack of research for change and implementation of new policies, as also by the scarce of human resources and annual investments in the sector (Wainberg et al., 2017). In fact, the governments of low-income countries invest only about $0.20 per person per year in MH, while some experts advise an investment between $2 and $3 per individual (Caddick et al., 2016). Given the importance of this issue, the WHO has supported and developed several policies with the aim of promoting rehabilitation, participation and social integration. Examples of these are the global and national targets set in the MH action plan 2013-2020 for Member States, where the rate of suicide must reduce 10% by 2020 (WHO, 2013).

Current situation and obstacles identified in Portugal

Compared to the European context, it has been estimated that in Portugal in the year 2017, 12.0% of disability-adjusted life years per 100,000 inhabitants and 18.0% of years lived with disability (YLDs) have MD as a root cause (Institute for Health Metrics and Evaluation, 2021). This means that although people have a longer average life expectancy, the number of days lived with a disability condition is also higher (Ministério da Saúde, 2018).

Portugal was estimated to be one of the EU countries with the highest prevalence of MD (OECD/EU, 2018). Namely, the most prevalent MD are anxiety disorders (16.5%), followed by depressive disorders (7.9%) (Direção-Geral da Saúde [DGS], 2014). The DGS (2014) also indicates that

there is a greater need for help-seeking in primary health care (PHC) for problems related to depression and anxiety. This is in line with what is expressed in the Annual Access Report, which indicates that the proportion of adults with depression/anxiety with a diagnosis in PHC was 72.6% in 2019 (Ministério da Saúde, 2019). Considering also that depression disorders can be associated with anxiety disorders (WHO, 2017), schizophrenia (Samsom & Wong, 2015) drug and substance addition (Torrens et al., 2015) and bipolar disorders (Vieta et al., 2018) and, in turn, anxiety disorders can be associated with eating disorders (Swinbourne et al., 2012), it is revealed that in 72% of internments in the Lisbon and Tagus Valley Region (LTV) in 2016 are the result of anxiety and depression disorders (Comissão Técnica de Acompanhamento da Reforma da Saúde Mental [CTARSM], 2017). These facts denote that depression and anxiety justify the majority of services provided.

Perelman et al. (2017) points out a variety of limitations to the MH system in Portugal such as lack of supply (Ministério da Saúde de Portugal & Department Mental Health and Substance Abuse, 2009), excessively hospital-centred care, lack of resources and insufficient prevention. This gap may increase given that the increase in ageing population, the prevalence and incidence of MD, the associated morbidity and the socio-economic constraints caused by the pandemic crisis have triggered an increase in the demand for MHC. That said, similarly to what occurs in the current paradigm of countries with a NHS structure, there is a concern to pool efforts to meet mental health care need (MHCN) in a timely and appropriate manner (OECD/EU, 2018). Consequently, the question arises of understanding and predicting the potential future demand for MHC. However, this information is not available in the literature, which increases the complexity of the task. As a response, some authors have been exploring methods to predict future needs/demand for Health Care (HC), mostly using epidemiological data. A minority of studies also use historical HC data. According to Roberfroid et al. (2009) forecasting based on historical utilization is not adequate when the current system does not cover unmet needs, as it leads to capacity-constrained results. Meanwhile, models based on epidemiological data reflect the real needs of the population and may consequently be overestimated, as not all people with perceived needs and/or requirements actually seek MHC.

Current supply of Mental Health Care in Portugal

There is a variety of MHC services in EU countries, with distinct health system paradigms and levels of provision. MHC in Portugal is provided through a network of public and private non-profit organizations (Annex A). The system consists of 2 components: (i) the health component which includes services delivered both by the NHS in PHC, general hospitals and psychiatric hospitals, and by the social and contracted sector which incorporates private social solidarity institutions (Instituições Particulares de Solidariedade Social, IPSS) with alliances with the NHS; (ii) the social component which includes the care provided by non-governmental organizations (NGOs) and IPSS. In the MH sector in

Portugal 5 types of care are provided: Inpatient care (IC), ambulatory care (AC), socio-occupational care (OC), residential care (RC) and home-based care (HBC). All these services are delivered by multidisciplinary teams composed of doctors, social workers, nurses, occupational therapists, among others (Administração Central do Sistema de Saúde [ACSS], 2015).

IC is intended for patients who occupy a bed for at least 24 hours, for diagnostic or treatment purposes (DGS, 2016). In this type of care acute patients (admitted for less than 30 days, due to moments of crisis) can be found who are institutionalized in general hospitals, psychiatric hospitals and IPSS, as well as residents or chronic patients (long-term inpatients) in psychiatric hospitals and IPSS. While, the social sector focuses mainly on the treatment of chronically ill patients, the public sector (PS) delivers MHC predominantly to acute patients (ACSS,2015). AC is intended for patients who are in a HC facility (general hospitals, psychiatric hospitals, IPSS) in a period of less than 24 hours (DGS, 2016). Outpatient consultations and partial institutionalization (day hospitals/day centres) are considered in AC. HBC is provided by the network of PHC, general hospitals and psychiatric hospitals. In Portugal, these services are provided under the Portuguese NHS, accessible to all citizens, who, depending on their economic and social background, benefit from approximately free services, due to a system financed by tax coverage (Barros et al., 2011).

Psychosocial rehabilitation services may be provided in the form of social-occupational units or residential units, present in psychiatric hospitals, IPSS and NGOs. OC is the only service that does not involve the residence of patients and is intended to support the reinsertion and integration of patients with low and moderate psychosocial disabilities into vocational training programmes. RC provides accommodation for patients who, although they are clinically stable, they do not have the necessary support at home. This care is provided in 3 different units as set out in the Dispatch 407/98 (*Ministérios Da Saúde e Do Trabalho e Da Soliedariedade*, 1998), depending on the patients' degree of psychosocial incapacity: independent living unit (low degree of incapacity), protected living unit (moderate degree of incapacity) and supported living unit (high degree of incapacity). Contributions of OC and RC are adjusted according to the patients' economic capacities (Segurança Social, 2021).

Table 1.1 compares inpatient and residential bed resources between 2005 and 2016. The number of beds in 2016 decreased by 8% compared to 2005 (CTARSM, 2017). This decrease was due to the reduction of beds present in the PS.

Table 1.1 – Number of inpatient and residential beds in Portugal in the year 2016 *(Adapted from CTARSM (2017))*

	2005					2016						
	Public		Entities Contracted	Dispatch nº 407/98	Total	Public				Entities Contracted	Dispatch nº 407/98	Total
	Acute	Resident				Acute	Resident	Psychosocial rehabilitation	Forensic			
North	416	92	1347		1855	334	187	14		1356	22	1913
Centro	407	582	520		1509	271	121	20	110	718	30	1270
LTV	470	628	1333		2431	416	154	97	32	1515	125	2339
Alentejo	40	62	120		222	40	14			132		186
Algarve	50	-	-		50	47	3				40	90
National	1383	1364	3320	208	6275	1108	479	131	142	3721	217	5798

When analyzing the number of inpatient beds in psychiatric hospitals in 2016, there is a decrease of 65% when compared to 2005. This is in line with what is defined in the MH plan from 2007 to 2016, regarding the WHO recommendation for the deinstitutionalization process (transfer of patients admitted to psychiatric hospitals to local residential homes), which aims to provide an alternative treatment with better quality (CTARSM, 2017; WHO, 2001). In contrast, it is also found that the number of beds in general hospitals increased by 22% from 2005 to 2016. However, this increase does not offset the number of beds extinguished from psychiatric hospitals.

Research question

The research problematic revolves around the following question: how can the capacity of healthcare services in Portugal be planned to ensure that the current and future needs are met?

Objectives and contributions of the study

The main objective of this dissertation is the assessment of the capacity of the HC services in Portugal. For this purpose, it is necessary to achieve 2 partial objectives: (i) characterize the current delivery of MHC in Portugal, namely, key challenges and risk factors; (ii) predict demand, in LTV, for MHC in its different areas - IC, AC, HBC, RC and OC and compare it to capacity. This study contributes to the literature as it: (i) allows predicting the potential demand for MHC in the coming years by combining historical data and epidemiological data (overcoming the difficulties associated with the individual use of each of these approaches); (ii) the proposed model allows predicting potential needs, distinguishing between effective demand, consciously unmet and unperceived needs; (iii) proposes a generic model to predict HC demand in countries with similar patterns and organization of HC demand that is, in countries where depression and anxiety account for most of the services provided and where the typologies of care are similar).

Structure of the thesis

The remainder of this thesis is organized as follows. Section 2 presents a brief literature review on studies focusing on demand forecasting in the health sector, with special emphasis on the MH sector. Section 3 presents the stages of the methodology followed in this study, as well as the findings of the interviews (stage I) and survey (stage III), without which it would not have been possible to arrive at the results of the forecasting model (stage II). The results obtained are subsequently detailed in Section 4, and the main conclusions and lines for future research are presented in Section 5.

CHAPTER 2

Literature review

This section presents a brief description of the different levels of planning in the HC supply chain, followed by the presentation of demand/needs forecasting models used in the HC sector, with special emphasis being provided to the MHC sector in particular.

2.1. Planning and Forecasting in Health Care Supply Chains

Planning in health plays a critical role in the ability of institutions to prepare and execute plans to meet the needs of a health system (Almohamadi & Lingga, 2021). As in any field, health planning decisions can be applied at 3 distinct levels: strategic, tactical, and operational.

Strategic planning refers to the direction chosen to achieve set goals and respond efficiently to new contexts and needs (Green & Kreuter, 2005; Bryson et al., 2018). This type of planning is done for a long-term time horizon, considering aggregated information and forecasts (Hans et al., 2012). Examples of this type of planning are the choice of the location of facilities, the decision about the service, the case mix and the size of the human or material resource capacity (for example, the number of health professionals or the acquisition of Magnetic resonance imaging scanners) (Hulshof et al., 2012).

Tactical planning focuses on defining the methods to be followed in the medium term, addressing the execution of the HC delivery process. First, the user groups are characterized according to disease diagnosis, resource requirements and urgency. In a second phase, the resource capacity decided earlier in strategic planning, is distributed by the patient groups (Anjomshoa et al., 2018; Green & Kreuter, 2005). One of the examples of tactical planning is the scheduling of staff shifts.

Finally, operational planning follows, which establishes the link between strategic and tactical planning, emphasizing on short-term decisions related to the execution of the previously established guidelines and the achievement of the proposed objectives. At this stage, the effective demand is completely known, with the exception of demand for emergency services, which should be predicted. This type of planning can be divided into 2 parts: online and offline (Hulshof et al., 2012). Offline operational planning solves planned issues as for example, the distribution of patients to appointments, allocation of staff to shifts and the scheduling of surgeries (Monteiro, 2016). Otherwise, online operational planning resolves unplanned issues and controls the whole process such as real-time dynamic inpatient re(scheduling) when an emergency patient requires immediate attention.

To support strategic and tactical planning, namely in issues related to service location, capacity planning and user allocation, several authors in the literature have applied different methodologies and applying multiple models, such as Markov Processes, Computer Simulation, and Optimization

models (Kuno et al., 2005; Leff et al., 2009; Brailsford & Vissers, 2011). According to Argiento et al. (2016), Carvalho (2017) and Rais & Viana (2010), the correct and accurate forecast of demand corresponds to a critical input to apply the most widely used models in the literature for HC planning, the optimization models. This statement is supported by several studies, namely in the MH sector among countries based on the NHS. This is the case of the mathematical programming model built by Monteiro (2016) and further developed by Rosa (2019), which aimed to support location of services, capacity planning decisions and allocation of users to services in the MHC network in Portugal, in order to meet existing needs. In both, it was necessary to integrate estimates of the demand for MHC, by municipality, age group, type of illness, type of services and year. As can be seen in Annex B, to create these estimates, the authors used prevalence rates by MD, service distribution rates and the population projections by municipality, age group and year. However, recent studies reveal that this information is not always available. Therefore, it is imperative to develop accurate forecasting methods to build estimates of the demand for HC services (Lehnert et al., 2011; Monteiro, 2016).

2.2. Healthcare Demand Forecasting

Health forecasting encompasses the prediction of future health services provided, health needs and service utilization rates based on previously acquired knowledge through a systematic process (Huang et al., 2020). Understanding these dimensions are part of preventive care and public health planning (Soyiri & Reidpath, 2013).

2.2.1. Definitions of Need and Demand for Health Care

The concepts of need and demand have been discussed by several authors (Bebbington et al., 1999; Aoun et al., 2004; Lopes et al., 2015; Pradeep et al., 2016).

Lopes et al. (2015) highlights that the economic or effective demand portrays the real or observed demand. This is usually measured through service utilization indicators (for example, number of inpatients) while needs encompass the epidemiological conditions that characterize the population under study. These are usually measured through morbidity (the relationship between the total number of cases of a disease and the population, in a certain period of time) and mortality rates. There is also the opinion of clinicians who help to understand how this information can be translated into a given amount of necessary health services (Lopes et al., 2015).

According to Matthews (1971) as cited in Wing (1990), the term 'mental health care need' is applied to individuals with MD or disabilities for which effective or acceptable treatments exist. Aoun et al. (2004) also point out that the concept of need is generally divided into "clinical needs" and "perceived needs". Clinical needs are the result of assessments conducted by clinical professionals,

based on diagnostic criteria (Rabinowitz et al., 1999, as cited in Olsson et al., 2020). On the other hand, perceived needs represent individuals who recognize the need to receive specialized care (Bradshaw, 1994; Sarriera, 2010; Schnyder et al., 2019). This suggests that not all care needs are perceived by the individual (Brewin & Wing, 1988). Also, Levinson et al. (2009) indicates that perceived needs can be measured through self-assessment questions of the need for professional help.

Among the perceived needs individuals are distinguished into those who (i) convert their desire into effective demand (expressed need) and those who (ii) see their need unmet due to structural (supply-side) or even attitudinal (demand-side) barriers (Pradeep et al., 2016; Rens et al., 2020).

Structural barriers are not controlled by users, as they occur at the system level. For example, waiting times, shortages of available MH professionals or even health insurance not covering the cost of services are mentioned (Moroz et al., 2020; Rens et al., 2020).

Demand-side barriers act at the community, family or individual level and influence the demand for HC. Examples of these are: not knowing how or where to obtain help from professionals, fear of disapproval from the close social circle, inability to bear the associated cost, belief that problems can be solved without the intervention of a professional, concern about confidentiality and non-recognition of the need (Ibrahim et al., 2020; Rens et al., 2020).

Considering the definitions presented above, it is relevant to note that the estimates built to support long-term planning models are distinguished by the forecasting methods implemented and the data used.

2.2.2. Healthcare Forecasting Methods

This subsection denotes the types of models that have typically been adopted in HC demand/need prediction, and specifically in MHC. For this purpose, keywords were selected, such as: "Demand/need Prediction/Forecast", "Health Care", "Mental Health Care", "Simulation methods", "Regression models", "Microsimulation". In addition, reliable platforms were used such as, ABI/INFORM Collection, OECD iLibrary, B-on, Google Scholar, Science Direct, Springer, PubMed, Research Gate. Through this process, 17 articles were found. First, an explanation of the regression techniques is given and then the simulation methods are exposed.

2.2.2.1. Regression Methods

This approach has been applied in the literature with the purpose of building estimates of future health care needs (HCN), particularly in forecasting the incidence of a given disease over time (Borralho, 2016). Since it allows studying the relationship between a dependent variable and at least one independent/predictor variable (Serrano, 2020). However, as exposed in section 2.2.3, regression

methods are not the most widely used in the literature. This may be justified by the fact that this methodology is only applied when there is a perceptible trend among the available data.

2.2.2.2. Simulation Methods

This approach may come in 2 types: macrosimulations and microsimulations. While macrosimulations assume the analysis of cohorts of individuals grouped by the characteristics they gather such as, for example, gender and age, microsimulations require a more detailed analysis on individuals, families, or households (Borralho, 2016).

Among the various macrosimulation techniques, the following can be distinguished: Extrapolation-based methodologies, Markov Models, System Dynamics.

Extrapolation-based methodologies

This method allows estimating the future prevalence and incidence of a disease by applying current rates to future projections of the population under study. The classification of this methodology is not consensual in the literature (Comas-Herrera et al., 2004; Norton et al., 2013). However, in this thesis is followed Comas-Herrera et al. (2004) who assign this method to the group of macrosimulation models. Among the macrosimulation models, this method is the simplest to implement since to forecast the number of people with future MHCN it is only required to multiply the expected number of people within an existing population projection by an estimate of the current prevalence of MD (Norton et al., 2013). As shown in section 2.2.3, it has been applied to predict various types of care and the presence of various diseases. The implementation of this method requires knowledge of current usage/need, which is a limitation this data is difficult to obtain. Moreover, this method may be very simplistic when there are many factors influencing the disease and these remain constant over time (Borralho, 2016).

Markov Models

The Markov chain (MC) can be considered an integral part of the macrosimulation or microsimulation methodologies, depending on how it is implemented (Borralho, 2016). MC are stochastic processes that give rise to models that support decision-making about processes that develop probabilistically over time, satisfying the MC property (Mourão et al., 2019). This property indicates that the future depends only on the current state, being independent of past events (Tijms, 2013). This methodology allows dividing the population into unique health states and assessing the transition behaviour between states over time, as a function of previously defined transition probabilities, in other words, the conditional probabilities (Rosa, 2019).

In section 2.2.3, it is mentioned that MCs appear in the literature within the scope of prevention, screening, progression, and distribution of diseases, as well as the factors that influence them. Therefore, these methods have also been used to predict future needs in several health sectors (Borralho, 2016).

System Dynamics (SD)

This method is also presented in the literature as a useful tool to predict future demand for HC. It focuses on the dynamic analysis of complex phenomena such as long waiting lists in HC systems and changes in demand (Homer & Hirsch, 2006; Mielczarek, 2016). It is used to address the relationship among various variables and present their interactions as their values vary. By definition, in SD simulation there is a feedback loop, a set of flows and stocks, and a time delay. At each specified time of the simulation, stocks report the current quantitative state of objects (for example, individuals). Flows are used to model the individuals during the specified period of time, and the dynamics of the system are given by feedback loops and delays. Therefore, any change in the system causes a chain reaction (Mielczarek, 2016).

This methodology has been applied to estimate future values of prevalence and growth of infectious diseases. According to Mielczarek (2016), SD models are not used in exact numerical predictions regarding HC issues. They are typically used to explore different policy options. However, its implementation requires a large amount of detailed data (Borralho, 2016) and makes its implementation challenging.

Microsimulation methodologies

In comparison with macrosimulation models, microsimulation models require more detailed longitudinal data. This type of data is expensive to collect, both in terms of time and resources. Therefore, data is mainly obtained through longitudinal surveys which reflect accurately the individual patient history. Using this information, microsimulation models are able to incorporate the impact of individual patient history on future events and more easily capture variation in patient characteristics at baseline (Comas-Herrera et al., 2004; Krijkamp et al., 2019; Onggo, 2012). In view of the above, this approach presents fewer studies than the macrosimulation methodologies.

2.2.3. Data required for Healthcare Forecasting Methods

In this section the 17 articles selected in section 2.2.2 were analyzed. From the literature review it was found that estimates constructed to support long-term planning models can be based on: (i) epidemiological data; (ii) past use data; (iii) a combination of the latter 2 approaches.

Models based on epidemiological data of the population

Needs-based predictions (potential demand) determine the demand for health services through epidemiological characteristics, namely the current and future prevalence and incidence rates of diseases (Lopes, 2017). With regard to MH, some epidemiological studies assess the needs by the presence of psychiatric disorders in the population under study. The disorders are detected through diagnostic scales or interviews (Dezetter et al., 2015; Forsell 2006; Mackenzie et al., 2012; Mojtabai 2009; Mojtabai and Olfson 2006; Wallerblad et al., 2012).

Annex C presents some scales used in the literature to screen for MD in EU countries, indicating for each one the total number of questions, the advantages and disadvantages. These 7 scales are highlighted because they assess the presence of MD and/or are recommended by highly prestigious organizations such as the WHO.

Mini International Neuropsychiatric Interview (MINI) includes multiple scales to assess the presence of 23 psychiatric disorders according to ICD-10 and diagnostic and statistical manual of MD (DSM-IV) (Øhre et al., 2014). Moreover, the assessment criteria are accessible as the scores for each response appear in the interview script itself to detect the presence of MD more easily. However, it is important to note that this scale has some limitations. Like most instruments designed to assess the presence of multiple MD, this structured interview is very extensive (Pettersson et al., 2018), can only be guided by clinicians or individuals who are more intensively trained and has not yet been validated in the Portuguese context.

Self-Report Questionnaire (SRQ-20) and WHO-5 was developed by the WHO. SRQ-20 is an instrument that allows for the screening of mental distress (Negash et al., 2020) from 20 binary response questions (yes/no). If the answer is affirmative, 1 point is awarded, while if negative, 0 points are awarded. Above 7 points it is suggested that individuals have significant mental distress (Harpham et al., 2003). Furthermore, the WHO indicates the validity of this instrument to detect MD. WHO-5 is an instrument developed to assess mental well-being. This instrument presents 5 statements and respondents have to answer how often they experience these symptoms, using a scale from 0 (never) to 5 (always) (Topp et al., 2015). Scores of less than 13 points suggest poor well-being (Garland et al., 2018). Studies testing its validity have shown good consistency with depression symptom severity (Hallliday et al., 2017). In contrast, both the SRQ-20 and the WHO-5 have not yet been validated in the Portuguese context.

General Health Questionnaire (GHQ-12) is a self-completion survey with 12 questions designed to assess anxiety and depression, loss of confidence and social dysfunction (Gao et al., 2004). The 12 items are answered on a Likert scale from 1 (more than usual) to 4 (much less than usual). The scale items are summed to obtain the final score, which can range between 0 and 12 points. The cut-off of 2/3 is the most described in the literature (Anjara et al., 2020; Chipimo & Fylkesnes, 2010). Although

it is a short survey and the scale has been validated for the Portuguese population, the author of this thesis does not have access to the document that validates it.

The Patient Health Questionnaire (PHQ-9) is a screening tool that assists clinicians in the diagnosis of depression, both in objectively determining the severity of initial symptoms and in monitoring changes in symptoms and the impact of treatments over a period of time (Löwe et al., 2004). This tool presents 9 statements and respondents are asked to answer how often they experienced depressive symptoms in the past 14 days, using a Likert scale from 0 (never) to 3 (almost every day) (Ferreira et al., 2018). Arias-de la Torre et al. (2021) estimated the prevalence of depressive disorders in 27 European countries by gender using the PHQ-8 scale. The scale used is the same as the PHQ-9 scale, however, it does not contain the last question regarding suicidal ideation. The cut-off point for considering the presence of depressive disorders was 10 (Torres et al., 2016). Ferreira et al. (2018) analyzed the validity of the factor structure and psychometric characteristics of the PHQ-9 in 2 different Portuguese clinical settings (basic health units and university clinics). These authors concluded that this scale should be used in several HC settings in Portugal, since it presents valid and reliable data for the assessment of depression. The cut-off point presented for the detection of cases with major depression is 9. However, Kroenke & Spitzer (2002) indicated that scores of 5, 10, 15, and 20 are cut-off points represent mild, moderate, moderately severe, and severe depression, respectively. The authors propose a treatment plan considering monitoring, counseling, and/or pharmacotherapy for moderate depression levels or higher.

The General Assessment of Anxiety Disorders (GAD-7) is a self-completion survey that identifies the presence and severity of symptoms for 4 most common anxiety disorders (generalized anxiety disorder, panic disorder, social phobia, and post-traumatic stress disorder) (Spitzer et al., 2006). The 7 items are answered on a Likert scale from 0 (never) to 3 (almost every day). The cut-off points to classify anxiety severity were 5, 10, 15 for mild, moderate, and severe anxiety, respectively (Sousa et al., 2015). Kumar et al. (2018) indicated that individuals with moderate or severe anxiety are likely to have clinically diagnosed GAD and are therefore recommended to receive MHC. GAD-7 was validated for the Portuguese language by Sousa et al. (2015).

Finally, the Hospital Anxiety and Depression Scale (HADS) is a tool used to analyze anxiety and depression symptoms. It is divided into 2 parts: 7 questions dedicated to the assessment of depressive symptoms, followed by 7 items dedicated to the assessment of anxiety symptoms, experienced within one week (Pais-Ribeiro et al., 2007). All items are answered on a 4 -point Likert scale (0-3), so the total score may range from 0 to 21. The survey manual indicates that scores of 8, 11, 15 are cut-off points for mild, moderate and severe anxiety/depression, respectively (Pais-Ribeiro et al., 2007). Sousa et al. (2018) assessed the prevalence of anxiety and depression symptoms in Portuguese medical students using the HADS. This study indicated that the prevalence rate of anxiety and depression was 21.5% and

3.7%, respectively. The high prevalence of anxiety symptoms was justified by the fact that there were more female students than male students. In addition, they reported that depression is associated with poor school performance in both groups. Thus, they concluded that developing adequate means of support to improve students' well-being and MH is an urgent task.

