

ESTIMATING MENTAL HEALTH PRODUCTION FUNCTIONS: WHAT DOES EXPLAIN THE MENTAL HEALTH STATUS OF THE PORTUGUESE POPULATION?

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Abstract. *According to the World Health Organization, the spread of mental illnesses is increasing. For Portugal, little is known about the determinants of the mental health state in the Portuguese population and there is few epidemiologic related data. This study is aimed at studying the determinants of the mental health state in the Portuguese population.*

We first developed an explanatory model for mental health, so as to structure how different determinants might contribute in explaining the mental health state of an individual. Data from the 4th Portuguese National Health Survey (2005/2006) has been used to test hypothesis defined in the model, whereas diagnosed depression was taken as the proxy variable for mental health state. We developed descriptive studies and multivariate logistic regressions to explain the determinants on the prevalence and incidence of depression; and a Bayesian network tool is proposed to support general practitioners in the detection of depression in an individual (using information from the Survey).

We found out that the following population groups have higher prevalence rates of diagnosed depression: females, divorced, retired, unemployed, middle-aged, low education, with chronic anxiety or obesity, living alone or with one person, living in the Centre region, and having high and low income. The following explanatory factors have a positive statistically significant impact on the probability of a prevalent individual with depression: females, unemployed, retired, divorced, middle-aged, having hypertension, chronic pain, anxiety, obesity and bronchitis, and presenteeism. As opposite, the following explanatory factors were found to have a negative impact: family size and hours of work per week. As for incidence, we found out that: incidence is affecting a much younger population in comparison to the prevalent population; and the determinants of incidence and prevalence quite differ. We have also illustrated how a Bayesian network can be used by GPs for diagnosing depression and health care planners for planning health services.

Evidence points for an underestimation of prevalence and incidence rates in the Portuguese population, which might be due to stigma of individuals seeking mental health related services, or because of lack of access of individuals to those services. It seems that special attention should be given to the incident population being at risk; and there is a need for developing additional studies so as to produce more detailed information for decision-makers in the area.

Key Words: Mental Health, Determinants of Health, Production functions.

1. INTRODUCTION

According to the World Health Organization, the spread of mental illnesses is increasing: from being currently 12% of the total burden of disease, projections for 2020 reach 15%. The most important example is depressive disorders, the fourth leading cause of disease and disability, which is expected to rank second by 2020. Interventions both to promote good mental health and to tackle the consequences of poor mental health demand for information on the determinants of mental health disorders and behaviours. Nevertheless, few studies have attempted to analyse and quantify the determinants of mental health state among populations. In particular, for Portugal, little is known about the determinants of mental health state in the Portuguese population, and there is few epidemiologic related data. This study is aimed at studying the determinants of the mental health state in the Portuguese population.

Therefore this study aims to provide information about the mental health status of the Portuguese population and to produce data that might be useful for Portugal and developed countries to develop effective mental health policies. In particular, we performed detailed analysis of the prevalence and incidence of the depression in the overall Portuguese population and for population subgroups.

According to World Health Report, mental illnesses are understood as clinically significant conditions characterized by alterations in thinking, mood (emotions) or behaviour associated with personal distress and/or impaired functioning. Recent evidence indicates that mental and behavioural disorders are the result of genetics plus environment

determinants, i.e. the interaction of biology with psychological and social factors (WHO, 2001).

Despite this, most mental illnesses are frequent and usually cause severe disability (WHO, 2001), and there is lack of precise information and of medical devices that may help the physician on carrying out an accurate diagnosis¹.

This article is divided in 5 sections: the introduction presents the context and burden of mental health, and the goal of this study; the methodology section describes and discusses the methodologies used throughout this work; key results are presented in the results section; which is followed by a discussion section, and a final conclusion section that resumes the main conclusions of this work.

This study only considers common mental health disorders: in particular it focuses on the depression disorder in Portugal, but also mentions anxiety disorders. Despite having applied methods on prevalence and incidence data, here we only present the results on the prevalence of depression.

1.1 The Portuguese context

The Portuguese health care system is based on a tax funded NHS, which is expected to provide universal access to health care, nearly free at the point of use. The Portuguese government is responsible for ensuring equal and good access to mental health services. Nevertheless Portuguese user charges account for approximately a third of all health costs,

¹ www.minsaude.pt/portal/conteudos/enciclopedia+da+saude/saude+mental/depressao.htm

and given the strong correlation between mental health problems, unemployment and deprivation, user charges for mental health services in Portugal are highly inequitable (Knapp et al, 2007).

Portugal, within the EU-15, was the country with less expenditure for mental health care, with mental health accounting only for 4,6% of total expenditure of the health budget in 2002 (Medeiros et al, 2007).

First steps in mental health policy began from 1848 until 1945, with the creation of several specialised hospitals providing mental health services. Between 1945 and 1970, it was established a period of regionalization and decentralization of mental health services (Graça, 1996). In this period, the goal was to formalise a supporting network at primary care level in general hospitals. Nevertheless, in the following decades few efforts were made to improve the difficulties and challenges that afterwards appeared. In 1998 a new mental health law was introduced, defining the principles and the path for the reorganization of mental health services. However, the defined policies were not implemented (Comissão Nacional para a Reestruturação dos Serviços de Saúde Mental, 2007).

Finally, in 2005, during the European Meeting in Helsinki, the Portuguese government has accepted to complete the reform of mental health services. Following this, in 2007 it was defined the action of development a plan, aiming to restructure and improve the access of mental health services to the Portuguese population. Its key policy was the transition between an institutional based model to a community based model, involving institutional changes, reallocation of resources, training of professionals and the creation of new services (Comissão Nacional para a Reestruturação dos Serviços de Saúde Mental, 2007).

With regard to mental health data the following facts were found:

A Eurobarometer Survey published by the European Commission in April 2003, using a 5-item Mental Health Index (MHI-5) on a sample of 16.000 residents of fifteen European countries has shown a prevalence rate for positive cases of depression of 29,8% for Portugal, where the European average was 23,4%. Females had a higher risk of being depressed in comparison to males, as well as retired citizens, the widowed and individuals with low social support had a higher risk of getting depression (The European Opinion Research Group, 2003). This study found the highest proportion of mental health problems in Italy and Portugal.

Another study has indicated that the prevalence for depressive disorders in the overall population of five European countries is 8,56%, with a rate of 10,05% for female and 6,61% for male (Mateus et al, 2001).

2. METHODOLOGY

2.1 Explanatory model

Lately, the Portuguese National Mental Health Council has developed a plan to implement measures to improve mental health service and to measure key mental health indicators. Despite that, there is still no study examining the explanatory multisystem for mental health, nor for depression in Portugal. Our work first develops an explanatory model as to structure how different determinants might contribute to explain the mental health state of an individual. Among others, these determinants include factors related with access to mental health services, personal characteristics of the individual, daily habits, stressful events, chronic disorders, and functioning and structure of public supporting services.

Its purpose is testing how social and individual contexts and characteristics might contribute for mental health. And also to shed some light on how public sectors intervene in mental health state of an individual.

Literature suggests that all these factors might contribute for the production of mental health state (Jané-Llopis et al., 2005) and thus in testing this model, we aim to assess these hypothesis.

To build these generalised models to explain the mental health state of an individual, a research review was performed on the information available in several documents, websites and databases (Weel-Baumgarten *et al.*, 2005; Directorate-General for health & Consumers, 2008; WHO, 2001; Jané-Llopis *et al.*, 2005),ⁱⁱ,ⁱⁱⁱ.

Our model was idealised having the characteristics present in table 1.

Table 1: Explanatory model characteristics

Explanatory model of mental health state	
Which factors were considered?	With what aim?
Signals and Symptoms	Characterise the mental health status
	Verify whether it exists or not an additional risk group outside of our identified group with poor mental suffering of poor mental health;
Personal Characteristics and Experiences	Find the causes of depression
Public Sector	Verify their impact in mental health state.
Temporal	Allow to understand their influence on the mental health state of an individual.

Then, this information was organised in mindmaps for easy illustration and understanding of the issue under analysis. Thus, applying our explanatory model to the database of the 4th National Health Survey allowed us to perform prevalence and incidence studies on Depression. To perform these studies, we applied descriptive analysis and multivariate econometric regressions.

The idea of using mindmaps appeared because, alongside with the literature review taken, it was necessary to organise the large amount and diversified information.

The mindmap method helps thinking about processes by unlocking of the dynamic of the brain, and through fastening memorization, and understanding of complex issues (Colin and Brian, 1995). It may use lines, symbols, words, colours and images, converting a long list of monotonous information in a colourful, memorable and highly organized diagram (Colin and Brian, 1995).

A mindmap should be read from the central node to the surroundings, whose first level of lines describes relationships between mental health state and its determinants and indicators, while the second level of lines indicates relationships between these and its explanatory factors. The established model is displayed in figure 1.

2.2. Fourth Health National Portuguese Survey

To test and validate the explanatory model of mental health state, the database of the Fourth National Health Survey for Portugal (which reports data from 2005/2006 period) was used. The sample was collected between February 2005 and January 2006.

ⁱⁱ <http://www.nimh.nih.gov/health/topics/depression/men-and-depression/signs-and-symptoms-of-depression/index.shtml>

ⁱⁱⁱ http://www.who.int/mental_health/management/depression/definition/en/

The survey includes individuals living in Portugal in familiar housing units, in the point of time that the interviews were made. Therefore the survey excludes individuals living in collective habitations, for example institutions, hotels and prisons. For those individuals that were not present in the interview, their information was collected through the remaining residents.

The sample was based on a mother sample used in national surveys by the Portuguese National Institute of Statistics (INE -*Instituto Nacional de Estatística*).