Additionally, the use of diagnostic scales does not replace the judgment of a professional specialized in MH. Some studies indicate that these scales can exclude individuals who, although not meeting the diagnostic criteria, feel the need for care (Anjara et al., 2020). In contrast, Sareen et al. (2013) and Vigo et al. (2016) indicate that it is possible to increase the true value of needs by including both individuals with MD who do not need treatment (mild) and people who do not recognize MHCN, even if they meet the diagnostic criteria. However, Ghio et al. (2015) argue that treatment should be enjoyed even by participants who have mild to moderate symptoms, as prevention contributes to reduced disability due to the disease/symptoms and improved life quality.

Annex D presents chronologically 17 articles that builds estimates of need/demand for different HC services, and out of these 8 require epidemiological data. First, the case of Gilbertson et al. (2005) is presented who developed a Markov model with the aim of estimating the incidence, prevalence and mortality of people with end-stage renal disease (ESRN) by 2015 in the USA. To do this, the population projections by age and race, the estimated prevalence, incidence and mortality rates were incorporated into the Markov Model. Data from 1980-2015 were collected through longitudinal studies. They were then subjected to linear extrapolations to obtain estimates from 1978 to 2015.

Also, Cardoso et al. (2012) and Xiaodong & Yuhua (2018) predicted long-term care (LTC) needs in Portugal for a 6-year period and in China for a 10-year period, respectively. For this purpose both studies used health-related factors, namely mortality rates, dependency levels, prevalence rates and incidence rates collected through longitudinal studies, such as National Health Surveys. The same method was used by Borralho (2016) to determine the number of current and future (2016-2021) palliative care needs in Portugal. For this the author used epidemiological data such as incidence rates and dependency levels. In this model, the population was divided into 6 states (individuals without cancer, with stable cancer, with transitional cancer, end-of-life cancer, death from cancer or death from other causes), of which 2 are absorbing states (death from cancer or death from other causes), that is, from the moment individuals are in this state they do not move on to another. Similarly to Cardoso et al. (2012), this study provided estimates disaggregated by sex, age group and type of service (outpatient, home care and inpatient).

Kingston et al. (2018) proposed a microsimulation model discrete-time dynamic model that simulates characteristics (socio-demographic, economic, health conditions, chronic diseases, geriatric conditions, and dependency) of individuals. All epidemiological data were collected from 3 longitudinal studies for the period 2008-2013. This model was divided into 2 parts: the creation of the base

population and the simulation of the ageing of individuals based on the estimated transition probabilities. In this way, it was possible to estimate the number of older people living in England with health and social care needs from 2015 to 2035.

Models based on historical data on healthcare demand

Estimates based on past and current demand consist of analyzing the HC supply that was actually available, which is subject to economic constraints and, consequently, may not be enough to fully satisfy the existing demand (Lopes, 2015).

Xue et al. (2001) applied regression models to predict the number of new, treated (needs met) and waiting list (unmet needs due to structural barriers) patients with end-stage renal disease (ESRD) from 1998 to 2010 in the USA using historical data such as the number of treated and waiting list patients per year (1982-1997). However, the authors considered that the nature of these data may incur inaccuracies and in turn affect the predictive value of the model used.

Ishikawa et al. (2019), used the extrapolation method with the goal of supporting Human Resources planning by forecasting future demand for needs. To this end, the authors multiplied the current rates of care utilization in Japan by disease (2014-2015) by age, gender, and counties with the future population projections from 2015 to 2035 by region.

Models based on epidemiological data and historical utilization

Huang et al. (2013) updated the epidemiological trend of Kawasaki disease (KD) in the USA and Taiwan and developed projection models employing SD to estimate what fraction of KD patients required HC derived from coronary complications in 2010-2030. This method included data from national databases from 2000-2010, such as historical natality and mortality rates, prevalence and incidence rates by age group. This study had some limitations, such as the fact that the incidence of KD was derived from KD hospitalization records, in other words, the number of patients in the database did not match the number estimated by SD model. Nevertheless, the authors concluded that SD models are highly useful for refining public policies and properly allocating resources when the necessary data are available.

Turkiewicz et al. (2014) and McRae S., (2021) used regression models to construct estimates of effective demand, respectively, for osteoarthritis (OA) cases in Sweden until 2032 and for various hospital services in Germany from 2018 to 2027. Similar to McRae S., (2021) who used demographic, epidemiological (birth rates, mortality rates) and historical data (aggregate data on patient discharges from hospitals in Germany between 2000 and 2017), also Turkiewicz et al. (2014) used data of the same nature such as mortality rates and prevalence rates, the latter being determined by historical data (population receiving diagnoses of knee OA or other sites between 1999 and 2012).

Lay-Yee et al. (2017) applied a microsimulation model to predict the future use of social care by older people in New Zealand. As such, to estimate the demand for social care provided under different modalities (informal, formal and residential care) the authors used epidemiological data such as disability levels (1996 to 2001), respective transition probabilities and average fertility, mortality and migration projections, and historical data on social care utilization (1996 and 2006). As only historical data on residential care utilization was available, to determine the level of formal and informal care utilization the authors used logistic regression models, which aim to model the probability of a certain discrete event occurs given an input variable.

Forecasts that use both epidemiological data and data on past HC use as inputs provide more transparent estimates by mitigating the overestimation and underestimation of demand caused by forecasts based on need and expressed demand, respectively.

2.3. Healthcare demand forecasting – the case of Mental Health Care

Following the review of studies aimed at constructing estimates of HC needs/demand, it is central to understand what methods and data are used in forecasting demand or MHCN. However, to the author's knowledge, the information is scarce. Only 6 articles were found. Of these, 4 papers based its estimates on epidemiological data, 1 study constructed forecasts based on historical utilization and 1 paper created estimates with both types of data.

Models based on epidemiological data

Wancata et al. (2003) and Wimo et al. (2003) used the extrapolation method to estimate the number of dementia cases in Europe and worldwide, respectively, until 2050. Incidence and prevalence rates of dementia were used in both studies for that purpose. The same method was used by Rosa et al. (2019), but in this case to forecast the demand for MHC in Portugal and current prevalence rates were used as a basis.

Furthermore, Patten et al. (2005) developed an MC model to estimate the prevalence of periods of major depression in its constituent elements - incidence and episode duration - over one year for residents in Canada by sex, age group and marital status. As such, the authors used incidence data from a national longitudinal study and depression episode duration data from a cross-sectional survey where interviews were conducted every 2 years (1994-2000).

Models based on historical utilization data

Sugawara et al. (2021) used extrapolation model to estimate the allocation of psychiatrists to MD patients in Japan by multiplying current MHC utilization rates by disease, age, gender and county by

population projections between 2015 to 2035 and 2045, respectively.

Models based on epidemiological data and historical data

A extrapolation method was proposed by Monteiro (2016), with the purpose of estimating the potential demand of MHC, in other words, the MHCN based on the characteristics of the population. The author applied the prevalence rates of the most common MD, the MHC services distribution rates based on the services provided in 2013, to the annual projections of the total population (2016-2019), by municipality and age group.

2.4. Conclusion

The literature has shown that current and future demand for MHC are critical inputs for the proper planning of services. However, this information is not always easy to obtain. To address the issue of predicting the long-term future demand for HC, several studies have used regression and simulation methodologies. The most widely used approach both in the general health sector and in MH has been simulation (Chung et al., 2019; Mielczarek, 2016).

Among simulation models, microsimulation and SD methods are complex to implement, they are time-consuming and require a large amount of individual data, which are often not available to the public or even not collected. Extrapolation methods require information about the current needs/use of HC, which represents information difficult to obtain. Moreover, this method may be very simplistic when there are many factors influencing the disease and these remain constant over time (Borralho, 2016). On the other hand, Markov models allow constructing estimates of HC needs without resorting to data on the historical use of the population under study, disaggregated by the number of desired characteristics. In addition, their implementation is relatively affordable, not time consuming and does not require the expenditure of monetary resources.

Furthermore, from the literature review it was possible to understand that most studies make use of epidemiological data to predict HCN, with only 3 articles analyzed focusing on historical data and 5 of the 17 articles analyzed on a combination of these 2 approaches. Roberfroid et al. (2009) consider that models based on historical HC utilization data should only be adopted when the current supply of HC is adequate to meet needs (Mielczarek & Zabawa, 2016). Otherwise, demand will be underestimated and, consequently, planning will be inadequate to the needs expressed. On the other hand, predictions based on epidemiological data reflect the effective needs of the population and consequently they can be overestimated since not all people with MHCN and/or perceived needs effectively seek for MHCN. In this sense, the combination of epidemiological data and historical utilization data allows reaching more transparent estimates, since the overestimation of demand

caused by predictions based on clinical needs is attenuated by the underestimation of demand caused by estimates based on historical expressed demand.

In addition, after analyzing the existing studies on the prediction of HCN/demand, it was possible to identify a gap in the literature, since to the thesis author's knowledge there are no studies that distinguish between needs that are actually met (effective demand) and needs that are not met, either consciously (attitudinal or structural barriers) and unconsciously (unperceived needs). This information not only adds value to decision-making in the network planning of this sector, but also to the definition of public policies aimed at reducing the occurrence of situations of unmet needs.

Within this setting, this dissertation contributes to the literature by addressing long-term estimates of MHCN in its different settings –IC, AC, HBC, and social services (OC and RC) – by combining historical utilization data and epidemiological data in a Markov model. Besides, the proposed generic model can be useful for countries with similar service organization and demand patterns, in other words, where depression and anxiety represent the MD that most affect the population and account for the majority of MHC services provided. The proposed method also allows predicting potential needs by distinguishing between effective demand, effective, perceived and unperceived needs.

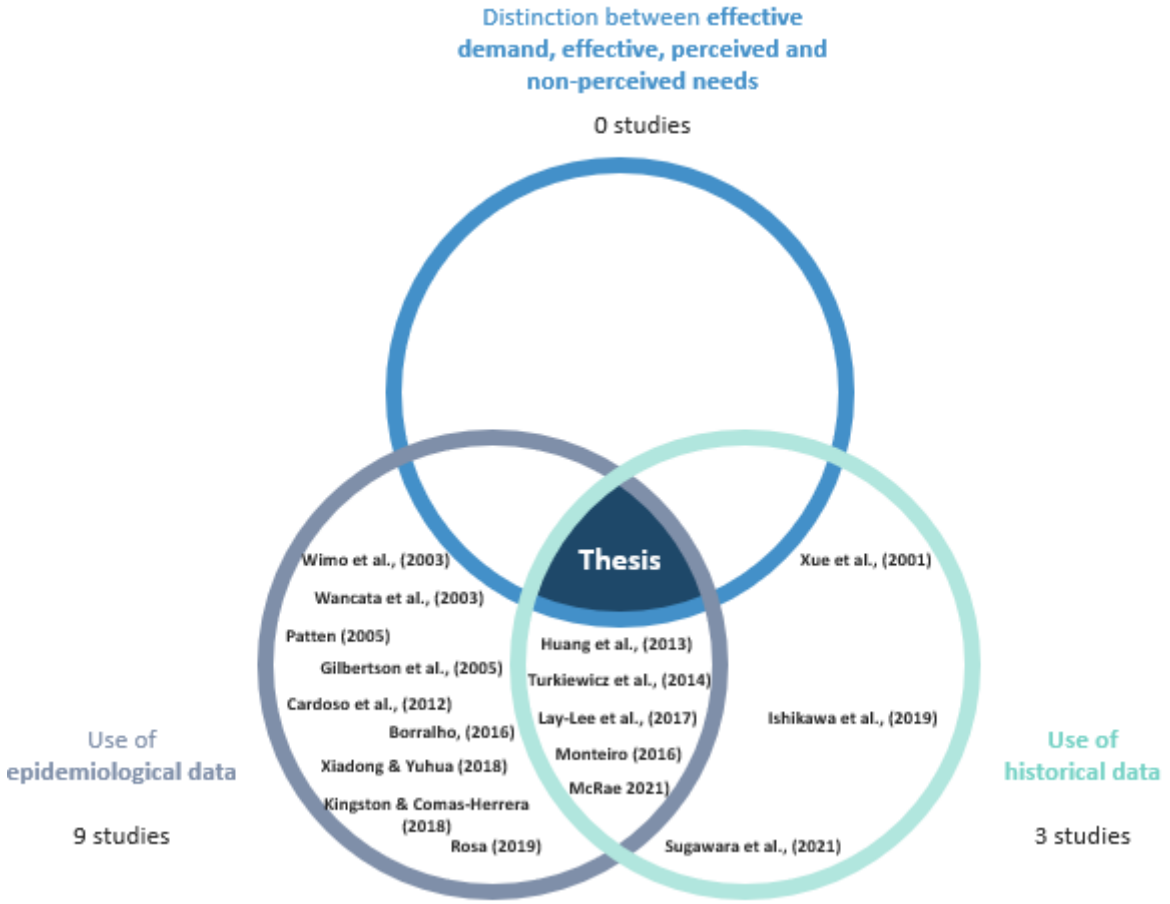

Figure 2.1 - Summary of studies responsible for forecasting HCN/demands in general and particularly in MHC services

(own elaboration)

CHAPTER 3

Methodology

The main objective of this thesis is to build estimates of the MHCN in the LTV region, which will serve as input for an adequate resource material and human planning of the MH sector network in that region.

As concluded based on the literature review, the combination of epidemiological data and past HC utilization has the potential to mitigate the overestimation and underestimation of demand often caused by forecasts built based on the use of each one of the inputs individually, and this is why this combination of inputs will be applied in this study. Regarding the method used, it was concluded that the Markov Model is the most appropriate methodology, for the following reasons: (i) it allows predicting future MHCN based in epidemiological data and historical utilization data; (ii) it enables the disaggregation of individuals according to the number of desired characteristics; and (iii) it is an accessible method to implement, in terms of complexity, time and cost, since its application can be done by a widely known tool such as Excel. The application of this model not only requires the division of the population into unique health states, but also the evaluation of the transition behaviour between states over time. This means that in a first stage, to define the Markov states, it is crucial to understand which characteristics of the individuals imply the need for MHC. Then it is required to obtain the transition probabilities between health states.

Section 3.1 presents an overview of the methodology adopted in this study, followed by a detailed explanation of each of the proposed key steps.

3.1. Methodology overview

The methodology used in this study is divided into 3 distinct stages (Figure 3.1). First, interviews were conducted with MH professionals in order to understand and designate indicative aspects of MH (subsection 3.2; Stage I). This stage provides an understanding of the risk factors and key symptoms that imply MHCN. As demonstrated in the literature review, this understanding is critical to the definition of the Markov model states (subsection 3.3) (Borralho, 2016; Cardoso et al., 2012; Gilbertson et al., 2005; Patten et al., 2005; Xiaodong & Yuhua, 2018). Subsequently, the Markov model is built, allowing the identification of the relevant Markov states, and consequently, of the necessary data for the construction of estimates of MHCN (Stage II). Finally, Stage III involves a survey used to collect information about the transition probabilities between the patient states as identified in the previous phase (subsection 3.4).

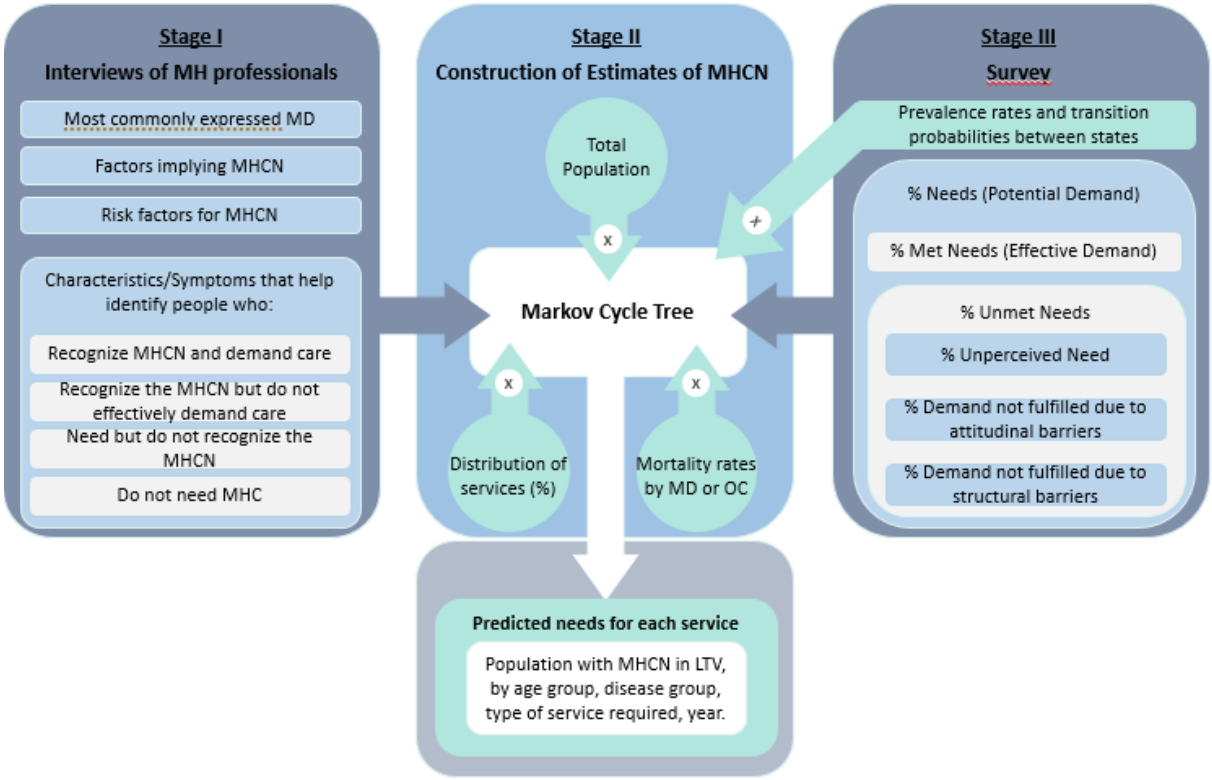

Figure 3.1. Overview of the methodology used in this study *(own elaboration)*

Legend: MH - Mental Health; MHCN – Mental Health Care Needs; MD – Mental Disorders; OC – Other Causes; LTV - Lisbon and Tagus Valley.

A mixed approach was chosen for this study since primary data collection was performed through qualitative (semi-structured interviews) and quantitative (survey) methods. According to Johnson et al. (2007) this approach allows clarifying the topic under study, as well as obtaining the big picture of the reality of the research issue. Furthermore, Rens et al. (2020) indicate that a qualitative methodology can improve the understanding of the quantitative results obtained.

3.2. Stage I: Designation of MH indicative aspects – Expert interviews

As a first step, interviews were conducted with experts in the MH area with the main purpose of acquiring missing information on the current reality of MD, clarifying which characteristics imply the need for specialized MHC, as well as understanding which personal or behavioural aspects help identifying individuals who: (i) recognize need and seek MHC; (ii) recognize MHCN but do not seek care; (iii) do not recognize MHCN but have clinical needs; (iv) do not need care. These 4 different groups are the ones recognized as relevant by the literature in the area (see chapter 2). In order to corroborate certain evidence found in the literature, clarify some missing information and add value to the results obtained, 5 MH professionals working in different contexts (general medicine, psychiatry, psychology and scientific research) were interviewed. Annex E provides more detailed information on the professional experience of each of the interviewees.

The interviews were conducted in Portuguese, according to a semi-structured script. The nature of these interviews ensures that all planned topics were covered, giving both the interviewees freedom to address other aspects and the interviewer flexibility to record key notes and add further questions when necessary. Each interview lasted on average 45 minutes.

Considering the pandemic situation currently experienced, the interviews were preferably conducted by videoconference, leaving the possibility of occurring in telephone call format, according to the availability and preference of the interviewees. As suggested by Catterall (2000), all of them were recorded by audio recorders with the interviewees' consent, to ensure an accurate transcription of answers and facilitate the analysis of the collected data.

It is important to note that in order to meet the proposed objective of the execution of the interviews, 2 distinct scripts were created. While the first interview guide (Annex F) aimed at MH professionals, the second set of questions (Annex G) was created with the purpose of complementing the conclusions of the interviews previously conducted by obtaining the perspective of an experienced researcher, who was familiar with studies and data recently reported in the literature for the Portuguese context. This second script (Annex G) allowed clarifying relevant information for the construction of the Markov model, such as, for example, the most frequent MD in society, the percentage of care provided in Portugal associated with anxiety and depression disorders, the respective mortality rates, the existence of characteristics implying the need for MHC as well as risk factors and, finally, the scales validated in the literature for the Portuguese context that allow quantifying people with MHCN. After the complete transcription of the interviews, the content of the answers was analyzed seeking to compress the long statements into key elements (Bardin, 2009).

3.2.1. Interview analysis

This section outlines the main findings from the interviews for the categories of questions asked.

Perception of statistical data on Mental Disorders

When questioned about which are the most frequent MD in the population, all interviewees agreed that the most expressed and prevalent disorders in the Portuguese population are anxiety and depression disorders. This information is in agreement with the literature (DGS, 2014) (interview 5). In Interview 4 it was mentioned that these 2 disorders may often be interrelated. Although less frequently, other disorders such as drug and alcohol addiction, eating disorders, bipolar disorder and schizophrenia are also observed (Interviews 1, 2, 3 and 4). The aforementioned pathologies can also be a reflection of others (interview 2). In interview 4 it was indicated that "both alcohol and drug addiction and bulimia end up being reflections of anxiety disorders and/or depression".

From interview 5 it was not possible to know the percentage of care provided in disorders linked

to anxiety and/or depression symptoms, however, it was reinforced that the concepts of prevalence and demand are distinct. Therefore, not all the population presenting symptoms of MD effectively seeks care. Even though it was recognized that these 2 disorders are the most socially accepted and thought of, for example, from the point of view of substance addiction, they are not those where there is more difficulty in asking for help.

In relation to the mortality rate associated with MH causes, it was noted that the literature (Liu et al., 2017) shows that “people with MH disorders are naturally at higher risk of mortality” (interview 5). In most cases, mortality in MD has to do with suicides, which are predominantly related to depressive conditions (interviews 1, 2, 3 and 4). Although there may be other less frequent causes of death resulting from "accidents in the context of mania or personality disorders" (interview 2), from alcohol and/or substance consumption (interview 3 and 5) and from the illness itself as is the case of anorexia, where there is "denial for food" (interview 5).

Identification of individuals with MHCN

With regard to question 3 of the script identified in Table 3.2, interviewees indicated that in order to identify the clinical needs for MHC, there are several specific visible warning signs for the different pathologies (interviews 1, 2, 3 and 4). In this sense, MH professionals try to understand what the individual's symptomatology is and how these interfere with their QL (interview 2). This leads to question 3 in Table 3.3, where the only factor common to all MD that implies the clinical need for MHC was identified. This specifically refers to the impairment that a given symptomatology has on the individual's overall functioning, whether in the family, social or even in the work context (interview 5).

Question 4 aimed to identify the characteristics that increase the probability of people needing MHC. The experts consider that this is difficult to define, since the probability of a MD occurring results from a balance between risk and protective factors (interview 5). As it is, there are different risk factors for different pathologies. While in interviews 3 and 4, gender was not considered a risk factor for the onset of MHCN, in interviews 2 and 5 it was mentioned that there are MD that are more frequent in one gender than in another, such as, for example, anxiety and depression disorders which are theoretically more frequent in women than in men, or at least men recognize them more easily.

As far as the age group is concerned, interview 2 indicated that there are age groups "where there is a greater risk of MD appearing", however, this may vary from one pathology to another. Interviews 2 and 5 show that characteristics such as "gender, age group, family composition, the presence of chronic illnesses, marital status, ethnic group, income level, exposure to violence, professional situation or even level of education have no value of their own. They only have value when integrated into a more complex framework of relationships between the individual variables, the family variables

and the disorder itself". On the other hand, in interview 3 it is mentioned that the emergence of needs has less to do with individual characteristics than with life cycles and the crises they go through, namely the loss of a job, the loss of a loved one, the excess or change of work combined with the fact that the person does not fit in, the birth of children associated with the fact that the individual does not feel well with increased anxiety, among others. In interview 1 it was indicated that unemployment increases the probability of people developing depression and anxiety frameworks, in the same way that the poor quality of relationships triggers disorders. This information is in line with interview 3 which indicated that the household does not influence MHCN as much as the quality of relationships that function here. Sexual orientation was considered by some interviewees as a risk factor for the onset of MD if there is a self or family rejection of the position taken (interviews 1 and 3).

Identification of MHCN assessment instruments

Regarding question 5 in table 3.3, the expert mentioned that there are several self-completed or other instruments (for example, interviews and scales) which have been constructed and adapted, using cut-off points, that is, points at which the person presents a significant problem. Predominantly, these instruments are used for psychological assessment, integrating information from observation and interviews. "*It is on this integrated information that a decision is made about the need for intervention*" (interview 5). Furthermore, it was reported that the GAD-7 and PHQ-9 scales were recently used in a report by the National Institute of Health Doctor Ricardo Jorge which aimed to study MH in times of pandemic.

Identification of individuals who recognize MHCN and demand care

In question 5 in table 3.2, all respondents indicated that women find it easier to recognize and seek MHC. It was also added that people with children (interview 3), married or preparing for divorce are the ones who seek professional help the most (interviews 3 and 4). The opinion regarding level of education, income level and age group was not consensual. Unlike interview 3 which presented that "the more educated and the more informed the person is, the more easily he/she adheres to a process" of MHC, in interviews 1 and 4 this characteristic was not presented as a risk factor for the formulation of this group of individuals. On the other hand, there are interviewees who consider that people aged under 55 have a greater tendency to recognize and seek help (interview 1) and others considered that young adults aged between 20 and 30 and over 60 tend to seek help (interview 4).

Identification barriers to unmet MHCN

In the following question several factors were identified that justify not seeking MHC. Among them the following could be highlighted: lack of self-recognition of MD (interviews 1, 3 and 4), lack of health

insurance (interview 4) or economic means to support the honorable position associated with service provision (interviews 1, 2, 3 and 4), associated stigma (interviews 1,2, 3 and 4), confidentiality concerns (interview 3) and the creation of drug dependency (interviews 3 and 4).

Identification of unperceived (UN) MHCN

In question 7 some characteristics were also highlighted that increase the probability of people not recognizing needs of which the following were highlighted: male gender (interviews 1, 2, 3 and 4), older people (interviews 1 and 2) and young people between late adolescence and early adulthood (interviews 1, 2 and 3), mothers with children (interviews 3). Furthermore, while in interview 4 it was identified that large families tend to have greater difficulty in recognizing specialist care needs, household number and marital status were not considered as risk factors for this issue.

Identification of Individuals with unmet MHCN due to attitudinal barriers

Most interviewees considered that the risk factors identified in the previous question are similar to the characteristics of people that increase the probability of people not seeking care by choice (interview 1, 2 and 4). However, the opinion regarding the level of income and education was not consensual. In contrast to interview 3, where it was that low level of education and income may be risk factors for people in need not choosing to seek help, in interviews 1 and 2 it was considered that what influences is more "*education and the way psychiatric illnesses are seen by the individual*".

Perception of factors influencing preference for MHC

Interviewees identified cost as the factor that most influences the choice of one MH in detriment of another, followed by the existence of agreements with insurance companies (interview 3 and 4). These 2 factors end up dictating the preference between the public and private sector (interviews 1, 3 and 4). The recommendation of MH professionals also emerged as an important factor in the choice (interviews 1, 2, 3 and 4). In addition, other factors such as, for example, the characteristics of the professionals (for example, sex and age) and the environment in which service is provided (home vs. institutional or virtual vs. face-to-face) (interview 2) were presented. Although with less importance, access to transport was also seen as a factor influencing the preference for MHC (interview 4).

Professionals' recommendations

Finally, the interviewees were asked if they had recommendations to strengthen the MHC network and thus meet the real existing needs. Several improvement actions were pointed out: (i) create better forecasts of the number of people in need (interview 3); (ii) open up a greater number of vacancies and possibilities for follow-up in the National Health System, through a fair political and

economic investment (interview 2), the creation of more permanent vacancies for MH clinicians, essentially, psychotherapists (interviews 3 and 4) and "partnerships in which the private sector could in an acceptable way, create follow-up grants at the social level, which would allow for the follow-up of the most needy people with the desirable quality and regularity" (interview 3); (iv) increase the number of consultations carried out outside the hospital environment, in order to decentralize care and provide MH treatment in the community (interview 1).

Conclusions

From the interviews it was possible to conclude that anxiety and depression disorders are the most prevalent and expressed in society and may be associated with other pathologies, such as alcohol addictions and bulimia. Furthermore, it was concluded that the mortality rate associated to MD is mostly explained by the suicide rate. The latter occurs predominantly in depressive pathologies.

Also, it was possible to understand that there is no consensus on the risk factors for MHCN. The diversity of answers may be explained by the interviewees' different ways of acting, as well as by the fact that MD are multifactorial and, therefore, there are no characteristics with their own value in isolation. In a macro perspective, what defines the clinical needs for MHC is the impairment that a given symptomatology has on the individual's daily functioning. Moreover, it was found that MD are multiple and that there may be specific symptoms for each of them. In this sense interviews and scales (self-completed or not) have been developed for psychological assessment.

3.3. Stage II: Demand forecasts through a Markov model

This section presents in detail the model used and the assumptions adopted to build the Markov model aimed at predicting future MHCN, by age group, type of service required and year. The simulation model proposed here has a Markov cycle tree structure that includes 2 components: a short-term decision tree and a long-term Markov model. This model groups individuals in different states (according to the characteristics they present), makes it impossible for individuals belonging to different states to interact and allows them to remain in or progress naturally to other states, according to epidemiological patterns translated into different transition probabilities.

The starting point for predicting the demand for MHC services is the assessment of clinical need. This need is dependent on demographic and health characteristics of the population. The approach ensures that existing needs are not restricted by supply factors such as past MHC utilization or prices. In this way it also includes people with unmet need. Furthermore, this model distinguishes in each year the forecast of met needs from unmet needs, whether unconsciously (unrecognized needs) or consciously (attitudinal and structural barriers) - recognized as relevant, yet not widely explored, in the

literature in the area (see chapter 2). This distinction is crucial for planning purposes and for defining public policies to reduce the occurrence of situations of unmet needs.

The literature review and the findings of the interviews allowed to distinguish the characteristics that should be considered in the prediction model, namely:

a) **Age group and gender** – The literature identifies gender and age as relevant determinants of non-modifiable psychological distress (Brooks et al., 2020; Holmes et al., 2020; Luo et al., 2020; Salari et al., 2020). Interviews with MH experts also revealed that there are pathologies more frequent in one gender than another. Particularly, anxiety disorders and depression disorders are more frequent in women than in men. In addition, Caron et al. (2012) indicate that individuals aged under 55 years have higher prevalence rates of psychological distress.

b) **Symptomatology and its impact on the individual's functioning** – The interviews showed that each and every individual should be the target of MHC. Considering that this study only considers clinical needs, it was assumed by the conclusion of the interviews that the indicators implying MHCN are the presence of symptomatology and the impairment it has on the individual's functioning, namely at work, in taking care of things at home or in socializing with other people. Furthermore, it was found that MD are multiple and that there may be specific symptoms for each one. Therefore, for the proposed simulation model only depression and anxiety disorders were considered, since both in the literature and in the interviews they emerged as being the most prevalent in society. In addition, from the supply point of view, they justify most of the care provided in Portugal.

Figures 3.2 and 3.3 present the 2 components of the proposed Markov cycle tree. First, a decision tree is used to understand the MHCN in the initial year. After dividing the population according to age, gender and geographical region, all individuals were divided into 5 distinct branches:

- **WDS ∩ WAS ∩ QL –** individuals who do not have significant symptoms of depression (WDS) and anxiety (WAS) and do not experience symptoms that negatively interfere with their personal, work or social functioning (QL) do not need MHC;
- **WDS ∩ WAS ∩ WQL –** individuals without/with mild symptoms of depression and anxiety who feel it compromises their overall functioning (WQL), have MHCN;
- **DS ∩ AS –** Individuals with MHCN, as they have moderate to severe symptoms of depression and anxiety;
- **DS ∩ WAS –** Individuals without significant symptoms of anxiety, but with moderate to severe symptoms of depression present with MHCN;
- **WDS ∩ AS –** Individuals without significant symptoms of depression, but with moderate to severe symptoms of anxiety, who present MHCN.

When the population has been divided into these groups, each branch is further divided between people who: perceive and satisfy their needs (met needs); perceive but do not satisfy their needs due to structural or attitudinal barriers (UPN); do not recognize MHCN and therefore do not satisfy them (UN).

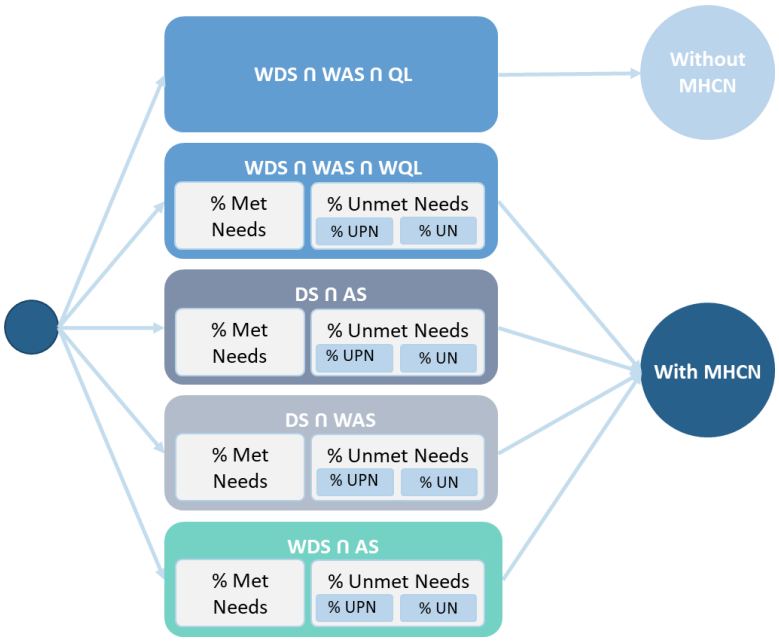

Figure 3.2. Short-term decision tree built to predict the initial (t=0) number of individuals with MHCN *(own elaboration)*
Legend: DS –Significant Depression Symptoms; AS – Significant Anxiety Symptoms; WDS – Without Significant Depression Symptoms; WAS – Without Significant Anxiety Symptoms; UPN – Unmet but Perceived Need; UN – Unperceived Need; WQL – Without Quality Life; QL – With Quality Life

After the organization of individuals in each group in the initial year it becomes possible to assess how they evolve over time. Such evolution is based on the Markov model structure shown in figure 3.3, which considers the population demography and epidemiological data such as the transition probabilities between states and the mortality rates. This model is composed of 7 different states, 5 of which are identical to the states of the decision tree applied at t = 0 and 2 are absorbing states concerning death by MD and by other causes.

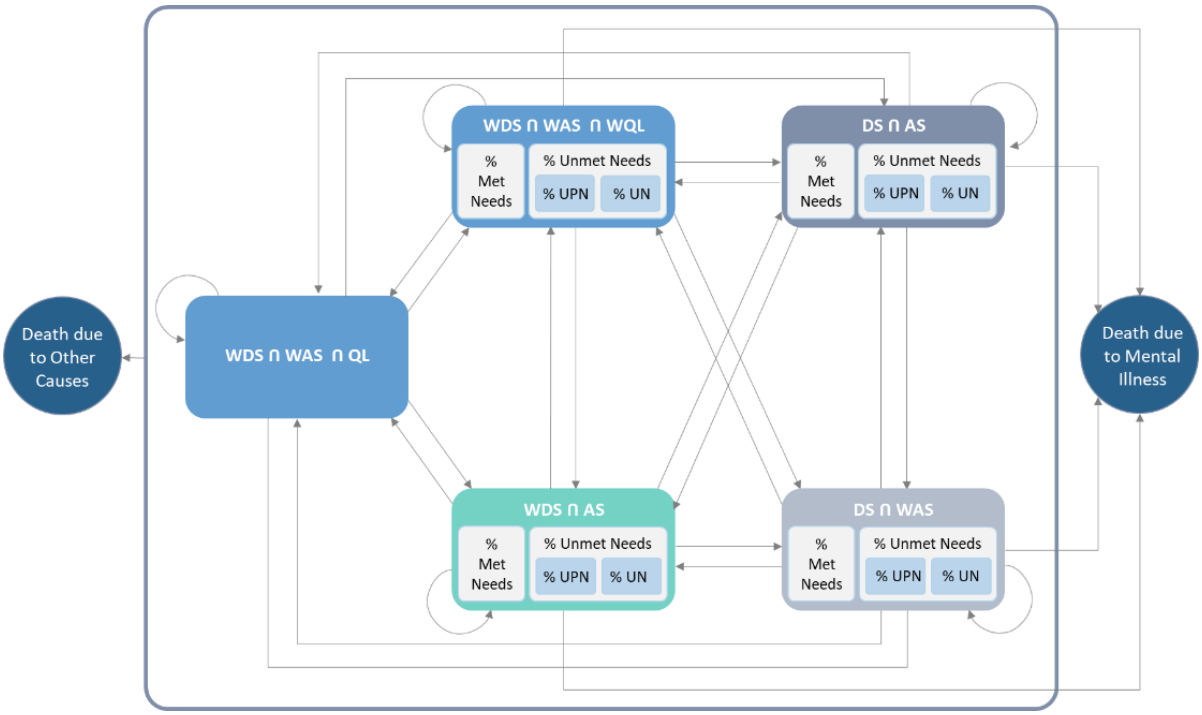

Figure 3.3. Long-term Markov Model built to predict how the number of individuals with need of MHC will evolve over time (1 ≤ t ≥ n) *(own elaboration)*

Legend: DS –Significant Depression Symptoms; AS – Significant Anxiety Symptoms; WDS – Without Significant Depression Symptoms; WAS – Without Significant Anxiety Symptoms; PN – Perceived Need; UN – Unperceived Need; WQL – Without Quality Life; QL – With Quality Life

3.3.1. Mathematical formulation

To facilitate the understanding of the mathematical formulation underlying the proposed model, the list of the notation (indices, parameters and variables) used is shown in Tables 3.1, 3.2 and 3.3.

Table 3.1 – Sets *(own elaboration)*

Indices and sets	Definition
$a \in A$	Age group
$j \in J$	Sex
$k \in K$	Borough
$d = \{1,2,3,4,5\} \subseteq S$ $s,m \in S$	Model states
$c \in C$	Mental health care services
$n \in N$	Level of satisfaction and perception of MHCN
$t \in T$	Time period

Table 3.2 – Parameters *(own elaboration)*

Parameter	Definition
$nInd^0_{ajk}$	Number of individuals from age group $a \in A$, sex $j \in J$ and living in borough $k \in K$ in the first year of the forecasting horizon ($t = 0$).

p^0_{ajkd}	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$ belongs to state $d \subseteq S$ in the first year of the forecast horizon ($t = 0$).
NSt_{ajkst}	Total number of individuals with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, that belong to state $s \in S$ in year $t \geq 1 \wedge t \in T$.
$P(WDS \cap WAS \cap QL)_{ajkt}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$ not experiencing significant symptoms of depression and anxiety and feeling that they have QL in year $t \in T$.
$P(WDS \cap WAS \cap WQL)_{ajkt}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$ having no significant symptoms of depression and anxiety and feeling no QL in year $t \in T$.
$P(DS \cap AS)_{ajkt}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$ presenting significant symptoms of depression and anxiety in year $t \in T$.
$P(DS \cap WAS)_{ajkt}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$ experiencing significant symptoms of depression rather than anxiety in year $t \in T$.
$P(WDS \cap AS)_{ajkt}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$ experiencing significant symptoms of anxiety rather than depression in year $t \in T$.
$PDMD_{ajkt}$	Annual mortality rate due to mental illness for individuals with age group a $\in A$, sex $j \in J$, borough $k \in K$ and in year $t \in T$.
$PDOC_{ajkt}$	Annual mortality rate due to other causes (excluding mental illness causes) for individuals with age group $a \in A$, sex $j \in J$, and living in borough $k \in K$, in year $t \in T$.
PD_{ajkt}	Annual mortality rate for individuals with age group $a \in A$, sex $j \in J$, borough $k \in K$ and in year $t \in T$.
p_{smajkt}	Probability of an individual with age group $a \in A$, sex $j \in J$, and living in borough $k \in K$, in year $t \in T$ to transition from state s to state m ($s,m \in S$).
$P[(WDS \cap WAS \cap QL)_t \mid (WDS \cap WAS \cap QL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state without significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL) to the same state.
$P[(WDS \cap WAS \cap QL)_t \mid (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state without significant symptoms of depression (WDS) and anxiety (WAS) and without quality of life (WQL) to the state without significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL).
$P[(WDS \cap WAS \cap QL)_t \mid (DS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and anxiety (AS) to the state without significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL).
$P[(WDS \cap WAS \cap QL)_t \mid (DS \cap WAS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and not anxiety (WAS) to the state without significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL).
$P[(WDS \cap WAS \cap QL)_t \mid (WDS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of anxiety (AS) and not depression (WDS) to the state without significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL).

$P[(WDS \cap WAS \cap WQL)_t \mid (WDS \cap WAS \cap QL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state without significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL) to the state without significant symptoms of depression (WDS) and anxiety (WAS) and without quality of life (WQL).
$P[(WDS \cap WAS \cap WQL)_t \mid (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with no significant symptoms of depression (WDS) and anxiety (WAS) and without quality of life (WQL) to the same state.
$P[(WDS \cap WAS \cap WQL)_t \mid (DS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and anxiety (AS) to the state with no significant symptoms of depression (WDS) and anxiety (WAS) and no quality of life (WQL).
$P[(WDS \cap WAS \cap WQL)_t \mid (DS \cap WAS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and not anxiety (WAS) to the state with no significant symptoms of depression (WDS) and anxiety (WAS) and no quality of life (WQL).
$P[(WDS \cap WAS \cap WQL)_t \mid (WDS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of anxiety (AS) and not depression (WDS) to the state without significant symptoms of depression (WDS) and anxiety (WAS) and no quality of life (WQL).
$P[(DS \cap AS)_t \mid (WDS \cap WAS \cap QL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state without significant symptoms of depression (WDS) and anxiety (WAS)and with quality of life (QL) to the state with significant symptoms of depression (DS) and anxiety (AS).
$P[(DS \cap AS)_t \mid (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with no significant symptoms of depression (WDS) and anxiety (WAS) and without quality of life (WQL) to the state with significant symptoms of depression (DS) and anxiety (AS).
$P[(DS \cap AS)_t \mid (DS \cap AS)_{t-1}]_{ajk}$	Probability that an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and anxiety (AS) to the same state.
$P[(DS \cap AS)_t \mid (DS \cap WAS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and not anxiety (WAS) to the state with significant symptoms of depression (DS) and anxiety (AS).
$P[(DS \cap AS)_t \mid (WDS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of anxiety (AS) and not depression (WDS) to the state with significant symptoms of depression (DS) and anxiety (AS).
$P[(DS \cap WAS)_t \mid (WDS \cap WAS \cap QL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with no significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL) to the state with significant symptoms of depression (DS) and not anxiety (WAS).

$P[(DS \cap WAS)_t \mid (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with no significant symptoms of depression (WDS) and anxiety (WAS) and without quality of life (WQL) to the state with significant symptoms of depression (DS) and no anxiety (WAS).
$P[(DS \cap WAS)_t \mid (DS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and anxiety (AS) to the state with significant symptoms of depression (DS) and not anxiety (WAS).
$P[(DS \cap WAS)_t \mid (DS \cap WAS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and not anxiety (WAS) to the same state.
$P[(DS \cap WAS)_t \mid (WDS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of anxiety (AS) and not depression (WDS) to the state with significant symptoms of depression (DS) and not anxiety (WAS).
$P[(WDS \cap AS)_t \mid (WDS \cap WAS \cap QL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with no significant symptoms of depression (WDS) and anxiety (WAS) and with quality of life (QL) to the state with significant symptoms of anxiety (AS) and no symptoms of depression (WDS).
$P[(WDS \cap AS)_t \mid (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with no significant symptoms of depression (WDS) and anxiety (WAS) and no quality of life (WQL) to the state with significant symptoms of anxiety (AS) and not depression (WDS).
$P[(WDS \cap AS)_t \mid (DS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and anxiety (AS) to the state with significant symptoms of anxiety (AS) and not depression (WDS).
$P[(WDS \cap AS)_t \mid (DS \cap WAS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of depression (DS) and not anxiety (WAS) to the state with significant symptoms of anxiety (AS) and not depression (WDS).
$P[(WDS \cap AS)_t \mid (WDS \cap AS)_{t-1}]_{ajk}$	Probability of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, in year $t \geq 1 \wedge t \in T$ to transition from the state with significant symptoms of anxiety (AS) rather than depression (WDS) to the same state.
$SRdmd_{ajkt}$	Survival rate of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, affected by mental illness (s = {2,3,4,5}), in year $t \geq 1 \wedge t \in T$.
$SRdoc_{ajkt}$	Survival rate of an individual with age group $a \in A$, sex $j \in J$ and living in borough $k \in K$, unaffected by mental illness (s = 1), in year $t \geq 1 \wedge t \in T$.
$Distrib_{cm}$	Distribution of mental health care $c \in C$ by state m = {2,3,4,5} (in %)
$Distrib_{nm}$	Distribution of the $n \in N$ level of satisfaction and perception of MHCN by state m = {2,3,4,5} (in %)

Table 3.3 – Variables *(own elaboration)*

Variable	Definition
$NSt_{ajkd(t=0)}$	Total number of individuals with age group $a \in A$, sex $j \in J$ and borough $k \in K$, that belong to state $d \subseteq S$ in year $t = 0 \wedge t \in T$.

$NDMD_{ajksmt}$	Total number of individuals with age group $a \in A$, sex $j \in J$, and borough $k \in K$, that in year $t \geq 1 \wedge t \in T$, moves from a state $s \in \{2,3,4,5\}$ to the state of death due to mental illness causes (m = 6).
$NDOC_{ajksmt}$	Total number of individuals with age group $a \in A$, sex $j \in J$, and borough $k \in K$, that in year $t \geq 1 \wedge t \in T$, transits from a state $s \in S$ to the state of death due to causes other than mental illness (m = 7).
NSt_{ajksmt}	Total number of individuals with age group $a \in A$, sex $j \in J$ and borough $k \in K$ that at t - 1 belonged to state s and in t belong to state m, where $m,s = \{1,2,3,4,5\}$ and $t \geq 1 \wedge t \in T$.
nMN_{ajksnt}	Total number of individuals with age group $a \in A$, sex $j \in J$, in borough $k \in K$, state $s \in S$ at $t \geq 1 \wedge t \in T$, with $n \in N$ level of satisfaction and perceived MHCN.
$nMHC_{ajksct}$	Total number of individuals with age group $a \in A$, sex $j \in J$, in borough $k \in K$, state $s \in S$ who need $c \in C$ care at $t \geq 1 \wedge t \in T$.

Following the logic of the proposed simulation model, first the mathematical formulation associated to the short-term decision tree is demonstrated, followed by the corresponding Markov model. Finally, the formulas common to any forecast year, regardless of the model used are presented.

3.3.2. Decision tree

Initially, the population under study is divided into 5 different branches. This division is given by Equation 3.1, where the total population by age group $a \in A$ and sex $j \in J$, and borough $k \in K$ at $t = 0$ is multiplied by the probability that an individual of age $a \in A$ and sex $j \in J$, and borough $k \in K$ is at state $d \in \{1,2,3,4,5\}$. This last parameter is represented by p^0_{ajksd} (equation 3.3 to 3.7). As an example, equation 3.5 indicates the calculation of the probability of an individual presenting significant symptoms of depression and anxiety at the initial moment of prediction (t = 0).

$$NSt_{ajkd(t=0)} = nInd_{ajk(t=0)} \times p^0_{ajkd}, \forall\, a \in A, j \in J,\ k \in K, d \in D \tag{3.1}$$

$$p^0_{ajkd} = \begin{cases} P(WDS \cap WAS \cap QL)_{ajk(t=0)}, & \forall\, a \in A, j \in J, k \in K, d = 1 \\ P(WDS \cap WAS \cap WQL)_{ajk(t=0)}, & \forall\, a \in A, j \in J, k \in K, d = 2 \\ P(DS \cap AS)_{ajk(t=0)}, & \forall\, a \in A, j \in J, k \in K, d = 3 \\ P(DS \cap WAS)_{ajk(t=0)}, & \forall\, a \in A, j \in J, k \in K, d = 4 \\ P(WDS \cap AS)_{ajk(t=0)}, & \forall\, a \in A, j \in J, k \in K, d = 5 \end{cases} \tag{3.2}$$

$$p_{ajk(d=1)(t=0)} = P(DS \cap AS)_{ajk(t=0)} = \frac{NSt_{ajk(d=1)(t=0)}}{nInd_{ajk(t=0)}}, \forall\, a \in A, j \in J, d \in D, k \in K, t \in T \tag{3.3}$$

$$p_{ajk(d=2)(t=0)} = P(DS \cap AS)_{ajk(t=0)} = \frac{NSt_{ajk(d=2)(t=0)}}{nInd_{ajk(t=0)}}, \forall\, a \in A, j \in J, d \in D, k \in K, t \in T \tag{3.4}$$

$$p_{ajk(d=3)(t=0)} = P(DS \cap AS)_{ajk(t=0)} = \frac{NSt_{ajk(d=3)(t=0)}}{nInd_{ajk(t=0)}}, \forall\, a \in A, j \in J, d \in D, k \in K, t \in T \tag{3.5}$$

$$p_{ajk(d=4)(t=0)} = P(DS \cap AS)_{ajk(t=0)} = \frac{NSt_{ajk(d=4)(t=0)}}{nInd_{ajk(t=0)}}, \forall\, a \in A, j \in J, d \in D, k \in K, t \in T \tag{3.6}$$

$$p_{ajk(d=5)(t=0)} = P(DS \cap AS)_{ajk(t=0)} = \frac{NSt_{ajk(d=5)(t=0)}}{nInd_{ajk(t=0)}}, \forall\, a \in A, j \in J, d \in D, k \in K, t \in T \tag{3.7}$$

3.3.3. Markov model

This group of equations predicts the long-term evolution of the number of individuals in each of the 7 states of the model. In order to simplify the exposition of the mathematical formulation of this model, each state was numbered (Table 3.4).