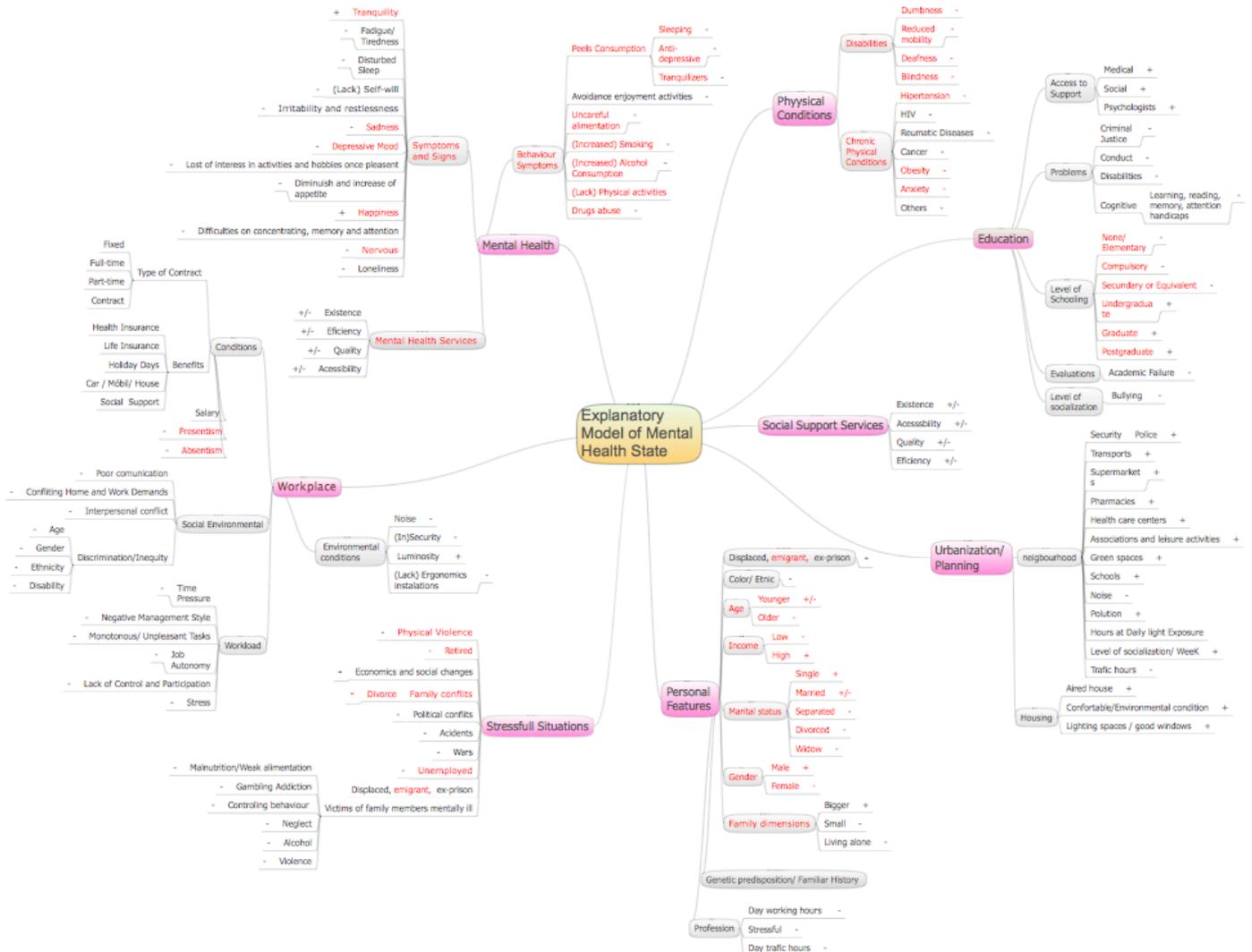


Figure 1: Explanatory Model for Mental Health State of and

The geographic areas were uniformly selected by trimester and week, with the aim of minimizing the seasonal effects in the results.

With regard to the dimension of the survey, the number of individuals was defined by INE, with the collaboration of *Instituto Nacional Saúde Dr Ricardo Jorge* (INSA) and was defined in accordance with the following criteria:

- Included the housing and population of the 2001 census, and the information of the Health National Survey taken in 1998.
- Ensured a homogenous distribution of the sample in all seven regions of 7 regions established at Nomenclature of Territorial Units for Statistics (NUTS II).
- Minimized seasonal effects, with selected areas being distributed more or less uniformly for each quarter and

week.

- Used representative samples for health regions.

Nevertheless, we found some survey limitations to our study, mainly due to sample limitations, and the fact that the survey did not have the purpose of a mental health study, because:

- Questions did not allow to identify individuals with mental health problems.
- Questions did not collect information about the majority of explanatory factors identified in our model and did not consent for analysing the conditions of others non-health sectors, reducing the possibility of testing some expected

hypothesis.

- Within mental health, the survey only included questions about depression and about chronic anxiety disorders.
- The survey only included a section with some symptoms of depression, such as feeling relaxed, nervous, depressed, sad or happy.
- The survey did not include questions capturing the dynamics of explanatory factors, such as the time and duration of situations and conditions.

As a result, a lot of factors defined in the explanatory model could not be tested, due to: lack of observations available in the respective question; sample dimension variations; difficulties in adapting the questions to what was intended; lack of questions asking for many variables embraced in our model.

Afterwards, we selected a subset of questions of the survey that could be used to test our explanatory model of

Mental Health state.

For identification of prevalent and incident populations the variables *diagnosed depression* and *new depressed*, respectively, were created. The first variable embraces individuals whose depression was detected by healthcare professional. The new depressed variable regards also to those with diagnosed depression, nevertheless only those whose identification was made during the previous year.

The diagnosed condition was taken to attain credible results in our analysis. Despite excluding possible cases of depression of individuals that have not yet been identified by a specialist, we removed people that could just have a perception of being depressed. Therefore, in our definition we have excluded people in psychological suffering, which might imply an underdiagnose of the number of depressed cases.

Figure 1 illustrates positive and negative signs, according to what we expect to be the impact of explanatory factors in mental health of an individual. The factors presented in red indicate factors that they were found in 4th Portuguese National Health Survey.

2.3. Statistical Analysis

2.3.1 Descriptive Analysis

First, we decided to carry out a bi-dimensional descriptive analysis (cross-table analysis) for identification of the groups with higher prevalence of depression. Afterwards, we defined minimum conditions on the size of these groups (only groups with considerable dimensions) to be considered as vulnerable groups of depression.

To detect differences between genders, we performed a separate analysis for each type of these population groups.

Second, we performed comparative analysis between the Portuguese population identified and not identified with depression regarding consumption of anti-depressant drugs and frequency of symptoms of depression. Our aim was to characterise the population and also to verify whether there was an outsider group to the prevalent population, in psychological suffering.

Third, we proposed Bayesian network, using data on the prevalent population with depression, as a tool that might support the diagnosis of depression in mental health services or to plan mental health services for specific sets of the population with higher needs. The network seeks to measure the risk of having depression in a patient according to its features and population data available. The Bayesian network consists of a graphical and probabilistic casual network composed by a set of nodes, representing variables, and by directed arcs, which establish dependent cause-effect relationships between variables (Jansen, 1996).

We used the Bayesian Network Netica 408 software for building the network. We consider vulnerable groups and risk factors of depression identified ahead in the results of the descriptive analysis on the prevalence of depression, and we have defined the nodes as close as possible to patient characteristics.

Moreover, we exemplify how this application is likely to be a useful tool in a depression detection program (and taking into account the limitations of the database in use) that could be exploited by the clinician, as a helpful tool when taking

the diagnostic, or applied in planning health services, we use a limited number of variables.

In the results chapter, we provide a patient example to show the risk probabilities provided by a Bayesian Network.

2.3.2 Econometric Analysis

Hereupon, we present the methods used to identify the causes of depression in the Portuguese population. Therefore, we have chosen to estimate production functions for the mental health state by estimating econometric regressions. Whether for the prevalence or for incidence of depression, we expect to find the statistically significant factors that contribute and others that do not contribute to depression.