Table 3.4 – Markov model states *(own elaboration)*

State of the Markov Model	State number (s)/(m)
WDS ∩ WAS ∩ QL	1
WDS ∩ WAS ∩ WQL	2
DS ∩ AS	3
DS ∩ WAS	4
WDS ∩ AS	5
Death due to MD	6
Death due to Other Causes	7

Population ageing is considered whenever $t \in T$ increases. It means that in each new year the number of individuals in age group a is calculated based on the total number of individuals aged $a - 1 \in A$ in the previous year, since population ageing is only considered at the end of the year. This method is used to calculate population ageing in all states, as can be seen in the following equations.

Death states

Equation 3. 8 indicates the total population with age group $a \in A$, sex $j \in J$, and borough $k \in K$, that in year $t \geq 1 \wedge t \in T$ transits from a state $s \in \{2,3,4,5\}$ to the state of death due to MH causes ($m = 6$) is achieved by multiplying the total population with age group $a - 1 \in A$, sex $j \in J$, and borough $k \in K$, by the annual mortality rate caused by MD for individuals with age group $a - 1 \in A$, sex $j \in J$, borough k ∈ K and in year $t - 1 \in T$.

$$NDMD_{ajksmt} = \sum_{s=2}^{5}\left(NSt_{(a-1)jkst} \times PDMD_{(a-1)jk(t-1)}\right),$$
$$\forall\, a \in A, j \in J, k \in K, t \geq 1 \wedge\ t \in T, s \in \{2,3,4,5\}, m = 6 \quad (3.8)$$

The Annual mortality rate due to all causes except MD for individuals with age group a ∈ *A*, sex *j* ∈ *J*, borough $k \in K$ and in year $t \in T$ ($PDOC_{ajkst}$) is given by equation 3. 9, where a subtraction is performed between the annual all-cause mortality rate (PD_{ajkt}) and the annual mortality rate due to MD for individuals with age group with age group a ∈ *A*, sex $j \in J$, borough $k \in K$ and in year $t \in T$ ($PDMD_{ajkt}$).

The total number of individuals that in year t ($t \geq 1 \wedge t \in T$) moves from state $s \in S$ to the state of death due to other causes ($m = 7$) *is* represented by $NDOC_{ajksmt}$ and is given by Equation 3.10.

$$PDOC_{ajkst} = PD_{ajkt} - PDMD_{ajkt}, \forall\, a \in A, j \in J, k \in K, \mathrm{t} \geq 1 \wedge\ t \in T \quad (3.9)$$

$$NDOC_{ajkst} = \sum_{s=1}^{5}\left(NSt_{(a-1)jkst} \times PDOC_{(a-1)jk(t-1)}\right)$$
$$\forall\, a \in A, j \in J, k \in K, \mathrm{t} \geq 1 \wedge\ t \in T, s \in \{1,2,3,4,5\}, m = 7 \quad (3.10)$$

Other States

Meanwhile, Equation 3.11 indicates the calculation of the total number of individuals of age group $a \in A$, sex $j \in J$ and borough $k \in K$ who belong to state m = {1,2,3,4,5} during the time period t ≥ 1 ∧ $t \in T$, through the transition rates between state $s \in S$ to $m \in S$ (Equation 3.13 with description of a particular case in Equation 3.14, where the individual moves from a state with significant symptoms of anxiety and no symptoms of anxiety at $t - 1 \in T$ to a state in which the individual exhibits significant symptoms of depression and anxiety at $t \in T$) and the survival rates represented by $SRdoc_{ajkt}$ in the case of individuals that in year $t - 1 \in T$ belonged to state s = 1 or $SRdmd_{ajkt}$ in which individuals belonged to any other state s = {2,3,4,5} (Equations 3.15 and 3.16).

It is important to note that since p_{ajksmt} are conditional probabilities, they must obey the condition imposed by equation 3.12 (Mourão et al., 2019).

$$NSt_{ajksmt} = NSt_{(a-1)jk(s=1)(t-1)} \times SRdoc_{(a-1)jk(t-1)} \times p_{(s=1)majkt} + \sum_{s=2}^{5} (NSt_{(a-1)jkst} \times SRdmd_{(a-1)jk(t-1)} \times p_{smajkt}),$$

$$a \in A, j \in J, k \in K, \text{t} \geq 1 \wedge\ t \in T, s, m \in \{1,2,3,4,5\} \quad (3.11)$$

$$\sum_{m=1}^{5} p_{ajksmt} = 1, \qquad a \in A, j \in J, k \in K, \text{t} \geq 1 \wedge\ t \in T, s, m \in \{1,2,3,4,5\} \quad (3.12)$$

$$p_{smajkt} = \begin{cases} P[(WDS \cap WAS \cap QL)_t | (WDS \cap WAS \cap QL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 1, m = 1, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap QL)_t | (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 1, m = 2, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap QL)_t | (DS \cap AS)_{t-1}]_{ajk} & \forall\, a \in A, j \in J, k \in K, s = 1, m = 3, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap QL)_t | (DS \cap WAS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 1, m = 4, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap QL)_t | (WDS \cap AS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 1, m = 5, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap WQL)_t | (WDS \cap WAS \cap QL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 2, m = 1, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap WQL)_t | (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 2, m = 2, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap WQL)_t | (DS \cap AS)_{t-1}]_{ajk} & \forall\, a \in A, j \in J, k \in K, s = 2, m = 3, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap WQL)_t | (DS \cap WAS)_{t-1}]_{ajk} & \forall\, a \in A, j \in J, k \in K, s = 2, m = 4, t \geq 1 \wedge t \in T \\ P[(WDS \cap WAS \cap WQL)_t | (WDS \cap AS)_{t-1}]_{ajk} & \forall\, a \in A, j \in J, k \in K, s = 2, m = 5, t \geq 1 \wedge t \in T \\ P[(DS \cap AS)_t | (WDS \cap WAS \cap QL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 3, m = 1, t \geq 1 \wedge t \in T \\ P[(DS \cap AS)_t | (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 3, m = 2, t \geq 1 \wedge t \in T \\ P[(DS \cap AS)_t | (DS \cap AS)_{t-1}]_{ajk} & \forall\, a \in A, j \in J, k \in K, s = 3, m = 3, t \geq 1 \wedge t \in T \\ P[(DS \cap AS)_t | (DS \cap WAS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 3, m = 4, t \geq 1 \wedge t \in T \\ P[(DS \cap AS)_t | (WDS \cap AS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 3, m = 5, t \geq 1 \wedge t \in T \\ P[(DS \cap WAS)_t | (WDS \cap WAS \cap QL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 4, m = 1, t \geq 1 \wedge t \in T \\ P[(DS \cap WAS)_t | (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 4, m = 2, t \geq 1 \wedge t \in T \\ P[(DS \cap WAS)_t | (DS \cap AS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 4, m = 3, t \geq 1 \wedge t \in T, \\ P[(DS \cap WAS)_t | (DS \cap WAS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 4, m = 4, t \geq 1 \wedge t \in T \\ P[(DS \cap WAS)_t | (WDS \cap AS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 4, m = 5, t \geq 1 \wedge t \in T \\ P[(WDS \cap AS)_t | (WDS \cap WAS \cap QL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 5, m = 1, t \geq 1 \wedge t \in T \\ P[(WDS \cap AS)_t | (WDS \cap WAS \cap WQL)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 5, m = 2, t \geq 1 \wedge t \in T \\ P[(WDS \cap AS)_t | (DS \cap AS)_{t-1}]_{ajk} & \forall\, a \in A, j \in J, k \in K, s = 5, m = 3, t \geq 1 \wedge t \in T \\ P[(WDS \cap AS)_t | (DS \cap WAS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 5, m = 4, t \geq 1 \wedge t \in T \\ P[(WDS \cap AS)_t | (WDS \cap AS)_{t-1}]_{ajk}, & \forall\, a \in A, j \in J, k \in K, s = 5, m = 5, t \geq 1 \wedge t \in T \end{cases} \quad (3.13)$$

$$p_{(s=5 \wedge m=3)ajkt} = P[(DS \cap AS)_t | (WDS \cap AS)_{t-1}]_{ajk} = \frac{P\left[(DS \cap AS)_{ajkt} \cap (WDS \cap AS)_{ajk(t-1)}\right]}{P(WDS \cap AS)_{ajk(t-1)}},$$

$$\forall\, a \in A, j \in J, k \in K, t \geq 1\ \wedge\ t \in T \quad (3.14)$$

$SRdoc_{ajkt}$ = (1 − $PDOC_{ajkt}$) ∀ $a \in A$, $j \in J$, $k \in K$, $t \geq 1 \ \wedge \ t \in T$ (3.15)

$SRdmd_{ajkt}$ = (1 − $PDOC_{ajkt}$ − $PDMD_{ajkt}$) ∀ $a \in A$, $j \in J$, $k \in K$, $s \in \{2,3,4,5\}$ (3.16)

Satisfaction of MHCN

Equation 3.17 arises in order to distinguish the following groups of individuals: individuals with MHCN satisfied (n = 1), individuals with needs recognized but unmet (n = 2) and individuals with unmet needs because they do not perceived their own needs (n = 3). This is done by multiplying the total number of individuals of age group $a \in A$, sex $j \in J$ and borough $k \in K$ who belong to state m = {2,3,4,5} during the time period t ≥ 1 ∧ $t \in T$ (NSt_{ajksmt}) by the distribution *of* $n \in N$ level of satisfaction and perception of MHCN by state m = {2,3,4,5} ($Distrib_{nm}$).

$nMN_{ajksnt} = \sum_{m=2}^{5} NSt_{ajksmt} \times Distrib_{nm}$,

∀ $a \in A$, $j \in J$, $k \in K$, 1 ≤ s ≤ 5, m = {2,3,4,5}, $t \in T$, $n \in$ N (3.17)

MHC Settings

After identifying in each year t ∈ T the number of individuals in each state $m \in S$ it is possible to calculate through Equation 3.18 the total number of individuals residing in borough $k \in K$, age group $a \in A$, sex $j \in J$ that in year $t \in T$ need care from IC (c = 1), AC (c = 2), HBC (c = 3), RC (c = 4) and OC (c = 5). This distribution is given by multiplying between of individuals of age group $a \in A$, gender $j \in J$ and municipality $k \in K$ who belong to state m = {2,3,4,5} during period $t \geq 1 \wedge t \in T$ (NSt_{ajksmt}) by the distribution of $n \in N$ level of satisfaction and perception of MHCN by state m = {2,3,4,5} ($Distrib_{cm}$).

$nMHC_{ajksct} = \sum_{m=2}^{5} NSt_{ajksmt} \times Distrib_{cm}$,

∀ $a \in A$, $j \in J$, $k \in K$, 1 ≤ s ≤ 5, $m = \{2,3,4,5\}$, $c \in C$, $t \geq 1 \wedge t \in T$, $c \in C$ (3.18)

3.4. Stage III: Mental health survey design

The absence of available data particularly regarding the transition probabilities between the states drawn in the Markov cycle tree, motivated the need to develop an instrument that would allow for the feasible collection of these primary data. In this sense, it was developed a survey with 16 questions written in Portuguese and English (Annex H) distributed through an online platform, Qualitrics. This survey explores 5 distinct areas with specific objectives (Table 3.5): (i) sociodemographic data, (ii) symptoms of depression and anxiety at 2 distinct moments, (iii) satisfaction and perception of MHCN, (iv) main attitudinal and structural barriers that justify not seeking MHC and (v) factors that most influence the choice of MHC. In Annex I is shown the exact correspondence between the questions raised in the survey and the parameters used as input in the proposed forecast model.

Table 3.5 – Specific objectives of the questions included in the survey *(own elaboration)*

Sections	Questions	Variables	Objective(s)
1	Q1	Sex	• Obtain the probabilities of transition between states by age and sex; • Restrict the predictions of MHCN to the adult population (15 years and older) residing in the LTV region. • All these characteristics were the main indicated in the literature (Caron et al., 2012; Santini et al., 2020) and/or in the interviews to characterize MHCN. They are further used to characterize the groups of met, unmet needs consciously and not consciously;
	Q2	Age	
	Q3	Region of residence	
	Q4	Marital Status	
	Q5	Education Level	
	Q6	Professional status	
	Q7	Monthly Income	
2	Q8/Q10	Symptoms in 2021 (Q8) and 2019 (Q10)	• Obtain given prevalence rates at $t = 0$ and transition probabilities between states at $t \geq 1$.
	Q9/Q11	Impairment of symptomatology on individual functioning in 2021 (Q9) and 2019 (Q11)	
3	Q12	Satisfaction and perceived MHCN	• Obtain percentages to distinguish the forecast of people with met needs, unperceived needs and unmet needs by attittudinal and structural barriers.
4	Q13	Attitudinal barriers	• Identify not only the factors that most influence MHC choice, but also the key attitudinal and structural barriers to support planning and policy decisions aimed at reducing the occurrence of UN or unmet perceived needs.
	Q14	Structural barriers	
5	Q15/ Q16	Factors influencing the demand for MHC	

The symptomatology of depression and anxiety experienced in the current year and in 2019 was assessed by questions 8 and 11, respectively, where the PHQ-9 and GAD-7 scales were used. These instruments were selected for their validation in the Portuguese context and for their adequate psychometric characteristics (Torres et al., 2016; Sousa et al., 2015). As considered by Torres et al. 2016 and Sousa et al. (2015), in both scales, the following cut-off points are used: 0 to 9 points - no symptomatology/with mild depression/anxiety symptoms; 10 to 21 (in the case of GAD-7) or 27 points (in the case of PHQ-9) - with moderate to severe depression/anxiety symptoms. Annex J represents the criteria needed to find the transition probabilities between states.

The survey allows for easy collection and analysis of data using statistical methods and does not require high financial and time costs. In contrast in this quantitative method it may be more difficult to reach the participation of specific groups, for example, people in higher age groups, people hospitalized for MD, people with low income without access to internet (Rens et al., 2020). The heterogeneity of the context according to which individuals respond to the survey may also make it difficult to extrapolate the sample data to the universe under study.

Saunders et al. (2009) indicate that the internal validity and reliability of the data collected depend, to a large extent, on the design of the questions, the structure of the survey and its pilot testing. Accordingly, the survey was pre-tested by 44 residents of the LTV region, above 18 years, with the purpose of understanding whether there was any difficulty in understanding the questions, thus helping to determine the appropriateness of the type of vocabulary used to explain the questions. This procedure originated slight changes, namely in the questions assessing symptomatology where: (i) the last 2 weeks of 2019, which appear in festive seasons, were defined in order to better situate the respondents about the symptoms experienced; (ii) the semantics of point 2 of the scale used to assess depression and anxiety symptoms was reformulated in order to decrease the relative concept from "On several days" to "On less than half of the days".

Both the final survey and the pilot test were shared online from 18 June 2021 to 14 September 2021, through social networks (Facebook, Instagram, LinkedIn, and WhatsApp) inviting colleagues, relatives, and their acquaintances to participate anonymously and share it with their own network contacts. Therefore, it is perceived that non-probability sampling was used since the sample was selected by convenience and consequently participants were selected because they had access to the Internet and to the survey link.

3.4.1. Validating the representativity of the sample

By analyzing table 3.6 it is possible to verify that this sample is representative of the population since, when subtracting the percentages by sex and age group relative to the resident population of LTV reported in the INE (2021) with the percentages by sex and age group relative to the survey sample, individual values of no more than 5% are obtained, with the exception of the age groups 45-54 and over 74 years which present approximately 8% variation.

Table 3.6 – Assessment of the representativity of the sample *(own elaboration)*

	% Women (Survey)	% Women (INE)	Δ Women	% Men (Survey)	% Men (INE)	Δ Men
[15-24]	10.55%	6.09%	-4.46%	9.09%	6.24%	-2.85%
[25-34]	9.58%	6.33%	-3.25%	4.97%	5.95%	0.98%
[35-44]	14.06%	8.79%	-5.27%	5.58%	7.82%	2.24%
[45-54]	17.58%	9.24%	-8.34%	8.97%	8.23%	-0.74%
[55-64]	8.12%	8.08%	-0.05%	4.61%	6.74%	2.14%
[65-74]	3.39%	7.70%	4.31%	2.67%	6.04%	3.37%
+75	0.12%	7.82%	7.70%	0.73%	4.94%	4.21%
Total	**63.39%**	**54.03%**	**-9.36%**	**36.61%**	**45.97%**	**9.36%**

Note: All figures have been rounded

After reaching a representative sample of the population, according to a considerable number of valid answers (825 complete answers from residents of LTV aged 15 years or more), the data collected in the online survey was then processed through Excel. When proceeded to the data processing phase,

where descriptive analyses and data frequencies were carried out in order not only to describe and discuss the information collected, but also to identify the transition probabilities and the probability of belonging to each state at t = 0.

3.4.2. Sample characterization

To better understand the sample characteristics, an analysis of the socio-demographic characteristics gathered through the variables is summarized in Annex K. Regarding the sex of the respondents, it is observed that most participants are female (63%). The distribution of respondents by age is presented in Annex L. After its analysis it is possible to confirm that most of the respondents are aged between 15-24 years and 35-54 years. Furthermore 51% of the participants are married or in a consensual union while 36% are single. In addition, approximately 91% of the respondents have completed at least secondary education. Regarding the professional situation it is found that the majority of respondents are employed in a paid job (68%) and 64% have a monthly income of 501-1300 euros or above 2900 euros.

By analyzing the answers to questions 1, 2, 11 it was possible to obtain the probabilities of an individual belonging to each state, by age and sex at *t* = 0 (Table 3.7). Complementing this analysis with the results obtained in question 8 it was also possible to identify the probabilities of transition between states for residents of LTV, by age group and sex, which will be applied in the model at *t* > 0 (Table 3.8).

Table 3.7 – Probability of an individual belonging to each group by age and sex at t = 0 *(own elaboration)*

	[15-24]		[25-34]		[35-44]		[45-54]		[55-64]		[65-74]		+75	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M
$p^0_{ajk(s=1)}$	0.45	0.59	0.52	0.66	0.43	0.57	0.61	0.69	0.63	0.82	0.75	0.73	1	1
$p^0_{ajk(s=2)}$	0.21	0.21	0.11	0.12	0.19	0.17	0.17	0.18	0.22	0.05	0.14	0.14	0.00	0.00
$p^0_{ajk(s=3)}$	0.21	0.07	0.25	0.20	0.22	0.09	0.12	0.08	0.10	0.11	0.04	0.00	0.00	0.00
$p^0_{ajk(s=4)}$	0.06	0.12	0.03	0.00	0.05	0.11	0.04	0.01	0.00	0.03	0.04	0.05	0.00	0.00
$p^0_{ajk(s=5)}$	0.08	0.01	0.09	0.02	0.10	0.07	0.06	0.04	0.04	0.00	0.04	0.09	0.00	0.00

Legend: F – Female; M – Male.

Table 3.8 – Probabilities of transition between states by age and sex at 1 ≤ t ≥ n *(own elaboration)*

	[15-24]		[25-34]		[35-44]		[45-54]		[55-64]		[65-74]		+75	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M
$p_{(s=1)(m=1)ajkt}$	0.64	0.61	0.61	0.74	0.60	0.77	0.77	0.86	0.83	0.87	0.76	0.94	1.00	0.67
$p_{(s=1)(m=2)ajkt}$	0.21	0.20	0.10	0.15	0.10	0.12	0.07	0.04	0.05	0.06	0.10	0.00	0.00	0.17
$p_{(s=1)(m=3)ajkt}$	0.10	0.09	0.17	0.07	0.20	0.04	0.09	0.06	0.02	0.03	0.05	0.00	0.00	0.00
$p_{(s=1)(m=4)ajkt}$	0.05	0.05	0.07	0.04	0.08	0.04	0.05	0.00	0.05	0.03	0.05	0.06	0.00	0.17
$p_{(s=1)(m=5)ajkt}$	0.00	0.05	0.05	0.00	0.02	0.04	0.02	0.04	0.05	0.00	0.05	0.00	0.00	0.00
$p_{(s=2)(m=1)ajkt}$	0.06	0.06	0.11	0.00	0.18	0.13	0.20	0.08	0.20	0.00	0.25	0.00	0.25	0.00
$p_{(s=2)(m=2)ajkt}$	0.33	0.38	0.33	0.60	0.55	0.63	0.60	0.54	0.40	0.50	0.50	1.00	0.50	1.00
$p_{(s=2)(m=3)ajkt}$	0.39	0.25	0.33	0.40	0.27	0.13	0.00	0.08	0.20	0.00	0.00	0.00	0.00	0.00
$p_{(s=2)(m=4)ajkt}$	0.17	0.13	0.11	0.00	0.00	0.00	0.16	0.31	0.13	0.50	0.25	0.00	0.25	0.00
$p_{(s=2)(m=5)ajkt}$	0.06	0.19	0.11	0.00	0.00	0.13	0.04	0.00	0.07	0.00	0.00	0.00	0.00	0.00
$p_{(s=3)(m=1)ajkt}$	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$p_{(s=3)(m=2)ajkt}$	0.06	0.00	0.00	0.00	0.04	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00
$p_{(s=3)(m=3)ajkt}$	0.83	0.80	0.85	0.75	0.69	0.75	0.94	0.50	0.86	0.75	1.00	0.75	1.00	0.00
$p_{(s=3)(m=4)ajkt}$	0.00	0.20	0.00	0.25	0.15	0.00	0.06	0.17	0.14	0.25	0.00	0.25	0.00	0.00
$p_{(s=3)(m=5)ajkt}$	0.11	0.00	0.00	0.00	0.12	0.25	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00

$p_{(s=4)(m=1)ajkt}$	0.20	0.33	0.50	0.40	0.17	0.40	0.00	1.00	0.00	0.00	1.00	0.00	1.00	0.00
$p_{(s=4)(m=2)ajkt}$	0.20	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.33	0.00	0.00	0.00	0.00	0.00
$p_{(s=4)(m=3)ajkt}$	0.40	0.22	0.50	0.40	0.67	0.40	0.17	0.00	0.17	1.00	0.00	0.00	0.00	0.00
$p_{(s=4)(m=4)ajkt}$	0.20	0.33	0.00	0.00	0.17	0.00	0.33	0.00	0.33	0.00	0.00	1.00	0.00	1.00
$p_{(s=4)(m=5)ajkt}$	0.00	0.11	0.00	0.20	0.00	0.20	0.17	0.00	0.17	0.00	0.00	0.00	0.00	0.00
$p_{(s=5)(m=1)ajkt}$	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00
$p_{(s=5)(m=2)ajkt}$	0.29	0.00	0.00	0.00	0.00	0.00	0.13	0.67	0.00	0.50	0.00	0.50	0.00	0.50
$p_{(s=5)(m=3)ajkt}$	0.71	0.00	0.43	0.00	0.42	0.33	0.38	0.00	0.33	0.00	0.00	0.00	0.00	0.00
$p_{(s=5)(m=4)ajkt}$	0.00	0.00	0.14	0.00	0.08	0.00	0.13	0.00	0.00	0.00	1.00	0.00	1.00	0.00
$p_{(s=5)(m=5)ajkt}$	0.00	1.00	0.29	1.00	0.50	0.67	0.38	0.33	0.33	0.50	0.00	0.50	0.00	0.50

Legend: F – Female; M – Male.

It is relevant to note that the sample collected does not involve the responses required in some age groups to reach the transition probabilities between all states. For these cases (highlighted in grey) it was assumed that the transition rates between states by certain gender and age group are identical to the transition probabilities between states by the respective gender and previous age group. The only exception is for males aged 25-34 years old transitioning from state s = 4 to m = 1,2,3,4,5 where it was assumed that the probability of transition between states is equal to the probability of a man aged between 35 and 44 years old transitioning from state s = 4 to m = 1,2,3,4,5.

On the other hand, the analysis of the results obtained in questions 1 to 8 and 14 allowed us to characterize the following groups: (i) MHCN recognized and demand fulfilled; (ii) MHCN recognized and demand not fulfilled; (iii) MHCN exist but they are not recognized; (iv) MHCN do not exist. About 52% of the sample has MHCN (Annex M). Among these individuals only 23.3% recognize and meet their clinical needs. While 76.7% see their unmet needs unconsciously (37.6%) or UN (39.1%).

The individuals who need and seek professional help are predominantly: (i) 15.68% of female respondents; (ii) 30% of widowed and 16.67% of divorced surveyed; (iii) 15.83%, 13.70% and 14.29% of individuals aged 25-34, 45-54 and aged over 74 respectively; (iv) 13.38% of people with secondary education surveyed, 12.55% of the respondents with higher education (bachelor or master degree); (v) 13.14% of the surveyed people with a paid job or internship and 12.94% of the surveyed retired people; (vi) 18.33% and 17.81% of the respondents respectively with a monthly income of 701-900 euros and 1301-1500 euros (Annex N).

From Annex N, it is clear that the individuals with unmet clinical needs due to attitudinal or structural barriers are mostly: (i) 22.56% of women respondents; (ii) 24.75% of single people; (iii) 29.01% and 26.54% of respondents aged 15-24 years and 35-44 years respectively; (iv) 24.70% of respondents with complete secondary school and 22.73% of respondents with higher education (doctorate or vocational higher), (v) 35.29% of students or in curricular internship and 30.67% of unemployed; (vi) 32% of people with no monthly income and 30.23% of respondents people with a monthly income below 500 euros (30.23%)

On the other hand, Annex N indicates that individuals who do not recognize their MHCN are predominantly: (i) 21.19% of the male respondents; (ii) 22.03% of singles, 22.22% of divorced, and

18.10% of married or cohabiting; (iii) 25.93% and 25.31% of respondents aged 15-24 years and 35-44 years, respectively; (iv) 26.76% of people with basic education, 22.92% of respondents with higher education (degree or master's degree), 22.73% of people with professional technical courses; (v) 26.67% of unemployed people and 20.60% of respondents with a paid job or professional internship; (vi) 25.58% of surveyed people with a monthly income below 500 euros and 25.93% of respondents with income between 1501-1800 euros.

The characteristics with the highest percentages of individuals without medical needs include: (i) 54.97 of male respondents; (ii) individuals over the age of 44 years; (iii) 53.81% of married or cohabiting respondents; (iv) 59.09% and 49.30% of respondents with doctoral and basic education, respectively; (v) 69.41% and 47.96% of retired and remunerated job respondents, respectively; (vi) 64.15% of people with net income between 1801 and 2200 euros and 65.79% of respondents with more than 2900 euros (65.79%) (Annex N).

Moreover, by analyzing the responses to questions 11, 12 and 14 it was possible to obtain the probabilities of an individual having a level $n \in N$ of satisfaction and perceived need for MHC, by state $m \in M$ at $t \in T$ (Annex O).

From the analysis of Annex P, the structural barriers most indicated by participants who have needs and do not receive adequate MHC are the fact that there are no MH professionals available when needed (24.3%) or people are on a waiting list (24.3%). Moreover, the fact that people believe they can cope with the problem without help/treatment (25.7%), they are not prepared to start the treatment process (19.02%) and they do not have the financial resources to bear the cost and/or consider that it is too expensive compared to the type of services available (16.85%) are the attitudinal barriers that most frequently justified the fact that participants do not seek help (Annex Q).

Finally in questions 17 and 18 respondents indicated the degree of importance of various factors when choosing MHC, using a scale of 1 (most important) to 7 (least important). Annex R shows that on average, cost, recommendations from institutions or health professionals and the existence of agreements with insurers are predominantly the factors with the greatest weight in decision-making, as they have a mean equal to 2.76, 2.99 and 3.48. Consequently, on average, the least important factors are access to transportation (5.41) followed by the characteristics of the professionals.

CHAPTER 4

Forecasting effective, met and unmet needs for mental health care in Lisbon and Tagus Valley

This chapter is dedicated to the application of the simulation model proposed in the previous chapter for the LTV region from 2022 to 2030. Thus, firstly, the data set used is presented, as well as the assumptions adopted for the application of the model. In the next section the model is validated, using real demographic data from 2015 to 2020. Subsequently, the Markov model prediction results are presented in section 4.3 and, finally, in the last section the forecasted results of MHCN are compared with the current level of MHC supply and an analysis is made in order to assess the needs under various operating conditions.

4.1. Dataset and assumptions

Table 4.1 summarizes the data collected from the literature and the survey to predict the needs for the different types of MHC (HBC, OC, RC, AC, IC) in the LTV region between 2022 and 2030, disaggregated by age group.

Table 4.1. Data collected from the literature and the survey developed to predict demand for MHC*(own elaboration)*

Data category	Year	Comments	Source
Demographic data	2022	Projections of the number of residents in the LTV region aged over 15 years old, by sex and age.	INE (2021b)
Mortality rates	2019	Aggregated and disaggregated data for the LTV region by sex, age group and cause of death.	INE (2021a)
Prevalence data	2019	Probabilities of residents in the LTV region belonging to each state (diseases commonly affecting the Portuguese population: depression disorders, anxiety disorders or both) by sex and age group.	Survey
Transition probabilities	2019/2021	Probability of an individual residing in the LTV region to remain in or change from one state to another by sex and age group.	Survey
Distribution of MHCS	2013	Distribution of MHC services based on patient use in 2013 (in %). Information such as occupancy rate, total bed capacity and average Length of Stay (LOS) for different types of IC (acute patients, residents, patients in contracted entities, contracted residential units and residences - Dispatch 407/98) is needed.	ACSS (2015) CTARSM (2017) ACSS (2018)
Distribution of satisfaction and perception of MHCN	2021	Distribution of satisfaction and perception of MHCN (in %)	Survey

In implementing the markov cycle tree model different assumptions were made:

- Survival and mortality rates (due to MD or other causes) remain constant over time;
- Mortality rates due to MD are the result of the sum of deaths caused by mental and behavioral disorders, dementia, alcohol abuse, drug dependence and drug addiction, in the region of LTV, by sex and age group;
- Needs were determined according to the following mental illnesses: (i) anxiety disorder, (ii) depression disorder or (iii) both.
- It was not possible to collect the necessary answers from individuals of some age groups and genders to reach the transition probabilities between all states. For these cases, it was assumed that the transition probabilities between states checked for the same gender and age group prior to the missing one. With the exception of males aged 25-34 that move from state s = 4 to m = 1,2,3,4,5 where a was assumed to be equal to the transition probabilities between the respective states verified for males aged 35-44.
- The probabilities of an individual belonging to a particular state, by sex and age group in 2019 is identical in 2022;
- Transition rates between states are determined by the symptomatology survey in two distinct moments (2019 and 2021). The year 2019 was considered as it was assumed that the effect of the pandemic in 2019 was not significant on MH;
- Both the distribution (in percentage) of various MHC services provided and the distribution of the level of perception and satisfaction of MHC do not change over time.
- Due to the limited information available, several assumptions were made in the calculation of the use of ambulatory and inpatient services. In calculating patients seen in AC in the PS, it was assumed that the ratio of external consultations/day hospital sessions given in the PS in 2013 to patients served in the same year would be equal to the ratio of day hospital sessions and patients seen in 2016. On the other hand, to determine the number of patients seen in AC in the social sector, it was assumed that the ratio between the number of external consultation sessions given in the social and convention sector (SCS) in 2013 and the patients served in the same year would be equal to the ratio between day hospital sessions and the number of users seen in 2013. As for IC, it was assumed that the number of patients is given by multiplying the overall average occupancy of beds (total occupancy × occupancy rate) and the result of dividing the 365 days of the year by the average LOS. As such, for acute patients it was assumed that the occupancy rate and average LOS in 2013 would be the same as in 2016. For resident inpatients, it was also assumed that the occupancy rate in 2013 would be identical to that of 2016. Finally, both for resident inpatients and for inpatients in contracted entities, the average

LOS was assumed to be the same as that of inpatients of integrated continuous MHC residences.

4.2. Validation

In order to ensure the ability of the developed model to effectively predict MHCN, a validation process is required (Cardoso et al., 2012). Ideally, this process should consist of a direct comparison between the predicted values of MHCN satisfied and the effective (observed) or projected values in studies reported in the literature (Borralho, 2016). As there is only information on the offer made available, another approach was chosen. This approach consists of comparing the demographic evolution arising from the results obtained by the retrospective application (2015-2020) of the proposed model, with the historical population reported in INE. The analysis of demographic change indicates whether the epidemiological data used (prevalence data, transition rates between states and mortality rates) and the transition probabilities between the various states are well calibrated or not (Cardoso et al., 2012).

Table 4.2 demonstrates the deviations arising from the analysis by age group and gender.

Table 4.2. Maximum deviation between real and predicted values of LTV residents during 2015-2020 *(own elaboration)*

Age group	Total deviation (Δ%)	Men (Δ%)	Women (Δ%)
[15;24]	2.78%	1.98%	3.60%
[25,34]	4.09%	2.27%	5.81%
[35;44]	1.89%	0.96%	2.71%
[45;54]	1.37%	0.40%	2.22%
[55;64]	1.49%	0.69%	2.15%
[65;74]	2.04%	2.30%	1.84%
+75	5.83%	11.46%	2.26%

The results show that there are relevant deviations to consider in males and especially for ages 75 and above. This can be justified by the fact that migration probabilities are not considered and even by assuming that the mortality rates used (referring to 2019) remain constant over time, when in reality there may be changes. Furthermore, by analyzing the table it can be seen that the values of the deviations are all positive. This means that the values of residents observed by age group and year are higher than the values achieved by the proposed model. This may occur due to the way in which the mortality rate from MD is estimated. Considering that the sum of mortality rates caused by mental and behavioural disorders, dementia, alcohol abuse, drug addiction and drug addiction is made, the mortality rates due to MD may be overestimated, since individuals presenting at least 2 of the above presented disorders are accounted for more than once.

Finally, it was found that among the estimated needs for the period 2022-2030, 53% on average per year corresponds to women. This information complements the validation of the model and is

corroborated by the conclusion of the interviews demonstrated in section 3.2.1 and by values of MHCN reported in the literature that help to understand certain trends in the simulation results such as, for example, the Mental Health Commission of Canada (2010) which estimates that women residing in Canada between 2011 to 2040 represent 53% to 55% of the population with MHCN.

4.3. Mental health care needs during the 2022-2030 period

Chart 4.1 shows the evolution of the number and percentage of MHCN for residents in LTV aged 15 years or more in the period 2022 and 2030, by year. Through its analysis it is possible to see that the need for this type of specialized care is expected to increase by an average of 4.44% per year, reaching an approximate percentage of 69% in 2030.

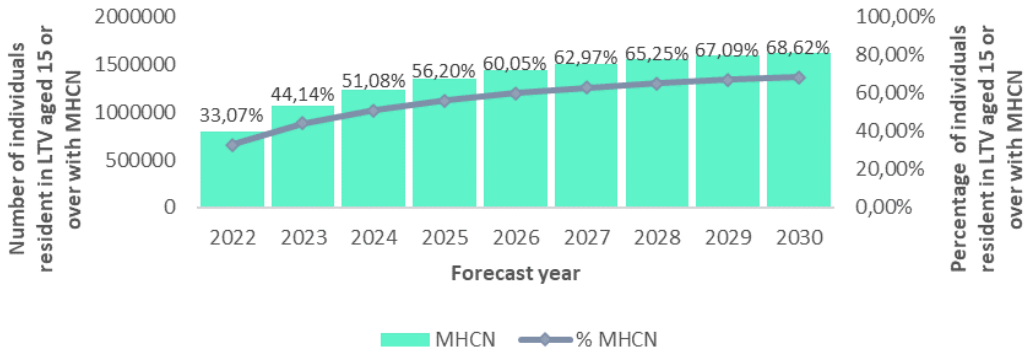

Chart 4.1. Evolution of the number and percentage of MHCN in LTV in the period 2022-2030 *(own elaboration)*

Legend: MHCN – Mental Health Care Needs; LTV - Lisbon and Tagus Valley.

Annex S presents the estimated number of residents in LTV disaggregated by sex, age, state and year. From its analysis is evident that in 2022, 22% of women and 16% of men presented AS or/and DS. Likewise, about 27% of the population aged 15-24 years, 29% of the population aged 15-24 years, and 32% of the population aged 35-44 years presented AS or/and DS.

Figure 4.1 provides a more detailed analysis of the estimated number of residents of LTV aged 15 years and above with MHCN for the period 2022 and 2030, by type of service required (HBC, OC, RC, IC, AC), year and age group. Annex T complements the figure below by presenting the MHCN for the forecast period by sex, type of service required and more disaggregated age groups.

By analyzing the figure 4.1 it is possible to observe that in the period 2022-2030, the needs for HBC, IC and AC are estimated to increase individually each year. Addressing specifically the estimated MHCN, there will be a significant demand for AC services (77.00% in 2022) responsible for addressing most of the estimated needs, with the demand for IC (18.25% in 2022), HBC (3.01% in 2022), OC (1.12% in 2022) and RC (0.62% in 2022) services being relatively similar. Furthermore, the age group that represents the majority of the MHCN is individuals under the age of 65 (on average, 83.45% per year), more specifically individuals between the ages of 35 and 64 (on average, 54.8% per year). However, it can be seen that in the period from 2022 to 2030 it is expected to be, on average, a decrease of -1.06%

per year in the number of people under 65 needing MHC, with a corresponding increase in the number of people aged 65 or over needing this type of care.

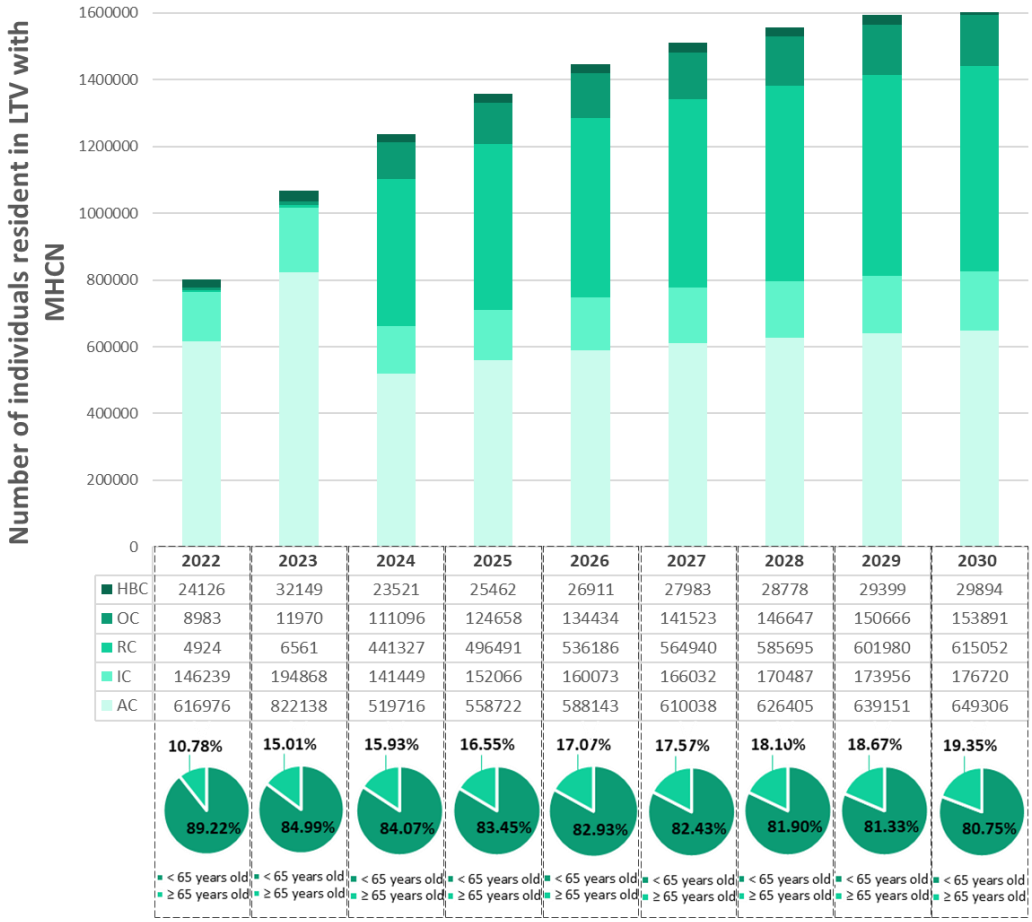

Figure 4.1. Number of residents in LTV with MHCN during the time period 2022-2030 by age group, type of service required and year. *(own elaboration)*

Legend: MHCN – Mental Health Care Needs; LTV - Lisbon and Tagus Valley; HBC – Home-Based Care; OC – Occupational Unit Care; RC – Residential Care; IC – Inpatient Care; AC – Ambulatory Care.

Among the estimated needs for the period 2022-2030, it can be seen from chart 4.2 that most people will not meet their MHCN due to structural or attitudinal barriers (on average 39.9% per year) or lack of recognition (on average 36.3% per year). Thus, it is estimated that on average only 23.8% of the population with MHCN per year would have their needs met.

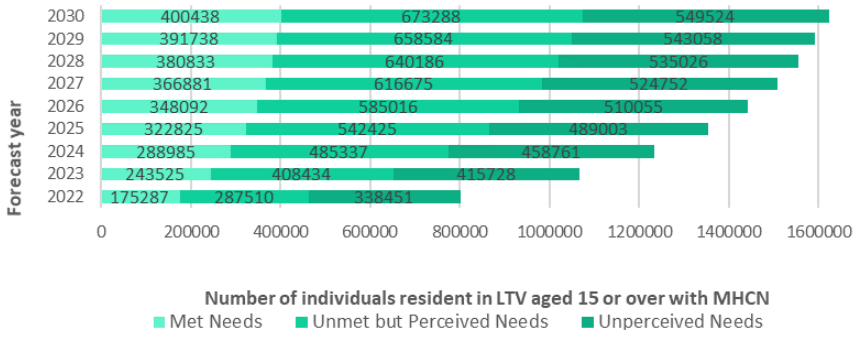

Chart 4.2. Annual MHCN in 2022-2030 by type of service in LTV *(own elaboration)*

Legend: MHCN – Mental Health Care Needs; LTV - Lisbon and Tagus Valley.

4.4. Mental health care needs vs current supply

In order to inform policy makers and managers responsible for MH network planning decisions, this section assesses the adequacy of the supply available in 2016 against the total inpatient and residential care needs (Figure 4.1), perceived and met forecast from 2022 to 2030, specifically, for: (i) the PS which meets 73.74% of IC demand; (ii) the SCS which is responsible for meeting 26.26% of inpatient demand and 100% of RC demand; (iii) the public, social and convention sectors. This analysis relies on knowledge of the number of total, perceived and expected met needs for IC and RC, patients possible to serve with available beds, beds in lack or excess and the percentage of lack or excess capacity among the total beds required to met needs.

The perceived needs for MH inpatient/residential predicted needs are given by multiplying the total predicted needs for inpatient/residential care (obtained by the model proposed here) and the result of the sum between the percentages of met needs and UPN, which are present in Annex U for scenario A and Annex O for scenario B. The same rationale is applied to calculate the met needs for MH inpatient/ residential care as it multiplies the total estimated needs for IC/RC with the percentage of met needs present in Annex U if scenario A is analyzed or Annex O if scenario B is analyzed.

The gap between patients able to serve given existing beds and patients forecasted with MHCN for IC/RC is given by the difference between the number of patients able to serve with 2016 beds by the number of patients with forecasted IC and RC needs or the number of patients with perceived IC and RC needs forecasted. This value can be interpreted as the predicted number of unserved patients if it is negative.

The forecast of the number of potential patients served with the available supply in 2016 depends on the average LOS and the existing beds in the respective year (Table 4.3). Assuming that beds are always occupied, this value can be obtained by multiplying the number of available beds and the number of patients admitted in one year, in one bed (result of the division between 365 days and LOS in days). It is important to note that information regarding the average LOS is limited. To the author's knowledge, only the average LOS of inpatient acute patients (less than 30 days) in the PS is available (ACSS, 2015) and the average LOS of rehabilitation patients in residential homes (dispatch 407/98) (ACSS, 2018). Given the constraint of available data it was assumed that the average LOS of inpatient resident patients is equal to the average LOS in psychosocial rehabilitation in residential homes (dispatch 407/98). To facilitate the comparison and disaggregated planning the average LOS of inpatient in contracted institutions and of rehabilitation in contracted residential care facilities was calculated by dividing the total number of days kept by inpatients during a year by the number of inpatients (OECD, 2021). This may constitute a limitation in that the actual LOS of patients who were

admitted to inpatient care in the previous year is not considered, as of patients who extend their inpatient stay into the following year.

Table 4.3. Number of inpatient and residential beds provided for MHC in LTV by sector *(own elaboration)*

	Public sector		Social and Contractual Sector		
	Acute patients (<30 days)	Resident patients (>30 days)	Patients in residences - dispatch nº 407/98	Patients interned in contracted institutions	Patients admitted to contracted residential care facilities
No. of beds(*)	416	283	125	1303	212
LOS (days)	20(**)	208(**)	208(**)	208(**)	349(*)

Note: (*) Adapted from ACSS (2015); (**) Adapted from CTARSM (2017); (***) Adapted from ACSS (2018).

The number of missing beds is obtained by dividing the gap between patients able to serve given existing beds and patients forecasted with MHCN for IC and the number of patients able to be admitted to a bed, given the average LOS.

The percentage of lack capacity among the total beds needed to meet the needs (perceived or not) is given by dividing the total number of lack beds by the number of beds needed to meet the needs.

It should also be noted that the indicators described below were calculated disaggregated by the respective average LOS and distribution of the use of the various types of IC and RC (Chart 4.3), since there are different average LOS for the same sector (public or social and contracted), depending on the patients' needs and the services provided: (i) gap between patients able to serve given existing beds and patients forecasted with MHCN for IC; (ii) number of potential patients served, of beds lacking/excess; (iii) percentage of lack/excess capacity from among the total beds required to meet needs. It is also noted that, the distribution of the utilization of the various types of IC/RC was given by dividing the total number of inpatients in each type and the total number of inpatients. The number of patients admitted to contracted entities, acute patients and residents in the PS is not provided in the literature, so this value was estimated by multiplying the average beds occupied by the result of the division between 365 days of the year and the respective LOS.

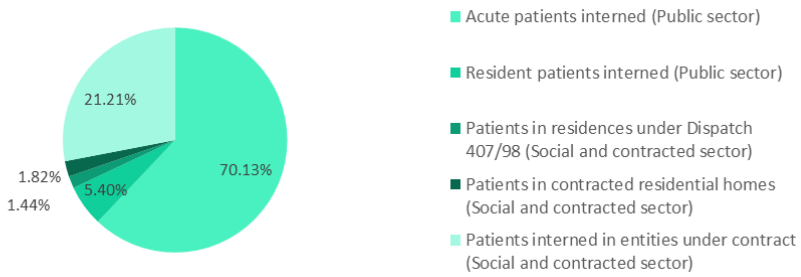

Chart 4.3. Distribution of utilization for the various types of IC and RC in LTV *(own elaboration)*

Once the necessary information for assessing the adequacy of supply in relation to estimated needs/demand was available, an analysis was carried out on two different scenarios.

Scenario A presents the results obtained, considering that the needs for MHC translate only to people with significant symptoms of depression and/or anxiety, thus excluding individuals who belong

to the group of people without significant symptoms of anxiety and depression, but who feel that their QL is affected by it (WDS ∩ WAS ∩ WQL). This scenario arises in an attempt to minimize the overestimation of predicted needs, as biased key parameters such as the probabilities of transition between states and the rates of perception and satisfaction of MHCN were included in the proposed model, which were collected still during the pandemic.

On the other hand, scenario B presents the results obtained by the model proposed in this research, where not only clinical but also perceived needs are considered. In this sense, even though the results may be high by the inclusion of people without significant symptoms of depression and anxiety and without quality of life, this prevention perspective is supported by the opinion of the MH experts interviewed (chapter 3) and is in line with the ideals of the World Health Organization (WHO, 2004) and the National Health Plan (Ministério da Saúde, 2017).