In addition, we also explain here the work carried out to study the prevalent population through the use of diagnosed depression variable, and the incident population through the use of the newly-depressed variable. In the study of prevalence, we carried out analysis for three groups of the Portuguese population: total population, male and female. According to each gender group, the estimations were

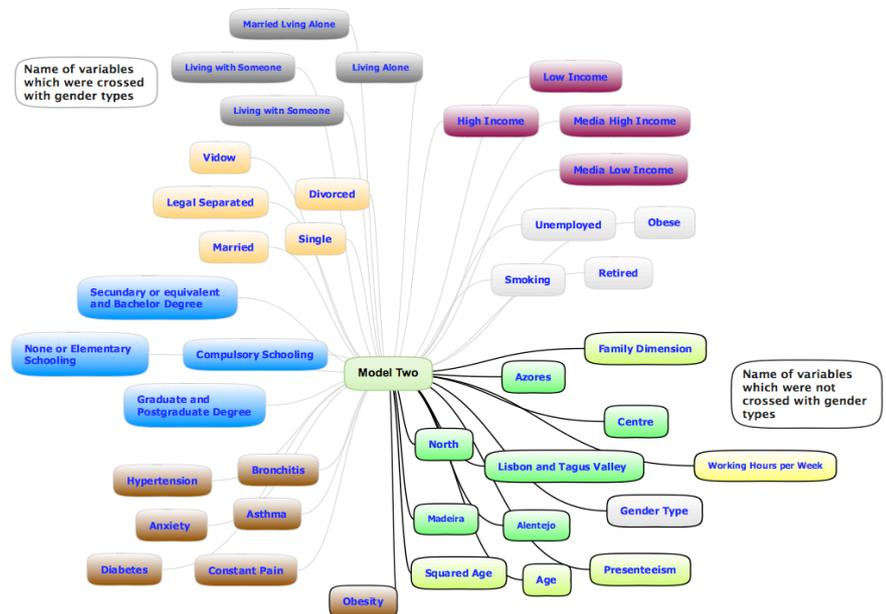


Figure 2: Name of explanatory variables used for evaluation of Model Two

performed so as to test whether different explanatory factors for the two groups exist (except for incidence studies). In order to achieve these objectives, we have estimated production functions using Logistic regressions.

The Logistic regression tests for the influence of explanatory factors on the binary response of the dependent variable. In addition, the coefficients should be interpreted as factors that contribute to higher or lower probability of being depressed, in comparison to an average individual.

The production functions were built using variables created from 4th Portuguese National Health Survey according to our hypothesis presented in our model. As a result of survey limitations, the number of hypothesis assessed was reduced, leading to the creation of two other simplified models.

The first created model – named as model One - uses simple variables and the second - model Two - uses model One's variables and also uses crossed-variables and variables crossed with gender types. Model Two was developed to achieve an increased level of explanatory power and a higher number of statistically significant variables, so as to attain

better identification of the causes of depression.

Figure 2 displays model Two using mindmap method. This mindmap shows indication of which variables were crossed with gender type and which were not. Also from figure 3, we can visualise the model One, if not considering the variables crossed with gender type and excluding those in dark grey balloons.

Furthermore, when we made the selection of variables for the two models, we took in consideration the need to avoid multicollinearity problems commonly affecting regression results, bringing unstable and skewed estimates.

Consequently, we exclude from the models the variables associated with consumption of antidepressant drugs and symptoms of depression. These groups of explanatory factors besides not being expected as cause of depression, they are indicators of poor mental health. Thus, they would present substantial redundancy with our independent variables.

At last, while we evaluate production function represented by model two, we observe severe multicollinearity problems, to which logistic regression algorithms of Stata solved excluding several variables.

In this analysis, we considered statistical significant relationships between explanatory variables and the likelihood of *diagnosed depression* and *new depressed*, for both studies of prevalence and incidence, respectively. As levels of significance, we considered 1%, 5% and 10%.

Nevertheless, in this article we only discuss the analysis and results for the overall Portuguese prevalent population with depression.

The software used for models evaluation was Stata version 9 in a Macintosh computer, with Mac OS X10.4.11 operating system and a processor of 2GHz and 1Gb of memory.

3. RESULTS

3.1 Vulnerable groups

In the descriptive analysis, we attain the following prevalence rates for *diagnosed depression*. From a sample of 41191 individuals, we found 6,84 % (2818 records), of which 10,46 % are females and 2,97% are males. We found that the risk of depression for females is nearly the triple of the risk found for the male group.

Afterwards, we performed descriptive analysis on several groups of the Portuguese population, aiming to identify which groups present higher prevalence of depression, and posteriorly provide information about the vulnerable groups of depression in Portugal.

The higher prevalence of depression was identified for the following groups: females, unemployed, retired, divorced, obese, middle-aged; Also in individuals with low income, anxiety or obesity, living in residences alone or with someone, and living in the Centre or Lisbon and Tagus Valley NUTs II regions.

Main differences encountered between male and female were that males presented higher risk with graduate and postgraduate degrees, whereas females show high risk with none or elementary level of schooling.

Also vulnerable groups were defined for Portugal, either for the overall population and male and female populations. For that, we use as minimum dimension of subgroups, 2,5% in the overall population and 5% for female and male groups. (These vulnerable were not displayed in this document.)

3.2 Behavioural and symptoms factors

Concerning the consumption of antidepressant drugs, the

groups taking prescribed pills for sleeping and anxiety disturbances involve a larger number of individuals in the non-depressed population than in the depressed population. Given that sleeping disorder is a severe symptom of depressive disorders, anxiety and depression are sometimes identified together. This phenomenon may show that there is a large group in the Portuguese population showing signs of developing poor mental health disorders.

Examining the depressive symptoms, we identified in the non-depressed population a large group of individuals with high frequency levels of depressive symptoms. Most of these groups show larger dimensions than the population identified with depression – the prevalent population. (For this analysis we examined the five questions of Mental Health Survey (MHI-5) included in mental health section of the 4th National Portuguese Health Survey)

Both analyses show the presence of a large group, outside our identified group with diagnosed depression, with indications (behaviours and frequency of symptoms) typical of people suffering from poor mental health.

3.3 A Bayesian network to help the diagnose depression and plan mental health services

Figure 2 presents an example of a Bayesian Network that determines a person's (a patient) probability of presenting depression, according to his characteristics. We consider five variables that are expected to influence the prevalence of depression. Each node describes each group of our Portuguese database and the ending node represents the probability of having or not having depression.

We seek to analyse the dependence of this dummy variable on the remaining and preceding categorical variables.

Figure 3 represents a patient with the following characteristics: female, with 30 years old, employed, suffering of hypertension and presenting a low level of income. As a result, this patient would have an expectable probability of being depressed of 28,6%.

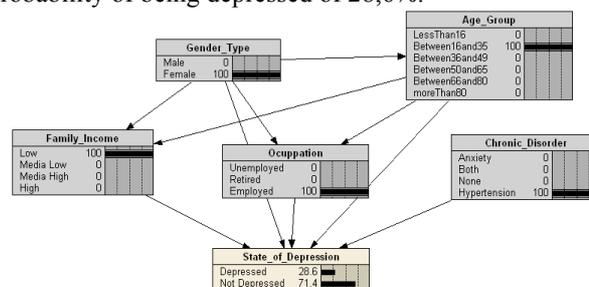


Figure 3: Information provided by a Bayesian Network for a female with 30 years, employed, suffering of hypertension and presenting a low level of income.

In order to evaluate the capacity of this tool to provide reliable information (i.e the capacity of the model to predict cases of depression), we use the confusion matrix (Hamilton, 2009).to obtain those indicators. To build this matrix, we tested it in a 5% random sample of the total population. In addition, to test the reliability of results, we also determined the results for the Bayesian network using the total population without the individuals included in this 5% random sample. The confusion matrix provides the following indicators for model evaluation: prevalence rate, sensitivity, specificity, positive and negative predictive values. To perform this assessment, we consider as capacity of the model to predict cases of depression from the probabilities of depression above 50%. Table 3 provides indications about the Bayesian network reliability to predict depression.

Table 3. Results of confusion matrix

Indicators	Results
Prevalence rate	6,90%
Sensitivity	20,40%
Specificity	94,40%
Positive Predictive Value	47,50%
Negative Predictive Value	98,30%
Number of Observations	1995

The Bayesian network indicates that the positive identified cases have 50% probability of being correctly identified with depression. Moreover, the sensitivity value shows that the proportion of individuals with the disease correctly predicted is around 20% (when depression is classified for probabilities higher than 50%). This indicator estimates the power of the model to predict depression in this sample. Besides this indicator, there is also another indicator of the model performance, which is the ratio between the positive predictive value and the prevalence rate of the population where this sample was extracted. It will tell us in what proportion our model is better in predicting depression with regard to the risk of the population suffer from depression, which is 7 (=47,5/6,8). Also observing the negative predictive and specificity values, we confirm that the Bayesian network is good in excluding the non-depression cases.

Given that, we believe relevant information is missing in this network. For instance: variables providing information of the level of schooling, marital status, consumption of sleeping pills and description of self perception of feelings. We expect that a higher complexity of the Bayesian network would provide higher capacity to predict depression.

In a first approach, we may indicate that this tool provides adequate information to help a positive or negative diagnosis of depression, although further analysis should be set before for its real application. In one hand, the Bayesian Network could be a plus to add in GPs diagnosing of depression, mainly in a detection program. On the other hand, it could support the planning of mental health services, since it helps to predict the risk of groups that require special needs. Policy planners could use the information produced as guidance to focuses mental health strengths and resources on those groups of individuals.

Unfortunately the dimension of our prevalent population with depression and some survey limitations reduced the number of variables to be included in the network. At the end, we consider that this tool is simple, and can be powerful when used together with a database with large dimension and good quality data.

3.4 Explaining the Prevalence of Depression

In this subsection we present the results of using multi-dimensional statistical analysis: we have used logistic regressions, trying to statistically explain which factors contribute for depression. With it, we have tested how each explanatory variable contributes for the probability of occurrence of the depression disorder. We also examined whether the models could effectively estimate production functions of the depression disorder in our prevalent

population, being this represented by the diagnosed depression variable, the dependent variable used on estimations. The assessed models were described in subsection 2.3.2.

3.4.1 Logistic Regression

Table 3 contains results of coefficients (β_i) of statistically significant variables (X_i) of the logistic regression. The coefficients should be interpreted as for each unit increase of the variable, the log odds (L) of being diagnosed depressed (vs. not being diagnosed depressed) increases according to the coefficient value, or decreases if this coefficient is negative (according to the relation (1)).

We also examined whether the models could effectively estimate production functions for the depression disorder. For the study of prevalence, the *diagnosed depression* variable was the dependent variable used on estimations. To complement our prevalence study, we have also carried out separate analyses for the female and for the male groups. Nevertheless these results are not presented and discussed in this article.

$$L = \ln\left(\frac{P_i}{1 - P_i}\right) = z_i = \alpha + \beta_1 x_1 + \dots + \beta_k x_k \quad (1)$$

Table 3. Main results of the Logistic regression using models One and two with levels of significance of 1%, 5 % and 10%

Significant Variables			Overall Population	
Type	Name	Reference level	Model One	Model Two
Continue	Age		0,1451*	0,1494*
	Squared Age		-0,0016*	-0,0016*
	Hours of Work per Week			-0,0055**
	Family Size		-0,1042*	-0,1274*
Dummy	Retired		0,3415*	0,7753*
	Unemployed		0,3360*	0,8133*
	Smoking		0,1352***	0,1765***
	Female gender		1,2145*	1,1325*
	Single	Divorced	-0,3951*	
	Married	Divorced	-0,4172*	-0,5564***
	Widow	Divorced	-0,4218*	
	None or Elementary Schooling	Compulsory Schooling	-0,2084**	
	Graduate and Post-graduate Degrees	Compulsory Schooling	0,5061*	
	High Income	Media High Income	0,3429***	0,7471**
	North	Centre	-0,5061*	-0,3941*
	Lisbon and Tagus Valley	Centre	-0,3956*	-0,4439*
	Alentejo	Centre	-0,4100*	-0,3179*
	Algarve	Centre	-0,6522*	-0,6550*
	Azores	Centre	-0,6820*	-0,6942*
	Madeira	Centre	-0,5142*	-0,4195*
	Hypertension		0,2513*	0,3115*
	Chronic Pain		0,3965*	0,4919*
	Chronic Anxiety		2,4857*	3,211*
	Chronic Obesity		0,2597**	
Chronic Bronchitis		0,4565*		
Presentism		0,5020*	0,5083*	
Crossed Dummies	Married Female			0,5341*
	Unemployed Female			-0,7240*
	Retired Female			-0,4837**
	Anxiety Female			-0,9755*

Analysing table 3, we perceive that the two models show robust robustness, since several significant variables of model One are confirmed by model Two and model Two contains new statistical significant variables – not significant or not included in model One. Hence it improves the number of significant explanatory variables and allows for identifying additional explanatory factors that might explain depression in the Portuguese population. So, model Two complements and adds relevant information to the results of model One.