The results evidenced below indicate that the overall service provision, in the PS, and in the SCS is far from meeting the perceived or UN for IC and RC. According to the conditions of scenario A and the analysis of the results obtained in case 1 (Table 4.4) it is possible to see that in 2022 there should be a shortfall of about 88% and 83% of the total beds required in the PS to meet the existing clinical needs (perceived or not) and the perceived projected clinical needs, respectively. Considering only the projected number of patients with met needs, it is concluded that from 2022 onwards (inclusive) there may be a shortage of capacity, reaching a maximum total shortage of 3924 beds in 2030.

Table 4.4. Scenario A: Total, perceived and satisfied aggregate MHCN for public service *(own elaboration)*

Case 1: Public Sector												
Year	Expected need for IC	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with perceived inpatient needs	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with met needs	Unassisted patients	Missing or excess beds	Lack of capacity (%)
2022	65443	-57355	-5260	88,27%	46193	-38105	-3494	83,33%	17107	-9019	-827	54,20%
2023	102917	-94829	-8696	92,56%	72644	-64556	-5920	89,44%	26903	-18815	-1725	71,17%
2024	127632	-119544	-10963	94,01%	90088	-82000	-7520	91,50%	33363	-25275	-2318	76,83%
2025	146641	-138553	-12706	94,79%	103506	-95418	-8750	92,60%	38332	-30244	-2774	79,87%
2026	161391	-153303	-14059	95,26%	113917	-105829	-9705	93,28%	42188	-34100	-3127	81,73%
2027	172772	-164684	-15102	95,58%	121950	-113862	-10442	93,73%	45162	-37075	-3400	82,95%
2028	181566	-173478	-15909	95,79%	128157	-120070	-11011	94,03%	47461	-39374	-3611	83,78%
2029	188692	-180605	-16562	95,95%	133187	-125100	-11472	94,26%	49324	-41236	-3782	84,40%
2030	194614	-186527	-17105	96,07%	137368	-129280	-11856	94,43%	50872	-42784	-3924	84,88%

Note: All figures have been rounded

As shown in Table 4.5, 37522 beds will be required in 2030 from the SCS (95.81% of the required beds) to meet the expected MHCN. Considering the forecasted perceived clinical needs, it is possible to understand that in 2030, 25986 beds will be needed (94.06% of the required capacity in the sector). Regarding the anticipated met needs it is found that from 2022 onwards (inclusive) there may be a lack of capacity, with a maximum in 2030 of 83.92% of the required beds.

Table 4.5. Scenario A: Total, perceived and satisfied aggregate MHCN for social and contracted sector *(own elaboration)*

Case 2: Social and contracted sector												
Year	Expected need for IC	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with perceived inpatient needs	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with met needs	Unassisted patients	Missing beds	Lack of capacity (%)
2022	21202	-18478	-11493	87,51%	14965	-12241	-7614	82,28%	5542	-2818	-1753	51,67%
2023	33342	-30618	-19044	92,07%	23534	-20811	-12944	88,75%	8716	-5992	-3727	69,44%
2024	41349	-38625	-24025	93,61%	29186	-26462	-16459	90,94%	10809	-8085	-5029	75,41%
2025	47507	-44783	-27855	94,44%	33533	-30809	-19163	92,12%	12418	-9695	-6030	78,62%
2026	52286	-49562	-30827	94,95%	36906	-34182	-21261	92,84%	13667	-10944	-6807	80,58%
2027	55973	-53249	-33120	95,28%	39508	-36784	-22880	93,31%	14631	-11908	-7406	81,87%
2028	58822	-56098	-34893	95,51%	41519	-38795	-24130	93,64%	15376	-12652	-7870	82,75%
2029	61131	-58407	-36329	95,68%	43149	-40425	-25144	93,88%	15980	-13256	-8245	83,41%
2030	63049	-60325	-37522	95,81%	44503	-41779	-25986	94,06%	16481	-13757	-8557	83,92%

Note: All figures have been rounded

Observing the results obtained in case 3 (Table 4.6), it is possible to determine that in order to meet the existing clinical needs (perceived or not) and the forecasted perceived needs there will be a shortage of approximately 86% and 80% of the total beds needed in 2022, respectively. Considering only the expected number of patients with met clinical needs, it is concluded that as of 2022 (inclusive) there may be a shortage of capacity, reaching a maximum total lack of about 82.22% of the required beds (12104 beds).

Table 4.6. Scenario A: Total, perceived and satisfied aggregate MHCN for public, social and contracted sectors *(own elaboration)*

Case 3: Public, social and contracted sectors												
Year	Expected need for IC	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with perceived inpatient needs	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with met needs	Unassisted patients	Missing beds	Lack of capacity (%)
2022	86645	-75344	-16270	86,14%	61158	-49857	-10766	80,44%	22649	-11349	-2451	48,35%
2023	136259	-124959	-26983	91,16%	96178	-84877	-18328	87,50%	35618	-24318	-5251	66,73%
2024	168981	-157680	-34049	92,86%	119274	-107974	-23316	89,91%	44172	-32871	-7098	73,06%
2025	194148	-182848	-39484	93,78%	137038	-125738	-27152	91,21%	50750	-39450	-8519	76,49%
2026	213677	-202376	-43701	94,35%	150823	-139522	-30128	92,01%	55855	-44555	-9621	78,61%
2027	228744	-217444	-46955	94,72%	161458	-150157	-32425	92,53%	59794	-48493	-10472	80,00%
2028	240388	-229087	-49469	94,97%	169676	-158376	-34200	92,89%	62837	-51537	-11129	80,96%
2029	249823	-238523	-51506	95,16%	176336	-165036	-35638	93,16%	65304	-54003	-11661	81,67%
2030	257663	-246363	-53199	95,31%	181870	-170570	-36833	93,36%	67353	-56053	-12104	82,22%

Note: All figures have been rounded

Giving primacy now to the conditions of scenario B, it can be seen in table 4.7 that, similarly to scenario A for the aggregate needs of the PS, it is also concluded here that the number of existing beds in the PS in 2016 will be insufficient to meet existing needs (perceived or not), perceived needs and expected satisfied needs, and the MH network managers will have to increase in 2022, 9729, 5805 and 1713 beds respectively.

Table 4.7. Scenario B: Total, perceived and satisfied aggregate MHCN for public service *(own elaboration)*

Case 1: Public Sector												
Year	Expected need for IC	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with perceived inpatient needs	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with met needs	Unassisted patients	Missing or excess beds	Lack of capacity (%)
2022	114174	-106087	-9729	93.30%	71392	-63304	-5805	89.25%	26772	-18684	-1713	71.03%
2023	152141	-144053	-13210	94.97%	95132	-87044	-7982	91.95%	35674	-27587	-2530	78.35%
2024	175709	-167621	-15372	95.65%	109869	-101781	-9334	93.03%	41201	-33113	-3037	81.29%
2025	192975	-184887	-16955	96.04%	120665	-112577	-10324	93.66%	45249	-37162	-3408	82.98%
2026	205644	-197557	-18117	96.29%	128587	-120499	-11050	94.05%	48220	-40132	-3680	84.04%
2027	214927	-206840	-18968	96.45%	134391	-126304	-11583	94.31%	50397	-42309	-3880	84.73%
2028	221730	-213642	-19592	96.56%	138645	-130557	-11973	94.48%	51992	-43904	-4026	85.21%
2029	227050	-218962	-20080	96.64%	141971	-133883	-12278	94.61%	53239	-45151	-4141	85.56%
2030	231306	-223218	-20470	96.70%	144633	-136545	-12522	94.71%	54237	-46149	-4232	85.82%

Note: All figures have been rounded

Furthermore, there is also a large discrepancy between the expected total, perceived or fulfilled clinical needs for IC and RC in the SCS and the number of patients that can be served with the current available capacity in the respective sector. As shown in Table 4.8, 92.85% of the beds required to meet the expected MHCN will be needed in 2022. Considering the forecasted perceived needs, it is possible to understand that in 2030 88.56% of the required capacity will be needed in the sector. Regarding the forecast met needs it is found that although there should be a shortfall in capacity from 2022 to 2030, reaching a maximum shortfall of 84.64% of the beds required.

Table 4.8. Scenario B: Total, perceived and satisfied aggregate MHCN for social and contracted sector *(own elaboration)*

Case 2: Social and contracted sector												
Year	Expected need for IC	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with perceived inpatient needs	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with met needs	Gap between patients able to serve and forecasted met needs for IC	Missing or excess beds	Lack of capacity (%)
2022	36989	-34265	-21313	92.85%	23129	-20405	-12692	88.56%	8673	-5950	-3701	69.29%
2023	49289	-46565	-28963	94.64%	30820	-28096	-17476	91.42%	11557	-8834	-5494	77.01%
2024	56924	-54201	-33712	95.36%	35594	-32870	-20445	92.57%	13348	-10624	-6608	80.12%
2025	62518	-59794	-37192	95.78%	39092	-36368	-22621	93.24%	14659	-11936	-7424	81.91%
2026	66622	-63899	-39745	96.04%	41658	-38934	-24217	93.66%	15622	-12898	-8023	83.03%
2027	69630	-66906	-41615	96.21%	43539	-40815	-25387	93.93%	16327	-13603	-8461	83.76%
2028	71834	-69110	-42986	96.33%	44917	-42193	-26244	94.12%	16844	-14120	-8783	84.26%
2029	73557	-70833	-44058	96.41%	45994	-43271	-26914	94.26%	17248	-14524	-9034	84.64%
2030	74936	-72212	-44916	96.48%	46857	-44133	-27450	94.36%	17571	-14847	-9235	84.92%

Note: All figures have been rounded

Observing the results obtained in case 3 of scenario B (Table 4.9) it is possible to ascertain that the bed capacity in 2016 will not be sufficient to satisfy the existing needs (perceived or not), perceived and satisfied projected needs from 2022 to 2030, missing in 2022 about 93%, 89% and 69% of the total beds needed, respectively.

Table 4.9. Scenario B: Total, perceived and satisfied MHCN for public, social and contracted sectors *(own elaboration)*

Case 3: Public, social and contracted sectors												
Year	Expected need for IC	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with perceived inpatient needs	Unassisted patients	Missing beds	Lack of capacity (%)	Predicted patients with met needs	Gap between patients able to serve and forecasted met needs for IC	Missing or excess beds	Lack of capacity (%)
2022	36989	-34265	-21313	92.85%	23129	-20405	-12692	88.56%	8673	-5950	-3701	69.29%
2023	49289	-46565	-28963	94.64%	30820	-28096	-17476	91.42%	11557	-8834	-5494	77.01%
2024	56924	-54201	-33712	95.36%	35594	-32870	-20445	92.57%	13348	-10624	-6608	80.12%
2025	62518	-59794	-37192	95.78%	39092	-36368	-22621	93.24%	14659	-11936	-7424	81.91%
2026	66622	-63899	-39745	96.04%	41658	-38934	-24217	93.66%	15622	-12898	-8023	83.03%
2027	69630	-66906	-41615	96.21%	43539	-40815	-25387	93.93%	16327	-13603	-8461	83.76%
2028	71834	-69110	-42986	96.33%	44917	-42193	-26244	94.12%	16844	-14120	-8783	84.26%
2029	73557	-70833	-44058	96.41%	45994	-43271	-26914	94.26%	17248	-14524	-9034	84.64%
2030	74936	-72212	-44916	96.48%	46857	-44133	-27450	94.36%	17571	-14847	-9235	84.92%

Note: All figures have been rounded

CHAPTER 5

Conclusions and future research

5.1. Conclusions

The increase in the ageing phenomenon, the prevalence and incidence of MD, the associated morbidity and the socio-economic constraints caused by the pandemic crisis make the adequate planning of MH services and associated resources one of the priorities on the health policy agenda in Portugal. However, there is no information about the current and future demand/needs for MHC, which corresponds to one of the crucial inputs for the strategic and tactical planning of the network.

Therefore, different demand/needs forecasting methods have been developed in the literature for several HC areas, but the applications in MH are scarce and limited to certain diseases such as alcohol and substance addiction or dementia. Most studies focus on the use of epidemiological data (overestimating demand/needs) and a minority of studies are based on the historical use of HC (underestimating demand/needs, in the case of current supply restricting effective demand/needs, which corresponds to the example of Portugal, as can be seen in the results obtained in this study), with few models combining these 2 approaches.

Thus, the present study addresses the gap identified in the literature by applying a Markov cycle tree model that aims at quantifying the future needs for the different types of MHC (IC, AC, HBC, OC and RC) in the LTV region based on epidemiological data (mortality rates symptomatology of depression and anxiety coupled with the compromise this has on the quality of life of individuals) and historical data (distribution of MHC required by typology), distinguishing between needs that are met (effective demand) and those that are consciously dissatisfied (perceived needs) or not (unrecognized needs). This represents an innovation in the area, since the methods verified in the literature were not concerned with estimating this information that should be used by managers in planning the MH network and by politicians for the definition of public policies in order to reduce the occurrence of situations of unmet recognized needs or unrecognized needs.

The conclusion of these estimates depended on 3 distinct phases. In the first instance, an attempt was made to interview MH experts to clarify which characteristics imply the need for MHC, as well as to understand which aspects help to identify individuals who (i) recognize the need and seek MHC; (ii) recognize MHCN but do not seek care; (iii) do not recognize MHCN but have clinical needs; (iv) do not need care. This phase essentially concluded that MD are multifactorial, which makes it difficult to define risk factors for the respective groups. However, it was defined that, from the perspective of MHC prevention, all individuals who consider that their global functioning is compromised for mental reasons or present significant symptoms of MD need MHC. By combining this information with the references found in the literature, a simulation model was developed that builds estimates based on

the assessment of the symptoms of depression and anxiety (the most prevalent and expressed diseases in Portuguese society) through scales validated in the literature (GAD-7 and PHQ-9) and the impairment that symptoms have on the quality of life of individuals. Subsequently, a survey was carried out to LTV residents, with the main purpose of reaching a critical input for the application of the model, the transition probabilities between the designed states. From the data collected in this primary source, it was also possible to collect which factors have the greatest importance in the demand for mental health care, the percentages of satisfied and unmet needs (perceived or not), as well as to characterize these groups according to demographic data. The results obtained at this stage allow us to conclude that cost, recommendations from institutions or health professionals and the existence of agreements with insurers were the factors that most influence the choice of one mental health care over another. In addition, there is about 21% of perceived and unsatisfied needs and 20% of unrecognized needs. Thus, in order to reduce unrecognized needs, politicians should create prevention and promotion actions aimed mainly at men, individuals aged 15-24 and 35-44, single and divorced, with basic or higher education levels, students or unemployed. On the other hand, in order to reduce the group of individuals with perceived needs and unsatisfied by structural and attitudinal barriers, policies should be defined aimed predominantly at women, individuals aged between 15-24 and 35-44, single, with complete secondary or higher education, students or unemployed, with/without low monthly incomes.

To validate the model, a retrospective application of the model was applied and compared with available information on the demand for MHC in LTV. Although the model results may be overestimated because the key model parameters were collected at a time when the effect of the pandemic crisis on MH was significant, the results obtained are in line with what was expected, showing that the total needs (perceived or not) are higher than the observed demand. This conclusion fortifies the choice of a prediction model based not only on utilization data but also on epidemiological data.

The application of the model revealed important aspects for MH network managers and policy makers: (i) MHCN will increase by 2030, reaching 68.62% of the local population; (ii) women are more likely to need MHC, as evidenced in the literature and in the interviews carried out; (iii) individuals aged 15-54 years represented a large proportion of MHC, as supported by the literature, although this finding may be biased as it was difficult to reach people aged over 75 years to participate in the survey; (iv) although outpatient care shows the highest percentage of care provided, there is also a considerable percentage of inpatient care. In cases of prolonged internments, consideration should be given to the option of expanding the capacity for residential care or creating new services closer to the community as substitute services for institutional care for some inpatients. This will free up capacity in psychiatric hospitals and according to WHO should increase the quality of treatment.

To conclude, the adequacy of IC and RC supply in 2016 was assessed for estimated needs in the public, private and convention sector, according to 2 different scenarios. The scenarios differ from each other in the definition of MHCN. Scenario A assumes that the key parameters and assumptions used in the model by the existing limitations overestimate the estimated needs, so only individuals with significant symptoms of depression and anxiety are considered to have MHCN. While in scenario B, the concept of MHCN meets the concept presented by the MH experts interviewed and the MD prevention ideal advocated by the WHO (WHO, 2013).

From this analysis it was concluded, as expected, that in a pessimistic hypothetical situation where the 2016 capacity remains the same until 2030, the number of beds made available for IC and RC is not appropriate to meet the existing total and perceived needs.

Importantly, the scenarios can be adapted by policy makers and managers of the MHC network as political, financial or management issues arise, such as redirecting institutionalized patients to new care closer to the community.

In summary, with the application of the proposed model to a small area (LTV), the proposed thesis objective was globally achieved.

5.2. Limitations

This study presents limitations that may be taken into account in future research:

- Even though the representativeness of the sample obtained from the survey has been validated, the collection of information from this method may contain the limitation of not easily obtaining the participation of specific groups such as the elderly, people with low income, individuals hospitalized or even with high dependency. Underrepresentation of these groups may give rise to skewed prevalence and transition probabilities between states. In addition, the survey may raise questions about the total veracity of the data obtained given that in a survey, respondents evaluate the questions against hypothetical scenarios (especially, in the question that asks for self-reflection of symptoms experienced in 2019).
- In the interview phase, a small number of 5 experienced MH professionals in different practice areas were recruited, given the reduced availability caused by the pandemic context.
- The estimates developed could be more precise if more information on the evolution of mortality, survival and prevalence rates, the probabilities of transition between states, the percentages of people with met, unmet needs (consciously or unconsciously) and the distribution of the various MHC over time were available. However, as there is no clear understanding of the above data and as the planning horizon is only 9 years, this hypothesis was chosen as the most feasible to provide a robust model;

- MHCN were only determined according to the following MD: (i) anxiety disorder, (ii) depression disorder or (iii) both. Although it may not cover all the existing MHCN, this hypothesis was considered the most feasible according to literature references and the interviews carried out with MH experts;
- Several questions arise regarding the LOS: (i) the average LOS was calculated by dividing the number of inpatient days by the number of inpatients, since there are no disaggregated data by type of service; (ii) the average LOS for both resident inpatients and inpatients in contracted entities, it was assumed that the average LOS rate would be the same as that of inpatients of integrated continuous MHC residences, as there is limited information available and due to the fact that most of them are long-stay patients.

5.3. Future Research

As future research more professionals with different job functions (for example, nurses) should be interviewed to ensure greater representativeness of what occurs across all sectors of the MHC.

In addition, one should consider constructing estimates of MHCN that are more disaggregated by: (i) various MD (namely psychoses, alcohol and drug addiction, among others), with different groups of patients requiring different care; (ii) various reasons for unmet and perceived needs, that is unmet needs for structural and attitudinal reasons. Estimates may become even more accurate if: (i) MH experts validate the proposed model as well as the data used; (ii) the transition probabilities between states are updated regularly for specific periods, as these may vary depending on socio-economic issues such as the pandemic situation; (iii) sensitivity analyses are conducted on the constant data used in the model, namely, distribution of care utilization, prevalence rates, transition probabilities between states, distribution of satisfaction and perception of needs; (iv) current data on the LOS, number of beds and patients served in the various types of MHC are made available.

The application of the proposed model to the remaining regions of Portugal (North, Centre, Alentejo, Algarve, Madeira and Azores Islands) or other countries where depression and anxiety justify most of the services provided and where the typologies of MHC are similar, can also be covered. The generic model can even be applied to different contexts of the NHS. Another suggestion is to use the proposed model as an input for a mathematical programming model with the aim of efficiently planning the supply and resources associated with MHC against the estimated needs in each region. This tool can better inform policymakers in the choice of actions to prevent MD directed to specific target audiences, such as the definition of investment in the different sectors, especially the convened sector, where the state contracts places in convened entities to treat patients referred from the National Mental Health System.

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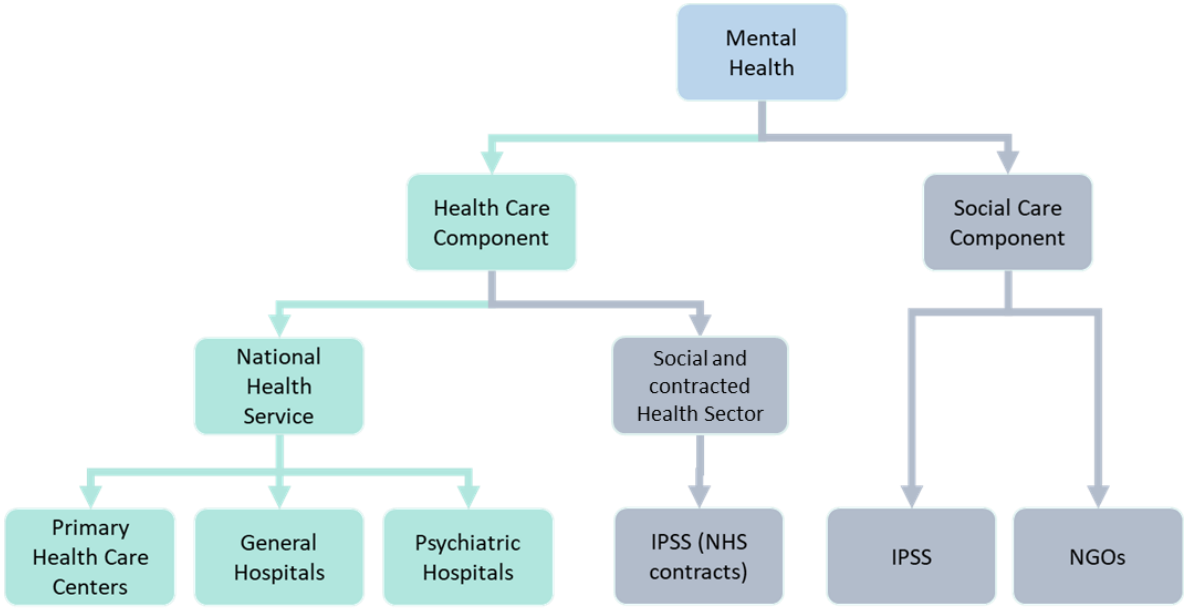
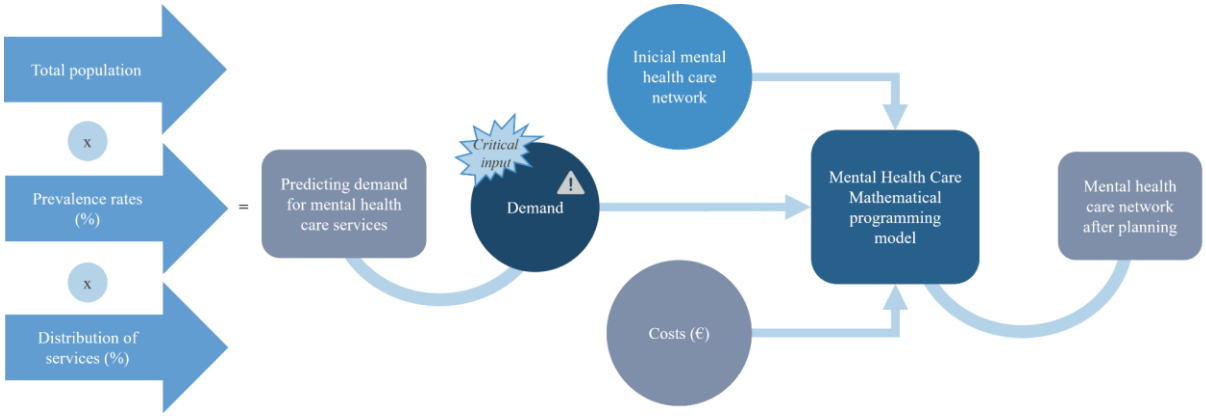
Annexes

Annex A - Mental Health Care Structure in Portugal (adapted from ACSS (2015))



Annex B – Representation of the methodology used in Monteiro's study (Adapted from Monteiro (2016))



Annex C – Assessment scales of mental disorders used in literature (own elaboration)

Scale	Item	Advantages	Disadvantages
MINI	>80	• Interview to assess various MD; • Score is accessible, since the evaluation criteria and points for detecting the presence of MD appear in the interview script.	• Extensive interview that can only be guided by clinicians or someone who has intensive training; • It is not possible to guarantee with absolute certainty that some factors will be considered in the response (e.g., duration); • The scale has not yet been validated for the Portuguese context.
SRQ-20	20	• Accessible scoring method; • Questions reflect on depression, anxiety and psychosomatic complaints, being used in literature to detect cases of MD with satisfactory accuracy; • Developed by a recognized organization. There are no restrictions on its use.	• Extensive questionnaire, since it has 20 questions; • The cut-off in any scale varies in different contexts (depending on culture, language, gender) (Giang et al., 2006; Ventevogel et al., 2007). The scale has not yet been validated for the Portuguese context.
WHO-5	5	• Short Questionnaire and accessible scoring method; • Adequate validity in depression screening (Topp et al., 2015). • No permission is needed to access and use of the survey (WHO, 1998).	• It does not assess symptoms of several MD, and it only has good consistency when used to screen for depression and the severity of the respective symptoms; • The scale has not yet been validated for the Portuguese context.
GHQ-12	12	• Short self-completion survey and simple to assess (Montazeri et al., 2003); • GHQ-12 was culturally valid in the Portuguese context (Laranjeira, 2008): • No permission is needed to access and use the survey.	• It does not measure psychotic problems or the function of relationships (Anjara et al., 2020). • Although GHQ-12 has been validated for the Portuguese context, the author of this thesis does not have access to the respective article.
PHQ-9	9	• Short self-filling survey and accessible scoring system; • Instrument validated in the Portuguese context (Ferreira et al., 2018). The authors suggests a cut-off of 9 for the identification of major depression; • Pfizer holds the copyright of the survey, however, no permission is needed.	• It only assesses depressive symptoms.
GAD-7	7	• Short self-completion survey and accessible scoring system; • Culturally validated tool for the Portuguese context (Sousa et al., 2018); • Pfizer holds the copyright of the survey, however, no permission is needed.	• It only assesses symptoms for the 4 most common anxiety disorders
HADS	14	• Short self-filling survey (Snaith, 2003) and accessible scoring system; • Culturally validated instrument for the Portuguese context (Pais-Ribeiro et al., 2007); • Unrestricted access to the questionnaire.	• Only assesses symptoms of depression and anxiety. • Article validating the scale for the Portuguese context has a rating of Q2/Q3.

Annex D - Specifications of the different studies using simulation models in the health care services in general and more particularly in the mental health care (own elaboration)

Models			Type of data used			Distinction between effective demand, effective, perceived and non-perceived needs?	Application		
Authors	Method	Objective	Epidemiological data	Historical data	Both		Applied to MH Sector	Country	Forecast period
Xue et al. 2001	Regression Model	Support planning for ESRD by estimating the number of treated, new and waiting list patients.		X		Effective demand and unmet needs due to structural barriers		USA	1998-2010
Wancata et al. 2003	Extrapolation Model	Estimate the number of dementia cases in Europe using incidence and prevalence of dementia cases by age in the year 2000.	X			Effective needs	X	Europe	2000-2050
Wimo et al. 2003	Extrapolation Model	Estimate the worldwide occurrence of dementia using prevalence and incidence rates, by age group and sex.	X			Effective needs	X	Worldwide	1950-2050
Gilbertson et al. 2005	Markov Model	Estimate the incidence, prevalence of ESRN and mortality by 2015.	X			Effective needs		USA	1978-2015
Patten et al. 2005	Markov Model	Estimate the prevalence of periods of major depression.	X			Effective needs	X	Canada	1 year
Cardoso et al. 2012	Markov Model	Support LTC care network planning by forecasting the number of people requiring LTC services annually.	X			Effective needs		Portugal	2010-2015
Huang et al. 2013	SD Simulation	Develop models for epidemiological projection of KD.			X	Effective demand		USA Taiwan	2010-2030
Turkiewicz et al. 2014	Regression model	Predict the demand for healthcare by the impact people with cases of OA by 2032.			X	Effective needs		Sweden	2012-2032
Borralho, 2016	Markov model	Current and future needs of palliative care patients in their different settings.	X			Effective needs		Portugal	2016-2021

Annex D - Specifications of the different studies using simulation models in the health care services in general and more particularly in the mental health care (continuation)

Models			Type of data used			Distinction between effective demand, effective, perceived and non-perceived needs?	Application		
Authors	**Method**	**Objective**	**Epidemiological data**	**Historical data**	**Both**		**Applied to MH Sector**	**Country**	**Forecast period**
Monteiro, 2016	Markov model	Estimating the MHCN based on the characteristics of the population.			X	Effective needs	X	Portugal	2016-2019
Lay-Yee et al. 2017	Microsimulation	Predict the future use of social care by older people in New Zeland.			X	Effective demand		New Zealand	2001-2021
Kingston et al. 2018	Microsimulation	Predicting the number of older people living with care needs of different intensities. This will enable health and social care services to adapt to the needs of the elderly population.	X			Effective needs		England	2015-2035
Xiaodong & Yuhua, 2018	Markov Model	China's 10-year LTC demand forecast.	X			Effective needs		China	10-year period
Ishikawa et al. 2019	Extrapolation model	Support human resource planning by forecasting future demand.		X		Effective demand		Japan	2015-2035
Rosa, 2019	Extrapolation model	Forecast the demand for MHC considering the current prevalence rates by age group and the population projections.	X			Effective needs	X	Portugal	2020-2022
McRae S. 2021	Regression model	Forecast future regional demand for different hospital services considering demographic changes and changes in incidence rates.			X	Effective demand		Germany	2018-2027
Sugawara et al. 2021	Extrapolation model	Estimate the distribution of psychiatrists for patients with MD by estimating the demand.		X		Effective demand	X	Japan	2015-2045

Annex E- Brief characterization of the experts interviewed (own elaboration)

Subject area	Professional Experience	Identification
General medicine (1 interview)	Graduated in 1980 and in 1981 started general internship in the civil hospitals of Lisbon. In 1985 started a specialty in general and family medicine, becoming head of service in 2001. In 2003 retired following an accident on duty, and to the present day the doctor has been working in private clinic.	Interview 1
Psychiatry (1 interview)	The doctor finished her specialty in psychiatry in 2002 and since then has worked in a psychiatric hospital located in Porto. In 2016 took over the position of clinical director. Simultaneously, she has been teaching at 2 renowned universities in psychology and nursing specialization courses for around 20 years.	Interview 2
Psychology (2 interviews)	In 1991 finished a degree in Social and Organizational Psychology. For 9 years she worked in the HR area and then did a specialization in Clinical Psychology. For 21 years she worked with children, adolescents and adults in psychological consultations. Always as a liberal professional never worked in entities that had to be subordinated to them.	Interview 3
	Since 1990 has been working in the MH sector and at the moment is working in the City Council of Almada. Her specialty is Pregnancy and Maternity Psychology, and her function is to accompany the pregnancy process, including the pre and postpartum periods.	Interview 4
Scientific research (1 interview)	In 2015, the researcher obtained a doctorate in Psychology. Since then, she has been a lecturer in the master's degree in Community Psychology, Protection of Children and Young People at Risk and an Integrated Researcher at the CIS-IUL. Her research interests include victimology, protection of children and young people at risk, family and residential care, family psychology, psychological assessment, and professional skills.	Interview 5

Annex F - Interview guide for mental health professionals (own elaboration)

Section	No.	Questions
Statistical Data on Mental Disorders	**1**	Taking into consideration your years of experience in the MH sector, which disorders do you consider most frequent in society and which are not expressed in the population?
	2	Given your experience, which MD have the highest mortality rate?
Individuals with MHCN	**3**	What are the main visible symptoms/warning signs of people with a MHCN? What questions do you usually ask to understand the need and diagnose a possible disorder?
	4	Are there characteristics that increase the probability of people needing MHC?
Individuals who recognize MHCN and demand care	**5**	From the many years of experience that you have in the sector, what are the characteristics that increase the probability of people needing MHC and effectively seeking this type of care?
Barriers to unmet MHCN	**6**	There is a percentage of people who do not receive MHC, either because the system does not have the necessary resources or because there is no demand for this care. Therefore, what are the factors that justify not seeking MHC? How do you identify these people?
Unperceived (UN) MHCN	**7**	What characteristics increase the probability of people needing MHC and not identifying that they have emotional problems?

Individuals with unmet MHCN due to attitudinal barriers	**8**	Based on your experience, what characteristics increase the probability of people needing MHC and not seeking care by their own choice?
Factors influencing preference for MHC	**9**	What factors influence the preference of people with MHCN to choose one specialist care over another.
Recomendations	**10**	Considering that there are barriers on both the demand and supply side, what recommendations would you make to improve MH services, and meet all existing needs?

Annex G - Interview guide for a scientific researcher in the field of mental health (own elaboration)

Section	No.	Questions
Statistical data on Mental Disorders	**1**	Taking into consideration your years of experience in the MH sector, which disorders do you identify as the most frequent in society? And what is the percentage associated with the care provided in anxiety and/or depression disorders?
	2	Given your experience, which MD have the highest mortality rate?
Individuals with MHCN	**3**	What factors, in your opinion, imply the need for MHC?
	4	Are there characteristics that increase the probability of people needing MHC?
MHCN assessment instruments	**5**	Are there validated scales in the literature that allow knowing the factors/characteristics of individuals with MHCN?

Annex H – Survey

Master's Thesis: Forecasting Needs for Mental Health Care Services

This survey is part of my Master's dissertation in Management at ISCTE - Instituto Universitário de Lisboa and is intended for citizens living in Lisbon and Tagus Valley.

Since Portugal is the second country in Europe with the highest prevalence of psychiatric disorders and considering that it does not have an adequate offer to meet the existing needs in this area, it is essential to invest in an adequate planning of these services and the associated resources (human and material).

In this context, this study aims to support the planning of the mental health network in Portugal, being particularly focused on the identification and quantification of the actual needs associated with this care, as well as on the identification of the factors that influence these needs.

Your participation is crucial to the development of this study. Therefore, to collaborate you will only have to complete the following survey, which will take approximately 5 to 10 minutes.

Your participation in the study is voluntary and anonymous, therefore confidentiality is assured. The data will be used exclusively for academic purposes.

Should any questions arise or should you wish to make any comments regarding the survey, please do not hesitate to contact me at the following e-mail address: cfhga@iscte-iul.pt

Thank you very much for your collaboration and availability.

Section 1: Sociodemographic data

Q1: Sex

1. Female
2. Male

Q2: Please indicate your age with numbers: _____

Q3: Region of residence

1. North
2. Centre
3. Lisbon and Tagus Valley
4. Alentejo
5. Algarve
6. Autonomous Region of Azores
7. Autonomous Region of Madeira

Q4: Marital Status

1. Single
2. Married or Registered partnership
3. Widowed
4. Divorced

Q5: Higher level of education completed

1. Basic Education (up to 9th grade)
2. Secondary Education (up to Year 12)
3. Higher Education - Professional Higher Technical Course
4. Higher Education - Bachelor or Degree
5. Higher Education - Pre-bologna degree or master's degree
6. Higher Education - Doctorate

Q6: Professional status

1. Paid employment (includes professional internship)
2. Student or curricular internship
3. Retired
4. Unemployed

Q7: Please indicate your net monthly income bracket:

1. No income
2. Up to 500 euros
3. 501-700 euros
4. 701-900 euros

5. 901-1100 euros
6. 1101-1300 euros
7. 1301-1500 euros
8. 1501-1800 euros
9. 1801-2200 euros
10. 2201-2900 euros
11. More than 2900 euros

Section 2: Symptoms of depression and anxiety at 2021

Q8: During the last 14 days, how often did you feel you were affected by the following problem(s)?

	Not at all	Less than half the days	More than half the days	Nearly every day
Little interest or pleasure in doing things.				
Feeling down, depressed, or hopeless.				
Trouble falling or staying asleep or sleeping too much.				
Feelling tired or having little energy.				
Poor appetite or overeating.				
Feeling bad about yourself - or that you are a failure or have let yourself or your family down.				
Trouble concentrating on things, such as reading the newspaper or watching television.				
Moving or speaking so slowly that other people could have noticed. Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual.				
Thoughts that you would be better off dead, or of hurting yourself.				
Feeling nervous, anxious or on edge.				
Not being able to stop or control worrying.				
Worrying too much about different things.				
Trouble relaxing.				
Being so restless that it is hard to sit still.				
Becoming easily annoyed or irritable.				
Feeling afraid as if something awful might happen.				

Q9: Do you feel that this problem(s) has/have interfered negatively with your work, taking care of your things at home, or socializing with other people?

1. Yes
2. No

Section 3: Causes that trigger the MHCN in 2 distinct moments

Q10: What were the cause(s) that triggered the problem(s) you selected?

1. Employment situation: You are unemployed, retired or do not adapt to the conditions of your new job.
2. School situation: You have school problems or have children with school problems.
3. Marital Relationships: Are you having marital problems, divorced or have ended a love relationship.
4. Exposure to violence.
5. Personal/Family Health: You or a loved one has suffered a chronic or disabling illness close to you has died.
6. Social rejection: I feel that my social circle plays a destructive/discouraging role in my life/decisions.
7. No cause identified.
8. Other. Which one?

Section 4: Symptoms of depression and anxiety at 2019

Q11: In order to recognize your situation in the period before the pandemic, in the last 2 weeks of 2019 or so, how often did you feel you were affected by the following problem(s)?

	Not at all	Less than half the days	More than half the days	Nearly every day
Little interest or pleasure in doing things.				
Feeling down, depressed, or hopeless.				
Trouble falling or staying asleep or sleeping too much.				
Feelling tired or having little energy.				
Poor appetite or overeating.				
Feeling bad about yourself - or that you are a failure or have let yourself or your family down.				
Trouble concentrating on things, such as reading the newspaper or watching television.				
Moving or speaking so slowly that other people could have noticed. Or the opposite - being so fidgety or restless that you have been moving around a lot more than usual.				
Thoughts that you would be better off dead, or of hurting yourself.				
Feeling nervous, anxious or on edge.				
Not being able to stop or control worrying.				
Worrying too much about different things.				
Trouble relaxing.				
Being so restless that it is hard to sit still.				
Becoming easily annoyed or irritable.				
Feeling afraid as if something awful might happen.				

Q12: Did you feel that this problem(s) has/have interfered negatively with your work, taking care of your things at home, or socializing with other people?

1. Yes
2. No

Section 5: Causes that trigger the MHCN at 2019

Q13: What were the cause(s) that triggered the problem(s) you selected?

1. Employment situation: You are unemployed, retired or do not adapt to the conditions of your new job.
2. School situation: You have school problems or have children with school problems.
3. Marital Relationships: Are you having marital problems, divorced or have ended a love relationship.
4. Exposure to violence.
5. Personal/Family Health: You or a loved one has suffered a chronic or disabling illness close to you has died.
6. Social rejection: I feel that my social circle plays a destructive/discouraging role in my life/decisions.
7. No cause identified.
8. Other. Which one?

Section 6: Satisfaction and perception of MHCN

Q14: In the last 12 months, have you felt the need to seek specialist mental health care from general practitioners, psychiatrists, psychologists, psychotherapists, occupational therapists and/or nurses? (If the participant ticks option: 1 proceed to question 17; 2 proceed to question 15; 3 proceed to question 16; 4 proceed to question 18)

1. Yes, I needed and received.
2. Yes, I needed and sought, but I didn't because receive proper treatment.
3. Yes, I needed but I didn't look for it.
4. No.

Section 7: Attitudinal and structural barriers that justify not seeking MHC

Q15: Which of the following option(s) best describes why you did not receive adequate mental health care? (After marking the answer, proceed to 17)

1. Required medicines not always available.
2. Mental health professionals are not available when needed.
3. I am on the waiting list for receive mental health care.
4. The attitude of service providers towards patients is not adequate.
5. There were/are no health professionals for the situation I faced/am facing.

6. Another option. Which one?

Q16: Which of the following option(s) best describes why you did not seek mental health care?

(After marking the answer, proceed to 17)

1. I didn't know how or where to get help.
2. Did not have the financial resources to support the cost and/or considered the cost too expensive for the type of services that exist.
3. I have been discouraged by my social circle (e.g. negative opinions from neighbours/family/friends/work colleagues).
4. Health insurance does not cover necessary mental health services.
5. I was not ready to start this process.
6. Concerned about confidentiality.
7. Concerned about the creation of a possible dependency (e.g. taking medication).
8. He thought he could deal with the problem without help/treatment.
9. I didn't have time.
10. No access to travel facilities.
11. Another option. Which one?

Section 8: Factors that influence the choice of MHC

Q16: Considering that you felt/feel the need to use mental health care, how important would the following factors be in choosing this type of specialized services. Rank them from 1 (most important) to 7 (least important), dragging the factors to the desired position. (After ticking the answer, proceed to the end of the survey)

- Access to transport.
- Public or private sector.
- Agreements with insurers.
- Cost.
- Recommendations from institutions/psychiatrists, psychologists, psychotherapists, occupational therapists or nurses.
- Face-to-face or residential/virtual treatment.
- Characteristics of the health professional (age range, sex, etc).

Q16: Imagine a hypothetical situation where you felt the need to seek mental health care. Below are represented some of the factors that may influence your choice for this type of specialised services. Rank them from 1 (most important) to 7 (least important) by dragging the factors to the desired position. (After ticking the answer, proceed to the end of the survey)

- Access to transport.

- Public or private sector.
- Agreements with insurers.
- Cost.
- Recommendations from institutions/psychiatrists, psychologists, psychotherapists, occupational therapists or nurses.
- Face-to-face or residential/virtual treatment.
- Characteristics of the health professional (age range, sex, etc).

Annex I – Correspondence between the questions and the parameters used in the proposed prediction model (own elaboration)

Parameters	Question	Variables
p^0_{ajkd}	Q1	Sex
	Q2	Age
	Q3	Region of residence
	Q10	Symptoms in 2019 (Q10)
	Q11	Impairment of symptomatology on individual functioning in 2019 (Q11)
NSt_{ajkst}	Q1	Sex
	Q2	Age
	Q3	Region of residence
p_{smajkt}	Q8/Q10	Symptoms in 2021 (Q8) and 2019 (Q10)
	Q9/Q11	Impairment of symptomatology on individual functioning in 2021 (Q9) and 2019 (Q11)
$Distrib_{nm}$	Q8/Q10	Symptoms in 2021 (Q8) and 2019 (Q10)
	Q9/Q11	Impairment of symptomatology on individual functioning in 2021 (Q9) and 2019 (Q11)
	Q12	Satisfaction and perceived MHCN

Annex J – Criteria and issues that allowed achieving the transition probabilities (own elaboration)

Transition probabilities	Criteria					
	Q8 (Total)		Q9	Q11 (Total)		Q12
	PHQ-9	GAD-7		PHQ-9	GAD-7	
$p_{(s=1)(m=1)ajkt}$	<10 points	<10 points	No	<10 points	<10 points	No
$p_{(s=1)(m=2)ajkt}$	<10 points	<10 points	Yes	<10 points	<10 points	No
$p_{(s=1)(m=3)ajkt}$	≥10 points	≥10 points	N/A	<10 points	<10 points	No
$p_{(s=1)(m=4)ajkt}$	<10 points	≥10 points	N/A	<10 points	<10 points	No
$p_{(s=1)(m=5)ajkt}$	≥10 points	<10 points	N/A	<10 points	<10 points	No
$p_{(s=2)(m=1)ajkt}$	<10 points	<10 points	No	<10 points	<10 points	Yes
$p_{(s=2)(m=2)ajkt}$	<10 points	<10 points	Yes	<10 points	<10 points	Yes
$p_{(s=2)(m=3)ajkt}$	≥10 points	≥10 points	N/A	<10 points	<10 points	Yes
$p_{(s=2)(m=4)ajkt}$	<10 points	≥10 points	N/A	<10 points	<10 points	Yes
$p_{(s=2)(m=5)ajkt}$	≥10 points	<10 points	N/A	<10 points	<10 points	No

$p_{(s=3)(m=1)ajkt}$	<10 points	<10 points	No	≥10 points	≥10 points	N/A
$p_{(s=3)(m=2)ajkt}$	<10 points	<10 points	Yes	≥10 points	≥10 points	N/A
$p_{(s=3)(m=3)ajkt}$	≥10 points	≥10 points	N/A	≥10 points	≥10 points	N/A
$p_{(s=3)(m=4)ajkt}$	<10 points	≥10 points	N/A	≥10 points	≥10 points	N/A
$p_{(s=3)(m=5)ajkt}$	≥10 points	<10 points	N/A	≥10 points	≥10 points	N/A
$p_{(s=4)(m=1)ajkt}$	<10 points	<10 points	No	<10 points	≥10 points	N/A
$p_{(s=4)(m=2)ajkt}$	<10 points	<10 points	Yes	<10 points	≥10 points	N/A
$p_{(s=4)(m=3)ajkt}$	≥10 points	≥10 points	N/A	<10 points	≥10 points	N/A
$p_{(s=4)(m=4)ajkt}$	<10 points	≥10 points	N/A	<10 points	≥10 points	N/A
$p_{(s=4)(m=5)ajkt}$	≥10 points	<10 points	N/A	<10 points	≥10 points	N/A
$p_{(s=5)(m=1)ajkt}$	<10 points	<10 points	No	≥10 points	<10 points	N/A
$p_{(s=5)(m=2)ajkt}$	<10 points	<10 points	Yes	≥10 points	<10 points	N/A
$p_{(s=5)(m=3)ajkt}$	≥10 points	≥10 points	N/A	≥10 points	<10 points	N/A
$p_{(s=5)(m=4)ajkt}$	<10 points	≥10 points	N/A	≥10 points	<10 points	N/A
$p_{(s=5)(m=5)ajkt}$	≥10 points	<10 points	N/A	≥10 points	<10 points	N/A

N/A: Not Applicable

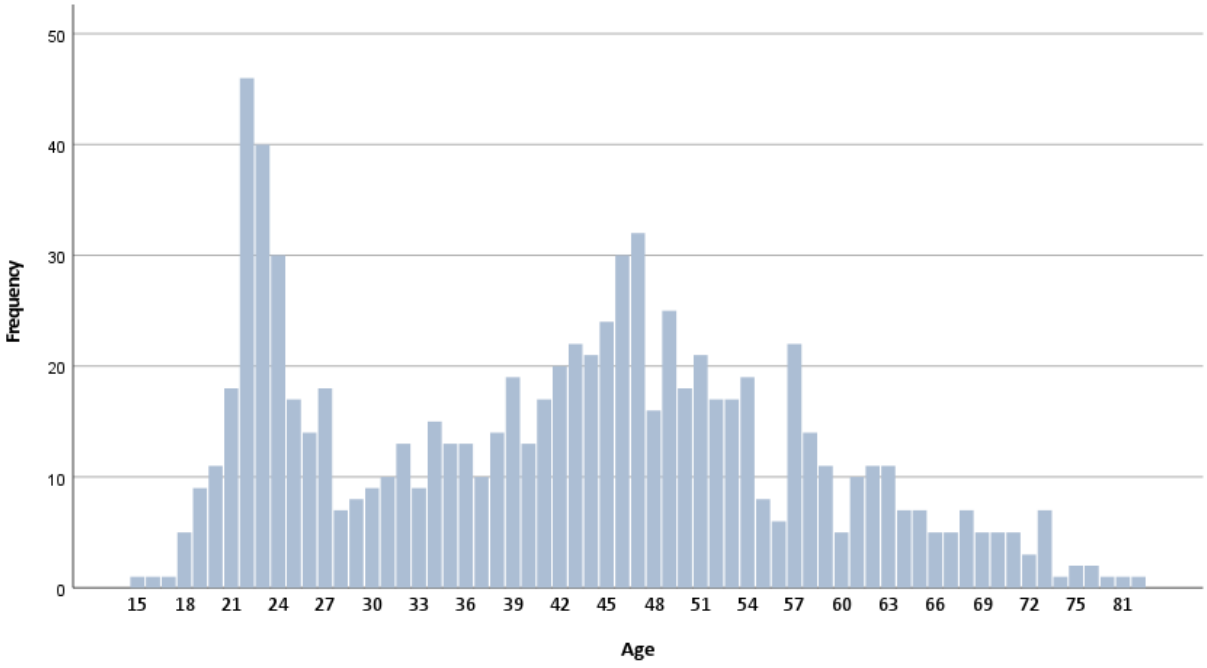
Annex K –Social demographic characterization (own elaboration)

Variable	Variable classification	Relative frequency (%)(*)
Sex	Female	63%
	Male	37%
Age groups	15-24 years old	20%
	25-34 years old	15%
	35-44 years old	20%
	45-54 years old	27%
	55-64 years old	13%
	65-74 years old	6%
	75-84 years old	1%
	>84 years old	0%
Marital status	Single	36%
	Married or Common law marriage	51%
	Widowed	2%
	Divorced	11%
Education level	Basic Education (up to 9th grade)	9%
	Secondary Education (up to Year 12)	30%
	Higher Education - Vocational Higher Technical Course	5%
	Higher Education - Bachelor or Degree	30%
	Higher Education - pre-bologna degree or master's degree	23%
	Higher Education - Doctorate	3%
Professional status	Paid employment (includes professional internship)	68%

	Student or curricular internship	13%
	Retired	10%
	Unemployed	9%
Monthly income	No income	5%
	Up to 500 euros	10%
	501-700 euros	15%
	701-900 euros	14%
	901-1100 euros	11%
	1101-1300 euros	9%
	1301-1500 euros	7%
	1501-1800 euros	6%
	1801-2200 euros	3%
	2201-2900 euros	5%
	More than 2900 euros	15%