To sum up, the explanatory variables contributing to a higher prevalence of depression across individuals in the Portuguese population are:

As Model Two indicates: retirement, unemployment, smoking, high income, female gender, divorced,

hypertension, chronic pain, Anxiety, presenteeism, Lisbon and Tagus Valley and Centre NUTs II regions, married female;

And as Model One adds: graduate and post-graduate, obesity, bronchitis, Azores region.

Furthermore, the age variable shows a statistically positive significant influence on depression and squared-age variable presents a negative statistical significant influence on depression. These two results indicate that the influence of age in depression behaves as an inverted parabola, describing higher risk of depression in middle-age individuals, and lower risk on below and above age groups.

The variable hours of work per week reveals a negative statistically significant influence in the probability of depression, and this confirms what we expected, the hours of work diminish with depression in all types of population analysed in this study of prevalence;

Family size has a negative statistical significant influence in all the populations. Therefore, we conclude that the larger is the family, the smaller is the probability of having depression in the prevalent population.

Table 4: Results of diagnostics tests performed to Logistic regressions

Tests	ONE	TWO
Sensitivity	17.99%	17.28%
Specificity	99.22%	99.29%
Positive predictive value	63.10%	63.12%
Negative predictive value	94.22%	94.48%
Pseudo R ²	0,19	0.20
Homer and Lemeshow Test	0,97	0.99
Specification Test	0,86	1,14
Total of observations	25169	17844

Finally, the diagnostic tests carried out indicate for our models the following results: good values of specification; good values of goodness of fit; high values of specificity; low values of sensitivity; positive predictive value higher than 50%; negative predictive value higher than 88%. (The confusion matrix used to achieve the first four indicators classifies depression for probabilities higher than 50%).

Since the positive predictive value evaluates whether or not the individuals positively identified with the disease are effectively depressed or not. Their values show that models are able to identify correctly depression in 60% of cases identify with the disease. Besides this, they suggest that our models are good at explaining depression. Nevertheless, the pseudo-R² results show that relevant explanatory factors are still missing.

4. DISCUSSION

4.1 Discussion of descriptive results

Concerning the burden of depression in Portugal, we found the following prevalence rates for the diagnosed depression: 6,84% for the overall population, 10,46% for the female group and 2,97% for the male group. These figures show that females are more vulnerable to depression than males. This finding on females is in conformity with several references, including results presented by the Eurobarometer study of 2003 (The European Opinion Research Group 2003). Given that this later study indicates for Portugal a prevalence rate for positive cases of depression of 29,8%, we suspect that our results underestimate the prevalence rate for depression. Also, according to certain references (Mateos et al, 2001), the prevalence for depressive disorders in the overall population of five European countries is 8,56%, with a rate of 10,05% for female and 6,61% for male. Our figures are much in agreement with the order of magnitude of the figures

indicated in this study, although there is a gap for males. The lower prevalence for males might be due to stigma in accepting that they are depressed. We should although remark that our rates were computed for diagnosed depression, and that the definition of depression captured in different studies is also different.

With regard to results of prevalence analysis, either the groups with higher prevalence of depression or the vulnerable groups of depression show non-expected groups in mental health.

Despite the high income group not presenting considerable dimensions to be dealt as a vulnerable group of depression, it was detected as presenting a higher prevalence in the three types of the population studied. Besides that, in the male population, media high income group was identified as risk group of prevalence of depression. We believe that both cases might be partly explained by the fact that these are people who possess economic resources to access mental health services, thus having a higher probability of being diagnosed. This finding contradicts what is expected in mental health.

Also, males with graduate and postgraduate degrees were found to have a higher rate of prevalence, which may indicate that this group is more vulnerable or may be more aware about what depression is and the advantages of its treatments (in comparison to the remaining male groups). These two reasons may explain a reduction on the impact of stigma. Stigma was also stated as affecting more males.

Moreover, high levels of education are often related with high levels of income, therefore it might also indicate that individuals with higher economic background are seeking and better accessing mental health support. At last, these two aspects may constitute risks that have not been evaluated in this work.

Concerning the results obtained in the analysis of depressed symptoms and consumption of anti-depressant drugs, we have characterised the population with and without diagnosed depression. We have verified that a high number of individuals suffering from depressed symptoms and consuming sleeping pills and tranquilizers were not identified as being diagnosed with depression. As these are typical symptoms and behaviours of common mental disorders, (mainly insomnia is a severe symptom of depressive disorder) these findings may show that these individuals suffer from poor mental health. Consequently we may infer a higher burden of poor mental health in the Portuguese population. Moreover, these findings might also contribute for our conclusion that prevalence and incidence results are likely to be underestimated. The factors that might contribute for this conclusion might be stigma and low recognition of mental health disorders. Stigma is related with culture and with attitudes in the provision of mental health services and may induce people not to seek medical help. The second factor might be associated with people that fulfil the criteria for a psychiatric disorder, but might not experience the level of disability required to seek medical assistance from mental health services (e.g., not being detected in consultations in the general primary care sector). Finally, this conclusion also contributes to the finding of our results may be underestimated.

4.2 Discussion of econometric results

In this part of the study, econometric analyses were performed, aiming at accomplishing statistically significant relationships between the explanatory factors and the prevalence and the incidence of diagnosed depression.

The results achieved for prevalence indicate that the explanatory factors presenting a positive statistical significant impact are: retirement; unemployment; smoking; divorced; high income; female gender; graduate and post graduate degrees; living in the Centre NUTs II regions; having hypertension, chronic pain, anxiety, obesity and bronchitis; presenteeism (situation where the employee goes to work, despite being ill or unable to work, instead of taking a leave); married female and age. The explanatory factors with negative statistically significant impact are: squared age, hours of work per week and family size.

From these findings, it might be interpreted that the following risk factors apply: middle-aged people, working less hours - likely to be associated with loss of productivity. The positive impact of high-income is a robust result from the application of econometric techniques and descriptive analysis. According to references (WHO, 2003a), poverty is a determinant of mental health. Therefore this is a non-expected risk factor. Nevertheless it may partly reflect the fact that individuals with high income might have better access to mental health service than people with a lower income, thus being diagnosed with a higher probability. At last, the reduced number of individuals being included in this group, in which a considerable part are depressed diagnosed individuals, leads logistic regression to be more sensible to this case in comparison to the remaining.

The marital status has been shown that divorced individuals are the ones with higher impact on the prevalent diagnosed population, which shows how family circumstances might have impact on mental health state. Concerning the area of residence, the most robust result was the higher risk of depression for individuals living in the Centre region. According to data presented by Comissão Nacional de Reestruturação de Serviços de Saúde Mental (Comissão Nacional para a Reestruturação dos Serviços de Saúde Mental, 2007), the rate of psychiatric doctors per 25000 habitants is higher in the Centre region and in the Lisbon and Tagus Valley regions, in comparison to the remaining regions. Also as stated in chapter 2, the number of specialised mental health doctors in the region might help to explain the higher rates of individuals identified with depression. Thus, our findings might reflect that a higher number of psychiatrists is contributing for to a higher diagnosis of depression in those regions. The retirement explanatory factor might be associated with loss of health, functional and cognitive abilities, diminished social contacts resulting in loneliness and lack of social activities, which also contribute for depression. The unemployment explanatory factor might be associated with economic difficulties and might contribute to entering into the poverty cycle.

4.3 Policy recommendations

Concerning the measures that might improve the mental health status of the Portuguese population, we suggest the following policy implications that follow from our findings.

For the retired, single, divorced and living alone individuals, we suggest that social programs and activities should be developed in order to increase social cohesion, interpersonal relationships and reduce the impact of loneliness in daily-life. (structured neighbourhoods stimulate social cohesion.)

For the unemployed population, expanded access to education should be provided, in order to increase intellectual competences and job prospects. Also policies and programs should prevent these individuals from entering the poverty cycle. Again, some policies already exist in Portugal, through

unemployment allowances, the “New Opportunities” program and other professional courses.

In the workplace, programs could be developed for early diagnosis of depression, in order that people can benefit from earlier treatment, and so that costs due to productivity losses and to healthcare services usage can be reduced.

With regard to chronic health conditions, such as obesity, anxiety, hypertension and diabetes, these are likely to be associated with poor food intake and lack of physical activity and with mental health problems and low quality of life. Promotion of healthy behaviours, good public transportation systems (weak public transportation systems can induce its users to a sedentary life), and teaching stress management techniques could help to improve the mental health status of these groups.

Developing public policies to improve housing and healthy urban planning could also potentially have a direct impact in mental health, because this type of policies potentially help in reducing stress and noise levels, generate perceptions of safety, increase social and community participation, and green areas promote physical activity.

Results in estimation of prevalence rates might be underestimated and high-income and postgraduate degrees as explanatory factors contributing to depression leads us to three questions: whether the causes for the number of people diagnosed with depression are: economic difficulties in accessing mental care support (the Portuguese population has difficulties in accessing mental health services); whether people more enlightened about mental health problems might overcome stigma and consequently seek medical support; or whether there are other factors not evaluated here. Thus, stigma problems and low recognition of mental health problems should be tackled.

Some measures could be developed. First, there could be anti-stigma and education campaigns. The information provided could be spread through media channels and websites (like the European Alliance Against Depression website) and the following information should be provided: mental illness is a disease like any other; in what mental illnesses consist, which are their typical symptoms, signs and behaviours; how a person can help another with a mental illness; the advantages and where to seek mental health support and treatments.

Second, increasing access to mental health services - this includes access not constrained by economic background. This is particularly important, since it is a factor already stated in international literature on health inequity in Portugal (Knapp et al, 2007), and was also confirmed in this work. Also, it might require re-allocating mental health specialists according to geographic needs, increasing the number of professionals and providing information to health professionals for better detection of depression.

4.4 Discussion of methods

Concerning methods and decisions taken throughout this study, we found several limitations and problems in the application to the Portuguese population. The 4th National Portuguese Health Survey limited the evaluation of our explanatory model in several points, such as the available issues and the dimension of recorded answers limited the quantity and the types of analysis performed. As a result, several hypothesis of our explanatory model of mental health state expected to be evaluated, could not be tested. Not all selected survey questions could be used in the econometric regressions and encapsulated in model One and Two due to

variations in the number of records. Also, some questions were not carried out in the survey in a form that could be suitable to be included in our study. The survey did not allow to identify and to characterise people with poor mental health beyond those having depression and anxiety disorders. In fact, the 4th Portuguese National Health Survey was not designed specially to answer the relevant questions to carrying out analysis on the mental health status of the Portuguese population.

Throughout this work we have used several methods, which have inherently some limitations.

With regard to attribution of the vulnerable groups of depression in the Portuguese population, we consider minimum sizes for the groups. As result we have exclude some by their reduced dimensions. This condition has as goal only show groups with considerable dimensions for that health policy makers may concentrate their efforts. Nevertheless these limits influenced the number of vulnerable groups found.

The variable developed to identify the prevalence of depression is dichotomous, which meant limiting the information provided about the type, severity and duration of depression. At last, it lead us to exclude the Multivariate OLS regression analyses. Moreover, we have only accounted for depression of individuals that have been diagnosed by a professional, which might limit our inference on the mental health state of the Portuguese population.

As key disadvantages of the selected methods, the descriptive bi-dimensional analysis does not show relations of causality, only providing simple summaries about the sample. In our case we used crosstabs, and they only express relationships between two selected variables, but in some cases it might induce to uncertain conclusions. With regard to econometric technique used, the logistic regression tests for the influence of explanatory factors on the binary response of the dependent variable. In addition, the coefficients should be interpreted as factors that contribute to higher or lower probability of being depressed, in comparison to an average individual.