Note: (*) *All figures have been rounded*

Annex L – Distribution of respondents by age (own elaboration)



Annex M – Crosstabs groups without clinical needs, with perceived needs met and unmet and unrecognized needs × Social demographic (% Total of Q1, Q2, Q4, Q5, Q6 and Q7) (own elaboration)

		Q14			
	Field	Met needs	Unmet but perceived needs	Unperceived needs	No needs
Q1	1. Female	9.9%	14.3%	12.0%	27.2%
	2. Male	2.4%	6.3%	7.8%	20.1%
Q2	1. 15-24 years old	1.8%	5.7%	5.1%	7.0%
	2. 25-34 years old	2.3%	3.5%	2.5%	6.2%
	3. 35-44 years old	2.4%	5.2%	5.0%	7.0%
	4. 45-54 years old	3.6%	3.6%	4.8%	14.4%
	5. 55-64 years old	1.5%	1.8%	1.5%	8.0%
	6. 65-74 years old	0.6%	0.6%	0.8%	4.0%
	7. 75-84 years old	0.0%	0.1%	0.0%	0.6%
	8. >84 years old	0.1%	0.0%	0.0%	0.0%
Q4	1. Single	4.6%	8.8%	7.9%	14.4%
	2. Married or Common law marriage	5.2%	9.1%	9.2%	27.4%
	3. Widowed	0.7%	0.5%	0.2%	1.0%
	4. Divorced	1.8%	2.2%	2.4%	4.5%
Q5	1. Basic Education (up to 9th grade)	1.0%	1.1%	2.3%	4.2%
	2. Secondary Education (up to Year 12)	3.8%	7.4%	4.7%	14.1%
	3. Higher Education - Vocational Higher 4. Technical Course	0.4%	1.2%	1.2%	2.5%
	5. Higher Education - Bachelor or Degree	4.1%	6.4%	5.8%	13.8%
	6. Higher Education - pre-bologna degree or master's degree	3.0%	3.9%	5.3%	11.0%
	7. Higher Education - Doctorate	0.1%	0.6%	0.4%	1.6%
Q6	1. Paid employment (includes professional internship)	9.0%	12.5%	14.1%	32.7%
	2. Student or curricular internship	1.5%	4.4%	2.4%	4.1%
	3. Retired	1.3%	1.0%	0.8%	7.2%
	4. Unemployed	0.6%	2.8%	2.4%	3.3%
Q7	1. No income	0.4%	1.6%	1.3%	1.9%
	2. Up to 500 euros	1.8%	2.5%	2.1%	4.0%
	3. 501-700 euros	2.7%	2.4%	2.8%	6.7%
	4. 701-900 euros	1.5%	2.5%	2.7%	7.2%
	5. 901-1100 euros	1.2%	2.3%	2.2%	5.6%
	6. 1101-1300 euros	1.6%	1.6%	1.1%	4.6%
	7. 1301-1500 euros	0.7%	1.0%	1.7%	3.2%
	8. 1501-1800 euros	0.2%	0.8%	1.2%	4.1%
	9. 1801-2200 euros	0.5%	0.5%	0.6%	1.6%
	10. 2201-2900 euros	0.2%	0.5%	0.8%	3.0%
	11. More than 2900 euros	1.6%	4.8%	3.3%	5.5%

Annex N – Crosstabs groups without clinical needs, with perceived needs met and unmet and unrecognized needs × Social demographic (% Within of Q1, Q2, Q4, Q5, Q6 and Q7) (own elaboration)

		Q14			
	Field	Met needs	Unmet but perceived needs	Unperceived needs	No needs
Q1	1. Female	15.68%	22.56%	18.93%	42.83%
	2. Male	6.62%	17.22%	21.19%	54.97%
Q2	1. 15-24 years old	9.26%	29.01%	25.93%	35.80%
	2. 25-34 years old	15.83%	24.17%	17.50%	42.50%
	3. 35-44 years old	12.35%	26.54%	25.31%	35.80%
	4. 45-54 years old	13.70%	13.70%	18.26%	54.34%
	5. 55-64 years old	11.43%	14.29%	11.43%	62.86%
	6. 65-74 years old	10.00%	10.00%	14.00%	66.00%
	7. >74 years old	14.29%	14.29%	0.00%	71.43%
Q4	1. Single	12.88%	24.75%	22.03%	40.34%
	2. Married or Common law marriage	10.24%	17.86%	18.10%	53.81%
	3. Widowed	30.00%	20.00%	10.00%	40.00%
	4. Divorced	16.67%	20.00%	22.22%	41.11%
Q5	1. Basic Education (up to 9th grade)	11.27%	12.68%	26.76%	49.30%
	2. Secondary Education (up to Year 12)	12.55%	24.70%	15.79%	46.96%
	3. Higher Education - Vocational Higher 4. Technical Course	6.82%	22.73%	22.73%	47.73%
	5. Higher Education - Bachelor or Degree	13.38%	21.29%	19.28%	45.78%
	6. Higher Education - pre-bologna degree or master's degree	13.02%	16.67%	22.92%	47.40%
	7. Higher Education - Doctorate	4.55%	22.73%	13.64%	59.09%
Q6	1. Paid employment (includes professional internship)	13.14%	18.29%	20.60%	47.96%
	2. Student or curricular internship	11.76%	35.29%	19.61%	33.33%
	3. Retired	12.94%	9.41%	8.24%	69.41%
	4. Unemployed	6.67%	30.67%	26.67%	36.00%
Q7	1. No income	10.40%	32.00%	21.60%	36.00%
	2. Up to 500 euros	6.98%	30.23%	25.58%	37.21%
	3. 501-700 euros	17.44%	24.42%	19.77%	38.37%
	4. 701-900 euros	18.33%	16.67%	19.17%	45.83%
	5. 901-1100 euros	10.53%	18.42%	19.30%	51.75%
	6. 1101-1300 euros	10.75%	20.43%	19.35%	49.46%
	7. 1301-1500 euros	17.81%	17.81%	12.33%	52.05%
	8. 1501-1800 euros	11.11%	14.81%	25.93%	48.15%
	9. 1801-2200 euros	3.77%	13.21%	18.87%	64.15%
	10. 2201-2900 euros	15.38%	15.38%	19.23%	50.00%
	11. More than 2900 euros	5.26%	10.53%	18.42%	65.79%

Annex O – Probabilities of an individual having a level *n* ∈ *N* of satisfaction and perceived need for MHC, by state *m* ∈ *M* at *t* ∈ *T* (own elaboration)

		Q14						
		Perceived Needs				Unperceived Needs		
		Count Met Needs	% Met Needs	Count Unmet but Perceived Needs	% Unmet but Perceived Needs	Count Unperceived Needs	% Unperceived Needs	Total
Q11 and Q12	WDS ∩ WAS ∩ WQL	22	17.1%	34	26%	73	57%	129
	DS ∩ AS	58	30.1%	95	49%	40	21%	193
	DS ∩ WAS	12	18.8%	26	41%	26	41%	64
	WDS ∩ AS	10	20.4%	15	31%	24	49%	49
	Total	102	23.4%	170	39%	163	37%	435

Annex P – Frequency of structural barriers (Q16) (own elaboration)

	Field	Choice Count	Relative frequency (%)
1.	I didn't know how or where to get help.	25	6.79%
2.	Did not have the financial resources to support the cost and/or considered the cost too expensive for the type of services that exist.	62	16.85%
3.	I have been discouraged by my social circle (e.g. negative opinions from neighbours/family/friends/work colleagues).	12	3.26%
4.	Health insurance does not cover necessary mental health services.	18	4.89%
5.	Concerned about confidentiality.	17	4.62%
6.	Concerned about the creation of a possible dependency (e.g. taking medication).	27	7.34%
7.	Thought I could deal with the problem without help/treatment.	93	25.27%
8.	I didn't have time.	38	10.33%
9.	No access to travel facilities.	4	1.09%
10.	I was not ready to start this process.	70	19.02%
11.	Another option. Which one?	2	0.54%

Annex Q - Frequency of attitudinal barriers (Q15) (own elaboration)

	Field	Choice Count	Relative frequency (%)
1.	Required medicines not always available.	4	10.53%
2.	Mental health professionals are not available when needed.	9	23.68%
3.	I am on the waiting list for receive mental health care.	9	23.68%
4.	The attitude of service providers towards.	7	18.42%
5.	There were/are no health professionals for the situation I faced/am facing.	1	2.63%
6.	Another option. Which one?	8	21.05%

Annex R – Average level of importance of factors in the demand for MHC (own elaboration)

Field	Average	Standard deviation
1. Access to transport.	5.41	1.72
2. Public or private sector.	3.69	1.71
3. Agreements with insurers.	3.48	1.74
4. Cost.	2.76	1.68
5. Recommendations from institutions/psychiatrists, psychologists, psychotherapists, occupational therapists or nurses.	2.99	1.76
6. Face-to-face or residential/virtual treatment.	4.47	1.70
7. Characteristics of the health professional (age group, sex, etc).	5.21	1.93

Annex S – Number of individuals living in LTV by sex, age group and state (own elaboration)

		WDS ∩ WAS ∩ QL			WDS ∩ WAS ∩ WQL			DS ∩ WAS			WDS ∩ AS			DS ∩ AS		
		Women	Men	% of Total (within age)	Women	Men	% of Total (within age)	Women	Men	% of Total (within age)	Women	Men	% of Total (within age)	Women	Men	% of Total (within age)
2022	15-24	67252	91304	52%	31039	33201	21%	8622	18676	9%	12071	2075	5%	31039	10375	14%
	25-34	77065	94581	59%	16917	17515	12%	3759	0	1%	13157	3503	6%	37593	28024	22%
	35-44	84265	99500	49%	37076	30615	18%	10112	19135	8%	20224	11481	9%	43818	15308	16%
	45-54	140429	142814	65%	39895	36404	17%	9575	2800	3%	12766	8401	5%	28724	16802	10%
	55-64	123234	136615	71%	44012	8814	15%	0	4407	1%	8802	0	2%	20539	17628	10%
	65-74	139589	106172	74%	26588	19907	14%	6647	6636	4%	6647	13272	6%	6647	0	2%
	+75	193465	125294	100%	0	0	0%	0	0	0%	0	0	0%	0	0	0%
	% of Total (within gender and age)	63%	71%		15%	13%		3%	5%		6%	3%		13%	8%	
2023	15-24	46905	65048	36%	31270	31475	20%	10423	16787	9%	5212	14690	6%	57329	29377	28%
	25-34	57443	69817	44%	13402	25109	13%	9381	9976	7%	9389	3684	4%	57687	34697	32%
	35-44	57361	85753	40%	28729	29392	16%	16326	3768	6%	16198	21922	11%	69700	30028	28%
	45-54	114673	129219	55%	38865	33998	16%	19566	14079	8%	11658	11362	5%	48976	19610	16%
	55-64	114004	117753	63%	23326	14620	10%	14849	14221	8%	11859	363	3%	32610	21542	15%
	65-74	116764	99715	66%	26948	24297	16%	20246	13317	10%	6491	5876	4%	14392	1190	5%
	+75	195115	81859	85%	1233	22774	7%	1233	21042	7%	0	577	0%	617	0	0%
	% of Total (within gender and age)	54%	58%		13%	16%		7%	8%		5%	5%		22%	12%	
2024	15-24	33901	47693	26%	26813	25222	17%	9705	18445	9%	8110	25528	11%	72663	41199	37%
	25-34	50430	55401	36%	10519	25658	12%	7058	11066	6%	6966	6873	5%	71870	45141	40%
	35-44	41508	69077	32%	22836	27324	14%	18791	3188	6%	16579	28280	13%	82097	37640	34%
	45-54	93436	125637	49%	39013	35594	17%	22346	14097	8%	12070	12836	6%	68098	20731	20%
	55-64	102780	101911	56%	20132	16315	10%	18419	17131	10%	13396	667	4%	42626	33647	21%
	65-74	113871	92992	63%	24159	25096	15%	18990	19989	12%	5483	2570	2%	21539	2360	7%
	+75	196904	55168	77%	1753	36960	12%	1470	33733	11%	0	542	0%	1753	0	1%
	% of Total (within gender and age)	49%	49%		11%	17%		7%	11%		5%	7%		28%	16%	
2025	15-24	25282	37170	20%	24302	19307	14%	8187	19804	9%	9609	34642	14%	84533	47930	43%
	25-34	46301	45048	31%	8796	23446	11%	5909	13176	7%	5737	11227	6%	79926	52469	45%
	35-44	31951	56280	26%	18768	24368	13%	19802	2568	7%	17702	33153	15%	87322	44435	39%
	45-54	76426	120507	44%	38083	37732	17%	23281	14768	9%	12166	13626	6%	84790	21400	24%
	55-64	93026	89414	49%	19693	16457	10%	20206	20234	11%	13727	887	4%	52009	43909	26%
	65-74	109476	86597	60%	22330	24268	14%	17349	26451	13%	5306	1104	2%	28845	4150	10%
	+75	199036	38730	72%	1944	45668	14%	1497	41507	13%	0	385	0%	3363	0	1%
	% of Total (within gender and age)	45%	43%		10%	17%		7%	12%		5%	9%		32%	19%	

Annex S – Number of individuals living in LTV by sex, age group and state (Continuation)

		WDS ∩ WAS ∩ QL			WDS ∩ WAS ∩ WQL			DS ∩ WAS			WDS ∩ AS			DS ∩ AS		
		Women	Men	% of Total (within age)	Women	Men	% of Total (within age)	Women	Men	% of Total (within age)	Women	Men	% of Total (within age)	Women	Men	% of Total (within age)
2026	15-24	19329	30828	16%	22523	14945	12%	7033	20430	9%	10818	42444	17%	93277	51302	46%
	25-34	43685	37878	28%	7680	20187	10%	5206	14496	7%	5005	16415	7%	84250	56463	48%
	35-44	26112	46419	22%	16064	21261	11%	20125	2098	7%	18572	37019	17%	89140	50178	43%
	45-54	62759	115086	41%	36215	39367	17%	23383	15459	9%	11894	13997	6%	98035	21754	27%
	55-64	85256	80565	44%	19825	16189	10%	21844	22509	12%	13723	1035	4%	61050	53641	31%
	65-74	103826	79710	57%	20951	22600	13%	16489	32639	15%	5067	465	2%	35943	6062	13%
	+75	200331	28366	68%	1952	50801	16%	1479	46320	14%	0	242	0%	5301	0	2%
	% of Total (within gender and age)	42%	38%		10%	17%		7%	14%		5%	10%		36%	22%	
2027	15-24	15035	26653	13%	21133	11906	11%	6146	20333	8%	11605	48901	19%	98923	52103	48%
	25-34	42118	33293	26%	7019	17178	8%	4795	15262	7%	4590	22424	9%	87031	58215	50%
	35-44	22410	38539	19%	14208	18225	10%	20013	1730	7%	18951	39919	19%	88836	54494	45%
	45-54	52017	109960	38%	34041	40455	17%	23150	15975	9%	11487	14185	6%	108553	21945	30%
	55-64	78569	73926	40%	20029	15766	9%	23382	24395	13%	13616	1128	4%	69378	61946	34%
	65-74	98312	73245	53%	19735	20645	13%	15655	38831	17%	4786	191	2%	42843	8264	16%
	+75	201157	21633	66%	1922	53577	16%	1455	49306	15%	0	142	0%	7587	0	2%
	% of Total (within gender and age)	39%	34%		9%	16%		7%	15%		5%	11%		39%	23%	
2028	15-24	11937	23648	11%	19994	9822	10%	5475	19707	8%	12060	54081	21%	102052	51106	49%
	25-34	41276	30307	24%	6627	14731	7%	4558	15544	7%	4358	29003	11%	89204	58321	50%
	35-44	20082	32438	17%	12986	15563	9%	19758	1448	7%	19044	42199	20%	87805	57793	47%
	45-54	43457	105335	35%	31734	40964	17%	22640	16274	9%	10955	14185	6%	116036	21920	33%
	55-64	72737	68731	36%	20225	15252	9%	24793	25832	13%	13494	1165	4%	76915	68807	38%
	65-74	93525	67114	50%	18730	18545	12%	14908	45105	19%	4540	76	1%	49692	10636	19%
	+75	200997	17188	65%	1832	54855	17%	1373	51212	16%	0	80	0%	10033	0	3%
	% of Total (within gender and age)	38%	31%		9%	15%		7%	16%		5%	13%		41%	24%	
2029	15-24	9788	21571	10%	19187	8472	9%	5004	18984	8%	12362	58850	23%	104107	49585	50%
	25-34	40834	28187	23%	6373	12837	6%	4410	15427	7%	4212	35866	14%	90801	57191	50%
	35-44	18523	27700	15%	12122	13314	8%	19371	1231	7%	18880	43907	21%	86134	60182	49%
	45-54	36439	100464	33%	29373	40933	17%	21917	16326	9%	10368	14071	6%	120703	21712	35%
	55-64	67782	65307	34%	20478	14923	9%	26166	27058	13%	13413	1209	4%	84038	74402	40%
	65-74	89285	61284	46%	17866	16355	11%	14273	51510	20%	4321	28	1%	56502	13115	21%
	+75	200273	14203	63%	1749	55199	17%	1312	52513	16%	0	44	0%	12693	0	4%
	% of Total (within gender and age)	36%	29%		8%	15%		7%	17%		5%	14%		43%	25%	
2030	15-24	8273	19903	9%	18568	7517	9%	4662	18111	7%	12531	62924	25%	105191	47510	50%
	25-34	40682	26607	22%	6237	11432	6%	4333	15079	6%	4141	43132	16%	92346	55438	49%
	35-44	17600	24193	14%	11592	11550	8%	19092	1072	7%	18729	45450	22%	84915	62229	50%
	45-54	30639	95092	32%	26999	40230	17%	20964	16114	9%	9692	13718	6%	122386	21165	36%
	55-64	63668	63403	32%	20772	14800	9%	27509	28151	14%	13392	1257	4%	90784	79035	42%
	65-74	85132	55551	43%	17029	14019	10%	13629	57919	22%	4107	9	1%	62931	15575	24%
	+75	199345	12233	62%	1696	55053	17%	1278	53606	16%	0	24	0%	15630	0	5%
	% of Total (within gender and age)	35%	27%		8%	14%		7%	17%		5%	15%		45%	26%	

Annex T – Number of individuals resident in LTV with MHCN by sex, age group and type of service required (own elaboration)

		Female					Male					%
		AC	IC	RC	OC	HBC	AC	IC	RC	OC	HBC	
2022	15-24	63736	15107	509	928	2492	49533	11741	395	721	1937	18.4%
	25-34	54999	13036	439	801	2151	37763	8951	301	550	1477	15.0%
	35-44	85649	20301	684	1247	3349	58936	13969	470	858	2305	23.4%
	45-54	70041	16601	559	1020	2739	49594	11755	396	722	1939	19.4%
	55-64	56484	13388	451	822	2209	23754	5630	190	346	929	13.0%
	65-74	35829	8492	286	522	1401	30658	7267	245	446	1199	10.8%
	+75	0	0	0	0	0	0	0	0	0	0	0.0%
2023	15-24	80262	19024	641	1169	3139	71094	16851	567	1035	2780	18.4%
	25-34	69194	16401	552	1007	2706	56569	13408	451	824	2212	15.3%
	35-44	100836	23901	805	1468	3943	65536	15534	523	954	2563	20.2%
	45-54	91683	21731	732	1335	3585	60869	14428	486	886	2380	18.6%
	55-64	63638	15084	508	927	2488	39075	9262	312	569	1528	12.5%
	65-74	52421	12425	418	763	2050	34404	8155	275	501	1345	10.6%
	+75	2374	563	19	35	93	34184	8102	273	498	1337	4.4%
2024	15-24	90316	21407	721	1315	3532	1315	3532	85005	20148	678	18.4%
	25-34	74239	17597	592	1081	2903	1081	2903	68329	16196	545	15.0%
	35-44	108036	25607	862	1573	4225	1573	4225	74254	17600	593	19.3%
	45-54	108978	25831	870	1587	4261	1587	4261	64110	15196	512	18.4%
	55-64	72823	17261	581	1060	2848	1060	2848	52176	12367	416	13.2%
	65-74	54033	12807	431	787	2113	787	2113	38513	9128	307	9.8%
	+75	3832	908	31	56	150	56	150	54852	13001	438	5.9%
2025	15-24	97509	23112	778	1420	3813	1420	3813	93698	22209	748	18.3%
	25-34	77285	18319	617	1125	3022	1125	3022	77247	18310	617	14.8%
	35-44	110570	26208	882	1610	4324	1610	4324	80485	19077	642	18.4%
	45-54	121909	28896	973	1775	4767	1775	4767	67397	15975	538	18.3%
	55-64	81341	19280	649	1184	3181	1184	3181	62747	14873	501	13.9%
	65-74	56851	13475	454	828	2223	828	2223	43100	10216	344	9.6%
	+75	5239	1242	42	76	205	76	205	67422	15981	538	6.7%
2026	15-24	102914	24393	821	1498	4024	1498	4024	99426	23567	794	18.2%
	25-34	78651	18642	628	1145	3076	1145	3076	82824	19631	661	14.5%
	35-44	110806	26264	884	1613	4333	1613	4333	85131	20178	679	17.7%
	45-54	130538	30941	1042	1901	5105	1901	5105	69746	16532	557	18.2%
	55-64	89662	21252	716	1306	3506	1306	3506	71900	17042	574	14.6%
	65-74	60408	14318	482	880	2362	880	2362	47561	11273	380	9.7%
	+75	6724	1594	54	98	263	98	263	74971	17770	598	7.1%
2027	15-24	106114	25152	847	1545	4149	1545	4149	102600	24319	819	18.0%
	25-34	79647	18878	636	1160	3114	1160	3114	87072	20638	695	14.3%
	35-44	109349	25918	873	1592	4276	1592	4276	88065	20874	703	17.0%
	45-54	136471	32347	1089	1987	5337	1987	5337	71272	16893	569	18.1%
	55-64	97334	23071	777	1417	3806	1417	3806	79492	18842	634	15.3%

	65-74	63926	15152	510	931	2500	931	2500	52308	12398	417	10.0%
	+75	8443	2001	67	123	330	123	330	79331	18804	633	7.3%
2028	15-24	107479	25475	858	1565	4203	1565	4203	103733	24587	828	17.6%
	25-34	80658	19118	644	1174	3154	1174	3154	90553	21463	723	14.2%
	35-44	107489	25478	858	1565	4203	1565	4203	90095	21355	719	16.5%
	45-54	139654	33102	1115	2033	5461	2033	5461	71876	17037	574	17.9%
	55-64	104281	24717	832	1518	4078	1518	4078	85516	20270	682	15.9%
	65-74	67661	16037	540	985	2646	985	2646	57260	13572	457	10.4%
	+75	10193	2416	81	148	399	148	399	81735	19373	652	7.4%
2029	15-24	108311	25672	864	1577	4235	1577	4235	104639	24802	835	17.3%
	25-34	81465	19309	650	1186	3186	1186	3186	93420	22143	746	14.2%
	35-44	105112	24914	839	1530	4110	1530	4110	91350	21652	729	16.0%
	45-54	140420	33283	1121	2045	5491	2045	5491	71644	16981	572	17.5%
	55-64	110956	26300	886	1616	4339	1616	4339	90549	21462	723	16.5%
	65-74	71583	16967	571	1042	2799	1042	2799	62378	14785	498	10.9%
	+75	12131	2875	97	177	474	177	474	82974	19667	662	7.5%
2030	15-24	108535	25726	866	1580	4244	1580	4244	104769	24833	836	17.1%
	25-34	82436	19539	658	1200	3224	1200	3224	96314	22829	769	14.2%
	35-44	103435	24517	826	1506	4045	1506	4045	92634	21957	739	15.7%
	45-54	138634	32860	1106	2019	5421	2019	5421	70247	16650	561	16.9%
	55-64	117394	27825	937	1709	4591	1709	4591	94900	22494	757	17.0%
	65-74	75227	17831	600	1095	2942	1095	2942	67393	15974	538	11.4%
	+75	14326	3396	114	209	560	209	560	83688	19836	668	7.6%

Annex U – Scenario A: Probabilities of an individual having a level *n* ∈ *N* of satisfaction and perceived need for MHC, by state *m* ∈ *M* at *t* ∈ *T* (own elaboration)

		Q14						
		Perceived Needs				Unperceived Needs		
		Count Met Needs	% Met Needs	Count Unmet but Perceived Needs	% Unmet but Perceived Needs	Count Unperceived Needs	% Unperceived Needs	Total
Q11 and Q12	DS ∩ AS	58	30,1%	95	49%	40	21%	193
	DS ∩ WAS	12	18,8%	26	41%	26	41%	64
	WDS ∩ AS	10	20,4%	15	31%	24	49%	49
	Total	80	26,14%	136	44,44%	90	29,41%	306