The logistic regression was found to be an adequate technique to estimate the risk of being depressed. We also verified that model Two provided better information than model One with regard to the relevant relations between predictors and dependent variables.

Furthermore, we should consider the possibility that our regression results have been affected by moderate collinearity problems since only the severe collinearity is overcome by the Stata algorithm commands. Moderate multicollinearity is fairly common, and is difficult to overcome. It emerges when predictors share redundancy of information or are correlated. As instance, the symptoms of depression and the consumption of antidepressant drugs were excluded from regressions analysis, because they can be seen as indicators of poor mental health. The inclusion of the consumption of antidepressant drugs in the model would bring redundant information with the independent variable, and thus would not provide additional information.

About the proposed Bayesian network tool, despite not being commonly used together with survey data, it was shown that Bayesian networks might provide good results in predicting the cases of depression. On the one hand, it could be used in general health services to complement the diagnosis of depression and help to predict individuals at high risk of being depressed. On the other hand, the information produced could be used by clinicians and planners of mental health

policies. We have exemplified how this tool might facilitate the diagnosis of this disorder, where medical devices and other methodologies to predict risk tend to be rare. Nevertheless, the choice of variables to include in a Bayesian network depends on the number of individuals that answers to the specific questions of the survey (i.e. it depends on data) that lead to the creation of those variables. Given that, we found out that probabilities on the network might vary with the configuration of the network. (Nevertheless, generally these do not vary too much, with the exception of cases where the number of respondents to the survey highly decreases, which implies higher variation in the probability estimates, and less precise results). Thus, the use of a Bayesian network should be informed by the quality of data used to estimate it. We also suggest the realization of further analyses on the verification of its capacity to correctly predict depression.

Moreover, this tool is not often used but was shown to be useful for GPs when diagnosing depressed individuals, and might be tested with other databases. Nevertheless, we may say that this study was a first approach to the issue of planning mental health services and policies.

Finally, it should be pointed out that we were expecting to have the opportunity to assess more hypotheses of our explanatory model, mainly regarding factors associated to other public sector infrastructures and support. Beyond the hypotheses displayed in our model, also temporal explanatory variables were not analysed. Therefore, a lot more can and should be done to understand the social and environmental factors influencing depression. The major weakness in evaluating this model was imposed by the characteristics of the 4th Health Portuguese National Survey. It limited the quantity of hypothesis available for assessment and the types of analysis performed. As a result, a less complete mental health multisystem was assessed in this work.

5. CONCLUSIONS

Along with the latest research studies that attempted to understand the interconnections between the determinants of mental health disorders and behaviour, this work has studied the determinants of mental health status in the Portuguese population.

First we began with the development of an explanatory model of mental health state of an individual. Among others, these determinants include factors related with access to mental health services, personal characteristics of the individual, daily habits, stressful events, chronic disorders and disabilities, and functioning and structure of public supporting services.

To test our model on data from to the 4th Portuguese National Health Survey, several studies were carried out: descriptive studies on the prevalence and incidence of depression; multivariate logistic regressions to explain the determinants of prevalent and incident individuals; and a Bayesian network tool is proposed to support general practitioners in the detection of depression in an individual (using information from the Survey).

For the Portuguese population, using the 4th National Health Survey we estimated a prevalence rate for diagnosed depression of 6,84%.

The following groups were found to be at a higher risk of depression (using descriptive statistics): females, divorced, retired, unemployed, middle-aged, low education, with

chronic anxiety or obesity, living alone or with one person, living in the Centre region, and having high and low income. Nevertheless, a more reduced number of groups was defined as vulnerable groups of depression. Econometric results have shown the explanatory factors as having a positive statistical significant impact on the risk of depression: female, unemployment, retirement, divorce, hypertension, chronic pain, anxiety, obesity, bronchitis, age and the "presenteeism" phenomenon. In contrast, the explanatory factors found to have a negative statistically significant relationship on the risk of depression were: family size, and hours of work per week.

The findings on the variables presenteeism and hours of work per week may suggest loss of productivity in the prevalent population with depression. High income and graduate and postgraduate results respectively suggest better access to mental health services and the group of individuals that might better recognise depression or better overcome stigma.

Data on depressed symptoms and on consumption of antidepressant drugs has shown that there might be individuals not being diagnosed with depression but having signs of poor mental health.

Concerning the estimates of prevalence rates, we found out that these can be underestimating the true rate of prevalence. Therefore this finding should be taken into consideration when analysing results, since they might describe a group with identified and diagnosed with depression, which can be different from the overall Portuguese group with diagnosed depression (Mainly in male groups, whose results suggests influence of stigma.)

Finally, this work proposed a Bayesian Network tool to help planning mental health services. The net determines the probability of an individual having and not having depression regarding the conditional characteristics, which consist in the characteristics of the individual or of the population group under analysis. The defined network included specific determinants: age, gender type, level of income, anxiety, hypertension and occupation. This proposed tool could also support the diagnosis and the detection of depression in general healthcare services; and the planning of mental health policies.

Given the complexity of the topics researched in this thesis and despite the limitations brought by the application to the 4th National Health Survey, and by the methods used to test the proposed hypothesis, we found out useful information with regard to factors that explain depression in the Portuguese population.

Hereupon, we discuss the importance of continuing to carry out studies on mental health in Portugal. There is lack of information on the burden of mental health in the Portuguese population and on the explanatory factors that influence mental health indicators.

As future research we suggest: the evaluation of the remaining hypothesis not assessed in this work; adapt the proposed model to study the different explanatory factors for in the several types of mental health disorders; likely could added to the proposed explanatory model other indicators such as concentrations of biologic chemicals (neurotransmitters) often verified in pathological circumstances.

Policy research should be held in order to: identify the best ways to capture population attention in promoting mental health and explaining mental health disorders; evaluate the effectiveness of health interventions that might influence the detection of depression – such as the provision of different

types of mental health related services, endorsing a better knowledge of health professionals on mental health disorders, promoting the use of risk assessment tools, and an improved planning of mental health services.

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